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ORIGINAL COMMUNICATIONS.

An Abstract of DR. BEALE'S LECTURES *on the* STRUCTURE *and* GROWTH *of the* TISSUES *of the* HUMAN BODY. Delivered at the Royal College of Physicians, April—May, 1861.

LECTURES VI AND VII.

THE CONNECTIVE TISSUE.

DR. BEALE commenced his lectures on the connective tissues with a description of ordinary tendon. This structure, he observed, is generally subjected to examination after having been dried, or partially dried, and then remoistened with fluid, but it has been found that these processes cannot be carried out without some considerable alterations in the characters of the tissue being produced. The specimens referred to have therefore been prepared without any desiccation at all. They have been soaked in carmine solution, and afterwards mounted in glycerine, according to the method already described.

In the tendon of the fœtus, the so-called nuclear fibres are much closer to each other than in the child, and the proportion of tendon (formed material) to the nuclei is considerably less in the imperfectly-developed than in the fully-grown tendon. These facts were illustrated by specimens. Dr. Beale then proceeded to ask what is the nature of these so-called nuclei and nucleated fibres? If the tendon be stretched they form narrow lines, and the very elongated nuclei seem to be connected together by very delicate lines, which are often granular. If the specimen be roughly handled, several nuclei with pieces of fibrous tissue may be detached, and they often assume an angular form with projecting processes. If, on the other hand, they be stretched laterally, the nuclei become very wide, and assume an oval form.

Longitudinal lines are seen in the oval 'nuclei,' and these are caused by a tendency in the germinal matter to split in the longitudinal direction, or result from peculiar creasings or markings, which, when fully formed, give rise to the fibrous appearance so characteristic of this tissue. If it is attempted to make a transverse section, the stellate bodies are obtained. It is impossible to obtain a very thin transverse section of tendon with these nuclei in their natural position. In attempting to do so, short pieces of tendon with the included nuclei are cut off. At the edge of the specimen are some bands of wavy fibres detached, with the nuclei in them, and in some the immediate continuity of the fibrous structure with the so-called nucleus can be positively traced.

The masses of germinal matter which are seen in the specimens are regarded by Virchow as areolar or connective tissue corpuscles, "bindegewebs-körperchen," and he states that they are connected together by tubes, so as to produce a stellate arrangement. In a longitudinal section he admits that nothing of the kind is to be seen, but in a transverse section the stellate arrangement is observable. It seemed to Dr. Beale that this may be explained thus:—It is not possible to obtain a very thin section in which all the divided parts are *in situ*. In the transverse sections made, some of the prolongations from these bodies are altered in position, so as to make it appear as if they passed from the corpuscle or cell between and amongst the longitudinal fibres to neighbouring cells.

These nuclei are the masses of *germinal matter* of tendon, and the fibrous substance is the *formed material* formed from it. The so-called nuclei are certainly connected with the wavy bands of the fibrous tissue. The tissue nearest the nuclei is not yet perfectly formed, and it is so soft that separation usually occurs at this point, and the nuclei or cells escape from the substance of the fibrous tissue in which they appear to have been embedded.

In the nutrition of this texture, therefore, it follows that the nutrient matter passes through, or permeates, the formed material, being drawn to the oval masses of germinal matter as towards centres. Certain of the nutrient elements then become living particles of the germinal matter of tendon, and in due order become converted into the firm, unyielding, fibrous structure or intercellular substance (formed material).

The appearances observed in a small piece of a longitudinal section of the tendon of a child at birth were then alluded to. The prolongations from the masses of germinal matter (*cells* or *nuclei*) are well seen, and their communications are tolerably numerous. The specimen has been pressed, and the disposition of the oval nuclei has therefore been altered. The processes are distinct enough in some places, but most of them gradually become lost among the wavy fibres with which all are connected and of which they are but the early stage. Although they somewhat resemble fibres of yellow elastic tissue in their general appearance and in their power of resisting the action of acetic acid, they are not of this nature; their outline is irregular, and when examined with very high powers they have a granular appearance, which is very different to the sharp outline and homogeneous appearance of the yellow elastic tissue. In the dead tissue they may be called tubes, but they are *artificial tubes,* and do not convey nutrient juices during the life of the tissue. The germinal matter and imperfectly formed tissue of which they consist, cannot be regarded as a nutrient material. It is merely an early stage of the fibrous tissue.

The dark lines continuous with the nuclei of tendon, are not elastic fibres, neither are they elastic tissue at an early period of its formation, as will be shown. Elastic tissue when it exists in tendon is not connected with these nuclei.

How are we to account for the delicate fibres of yellow elastic tissue surrounding the fibres of many specimens of tendon? Their existence is undoubted but they are not in sufficient number to be considered as essential constituents of the tissue, and they are not to be detected in all forms of white fibrous tissue. For the most part they wind round the bundles. By great patience one may occasionally succeed in finding a nucleus connected with these fibres, but when this is so the nucleus is very small, and quite distinct from those which are connected with the white fibrous tissue. It is so very seldom that a nucleus can be demonstrated in connection with the yellow elastic tissue in tendon, and from the fact that this appearance has been proved in certain cases to result from alterations produced in an undoubted capillary vessel, Dr. Beale is disposed to explain the very few cases in which he has met with it in this manner.

As a rule the fibres encircling the bundles of the white fibrous tissue are certainly not connected with nuclei. The nuclei which are constantly present, exhibit a linear arrangement at every period of the growth of tendon. The yellow elastic tissue on the other hand is not arranged in parallel lines, but the delicate fibres of which it is composed form a lax network.

As to the tubular nature of these fibres of yellow elastic tissue. In yellow fibrous tissue, from many situations Dr. Beale has seen prolongations of germinal matter as in other tissues, but he has completely failed to prove that these yellow elastic fibres generally are tubular, and concerned in the distribution of nutrient matter. Over and over again, the nuclei amongst the fibres of yellow elastic tissue have been stained with carmine, while not a single fibre exhibited the slightest alteration. Dr. Beale does not think, therefore, that these fibres at any period of their existence, have any such office as that of distributing nutrient fluid to the tissues in connection with which they are found.

Dr. Beale would bring forward evidence to show that many tissues which, after having existed in a state of functional activity for a certain time, waste and disappear, leave behind a certain quantity of transparent fibrous tissue, which is not completely removed by absorption. If muscle or nerve waste from any cause, a structure somewhat resembling white fibrous tissue remains behind, and in some cases a similar structure occupies the situation which was filled by a vessel at an earlier period. Dr. Beale desired to draw attention to the cord-like network of fibres in connection with the external coat of a small branch of artery. The specimen is taken from the abdominal cavity of a frog; *a* is the outer part of the muscular coat of the artery. A bundle of nerve fibres is seen running in the external coat of the artery, and at *c* some of the fibres are seen to leave the large trunk of the nerve and run in the central part of some of the fibrous cords. In another specimen a portion of one of these cords with most distinct nerve fibres was seen magnified 700 diameters, and a transition may be traced from most undoubted nerve fibres to the very narrow branching fibres seen in the upper part of the specimen. These fibres are not altered by acetic acid, but by careful examination it is clearly proved that they may be split up into finer fibres if they are not actually composed of several minute fibres collected together. They somewhat agree in character with the axis cylinder of a nerve fibre. Some of the finest of these cord-like fibres of connective tissue seem to consist of a transparent matrix, in which two or three nerve fibres are embedded. The transparent matrix is the so-called tubular membrane of the nerve fibre. Dr. Beale believed that the nuclei and delicate fibres continuous with them, embedded in a more or less fibrous connective tissue, are nerve fibres which were functionally active at an earlier period of life, and that the matrix in which they are embedded corresponds to the so-called tubular membrane.

There are in different parts of the frog, especially in connection with the skin and areolar tissue beneath, cord-like fibres very much resembling those just described in their general appearance, but differing from them in the disposition of the nuclei and in the matter which passes between the nuclei, being granular and less fibre-like. Such fibres are composed of white fibrous tissue with its nuclei and their prolongations (formed material and germinal matter).

The mode of development of these thick cord-like fibres of connective tissue in the cutis of the frog was described. Numerous oval nuclei are seen undergoing division which occurs transversely and longitudinally. The distance between each gradually becomes increased, and for some time granular matter (which ultimately becomes fibrous tissue) may be seen intervening between one nucleus and the other.

A tissue, therefore, which possesses the characters of white fibrous tissue may be formed like other tissues from germinal matter, or it may result from changes taking place in tissues which originally possessed much higher endowments. In the last case it may serve as a support to the new texture which is developed, and as life advances this tissue, the débris of more important structures, becomes, in certain localities, more abundant. Although it is true that many very different forms of white fibrous tissue exist, it is interesting to observe, in certain cases, the great similarity between the arrangement of the lowest temporary forms of this tissue, of which false membranes are composed, and that of the higher and more permanent forms of the structure, as seen in tendon, fascia, and even the proper tissue of the cornea.

In prep. 38 might be seen, at one view, some of the youngest portions of the ensiform cartilage of the mouse and its connection with tendon to which muscular fibres are attached. The matrix of the cartilage is in direct continuity with the fibrous tissue of the tendon. Upon a careful examination of this specimen it might be observed that the youngest elementary parts are only separated from each other by a very thin line of formed material, and the germinal matter tinted with carmine, seems to shade gradually into the intervening substance. The proportion of formed material between each oval mass, or between the collections of masses of germinal matter, gradually increases towards the outer part. These very important points are most satisfactorily shown in specimens treated with carmine. As in other tissues, the relative proportion of the germinal matter to the formed material of cartilage, gradually becomes less as we pass from the youngest towards the older parts of the tissue, or, in other words, as the elementary parts advance in age.

A thin section through the tendo Achillis and os calcis (in that part which is now cartilaginous) of a kitten soon after birth was then passed round. In the centre of the specimen was a line marked by the existence of capillary vessels (*a*). This divides the cartilage from the tendon. The arrangement of the germinal matter and the formed material is the same in the adjacent parts of the cartilage and tendon, except that in the tendon there is already an indication of parallel fibres. The proportion of the germinal matter and formed material is about the same in both tissues. In the cartilage the masses of germinal matter divide, and the resulting portions at once become *separate masses.* In the tendon the masses divide, but the resultiug portions are *connected together* for some time by a thin line of germinal matter. Between the cartilage and the tendon is a layer which eventually becomes the periosteum. The stellate arrangement of the masses of germinal matter (areolar or connective tissue corpuscles) is very distinct, and their character is retained in the adult tissue.

At an early period of development of all forms of cartilage, masses of germinal matter are seen situated very close to each other, and as the growth advances, the quantity of formed material between them (matrix, intercellular substance) gradually increases. It is formed from the germinal matter. If any of those cartilages in which small parcels of cells exist at intervals through the matrix be examined, it will be observed that there exists a greater amount of formed material between the various collections, than between any of the individual masses of each collection. If it be admitted that the matrix is formed from the masses of germinal matter this fact is at once explained. The more recent the division of the mass of germinal matter the thinner will be the intervening layer of formed material between the resulting masses.

The manner in which the matrix of cartilage is formed was easily understood after a careful examination of the specimens. Large oval masses of germinal matter are seen to be separated from each other by a very thin layer of soft formed material (matrix). Further out this has increased, but as the germinal matter grows, while the conversion of its outer portion into formed material proceeds, the elementary part becomes larger. The next stage was shown in another specimen. In the other elementary parts *growth* has ceased, and the germinal matter gradually undergoes conversion into formed material until at last only what is termed the nucleus remains, and this in many instances dies, and a small oval collection of granules, which are not tinged red with carmine, is all that marks the position of the germinal matter of the cartilage cells by which the matrix, or formed material, has been produced. After this has occurred the matrix may become harder and undergo other changes, but no more can be produced. The *formation* of the matrix has ceased. The matrix, close to the germinal matter which is recently formed is of course soft, and when it is broken away the mass of germinal matter within escapes entire. In all tissues the bond of union between the germinal matter and the formed material is very slight; a fact which receives a simple explanation upon the view of growth brought forward. The matrix gradually undergoes condensation and probably contracts somewhat after it has been formed.

The formation of fat, a change which is not unfrequently observed in cartilage, was illustrated by a specimen. A small globule of fatty matter, is first seen in the germinal matter of an elementary part external to the nucleus, as this increases the nucleus is pushed over to one side, and gradually becomes compressed between the fatty matter and the recently formed matrix of the cartilage. The changes occurring in cartilage during the formation of fatty matter resemble those which take place in the development of ordinary adipose tissue.

The formation of cartilage is generally described in a very different manner. It has been said that the membranous capsule of the cartilage cell *sends in septa,* when the cells it contains, undergo division "which serve as new envelopes for the young cells, yet in such a way, that even the gigantic groups of cells, which proceed from each of the original cells, are still enclosed in the greatly enlarged parent capsules." (Virchow.)

Against this theory Dr. Beale had endeavoured to show that the matrix or intercellular substance with the membranous capsules of the cartilage cells corresponded with the cell wall of a spore of mildew. This outer capsule of the mildew, as he had tried to prove, does not possess the power of growth. It is the internal germinal matter which is alone concerned in the growth of the plant. So in cartilage, the matrix was once in the state of germinal matter. The septa do not *extend themselves in, or grow in,* but the material of which they are composed results from an alteration taking place in the oldest particles of the germinal matter.

Mucous tissue of the umbilical cord.—Dr. Beale then directed attention to the anatomy of a peculiar connective tissue which has been particularly studied by Virchow, and on the structure of which he lays the greatest stress, for he states that in a good preparation, "a symmetrical network of cells is brought into view, which splits up the mass into such regular divisions that by means of the anastomoses which subsist between these cells throughout the whole of the umbilical cord, a uniform distribution of the nutritive juices throughout the whole of its substance is in this instance also rendered possible."

A specimen of the "mucous tissue" from the umbilical cord was placed and passed round, under a power of 130 diameters. The texture appeared to be composed of delicate fibres with oval nuclei, which were for the most part arranged to form the boundaries of small circular spaces, in which were seen more delicate fibres arranged without regularity. The interspaces between the fibres Dr. Beale said were occupied with a transparent fluid.

In the next specimen some of the fibres and their nuclei were seen under a power of 700 diameters.

The preparations of this tissue which have been made by Dr. Beale, exhibit a great number of the so-called fibre cells. In very many instances the continuity of the germinal matter with the *outer fibrous portion* of each elementary part is most distinct. The lecturer had not succeeded in demonstrating the appearance figured and described by Virchow. What appears to be a space or cavity in the centre of the elementary parts is really occupied with germinal matter, and the apparent tubes contain prolongations of this with the recently formed and soft fibrous tissue, which very readily breaks down. The arrangement of the fibrous tissue was shown in a drawing. It would be noticed that there was not the slightest resemblance between the drawing and Virchow's figures. (See pages 98 and 100 of Dr. Chance's Translation.)

In another specimen some of the muscular fibre cells which form a very thick layer around the arteries of the cord were shown. The relation and mode of formation of the formed material in both structures was the same, but its properties were very different.

The so-called "mucous tissue" of the cord seems to be composed of a soft form of fibrous tissue which is produced in the same manner as the formed material of other tissues. Dr. Beale had not been able to make out in it an arrangement of channels as Virchow has described. He could not, therefore, agree with his statements with reference to the existence of a special canalicular system for the circulation of the nutrient juices in this tissue.

Bone.—Specimens illustrating how the perfect and more permanent bone is produced by changes at the periosteal surface were brought forward. In the figures generally given the cells are themselves seen to become stellate, while in Dr. Beale's drawings and specimens, the stellate appearance was shown to depend, not upon any alteration in the form or position of the cells or nuclei, but merely upon the manner in which the calcareous matter is deposited in the formed material.

No stellate corpuscle has been produced, but the stellate appearance seems to result from the circumstance that the calcareous matter has been deposited in the matrix in such a manner as to leave intervals of a form more or less stellate. The reason of this will presently appear. The calcareous matter is at first deposited so as to form a network with nearly equal meshes. Each space contains an oval mass of living germinal matter and is the earliest condition of a lacuna.

The elementary parts concerned in the formation of lacunæ in the above specimen were represented in different stages of growth under a power of 1700 diameters.

The manner in which the earthy matter is deposited in the matrix of the cartilage was represented in a diagram. It was copied from a section of the temporal bone of a frog. Globules of earthy matter may be seen to form imperfect rings around the cartilage cells. The calcareous matter is always deposited in the matrix (formed material), at a point midway between adjacent "cells" that is in the oldest portion of the formed material of the cartilage. The deposition gradually proceeds from without inwards. The outer part of the germinal matter of the cell gradually undergoes conversion into matrix, which in its turn becomes impregnated with calcareous matter until only a small space remains in which the nucleus still exists.

These stages were represented in drawings, and in many specimens, especially from the frog, rounded globules of calcareous matter, which coalesce and undergo great change in form, can be demonstrated without difficulty in lacunæ in an advanced state of formation. Mr. Rainey has watched this process, and seems to consider that molecular alterations in the earthy particles are the essential changes to which the formation of bone is due.

Dr. Beale has examined the process of ossification as it occurs in various animals with the aid of carmine, and has always been able to demonstrate masses of germinal matter in a position corresponding to the lacunal space. He believes these masses of germinal matter to be as necessary to the production of bone as they are to the formation of every other tissue, and feels certain they are constantly present, and that through their agency alone, osseous, as well as all other tissues, is formed. They are not directly concerned in the deposition of the calcareous matter, but the matrix in which this is deposited cannot be formed without them, and it is probable that by their instrumentality alone the regular circulation of fluids holding the calcareous matter in solution is maintained, and thus the extreme regularity with which the growth of the tissue occurs is ensured.

For some time after the first deposition of the calcareous matter in the formed material, very thin fragments of the bone torn away exhibit the appearance of fibres (a fact pointed out many years ago by Dr. Sharpey), in the substance of which globules have been deposited, but slowly the calcareous matter becomes more homogeneous, in consequence, probably, of changes occurring in its substance, and its more perfect incorporation with the organic matrix, and ultimately the hard mass appears even in texture, uniformly transparent, and penetrated everywhere by minute tubes.

It seems to Dr. Beale that these tubes are the altered spaces which are left between the calcareous globules originally deposited. They were at first triangular in outline, but gradually they have become altered by the filling up of the angles, until at last they become pores, the section of which is nearly circular. From appearances the lecturer has seen in some preparations of the bones of the frog's skull (frontal, parietal), he feels sure that in this case the bone results from changes in the original cartilage; the nucleus of the cartilage cell remaining as the nucleus in the lacuna. The calcareous matter deposited in the matrix around a cartilage cell undergoes changes, probably slowly becomes incorporated with the organic matter, and gradually ceases to exhibit the appearance of being composed of separate masses, and becomes more homogeneous. The spaces become canaliculi, and the mass at last assumes the structure of perfect bone.

For some time separate calcareous particles are seen within the outline of the lacuna, which gradually diminishes in size as calcareous matter is deposited in the matrix from without inwards. This point was represented in a drawing which showed about one-third of the inner part of a recently-formed lacuna of the frog, magnified 1700 diameters. A part of the nucleus is seen in the lower part of the drawing.

In the development of the long bones of mammalia, on the other hand, it is equally certain that the spongy, imperfectly formed bone at first developed is gradually removed, and gives place to new bony tissue of a more perfect structure not formed from cartilage, while, as is well known, there are examples of the formation of bone without the existence of cartilage at any period, in the case of certain bones of the cranium.

Kölliker considers that the capsule of the cartilage cell and the matrix become impregnated with calcareous matter, while the granular cell corresponding to the primordial utricle of the vegetable cell and with the endoplast of Mr. Huxley remains within unaltered. He thinks that the canaliculi extend through the matrix by resorption.

Virchow regards bone as consisting of cells and an intercellular substance, and he considers the canaliculi to be processes which grow from the cells.

In the following MS. note, copied from page 417 of Dr. Chance's translation, he expresses himself very clearly as to the manner in which processes are formed from cells. "The cartilage cells (and the same holds good of the marrow cells) during ossification throw out processes (become jagged) in the same way that connective tissue corpuscles, which are also originally round, do, both physiologically and pathologically. These processes, which in the case of the cartilage cells are generally formed after, but in that of the marrow cells frequently before, calcification has taken place, bore their way into the intercellular substance, like *the villi of the chorion do into the mucous membrane and into the vessel of the uterus,* or like the Pacchionian granulations (glands) of the pia mater of the brain into (and occasionally *through*) the calvarium. Again, "The cells which thus result from the proliferation of the periosteal corpuscles are converted into bone corpuscles exactly in the way I described when speaking of the marrow. In the neighbourhood of the surface of the bone the intercellular substance grows dense and becomes almost cartilaginous, the cells *throw out processes, become stellate,* and at last the calcification of the intercellular substance ensues."

There are few points in minute anatomy upon which such different views have been advanced as the one under consideration, and observers differ not only in the explanations and opinions they have put forward, but that there are irreconcilable differences in their statements of the facts.

Although many observers have described and somewhat faintly expressed in their drawings the growth of the processes referred to, all agree that they are most difficult to see in healthy growing bone. Dr. Beale's own observations compelled him to oppose the statements generally made with regard to these processes. As far as he had been able to see, neither the cartilage cell, nor the medullary cell, nor the periosteal cell, nor indeed any cell in the organism becomes stellate by the "shooting-out process." That cartilage and the other "cells" may become angular is perfectly true, and that a few little projections may be seen from different parts of their surface is also true, but these projections and angles have nothing to do with the formation of canaliculi. The appearance is exceptional instead of being constant, and a lacuna with numerous canaliculi may be produced without the existence of an angular cell at all. The mass of germinal matter is oval from the period it first existed as a separate object to the time its nucleus is seen in the lacuna. Into each lacuna forty or fifty or more canaliculi open, and these communicate with those of adjacent lacunæ. Surely, if these were formed in the manner described, we ought to be able to demonstrate something like this during the formation of the lacunæ; but nothing of the sort has been seen, and the warmest advocates of the theory have only been able to observe a very faint indication of the arrangement which they believe actually exists. Their drawings only show these processes projecting a very short distance from the cells, and no one pretends to have seen processes from two neighbouring cells in process of communicating with each other, as exists constantly in the perfect canaliculi of bone. It is not only very difficult to conceive such channels formed by an outgrowth, but it is inconsistent with what is generally observed, to suppose that channels are scooped out in a tissue which has just been formed. The tissue *during its formation* requires channels for the transmission of nutrient matter just as much as after its formation is complete.

If the canaliculi were formed as described, it seems impossible that every observer should have failed to see the prolongations of the cell undergoing development and coalescing with those of neighbouring cells. The extremities of these tubes which were gradually extending through the matrix would be rounded, and would contain germinal matter which would absorb the solid matrix, and thus the tube would extend through its substance. No such appearance has ever been seen. The canaliculi are no more processes of the cell which bore their way through the hard material than the tubes which are found in the masses of secondary deposits in the hard walls of certain vegetable cells are processes of the germinal matter in the centre of the cell.

Again, it is very difficult to understand why tubes growing centrifugally from adjacent cells should not grow outward, at least at first, in direct lines, and reach each other by the shortest cuts, while, according to my view, as the deposition of the calcareous matter commences always at the point where two elementary parts coalesce, where the oldest part of the formed material is situated, it is easy to show how the canaliculi, or spaces left, must be continuous with each other;

and their tortuous course also receives explanation from the fact, that the particles first deposited become globules before the process of ossification is far advanced.

It may be said, that the growing matter extending from a spore of mildew bores its way into the soft material, at the expense of which it grows; but here this soft material is clearly appropriated by the mildew, and becomes converted into the germinal matter of the plant: but this process is totally different from that by which canaliculi are produced.

A specimen of the so-called myeloid cells from one of the cancelli of the bone of the great toe was next passed round. Two or three of the masses are elongated and much bent. These Dr. Beale believed might afterwards become ossified, and form the spiculæ of bone which form the imperfect septa between the cancelli. Around these are many small granular cells, and it is interesting to notice the fact, that while the first structures are of a dark-red colour the latter are scarcely tinged with the carmine, although both have been exposed to its influence in the same way. The first is growing actively, the last is comparatively inactive, and there can be no doubt that it is being gradually removed as the former structure advances. What remains will become the medulla. The so-called myeloid cells are not peculiar to the cancelli and the medullary membrane of bones, but they are also found in the periosteum. Under ordinary circumstances many of them gradually become converted into bone, but in disease they increase in number rapidly, producing a soft, spongy structure which only undergoes very imperfect ossification or receives no calcareous deposit at all. In these so-called myeloid cells the lecturer has not been able to distinguish a cell-wall. Each mass is composed of a number of small oval elementary parts, each of which consists of an oval mass of germinal matter which is faintly coloured, while the nucleus is coloured dark-red with carmine. The germinal matter gradually undergoes conversion into a soft-formed material externally, which increases in thickness. Afterwards the nucleus diminishes in size. In some cases the formed material exhibits a somewhat fibrous appearance.

Dentine.—There are few anatomical questions, Dr. Beale observed, which have given rise to more controversy, than the structure and mode of formation of the dentine, and the very last writer on the subject, M. Lent, describes the dentinal canals as consisting of direct processes of the whole dentinal cells. "The matrix of the dentine is not formed of the dentine cells, but is a secretion of these cells and of the tooth pulp, in other words, an intercellular substance."* Now, Mr. Tomes has shown that the dentinal tubes are occupied with a soft, solid structure which may be seen projecting in the form of solid processes from the broken ends of the dentinal tubes. The truth of these observations has, however, been doubted by several observers. Dr. Beale has been able to verify Mr. Tomes' statements as to the dentinal tubes being occupied with this soft structure, and sent round a preparation in which this material had been coloured red with carmine, and was most clearly demonstrated. The dentinal "tubes" of a *living tooth,* Dr. Beale says, are never empty; indeed they are not tubes, nor are they canals for the transmission of nutrient substances dissolved in fluid, but they contain a soft solid substance, the central portion of which is in a state of active vitality.

If for a moment one of the soft nuclear fibres of tendon was supposed to be surrounded with a matrix impregnated with calcareous matter a good idea would be formed of the structure of the "dentinal tube" and its contents.

The wall of the tube with the matter between the tubes correspond to the "wall" of an ordinary cell, or to this and the intercellular substance (*formed material*), and the contents of the tube to the granular cell contents with the nuclei (*germinal matter*). If the tissue of the pulp just beneath the surface of the dentine be examined, a number of oval masses of germinal matter coloured intensely red by carmine are observed. These are nearly equidistant and separated from each other by a certain quantity of material which is only very faintly coloured, and in cases when the solution was not very strong it remained colourless. This colourless matrix is continuous with the *intertubular dentinal tissue,* while the intensely red germinal matter, or rather a prolongation from it extends into the dentinal tubes. The germinal matter with a thin layer of soft and imperfect formed material is easily detached from the formed material by which it is surrounded, and its continuity with the dentinal tubes may often be torn away. The whole then appears as an oval mass (cell) with a prolongation as it were into the dentinal tube.

The general description given of the manner in which these dentinal tubes *open* upon the walls of the pulp cavity is certainly true, but it is true only of the dry tooth. In the living tooth a prolongation from one of the "cells" on the surface of the pulp is prolonged into each tube. The tubes cannot, therefore, serve as mere conduits for nutrient fluids which

* Kölliker's 'Manual of Microscopic Anatomy,' page 307.

transude through the walls of the vessels, and are supposed to pass along the tubes to the outer part of the tooth. Moreover, in some cases certain of the so-called dentinal tubes are completely solid, the tube being obliterated.

The specimens which have been sent round prove, the lecturer thinks, that the formation of the dentine and the so-called tubes, is effected in a much more simple manner than is usually believed. The elongated masses of germinal matter first of all produce *formed material,* which gradually increases as in other cases, upon the outer surface of the germinal matter. The formed material of the adjacent elementary parts is continuous, and calcareous matter is first deposited in the oldest part of this formed material. The calcareous matter appears in the form of small globules, which gradually increase in size, and often several coalesce. Thus the formed material, or matrix, of the dentine becomes calcified.

Not unfrequently, however, several of the calcareous globules increase in such a way as to enclose a portion of uncalcified matrix. This being, as it were, imprisoned by hard impermeable structure retains its soft primitive state. If the tooth be dried the soft matrix in these spaces shrinks and air rushes in. Thus the appearance known as "globular dentine" is produced, and the reason why uncalcified tubes are seen traversing these spaces becomes manifest.

After the matrix of the dentine is calcified the germinal matter still slowly undergoes conversion into formed material, which in its turn becomes impregnated with calcareous matter. The germinal matter diminishes in thickness. The formed material is produced more slowly after the general basis has been laid down, and hence the dentine immediately surrounding the tube seems to be distinct from that lying in the intervals between the tubes. The germinal matter gradually shrinks from the outer part of the dentine (the oldest portion) towards the pulp-cavity, where these changes still go on. In the dry tooth the same fact may be expressed by saying that the narrowest part of the dental tubes is at the circumference of the dentine, and this part was the first formed; the widest part is that which is in contact with the pulp, and this is composed of dentine most recently developed. Internal to this is a narrow layer, the formed material of which is still soft and not yet calcified.

The appearances described can only be demonstrated in perfectly fresh teeth, which have been placed in carmine solution very soon after extraction.

The principal changes in such a tissue as dentine seem to consist of the conversion of germinal matter into formed material, and the impregnation of this formed material with calcareous matter, rapidly at first, but more slowly as the quantity of calcareous matter increases. In the adult, the remains of the germinal matter slowly undergo conversion into formed material, and this slowly becomes impregnated with calcareous salts. In old age, although the pulp is very much reduced, this conversion is not complete, and a certain amount of germinal matter still remains in the tubes and in the pulp cavity from which dentine might have been produced.

Stellate tissue on surface of crusta petrosa.—Upon the surface of the fang of the tooth in contact with the crusta petrosa is a tissue of a very interesting structure, which takes part in the formation of the cementum. It is composed entirely of what may be described as branching cells (elementary parts), the processes of which anastomose freely with each other. It is from this tissue that the crusta petrosa is formed; but the lecturer alluded to it because it was a most perfect example of a tissue consisting entirely of cells, the cavities of which *communicate with each other by tubes.* The stellate cells are here as distinct as they are in the pith of a rush. But do these cells and tubes merely constitute an elaborate system of channels for the distribution of nutrient material to the tissue which intervenes between them? This tissue it may be remarked, grows very slowly; it is a very low simple form of tissue, and probably requires but very little nutrient matter. If the above view is adopted it must be admitted that the means for nourishing the structure are far more elaborate than would be expected, supposing the conclusion is accepted that there ought to be a constant relation between the activity of change in a tissue and the mechanism for bringing new matter to the elementary parts and carrying off the effete material from them.

Neither does it appear that all these bodies become lacunæ of the cementum. The stellate cells just described for the most part have not more than from ten to twelve processes or tubes projecting from them, while many of the lacunæ of the cementum have as many as thirty or forty, hence these tubes are certainly not an early stage of the canaliculi, and the cells cannot become lacunæ simply by the deposition of calcareous matter in the intervening matrix or intercellular substance.

This stellate tissue on the surface of the fang nevertheless undergoes calcification. The process of calcification may be seen to take place in one of the specimens. The processes of the stellate masses become narrower and narrower, until the germinal matter, which they contained, having undergone conversion into formed material, they ceased to be coloured by carmine. They now look like roundish, highly refracting cords, which are colourless, and connect the several stellate masses of dark-red germinal matter with each other. Here and there in the intervals between these processes small globules of calcareous matter have been deposited, and these increase and completely surround the cord-like processes. Many of the processes gradually assume the character of the surrounding matrix, disappear as distinct cords, and like the rest of the tissue become impregnated with calcareous matter.

Many of the stellate masses of germinal matter (cells) shrink and disappear in consequence of the same changes having occurred. Others remain with their processes, and their nuclei possibly remain as the nuclei of the lacunæ which are irregularly distributed through the cementum; but Dr. Beale could not express himself positively on this point. It is certain that all the cells do not become lacunæ, for in this tissue there are half-a-dozen stellate cells to one lacuna in the cementum, and many of the canaliculi are five times as long as these tubes. Are these processes tubes? This question would doubtless be answered in the affirmative by every one who examined the tissue long after death, but during life they contain a solid, or semi-solid, substance corresponding to that which occupies the so-called dentinal tubes. They contain portions of the germinal matter which is undergoing conversion into formed material, and the situations in which these tubes existed are the last portions of the formed material to undergo calcification.

This is precisely the same change which takes place in the calcification of the dentine, the only difference being in the forms which the masses of germinal matter assume in the first instance. It need hardly be remarked, that cementum, as it ordinarily exists upon the fangs of the human teeth, differs from true bone in its greater degree of hardness, in the small number and irregular arrangement of its lacunæ, and in the absence of the arrangement for its absorption and reproduction. It is a more permanent but less perfect tissue than bone.

Stellate fibre cells from the aorta.—Attention was next drawn to a very thin section of the circular coat of the aorta, coloured by soaking in carmine, showing large stellate muscular fibre cells. It will be interesting to compare this with the tissue upon the fang of the tooth. The radiating processes seen in this specimen are clearly not tubular; the large stellate elementary parts were very readily separated from each other. The lecturer hoped it would be particularly remarked that in this specimen the central part of each is very darkly coloured by carmine; external to this the structure is coloured, but the colour becomes fainter in the most external portions, and the outermost part of each fibre and its prolongations, are perfectly colourless. The fibrous character of the tissue is sufficiently manifest. As in many other cases, the germinal matter is here seen in the centre of the mass, and is gradually giving rise to the production of formed material, the oldest and that which is perfectly formed being at the greatest distance from the central mass, while that which was but recently germinal matter, and is now in a transition state, is continuous with it. The latter is slightly coloured with carmine, while the perfectly developed formed material is not coloured at all.

In concluding his sixth lecture Dr. Beale remarked that the early formation of bone was not the least like the early formation of a tissue with stellate cells. In the former the so-called cells (masses of germinal matter with formed material externally) are round or oval at every period of their development, and may be separated from each other without difficulty. In the stellate tissue the masses of germinal matter are connected together for a considerable period of their existence; at first the points of communication are wide, but they gradually become narrower and narrower as the distances increase, and at last they are reduced to narrow processes which at length undergo conversion into formed material. The germinal matter of the different masses may communicate through these processes up to a certain period, but gradually they become more solid, and then the masses are distinct, but still connected to each other by narrow cord-like processes.

The nutrient material passes to the germinal matter of each mass, and to that prolonged to each *through* the formed material which is deposited in the intervals. In some stellate tissues fluid only exists in this situation, which is afterwards absorbed, leaving spaces between the walls of the tubes into which air passes.

The dentinal tubes, and the tubes of the stellate tissues, therefore, do not correspond to the canaliculi of bone. Their counterpart is seen in many vegetable tissues, at the point where the separate masses of germinal matter are connected together; while the channels corresponding to the canaliculi are the pores which extend through the secondary deposits in vegetable cells.

The stellate cells are stellate from the very beginning. The bone cell is never stellate at any period of its existence. The tubes in the first case contain germinal matter. The tubes in bone are merely spaces left between the particles of calcareous matter which are deposited in the matrix, and for this reason do not exist in the formed material of bone or cartilage prior to the deposition of calcareous matter. They are present when calcareous matter is deposited in cartilage. The dentinal tubes correspond to the processes from, and the cavities of, the stellate cells, but they differ entirely from the canaliculi of bone. The so-called tubes in the stellate tissue and in dentine are no more tubes than the space filled with germinal matter in an elementary part—say of the cuticle—is a cavity. Spaces remain if the germinal matter is removed; but during life these so-called tubes and spaces are occupied with the most important part of the whole structure,—the living, active-growing germinal matter. The canaliculi of bone, therefore, do not correspond to the above tubes or spaces; they do not contain at any period of their formation germinal matter. They are mere channels left during the deposition of calcareous particles in the formed material.

These channels in bone are, no doubt, subservient in a very important degree to the rapid changes which occur in this hard tissue. The bone tissue could not be so rapidly formed or so quickly removed if it were not freely permeated by canals. In dentine the formed material becomes much more slowly impregnated with calcareous matter and incorporated with the organic matter, so that a very hard, even, and very permanent structure results in which pores exist only in certain parts, especially in the granular layer of the dentine.

In all cases the formed material is impregnated with calcareous matter from without inwards. The necessity for the existence of bone at a very early period of development, the gradual alteration in the size of the bones during the growth of the body, and the changes in their form seem to be incompatible with a mode of development like that by which dentine is produced.

While Virchow has been led by his researches to the conclusion that nutrient tubes exist in connexion with cells in soft tissues, the results of Dr. Beale's observations have compelled him to conclude that such tubes do not exist in soft tissues as tubes for the transmission of nutrient material, and that even the so-called dentinal tubes are not nutrient canals; while it appears that the canaliculi of bone which are of this nature do not correspond to the dentinal tubes, nor to the communicating system of channels in a tissue composed of stellate branching cells, but are mere spaces left during the rapid formation of a tissue impermeable to fluids.

Remarks on the intercellular substance (formed material) of connective tissue.—Many observers in the present day seem to consider that the intercellular substance is of far higher importance than the cells or nuclei imbedded in it. This *matrix* or *intercellular substance* has been supposed, too, to play a most important part in morbid changes. It is considered that the intercellular substance possesses active powers. It may be at first composed of a soft and perfectly clear and homogeneous substance, but it subsequently undergoes important changes in its properties. By some observers it is supposed to become *differentiated* into various substances by virtue of its own inherent powers, while others attribute the changes which occur to the action of the cells. It is asserted that in all connective tissues, cells and an intercellular substance can be satisfactorily demonstrated. In white fibrous tissue the yellow elastic tissue is said to be developed from, and is the representative of, the cellular element, while the white fibrillated tissue is regarded as the intercellular substance which by many is supposed to be formed independently of cells. This part of the question has already been considered.

It appears, then, that some observers consider that the intercellular substance is simply deposited from the blood, and perhaps somewhat modified by the action of the cells between which it is formed, while by other authorities the intercellular substance itself is believed to possess inherent powers of growth, assimilation, and conversion.

If the intercellular substance of white fibrous tissue and cartilage is merely deposited from the blood by a process akin to crystallization, same substances from which gelatine or chondrin could be obtained should exist in that fluid. But no such substance has ever been detected.

If, on the other hand this intercellular substance possesses formative power, and by its own inherent powers can convert certain nutrient materials into matter possessing the same properties as itself, what end is served by the germinal matter which is so constant? And why are these masses so much more numerous in young than in fully developed cartilage? The object fulfilled by the growth of such textures as fibrous tissue and cartilage is the formation of the so-called intercellular substance upon which all the properties of the tissue depend. It is in this that the peculiar properties of firmness, strength, or elasticity reside: for the cells (masses of germinal matter) certainly do not possess any such characters. If, then, this substance can increase itself, wherefore are the cells present at all? The universality of the presence of germinal matter is meaningless, and its abundance in all rapidly-growing tissues, its gradual diminution as the formed material increases, and the deterioration in the properties of the tissue constantly associated with its abnormal increase or with its death, are facts which do not receive explanation.

If both cells and intercellular substance require to be nourished, what regulates the exact supply so that neither increases upon the domains of the other? And how is it that the selected powers of each are exactly balanced?

The investing membrane of a spore or a portion of the stem of mildew, or other simple plant, corresponds to the so-called intercellular matrix of tendon, cartilage, &c. If the latter grows by selecting substances from the nutrient fluid which bathes it, the former must be produced by selecting substances from the fluid which surrounds it. But I have shown that the inner germinal matter may diminish as the cell-wall increases in thickness, and that while there are many examples of germinal matter which is not surrounded with a distinct cell-wall or intercellular substance, there is not an instance of the latter existing in a growing state without the former. When the mildew grows, so far from the outer material or cell-wall increasing in thickness, it becomes thinner. It is the germinal matter within which increases. The germinal matter alone grows, and the more rapidly it increases the thinner is the external membrane (formed material) found to be. A small portion of the germinal matter of the mildew placed under favorable conditions will grow and will produce the formed material or cell-wall, but the cell-wall from which the germinal matter has been removed will not grow under any circumstances whatever. The envelope or cell-wall exhibits the same characters after the death of the germinal matter as it possessed during its life, but the germinal matter undergoes very rapid changes after death: it soon becomes liquefied, passes into decomposition, and various chemical compounds are formed which did not exist during its life, which, in fact, are incompatible with its life and with the changes which occur while it is alive.

Cells or nuclei (*germinal matter*).—The germinal matter of connective tissues differs remarkably in its arrangement, as has been stated. Although in many cases in the adult tissue the portion of formed material (intercellular substance) is very great, this is not the case in the young tissue. At an early period of development of all these textures, germinal matter is present in considerable proportion.

Those who consider the so-called nucleus as the least important and least constant part of the tissue will perhaps answer the above remarks by the assertion that nuclei are not to be detected in all tissues, and by calling attention to observations in which these nuclei are stated to be vacuoles in a homogeneous structure. It has been already stated that they are much more numerous in many tissues than is generally supposed, and are to be demonstrated only by the action of carmine and certain other colouring matters. With regard to the so-called *vacuoles* in young tissues generally, Dr. Beale remarked that the clear material occupying these spaces is the substance which he has termed germinal matter, which becomes coloured red by carmine.

In young vegetable tissues the term vacuole is applied to spaces containing a transparent material which occupies the same position as that in which the primordial utricle is afterwards found. This transparent material and the primordial utricle are both coloured by carmine, and both consist of germinal matter. The manner in which secondary deposits occur in the substance of this germinal matter has been referred to in page 263, Vol. II.

As it has been shown that the material (germinal matter) coloured red by carmine in cartilage and tendon exactly corresponds to that in epithelium, and that neither cartilage, epithelium, or any other structure exists in a growing state without it, the inference that it is *essential* to these tissues seems justifiable. If cartilage could be formed without germinal matter the cell-wall could be produced independently of it. There is no more reason for believing that cartilage or fibrous tissue can be produced from a nutrient fluid without the agency of active living matter than that this living matter can be precipitated from a fluid composed of a solution of inanimate matter.

The contents of cells are easily removed from the investing membrane, or from the walls of the cavity in which they are contained, because the structure which lies between the germinal matter and the perfectly-developed formed material, although continuous in the natural state of the parts with both, is exceedingly soft. It is no longer composed of particles like the germinal matter which are held together as a viscid coherent mass, nor is it yet sufficiently firm to possess the powers of resistance resident in the fully-developed formed material. The substance in this situation is in a transition state, and separation very easily takes place at this point. After death changes commence very soon in this imperfect formed material.

Areolar or connective tissue corpuscles, and their system of communicating nutrient channels.—The term *areolar* or *connective tissue corpuscle,* has been applied to the corresponding structures in several different tissues. In certain textures where it may be shown that nerves and capillaries are abundant, a vast number of these connective tissue corpuscles are said to exist. The nature of the so-called areolar tissue corpuscles in the skin and other tissues will be discussed shortly.

Supposing the relation which has been described as existing between the germinal matter and formed material of tissues is true, and the arguments advanced sound, it follows that if this term (connective tissue corpuscle) is applied to the elementary parts of bone, cartilage, and tendon, it must also be applied to those of muscle, nerve, the epithelium of the skin, glands, &c., for the germinal matter of cartilage makes cartilage, that of tendon tendon, and those of muscle, nerve, and epithelium, &c., produce the formed material which exhibits the peculiar endowments characteristics of these tissues.

With regard to the existence of spaces and tubes, it has been observed that, under certain circumstances, spaces are undoubtedly to be demonstrated in the substance of various tissues, and connecting these there are tubes. They do not exist, however, as spaces and tubes for the conveyance of nutrient fluids in the living tissue. Both are the result either of a change occurring in the course of nature, or are artificially produced by the alteration of their contents by chemical reagents, the action of water, &c. In the first case the tissue is dying or dead, but the last is the explanation when tubes and spaces are said to have been demonstrated by the passage of air or coloured fluid in tissue, which was recently in an active growing state; except in the case of bone and analogous structures, where tubes are present. In short, these so-called spaces and tubes in soft tissues actually contain the active living part of the tissue. It is here that the inanimate nourishment commences its life, and passes through various changes until its place is occupied by new matter, and it has become firm and hard, and perhaps comparatively permanent, as tissue. The tubes and spaces really contain living spherical particles in all stages of being, from the recently animated matter to the particles becoming tissue. The soft living material is, of course, easily destroyed, soon decays after death and leaves spaces and tubes, but during life these are occupied with the only matter of the tissue which can produce new matter, the material on which the growth, the nutrition, in short, the life of the whole depends.

In pathological alterations the germinal matter of cuticle or of cartilage will undergo multiplication in precisely the same manner as the germinal matter of a tissue, the several masses of which communicate with each other by tubes.

It has been shown that in some tissues, as cartilage, the masses of germinal matter are entirely separated from each other by formed material, while in others, as tendon, they are continuous. Gradually, however, these channels of communication in many tissues become completely closed up, although their position continues to be marked by a line exhibiting a different amount of refractive power to the rest of the formed material. How is this fact to be accounted for on the supposition that these are mere tubes for the transmission of nutrient fluids?

In tissues which are rendered impermeable by the precipitation of calcareous matter in the formed material, and which are at the same time quickly produced and quickly removed, channels must exist for the transmission of fluids to and from the germinal matter. But in soft, permeable textures such tubes are not required as fluids circulate freely through the interstices of the tissue or formed material.

These corpuscles and communicating tubes which are regarded by Virchow as belonging to an extensive nutrient system of tubes and cavities, exhibit very different characters in closely allied tissues. Although present in periosteum and perichondrium, they are absent in permanent and temporary cartilage. The bundles of white fibrous tissue contain, it is admitted, a vast number of them, while the substance of the elementary fibre of muscle in immediate continuity with the tendon is, at least in many instances, destitute of anything like such an arrangement; although the first tissue is one in which the nutritive changes are slight, while in the latter they are admitted to be very active.

The mucous tissue of the cord, according to Virchow, consists almost entirely of these anastomosing tubes, and there a most elaborate system for the conveyance of nutrient juices is said to exist, although with the exception of a little imperfectly formed fibrous tissue and viscid matter there appears nothing in this texture requiring nourishment.

There is no secretion, and the changes occurring in such a texture must be slow.

They (connective tissue corpuscles) are found in connexion with the capillaries of the ciliary process of the eye and those of the Malpighian bodies of the kidney in greater number than with capillaries generally. They are numerous in the cornea, in fibrous tissue, and in inflammatory lymph, and although present in some forms of cartilage they are absent in others. It is not easy to understand why they should be very numerous in some tissues situated quite close to vessels, and absent in others separated a considerable distance from the vessels. Why they should be present in some textures which undergo slight change, and absent in others where important nutritive changes must be continually and rapidly taking place. Why the soft, permeable, temporary, mucous tissue of the cord should require a wonderful nutrient system of this kind, while the hard and much less permeable cartilage is destitute of any such arrangement. Why the "cells" should be arranged in linear series in tendon and fascia, stellate in periosteum, perichondrium, and fibro-cartilage. Why the *radiating* tubes should be so distinct and so large in the mucous tissue of the cord, periosteum, and certain forms of fibro-cartilage, and so difficult of demonstration in tendon, and so narrow that the advocates of the doctrine are compelled to admit that in adult tendon the indisputably solid fibres of yellow elastic tissue are their representatives, and are forced to support their argument with the statement, that at least at an early period of development the fibres of yellow elastic tissue are hollow? If the young white fibrous tissue, which is comparatively freely supplied with vessels, requires a special system of nutrient canals we should expect to find such canals at least persistent in the adult where the tissue is farther removed from the blood, instead of which they appear to become occluded as the necessity for their existence increases. Moreover, I have adduced instances of white fibrous tissue with parallel fibres, in which no fibres of yellow elastic tissue could be demonstrated, although the arrangement of the nuclei was the same as in other forms of this structure.

It is to be observed, however, that the stellate arrangement does exist in cases where a tissue is gradually increasing for a considerable period of time in all directions. In the cartilage of which the semicircular canals are composed in the frog, the masses of germinal matter do communicate, while in the adjacent cartilage of the temporal bone no such arrangement exists. In periosteum and in the areolar tissue of the skin, which extend in all directions, the arrangement is stellate, while in tendon, which extends chiefly in two directions, it is linear. In voluntary muscles of the system of vertebrate animals generally (with some exceptions) the masses of germinal matter are separate, while in the muscular fibre of the heart they are connected, forming lines which occupy the centre of the fibre; and I might bring forward many other facts which receive something like an explanation according to the view I have proposed, but which cannot be accounted for on the other theory. It is very hard to believe that different forms of cartilage are developed and nourished in a totally different manner. This question, however, requires further investigation.

(*To be continued.*)

Polarized Light *as a* Recreation *and* Study.

By Thomas Davies, Esq.

Every man is subject to a certain amount of influence from his fellow-men. Perhaps, in fashions of dress, this power displays itself most strongly, yet it is by no means confined to outward show; even in science it is as plainly developed, and, during one age, some branch is eagerly pursued, which is treated with apparent indifference in the next. In some degree this kind of *fashion* influences even the microscopist. At the present time the Diatomaceæ seem to be the predominant subject of inquiry, to the partial neglect of some of the many others which our improved instruments offer us. One branch in particular seems to me to suffer (at least in some degree) from this fashion; that is, Polarized Light in its causes and effects. *Chemically* this study will one day, most likely, assume an interest and importance of which we can now have no idea. But there is a certain class of men to whom science seems forbidden fruit—men who have not courage to begin a systematic study of any kind, and yet who would be drawn gradually by any pleasant occupation from amusement into deeper inquiry that would at length, albeit imperceptibly, take possession of them; and from these very men might rise numbers to whom science would be indebted. What could be so likely to effect this as *polarized light and the microscope?*

Even a child would be delighted with its beauties, and the highest mind may here find an unexhausted, indeed, inexhaustible field for both eye and mind.

It is for such a class of "microscope owners" that I venture to offer this notice of "polarized light as a recreation and study." For these men alone I suggest the following objects; and if many know all that I write, some few, perhaps, may be ignorant of at least a part.

Crystals are generally looked upon as the legitimate field of polarized light; but many have resigned this branch, deeming it exhausted. There can be, however, no greater mistake than this. Every day new phenomena start up which we have no means of proving except by this peculiar test. The difference in many crystals (as to form as well as substance), we have no other power of pointing out so simple as this; and in glass, as well as many other bodies, good and bad qualities lie hidden which are readily tested by this agent.

Crystals of the same substance, however, are very liable to be mistaken for others, especially by those who are novices in this study. Before we are thoroughly conversant with crystallization we find such a difference in form, even when working with the same salt, that we are inclined to disbelieve in any law governing it. In most instances, however, this is but a seeming difference, as may be easily shown. Suppose the *true* form to be rhombic, some peculiar treatment may be adopted which will so join these rhombs together, cause them to interfere, and *work into* each other, that none but experienced observers can reconcile these apparent anomalies. A very simple proof of this lies in the sulphates of copper or iron. Take a saturated solution of either of these salts, allow it to flow over a glass slide, and dry spontaneously; the plate will then be found covered with comparatively broad strips, showing angles of the separate crystals at the edge of each strip. But if, instead of allowing the solution to crystallize untouched, we keep it in motion until the liquid is evaporated, the crystals are formed separately, each taking its own peculiar shape, and to an inexperienced eye belonging to a totally different class. I have put up examples of this. One in which the crystals are intimately joined, and the other, where, by simply keeping the solution in motion, they are distinctly formed.

In anything like chemical inquiry, it is of the greatest importance that every agent used should be of the utmost purity. Some of my friends have, however, become possessed of a crystal which they look upon as invaluable, being of so beautiful and uncommon a form, and so very different from the usual productions of the same salt, that we believe there is some mistake as to the substance. To reconcile this anomaly, we have but to know that from using impure water, a speck of dust, or many other accidental occurrences, these differences in form are constantly developed. The *size* of the crystals is often varied by the degree of heat, or in other words, the quickness or slowness of evaporation, and also by the strength of the solution.

I have said before, that "*in most instances there is but a seeming difference*" in the forms which the same salt takes when crystallized by different methods. In some salts there is, however, a real change of shape; indeed, it is said by those who follow out this branch, that no salt *ever* assumes the same shape crystallized by solution and sublimation; the two forms do not even possess any relation to each other. Arsenic, corrosive sublimate, and sulphur, are common examples of this; but a very striking illustration is afforded in pyrogallic acid. Pyrogallic acid is produced by heating common gallic acid to about 400°, which then sublimes in brilliant white plates. These plates are so large that they are easily examined by the unassisted eye. But if they are dissolved in pure water, and then allowed to recrystallize, a surprising change takes place, and a crystal is formed which has a beautiful effect when examined by polarized light. Very often it assumes the appearance (from the arrangement of the crystals) of the "eyes" of the peacock's tail, and this is only one of many salts of a similar "behaviour."

Again, I have before said that "*the size of the crystals is often influenced by the degree of heat used;*" but in some instances not only is the size varied, but the shape also undergoes a change, and carbonate of lime has been crystallized in six hundred different forms; in *this* case, however, all being traceable to the original crystal.

Some of the wines give us beautiful objects for the polariscope, which differ as much as the countries from which we are supplied. There is, however, one class of crystals which are very similar in almost all, though their fitness for microscopic purposes differs very greatly—the bitartrates of potash. These are sparingly soluble in cold water, and therefore may be washed before setting, and freed from almost all impurity. They are well defined crystals, giving exquisite colours, and are easily procurable, being naturally formed at the bottom of the bottles. From the same wine we may also get a totally different crystal. A drop is laid upon the slide, and either by natural or artificial heat evaporated. For some short time no formation will show itself, but ere long the slide will be well covered, where the wine was laid, with a number of crystals, most of which closely resemble in form the side view of some of the gyrosigmas, but of course are much larger. These crystals are beautiful polarizing objects.

The next branch of this is the effect of mixing the solutions of many of the salts. Here we find a new and never ending field for study. The resulting configuration, however, is not *always* a consequence of any chemical interchange taking place; it is often simply a *mutual interference of form* (as it might justly be termed). Still these results are often most interesting and beautiful. Each crystal may contain a portion of the two salts mixed, and yet there may be no chemical combination, as the quantity of each salt may be more or less in proportion to the other; but this close intermixture can only take place when the salts are almost, if not quite, alike as to crystalline form. Another modification of these forms takes place when two salts are mixed which do chemically combine, but too great a quantity of one or other being added, on evaporation there is no chance of getting rid of the superfluous portion, and so a granular, or other abnormal, appearance is given to the result, which often greatly interferes with its beauty for the microscopist.

Often enough it is not an easy matter to determine whether some polarizing salts, which have perhaps been accidentally mixed, be *formally* or *chemically* joined. Those who pursue this branch for amusement alone might feel little interest in the question, but all who go deeper into the phenomena would feel at least a curiosity to be assured on this point. Sometimes the formation points this out very distinctly by an irregularity not easily mistakable, but in other instances even clever chemists are divided in opinion.

In preparing these double salts a very obliging agent is offered to us in iodine. With many salts this unites, and the results are very fine, giving colours unsurpassed. As an instance of this, we have the preparation of iodo-cyanide of potass, first mentioned, I believe, by an American. This salt is rather unstable, but equal to most objects for the polariscope. Lately I have succeeded in bringing together two salts which I do not know to have been before used for this purpose, viz., the sulphates of copper and magnesia. The peculiar flower-like form of the crystals, centre and petals appearing complete, together with its beautiful polarizing powers, you will yourselves judge of. It is a salt rather difficult to crystallize *well*, but when once thoroughly understood, the forms seldom differ much. Many have thought this a *me-*

chanical mixture only, but I think it is certainly chemical. One of our standard works on chemistry says, "Of the five atoms of water which sulphate of copper contains, one is constitutional, and may be replaced by the alkaline sulphates to form a class of double salts of great beauty."* I have slides of this.

In mentioning iodine above as an "obliging agent," I omitted to state, that very often I have thought the salts which I have been crystallizing gave better defined forms when used with a small quantity of iodine, although it certainly did not enter into any *chemical* combination with them, not altering in the least the general characters of these crystals. Has any other person worked in this direction who would give his experience?

In working amongst these crystals there is but one drawback, and that is the *instability* of some of them. The difficulty of setting them is very great, as some will change, whether set in balsam, dry, or in oil; but this only occurs with a few, and the beautiful results of many, more than compensate for the difficulties offered by a few.

With the crytals a novice thinks the field of the polarizer is well nigh exhausted. He can make no greater mistake than this; its field is no more limited than that of the microscope without a polarizer. Many of the Zoophytes which he can pick upon any sea-shore will surprise him when used with this agent. Some of the Cellulariadæ, Gemellariæ, &c., afford beautiful specimens of this; many of them appearing to be golden casts from the richness and brilliancy of their colours. Some of this class, however, are irremediably opaque; but others, when set in balsam, are quite transparent enough to use with the power they require or even admit of.

I have already written enough, perhaps, on this subject; but I should be omitting one of its great functions if I made no mention of the Foraminifera as well adapted for purposes of polarization. Here is a great field for research; and even as objects of *show* we may do much work. Amongst the most transparent we find many specimens, which almost resemble miniature rainbows when viewed by polarized light, more especially when set in balsam. Of many which are too opaque we must make sections, but we shall be repaid for our trouble. Some of the minute molluscs give us a cross closely resembling that produced by starch, though not quite so well defined. Amongst the sponge spicula we may also

* Dr. Kane's 'Elements of Chemistry,' article, "Sulphate of Copper."

find no little work; and, as a sample of what we may meet with in this class of objects, let the spicular hooks of the Synapta (a very common slide), be examined by polarized light, and the result will surely draw the observer on to further researches.

The scales of plants and ferns, with their usual star-like forms, are already well known, but they are as yet far from exhausted; and some of the foreign specimens are still new to most, if not all, of the microscopic world.

I look upon polarized light as a country whose borders only are yet known. If one inquiring mind is stirred to this study by my few and incomplete remarks, my object will be attained in writing them.

On Closterium aciculare (West).

By W. Archer, Esq.

In the 'Quarterly Journal of Microscopical Science,' vol. VIII, p. 153, Mr. Tuffen West described a new species of *Closterium* under the above name, and, appended to his description, he did me the honour to quote a few lines of mine to him in regard to it. I had then seen only a hurried tracing, but had not seen either Mr. West's truthful figure (l. c. Pl. VII, fig. 16), or an actual specimen, and, if so, I should perhaps have written slightly differently, while, moreover, the printers have misplaced a stop, thus rendering my meaning doubtful. Under these circumstances, I trust I may be allowed a very small space to point out the error alluded to, and to try to make what I then meant to convey more clear.

By saying that the great length and slight breadth of the form named *Closterium aciculare* by Mr. West, brought it near to *Closterium prælongum* (Bréb.), I merely intended to state that, *proportionate* length and breadth being considered, these two species were amongst the most slender in the genus, and not that any more immediate affinity existed between them. Since the occasion referred to, I have had, by Mr. West's kindness, an opportunity to examine authentic specimens of his *C. aciculare*, and lately I have had the pleasure to meet both these species in Ireland (very sparingly indeed, but they are each scarce, or "very rare" to the discoverers). As M. de Brébisson has not appended any measurement to his description of *C. prælongum*, I may here take the opportunity to give those of my specimens, as follows:—length of frond $\frac{1}{32}$, greatest breadth $\frac{1}{1270}$ of an inch. It will thus be seen that this species is absolutely (microscopically speaking, by something considerable) the longest Closterium known. Mr. West gives the length of his *C. aciculare* as $\frac{1}{56}$ of an inch—none of my specimens, which I have little doubt are referable to this species, measured greater than $\frac{1}{55}$ of an inch, and the greatest breadth was somewhat more than that of his, $\frac{1}{5000}$ of an inch. The very great length of the frond in *C. prælongum* and *C. aciculare*, combined with the proportionately slight width, seems indeed at first to justify a comparison between those species; but, as I indicated above, I do not conceive there is any closer affinity between them—in fact, *à priori*, I should venture to say that *C. aciculare*, as indicated by its long, slender, setaceous hyaline extremities, when possibly hereafter discovered in a conjugated state, may be found to belong to Kützing's genus Stauroceras, that is, in other words, to have a cruciately four-lobed or sub-cruciform sporangium, while I should as equally predicate of the other an orbicular or elliptic one. I wrote (or intended to write) ('Mic. Journ.,' l. c.) of *C. prælongum* (Bréb.), that "in that species the ends are slightly turned upwards, in that respect like *C. turgidum*;" whereas the printer, by placing the semicolon after "upwards," in place of after "*C. turgidum*," where there should be a comma only, makes me to *convey* that in the new form (*C. aciculare*) the ends look rather downwards (which is the case), "in that respect like *C. turgidum*"—in which latter, as above indicated, and as is well known, the ends are really turned upwards, and not downwards—thus rendering the sentence not only obscure, but absolutely wrong and erroneous.

Had I seen, when I had the pleasure to write Mr. West on the subject, either his plate or a specimen, I should hardly have been disposed to institute a comparison between his new species and *C. macilentum* (Bréb.), further than that like *C. prælongum* they are slender forms, and all three non-striate. Since then I have met with, on Howth, near this city, and in a conjugated condition, a *Closterium*, which I am disposed to look upon as a small form of *C. macilentum* (Bréb.); but on submitting specimens to M. de Brébisson, he did not seem quite to concur with me, and obligingly sent me dried authentic specimens of his *C. macilentum* for comparison. I must own, however, except that my specimens are slightly smaller in every way, I am not able to see any distinction that could be relied on as of specific importance. In this Closterium, as in a few other species, conjugation takes place immediately after the act of self-division, so that one (the younger) segment is considerably shorter than the other (the older); and here in the act of conjugation each of the longer (and of course also each of the shorter) segments are pointed in opposite directions, the empty segments remaining for some time attached to the orbicular sporangium, which is surrounded by a conspicuous hyaline mucous investment. In all these respects my specimens agreed with M. de Brébisson's; and I take the opportunity to draw attention to them here, because I conceive it to be a probability that such circumstances attendant on conjugation, as those I above point out, may be eventually found to have perhaps a specific importance, and to be in certain cases specially characteristic.

If I be right, then, in anticipating for *C. aciculare* a lobed sporangium, besides the characteristic difference in the general external outline, such a further difference, more recondite it is true, but most probably of greater (certainly I should say of considerable) importance would, so far as I can see, place them apart.

It will have been gathered from the foregoing, that it is amongst those species falling under the genus *Stauroceras* (Kütz.), that I imagine the nearest allies of *C. aciculare* are to be found; but it is precisely the uncertainty in regard to the actual mode of conjugation, and of the sporangial condition in a few species, and which of course direct observation alone can remove, that renders the value of that genus doubtful. It may hereafter be found to be a good and natural genus, but *C. luceatum* (Ehr.) and *C. Ehrenbergii* (Menegh.) present remarkable peculiarity also in their conjugation; and it seems more advisable, then, to look on those species which would rank themselves under *Stauroceras* (Kütz.), for the present at least, as merely a subdivision of *Closterium* (Nitzsch).

Of British Closteria, undoubtedly belonging to that group the most slender is *C. setaceum* (Ehr.); but that species is wholly and unmistakeably distinct from *C. aciculare*, by its narrow-lanceolate, rather inflated body, and striate frond, as well as by its length being not so great. As to Continental species of an intermediate character, *C. elegans* (Bréb.) is also quite distinct on account of its narrow-lanceolate body, its under margin being somewhat ventricose, nor are the colourless setaceous extremities so much prolonged. It is, however, *C. pronum* (Bréb.) that presents any serious difficulty. Through the kindness of M. de Brébisson I have had an opportunity of comparing dried specimens of his *C. pronum* with *C. aciculare*, and while they seem to approach very closely, I do not doubt but that they are distinct species, and yet it would be difficult to express their special distinguishing characteristics. They are about equal in length; *C. aciculare* is perhaps slightly the longer, but the specimens I possess of *C. pronum* are about two and a half times broader at the widest part than Mr. West's specimens of his *C. aciculare*, hence the tapering in the former species is less gradual, and the colourless extremities not so prolonged, nor probably quite so slender as in the latter, nor is their curvature, perhaps, quite so great. It would of course be desirable to see fresh specimens of both. I have never myself met with *C. pronum*, and specimens dried on talc may not a little lose their characteristic outline. It seems to me that *C. aciculare* may be said to bear a relationship to *C. pronum* somewhat similar to that which *C. setaceum* (Ehr.) or *C. elegans* (Bréb.) bear to *C. rostratum* (Ehr.), which are, I doubt not, good and distinct species. It may, perhaps, appear to some that the specimens met with by me in this country, and which I refer to *C. aciculare*, and which, as stated above, are slightly less slender than Mr. West's specimens, might be looked on as an intermediate variety connecting this form with *C. pronum*, but I am not disposed to think so. My specimens are much more slender than those I possess of *C. pronum*, and agree, so far as I can see, in general outline with *C. aciculare*. De Brébisson himself, judging from the figure, is disposed to think *C. pronum* and *C. aciculare* to be distinct; he had not, however, seen any specimens of the latter.

There seems little danger of the form under consideration being mistaken for *C. gracile* (Bréb.) (not uncommon here), a species whose diameter is not greater, but its length is considerably less. Instead, however, of gradually tapering from the middle towards each apex, that species presents a linear outline, the endochrome reaching to near the slightly curved blunt extremities. Its conjugated condition, too, is unknown; but though very slender throughout the length of the frond, its extremities are not prolonged in a setaceous manner.

Such, then, seems to me the state of the question as regards this elegant form. I conceive that it and *C. pronum* are distinct species; doubtless, it might indeed eventuate that they are but extreme forms of the same species, but I should be disposed to say that that side of the question would not be proven till they be found conjugating with each other, or till distinctly intermediate gradational forms are discovered.

Note *on* Gyrodactylus elegans. By T. Spencer Cobbold, M.D., F.L.S., Lecturer on Comparative Anatomy, Zoology, and Botany, at the Middlesex Hospital Medical College.

Mr. Bradley, F.L.S., having lately drawn the attention of parasitologists to the occurrence of *Gyrodactylus* on Sticklebacks taken from the ponds on Hampstead Heath, I have recently sought for this curious genus of ectozoa on *Gasterostei* obtained from the Serpentine in Hyde Park.

As anticipated by the zoological editor of this 'Journal' (in last July number, p. 196), the *Gyrodactyli* are not confined in this country to the locality mentioned by Mr. Bradley; at least, I find them tolerably abundant on the Sticklers in the Serpentine. No doubt they are common elsewhere, but now that the cold weather has set in their numbers will, in all probability, rapidly diminish. I have chiefly examined the tails of the *Gasterostei,* and in proof of the truth of the observation just made, I may remark that on the tails of eleven fishes obtained (from beneath the Serpentine bridge) on Saturday, the 16th of November, I found only one *Gyrodactylus,* whereas, six Sticklebacks taken from the same spot several weeks earlier, had their caudal appendages almost covered with them. One fish supported several dozen parasites.

In all cases the *Gyrodactyli* were accompanied by numerous *Trichodinæ;* the latter being constantly present when there were no other ectozoa or infusoria attached.

Before my attention was drawn to the fact of *Gyrodactyli* having been found in this country, I had familiarised myself with the general characters of the genus from the descriptions of Nordmann, Wagener, Van Beneden, Siebold, and more particularly from the observations of Wedl, whose 'Anatomische Beobactungen über Trematoden' contains an interesting appendix on the genus in question. This memoir, therefore, may appropriately be added to Professor Busk's list of writings on *Gyrodactylus,* given at p. 212 in the last volume of this periodical.

These authors have collectively treated the subject in so exhaustive a manner, that observers in this country can barely hope to add important novelties; yet I would especially invite those who are fortunately possessed of "Wenham's binocular arrangement," to make the attempt, as there are points which an instrument thus furnished will materially assist in elucidating.

In common with several of the above-mentioned investigators I have noticed the second generation (or "daughter" of the so-called nursing animal) of *Gyrodactylus elegans* to contain in its interior clear evidence of a third generation. Indications of this third progeny may be seen, whilst the embryo is still within the body of the "nurse" or parent; but it acquires much greater distinctness immediately after birth. In one instauce I had a very satisfactory opportunity of watching the process of separation. The embryo (or daughter) commenced showing itself externally by a slight bulging near the centre of the body of the parent; the integument of the latter yielding on all sides of the bud-like projection, and in such a manner as to convey the idea of a vaginal opening, although the channel was not actually demonstrable. As Mr. Bradley observes, there is an evident effort on the part of the young creature to free itself from the parental envelope; but I did not find the tissues to exhibit any evidences of injury, such as the expression "tearing" might seem to imply. On further protrusion it became evident that the budding portion of the young corresponded with the centre of its body, which, in a little while, assumed the appearance of a semicircular band, or horse-shoe-shaped loop. Subsequently the upper or anterior end of the band became detached, the free extremity being at once recognised as the head of a young *Gyrodactylus elegans,* furnished with its two characteristic ventricose lobes. About this time a pair of strong, backwardly curved hooks also came into view; these were attached to the ventral surface, and corresponded in all respects with those figured by Nordmann. Curiously enough, I noticed these spines in one or two other specimens, and I believe they altogether escaped Mr. Bradley's observation. A considerable interval elapsed before the broad posterior end of the animal could be disengaged, but immediately this was effected the sides of the parental envelope closed in upon the opening, and all that remained behind was a small cavity or sac indicating the position recently occupied by the young *Gyrodactylus.* Altogether the process occupied about five minutes from the commencement of the "budding" to the closure of the assumed vaginal passage.

One of the most striking phenomena connected with the reproductive process, is the remarkable size of the young at the time of birth. In the instance just given I carefully compared parent and child, but, in regard to size, I can scarcely aver that the former was the larger of the two. The similarity of bulk is, perhaps, more apparent than real, owing to the circumstance that the freed embryo rapidly extends itself, and moves about in all directions, whilst the parent as readily contracts, or "shuts up," so as to appear at a striking disadvantage.

In a second young individual I particularly remarked the curious changes affecting the skin, which Wagener describes as occurring "shortly after the birth of an embryo" (loc. cit., p. 198). The integument was here and there thrown into villous-like projections, which, as Wagener implies, involved the subcutaneous tissues. There was a degree of regularity in their disposition, and their general aspect forcibly reminded me of the permanent, compound, wart-like processes or spherules seen on the surface of *Sphærularia*.

In regard to the disposition of the hooks on the caudal disc, as well as other arrangements connected with the internal anatomy, I have nothing new to add; but, so far as my examinations have extended, I have satisfied myself as to the general accuracy of Dr. Guido Wagener's elaborate descriptions; and I have thought it might not be unacceptable to append Professor Wedl's conclusions, as given in his "*Anhang über die Gattung Gyrodactylus*," at the close of the memoir previously referred to.

I must premise, however, that in this same memoir he makes the following statement: "During my inquiries," he says, "respecting the genus, the species (named) *Gyrodactylus elegans* never turned up; on the contrary, I met with numerous forms attached to the fresh-water fishes, which materially circumscribe the universality of Siebold's inference that *Gyrodactylus* is only a kind of nurse."

Dr. Wedl's conclusions are afterwards recorded as follows:

"I. As hitherto known, *Gyrodactylus* is found on the gills (*G. elegans* being also found by Creplin and Siebold on the fins) of fresh-water fishes in numerous forms, and as, moreover, I have found a particular gyrodactyle-representative on nearly every species of such fish, it would appear that each finny creature supplies its own *Gyrodactylus*. Sometimes two of them play the parasite upon the same gill, and they are frequently associated with *Trichodinæ*, as well as with the still unintelligible *Psorospermiæ*.

"II. The clasping apparatus at the posterior end of the body, must, in an animal so soft and constantly exposed to the passage of regular currents, be comparatively strongly developed, and accommodated to the peculiar dwelling places; and probably the latter supply a reason why there should be so great a variety in the mechanism of the hooks belonging to the disc.

"III. This hooked apparatus affords a very valuable means of diagnosis for the determination of the species with mathematical precision. This may be accomplished by observing whether there are two or four large hooks; whether there be one or two connecting portions, and by noticing their several forms and relation to one another; whether there are hooklets present or not, remarking in the first instance their position, form and distribution, and so forth.

"IV. The integument is sometimes wrinkled transversely, at other times appearing to be smooth.

"V. The muscular apparatus is sometimes very strongly developed. In the majority of instances special muscles are inserted into the handles of the hooks, and they are also very frequently directed into the transverse muscles of the skin. A *retractor palparum medius*, and *protrusor penis*, are found in *Gyrodactylus crassiusculus*.

"VI. The four so-called eye spots are observed on the dorsal surface, at the fore part of all Gyrodactyli (with the exception of *G. elegans*). As already taught by Siebold they answer the purpose of light-refracting organs. The palpi appear to be retractile touch-organs (seen to contain muscular bundles in *G. crassiusculus*), and extend more or less prominently forward.

"VII. The observations in regard to the alimentary canal are at present incomplete, for only in the case of *Gyrodactylus cochlea* was a single gullet demonstrable; this was furnished with epithelium, being tinged either yellow or brownish-yellow; it passed from before backwards, and was probably provided with an anus, whilst, in all other instances, its passage could not be traced. The reason of this arises from the transparency of the intestinal contents, and from the internal blending of the wall of the canals with the parenchymatous substance. The other organs likewise hinder our observation.

"VII. In three species of *Gyrodactylus* (*G. cochlea*, *G. crassiusculus*, and *G. tenuis*) the generative organs are thus disposed:—The vitelline organ is characterised by its botryoidal structure, and its round secretion-cells, which contain granular matter; these are so completely surrounded by an investing membrane that there is no direct connexion between this organ and the oral sucker. Its excretory duct lies in front of the ovary. In all Gyrodactyli, where, generally speaking, a single egg with its yellow shell came under observation, there was only this solitary example seen, and its escape was but once observed. The two seminal vesicles standing out most conspicuously in *Gyrodactylus tenuis*, are filled by a convolution of filaments, and intercommunicate by a canal. The connexion of the posterior seminal vesicle with the presumed testes was not perceivable; the anterior one is connected with the external, horny, male-reproductive apparatus. The latter organ is characterised by a great variety of form, so that one may say '*Ex pene speciem.*' Speaking generally, we observe a peculiar, more or less curved penis, grooved for the passage of the semen, and an accessory solid portion which is often hooked; the latter serving, probably, as a fang or organ for adhering to the vagina. In one instance, where the accessory portion was absent, two hooklets at the entrance of the vagina in all probability represented the same, for the purpose of laying hold of the penis when lodged within the sheath. Thus Gyrodactylus sometimes becomes sexually developed, and cannot be regarded merely as a form of 'Nurse.'"

Observations *on the* Fly *affecting the* Mangold Wurzel Crops, *in the year* 1861. By the Rev. W. Houghton, M.A., F.L.S.

The mangold wurzel crops have, as is too well known amongst farmers in some parts of this country, suffered considerably from the attacks of the larvæ of some insect during the last year. In the report of the meeting of the Entomological Society, July 1, 1861, Professor Westwood observed "that although mangold wurzel has been usually considered almost free from the attack of insects, yet the crops this season in many distant countries, Devon, York, Hereford, Oxon, &c., were attacked by the larvæ of a dipterous insect, *Fam. Muscidæ*, and probably allied to *Tephritis*, which mine into the leaves, forming large blotches, which soon shrivel up and do much damage to the plants." In the Journal of the Royal Agricultural Society of England, vol. vii, p. 399 (1847), Mr. Curtis has published some 'Observations on the Nat. Hist. and Economy of a Weevil affecting Pea-crops, and various insects which injure or destroy the Mangold Wurzel and Beet,' and at p. 411, he has described the male of a species of *Anthomyia*, which he appropriately calls *Amthomyia betæ*. Mr. Curtis states that his acquaintance with this fly was made from a communication sent him by a gentleman of Crawford, and that he was indebted to him for the history of its economy. "The maggots were brought to me from Surrey, on the 26th of June, found feeding between the skins of the leaves, the integuments of which they cut rapidly, giving the plants attacked a blistered appearance. They were of a greenish colour, a quarter of an inch long, pointed at the head, and rather abruptly cut off at the tail, they turned to pupæ *in situ*, as you may see by the fragments of the leaves, and hatched July 17th and 20th;" it may be added that the plant whence the insects were obtained had been destroyed by their attacks, and that the sugar-beet had also suffered from the same cause.

This account, so far as I have been able to ascertain, contains the earliest and only information as to the "fons et origo mali," which during the last year has seriously injured the mangold crops; for that the same insect, which was described by Curtis in 1847, is identical with that which attacked the crops last year I am in a position to show, as also to figure and describe the female fly, which appears hitherto never to have been recognised, "the males only," writes Mr. Curtis, "being known at present" (1847). My attention was naturally called to this subject in the summer of last year, by the sickly appearance of the mangolds, whole fields in this neighbourhood presenting an appearance as if the leaves of the plants had suffered from some *scorching* influence. With a view to ascertain the origin of the evil, I paid frequent visits to a mangold field, in order to discover the fly which was the parent of the leaf-mining larvæ, whose existence within the cuticles an intelligent farmer in the parish had first pointed out to me. I searched hundreds of leaves, in order to obtain possession of some pupæ, but in vain. I brought home several leaves containing full-grown larvæ, which I anticipated would soon become pupæ, and placed them in water, in hopes of thus being able to secure a pupa or two; but I found that the larvæ always dropped out of the leaves. Failing in this, I determined to watch the insects in the field, and my suspicions were soon fixed upon a two-winged fly with reddish-brown eyes, which was very abundant on the mangold leaves, and seemed evidently to have some object in view beyond the mere ordinary and incidental one of settling upon them. At this time I knew nothing of what Mr. Curtis had published on the subject. I observed on the under surface of the leaves a number of small, white, cylindrical *ova*, in clusters varying from two to six or eight together. On holding these up to the light I could clearly see from the track, which extended from the ruptured *ova* between the cuticles to the larvæ in another part of the leaf, that these were the undoubted *ova* of the damaging insect; but it still remained to prove that the suspected fly was the parent of the *ova*. I therefore made a microscopic examination of the eggs which had been deposited on the leaves; these, under a power of 250 diam., presented a beautiful reticulated structure. I then dissected a number of the flies, whose abdomens were evidently distended with *ova*, with a view to compare the eggs in the ovary with those I had already examined. I found them in every stage of development, and discovered some of the exact shape and size, though of softer consistency, than the eggs on the leaves, and presenting the same network structure characteristic of those which had been naturally excluded. About this time I was made acquainted with Mr. Curtis's description of the male of *Anthomyia betæ*, which exactly agreed with specimens I had taken myself, and as I also discovered a couple of flies *in coitu* I could no longer have any doubt on the subject.

It appears singular that this is the first instance on record of the mangolds suffering to any extent from the depredations of these larvæ; the direct cause of the injury last year being the large proportion of female flies compared with the number of the males, being, on an average, as twelve to one; from the fact of the males only being hitherto recognised, there can be little doubt that in former years this sex predominated, hence the immunity of the plants from injury up to this time; but, as to the cause, whether atmospheric or otherwise, of the large proportion of females during the last year—this is a question which perhaps can never be solved. The female fly continues to deposit *ova* quite late in the season; I found this to be the case as late as the first week in November. I cannot think that the *larvæ* change to *pupæ in situ*; I never could detect a single pupa in the leaf, and my observations, so far as they go, tend rather to show that the maggots drop out from between the two cuticles, and undergo their metamorphosis in the ground;* at any rate, I could occasionally discover, by scraping away the soil, at the

* While these pages were at the press, I have accidentally become acquainted with three or four *pupæ*; I had placed fragments of leaves containing *larvæ* in a small cardboard box about two months ago, and on opening this (Dec. 17), I found that the larvæ had assumed their *pupa* form, and were loose in the box.

root of the mangolds, here and there a *larva;* indeed, if the late broods do not remain as *pupæ* under the ground, how are they able to survive the winter, and by what means is the continuation of the species to be carried on? The larva, at the time of the rupture of the *ovum,* is about a line long; it is armed with two strong hook-shaped mandibles; it grows fast, and reaches the size of about the third of an inch in length, feeding upon the green parenchyma of the leaf. For a description of the male fly, see 'The Journal of the Royal Ag. Soc.' for 1847, vol. vii, p. 411. The female fly may be thus described: colour of thorax light brown, marked with five or six darker longitudinal lines, with four or five series of black bristles similarly disposed; abdomen rather variable in colour, generally light brown or ashy gray, rather glossy, with a distinct or indistinct darker line down the middle, occasionally with irregular dusky patches, which sometimes become so confluent as to give the abdomen a uniform dusky colour; shape of abdomen oval, narrow at the extremity; head semi-orbicular; eyes reddish-brown, remote, destitute of hairs; antennæ velvet-black, drooping, arista bare; face satiny white, with black bristles, having a broad bright-chestnut band down the centre; ocelli three, situated on a satiny sub-triangular spot on the crown; wings the size of the body, tinged with tawny at the base; alulæ of moderate size; legs black, tawny at the base, long; proboscis dark, with tawny tinge; whole length nearly three lines. The female is readily distinguished from the male; the more general obvious differences being—the shape of the abdomen, which is oval in the female, but linear in the male; the remoteness of the eyes, those of the male being nearly contiguous; and the less bristly character of the female. Two important practical questions will naturally suggest themselves to the agriculturist; 1st. Is this insect likely to abound again in such numbers as to affect the mangold wurzel crops this year? 2ndly. If it does so abound, what remedial measures can the agriculturist adopt? To both these queries it is perhaps impossible to give a satisfactory answer. It has been seen that the injury done to the plants last year is owing, in a great measure, to the large proportion of female flies, a fact which depends on phenomena of the nature of which we are wholly ignorant. A frost of some weeks duration is generally considered to be the means of destroying many noxious insects, and no doubt this is true to some extent; but it will be remembered that the winter of 1860 was tolerably severe, and yet these *Anthomyiæ* abounded in the following spring.

With regard to the second problem, the only possible direct mode of lessening the evil is, as it appears to me, to examine the leaves when the mangolds are young, and when, in consequence, they are most likely to be injured, and to crush between the finger and thumb the little groups of ova which can readily be detected by the naked eye; of course this would demand a good deal of valuable time, and, perhaps, for this very reason, may be deemed altogether impracticable. There can be no doubt that many of our smaller birds are of great use to us in helping to diminish the extent of the injury, and since the first appearance of the *larvæ* of this destructive insect is contemporary with the time when birds are very busy seeking food for their young, perhaps the farmer's best policy is to abstain from an indiscriminate slaughter of the feathered tribes, and to leave with them the chance of being of considerable benefit to him.

On the Molecular Theory *of* Organization. By Professor Bennett, M.D., F.R.S.E., &c.

(From the Proceedings of the Royal Society of Edinburgh, April 1, 1861.)

Parodying the celebrated expression of Harvey, viz., *omne animal ex ovo*, it has been attempted to formularise the law of development by the expression *omnis cellula e cellula*, and to maintain "that we must not transfer the seat of real action to any point beyond the cell."* In the attempts which have been made to support this exclusive doctrine, and to give all the tissues and all vital properties a cell origin, the great importance of the molecular element, it seemed to the author, had been strangely overlooked. It becomes important, therefore, to show that real action, both physical and vital, may be seated in minute particles, or molecules much smaller than cells, and that we must obtain a knowledge of such action in these molecules if we desire to comprehend the laws of organization. To this end the author directed attention—1st, to a description of the nature and mode of origin of organic molecules; 2nd, to a demonstration of the fact that these molecules possess inherent powers or forces, and are present in all those tissues which manifest vital force; and 3rd, to a law which governs the combination, arrangement, and behaviour of these molecules during the development of organized tissue.

* Virchow, 'Eng. Trans.,' p. 3.

I. By a *molecule* was understood a minute body, seen under high magnifying powers in all organic fluids and textures, varying in size from the four thousandth of an inch down to a scarcely visible point, which may be calculated at much less than the twenty thousandth of an inch in diameter. Optically it is distinguished according to its size—the smallest presenting dark or light points as the focus is changed, and the larger exhibiting a dark or light centre, surrounded by a distinctly shadowed ring. These last are frequently distinguished by the name of *granules*. The ultimate molecule had never been reached even with the highest magnifying powers. In the same manner that the astronomer with his telescope resolves nebulæ into clusters of stars, and sees other nebulæ beyond them, so the histologist with his microscope magnifies molecules into granules, and sees further molecules come into view. The chemical composition of these molecules must vary infinitely, but the author had been in the habit of classifying them into three groups, and referring them to—1st, the albuminous, 2nd, the fatty, and 3rd, the mineral compounds. These constituents may be mingled together in various proportions, so as to produce simple and compound molecules. In the vast majority of cases they are globular in shape, but they may be angular, square, and of various forms. They may differ in size or be of tolerably uniform size in the same liquid or substance. They may be regularly or irregularly diffused in the matter examined. Sometimes they are concentrated in particular places, and at others scattered in groups. Their colour is various. Most of the pigments in plants and animals are dependent on the formation of molecules, which in the human lung have been proved to be pure carbon, and in the tissues of plants and animals differently tinted kinds of fat or of wax.

These molecules may be formed in two different ways—1st, by precipitation in fluids; 2nd, by the disintegration of previously formed tissues. The former may be called *histogenetic* (ἱστος and γένεσις, *generatio*), and the latter *hystolytic* (ἱστος and λυσις, *dissolutio*). They may be denominated molecules of formation and molecules of disintegration.

Histogenetic molecules are formed either from the union of two simple organic fluids or from precipitations occurring in formative fluids, holding various substances in solution. Fourteen years ago the author read to the society a paper giving an account of the results obtained by a union of oil and liquid albumen, the two organic fluids from which molecular matter is most commonly derived. It was Dr.

Ascherson, of Berlin, who first discovered the important fact, that the mere contact of oil and fluid albumen caused the latter to coagulate in the form of a membrane, which he called the haptogen membrane, from 'Απτομαὶ, to come in contact. A more complete mixture of two such drops produces, as is well known, a white, opaque fluid or emulsion, which in structure exactly resembles milk. That is to say, it consists of molecules composed of a drop of oil surrounded by a layer or membrane of coagulated albumen. Such compound molecules possessing the property of endosmose may therefore readily be produced artificially, and by trituration can be reduced in size so as to resemble the elementary molecules in chyle or in the yolk of the egg. If oil and albumen be introduced into the stomach and intestinal canal, they are always so reduced; and one of the objects of digestion would appear to be separating from the food, and rendering fluid, its oil and albumen, so as to produce the chyle-molecules which are ultimately transformed into blood. Indeed, everywhere in living organisms it may be observed that oil and albumen, formed as secretions by plants, and entering the bodies of animals as food, either separately or united, constitute the chief origin of molecular formations.

Mr. Rainey has recently pointed out the condition which causes molecular mineral matter to assume the form of rounded, nuclear bodies.* This condition is viscosity. If carbonate of lime be dissolved in water, the forms produced on its precipitation are crystalline; but if the fluid be glutinous, composed, for example, of fluid, gelatine, or gum, the forms produced are oval or globular. Precipitations made in this way on slides of glass closely resemble the appearances called nuclear or cellular in different stages of development. Mr. Rainey has further shown how starch-granules are produced in the juices of vegetables by the endosmose of gum into a cell containing a solution of dextrine.† In the same manner that the contact of oil and albumen produces oleo-albuminous molecules, so does the contact of gum and dextrine precipitate starch-molecules. In this manner we can comprehend how the mixture of various organic fluids gives rise to particles of different kinds.

Hystolytic molecules are the result of the transformation and disintegration of fluid and solid substances by chemical

* 'On the Mode of Formation of Shells of Animals, of Bone, and of several other Structures, by a process of Molecular Coalescence, &c.' By George Rainey, M.R.C.S. London, 1858.

† 'Microscopical Journal,' 1859.

or mechanical action. They are generally larger in size than histogenetic molecules, are more purely fatty, and, from being associated with the débris of broken-down texture, may, in most instances, readily be distinguished. Thus, in the breaking up of cells and of muscles when they become fatty, or in the putrefaction of vegetable or animal matters, these may be seen to soften, lose their peculiar structure, break up, and ultimately be reduced to a molecular condition.

We shall subsequently see that these two kinds of molecules are constantly changing places, or, in other words, molecular matter formed from the process of disintegration may, when placed under peculiar circumstances, become the basis of matter which undergoes development. In nature, the breaking down of one substance is the necessary step to the formation of another, and the hystolytic or disintegrative molecules of one period become the histogenetic or formative molecules of another. This fact constitutes the basis of the law which I shall subsequently seek to establish.

II. The author pointed out, in the second place, that these molecules are governed by forces, which induce among them a variety of movements, and cause them to combine in definite ways. This force, which we may call *molecular force*, is altogether independent of cell, nucleus, or other form of structure.

1st. He alluded to the well-known molecular movements described by Robert Brown. These vibratile, circular, serpentine, or irregular motions may be observed whenever molecules are suspended in fluids of certain densities, but are too well known to require notice here. They occur altogether independent of organized structures, and must be regarded as in their nature purely physical.

2nd. The peculiar movements observed in the interior of cells, vegetable or animal, and during the putrefaction of organic matter. The former are seen in the large vegetable cells of the Chara, Vallisneria, and Tradescantia, among plants; and those of chyle, the yolk of the egg, and of the salivary cell among animals. The author had frequently watched the formation of the latter in putrid fluids. A scum composed of molecules collects on the surface; gradually several of these unite in minute filaments more or less long, which assume vibratile or serpentine movements. They are then called *vibriones*. It has been much disputed whether this class of molecular motions be physical or vital.

3rd. The movements which are unquestionably vital that occur in the molecules of the yolk, on the entrance into the ovum of the spermatozoid. Here it cannot be maintained that the results are purely physical, because in different ova we see such widely varying effects from apparently the same cause. Neither can it be attributed to any direct influence of the cell or of its nucleus, the germinal vesicle. For example, an egg is fully maturated in the female organs of generation, and would prove abortive if a spermatozoid did not find its way through the zona-pellucida and get among the molecules of the yoke. As soon as it does so, the apparently purposeless Brunonian movements receive a new impulse and direction. Both spermatozoid and germinal vesicle are dissolved among them, and that wonderful phenomenon of the division of the yoke takes place, not by cleavage or other action of the cell-wall or nucleus, but by the separation of the mass into two masses instead of one. This was compared to what is observable in a dense crowd of men, called upon to pass over to the right or left hand in order to settle any disputed question by a majority. At first, unusual confusion is communicated to the whole; some hurry in one direction, others in another; but after a time there is seen at the margins, where the crowd is least dense, a clear space, which gradually approaches the centre, and at length, bisecting the whole, produces a complete segregation of the crowd into two portions. So with the molecules of the yolk in the egg after impregnation; their movements are directed by conditions which did not previously exist, and a stimulus is imparted to them which causes the peculiar result. It is the division and subdivision of the yolk, wholly or in part, which produces the germinal mass out of which the embryo is formed, and this not by any direct influence of the cell or nucleus, but in consequence of a power inherent in the molecules themselves, which was communicated to them for a specific purpose.

4th. The peculiar movements so well described by Brücke, Von Wittich, Harless, and especially by Lister, in the pigment-cells of the frog's skin.* and which occasion the sudden change of colour in the chameleon, in fishes, and numerous other animals. The black pigment-molecules may be diffused throughout the cell or concentrated in a mass, and all kinds of intermediate gradations may exist between diffusion and concentration. The change in colour is owing to these alterations in the molecules, the tint being light when they are concentrated and dark when they are diffused. Mr. Lister ascertained by experiment that their concentration is caused by exposure to the light, by death of the animal,

* "On the Cutaneous Pigmentary System of the Frog." 'Philosophical Transactions,' 1858.

and by sudden section of the nerve going to the skin, while darkness and irritation of the nerve or skin causes diffusion. Sudden amputation of a limb produced, at first, by diffusion, followed by the concentration of death. These movements of the pigment-molecules are peculiarly vital, and altogether independent of the cell-wall or nucleus. The cell-wall is stationary, and acts only as a sac or investing membrane around the moving particles, while the concentration of these about the nucleus is purely accidental, and frequently occurs in other parts of the cell. The author had seen these molecules himself, as Mr. Lister describes them, streaming out to and returning from the circumference under the influence of the stimuli referred to, where no cell nor nuclear action could be thought of.

5th. There are many other kinds of movements which are evidently independent of cells, for example, those of cilia and of spermatozoids. The former are outside cells, and the latter only move when they are liberated from cells. The contractile fibrillæ of muscle are evidently not dependent for their inherent power on cells or other form of structure, but on the square-shaped molecules of which its substance is composed. All these phenomena, therefore, are connected with the molecules themselves; the force occasioning them is a molecular force, and has nothing to do with preexisting cells, or supposed germinal centres, as some have imagined.

Again, the power of combination between these molecules, which, under peculiar conditions, not only move but so move as to advance towards and press upon each other that they at length unite and produce higher forms, must also be attributed to a molecular force operating in obedience to fixed laws. Thus, it was demonstrated by Newton that in a sphere the total attraction resulting from the particular attraction of all its component parts is, as regards any body drawn towards it, the same as if they had been concentrated at the centre. Hence minute spherical particles, as so many gravitating points, will be drawn towards each other with a force varying inversely as the squares of the distances between their respective centres. The author referred at length to the able descriptions of Mr. Rainey,* as to the physical laws regulating the formation and distntegration of bodies by molecular attraction and repulsion, as well as to the effects of molecular superposition, showing that the same physical power which leads to the formation of these artificial bodies, when long continued, causes their disintegration and destruc-

* Op. cit. See also papers in the 'Microscopical Journal,' 1860.

tion. All these changes occur slowly, and require time; but their contemplation, when regarded as purely physical phenomena, must strike us with surprise, as being closely allied to all our conceptions of the progress of life itself.

Here the author explained that, in making use of the expressions *life* and *vital action,* he was only using terms to indicate phenomena which, in the present state of science, cannot be accounted for by the ordinary laws of physics. Or it might be said that certain actions are directed and governed by conditions which are as yet undetermined, but which, as they only occur in organic as distinguished from inorganic bodies, constitute vital actions. Not that an organized body is independent of physical forces, but that certain directions are communicated to them, which, as invariably resulting in specific forms or properties, make up the sum of what we call vitality.

Hence, although we see molecules combining in the forms of crystals and nucleated spherules, inasmuch as we have discovered the physical conditions on which they depend, and can produce them artificially, we have no difficulty in classifying these among purely physical phenomena, even when they occur in the interior of animals. But when other molecules unite to form nuclei, cells, and fibres, and these arrange themselves into tissues and organs to produce plants and animals, we are ignorant of the conditions by which these results are brought about—we cannot imitate them artificially, and are content to call them vital. But the fact the author was anxious to point out was this, that, so far as observation and research had enabled us to investigate this difficult matter, it would appear that the formations and disintegrations of vegetables and animals, as well as the peculiar properties they exhibit, are essentially connected with the molecular element. Thus, when we investigate the functions of plants and animals—for example, generation, nutrition, secretion, motion, and sensation—we find them all necessarily dependent on the permanent existence and constant formation of molecules.

Thus, generation, both in plants and animals, is accomplished by the union of certain molecular particles called the male and female elements of reproduction. Among the Protophyta the conjugation of two cells enables their contents, or the endochrome, to mix together. This endochrome is a mass of coloured molecules, and the union of two such masses constitutes the essential part of the generative act. In the Cryptogamia a vibratile, antheroid particle enters a germ-cell, and finds this last filled with a mass of molecules which, on receiving the stimulus it imparts, assumes the power of growth. It is the same among the Phanerogamia, when the germ-cell is impregnated by the pollen-tube. In all these cases it is necessary to remember that the protoplasm is a mass of molecules; that a spore is another mass of molecules; that sporules are molecules; that antherozoids are only molecules with vibratile appendages; and that the so-called germinal matter of the ovule is also nothing but a mass of molecules. Cell-forms are subsequent processes, and once produced may multiply endogenously, by gemmation or cleavage; all that is here contended for is that the primary form is molecular, and that the force-producing action in it is a molecular force.

In animals, as in vegetables, every primary act of generation is brought about by the agency of molecules. The Protozoa entirely consist of mere molecular, gelatiniform masses, in which it has never been pretended that a cell-wall or central cell exists. And yet such masses have the power of independent motion and of multiplying by gemmation. Considerable discussion has occurred as to whether, among Infusorians, there is a union of sexes or a conjugation similar to what occurs among the Protophyta; but in either case it is by molecular fusion that the end is accomplished. In the higher classes of animals there are male elements, consisting of molecules, generally with, but sometimes destitute of, vibratile filaments, and female elements, composed of the yolk within the ovum, containing a germinal vesicle or included cell. Both spermatozoid and germinal vesicle are dissolved in the molecules of the yolk, which then, either wholly or in part, by successive divisions and transformations, constitute a germinal mass out of which the embryo is formed. Here, as in plants, it is necessary to remember that the spermatozoids, the yolk, and the germinal mass, are all composed of molecules, and that these, combining together, form the nuclei, cells, fibres, and membranes which build up the tissues and organs of the organism. It is not from either the male or the female element that the embryo is formed. The supporters of an exclusive cell doctrine have endeavoured to show that there is always a direct descent either from the wall of the ovum or from the germinal vesicle as its nucleus. Thus, some consider that the vitelline membrane sends in partitions to divide the yolk mechanically. Others have formed the idea that the germinal vesicle bursts, and that its included granules constitute the germs of those cells which subsequently form in the germinal mass. Others, again, suppose that on impregnation the germinal vesicle divides first, and that the molecules of the yolk are attracted round the two centres so formed. But numerous observations had satisfied the author that both spermatozoid and germinal vesicles are simply dissolved among the molecules of the yolk, from the substance of which, stimulated and modified by the mixture so occasioned, the embryo is formed; a view which has further the merit of explaining what is known of the qualities of both parents observable in the offspring. He was only acquainted with one exception to this general law, viz., the development of *Pyrozoma*, recently described by Mr. Huxley, the description of which, however, was incomplete.* The truth appears to be that, in an analogous manner to that in which the pigment-molecules of the skin are stimulated by the access of light to enter into certain vital combinations with one another, so are the molecules of the yolk stimulated by the access of the spermatozoid to produce those other vital combinations that result in a new being. The essential action is not so much connected, as has hitherto been supposed, with the cell-wall or nucleus as with the molecular element of the ovum.

With regard to nutrition—food and all assimilable material must be reduced, in the first instance, to the molecular form, while the fluid from which the blood is prepared, viz., chyle, is essentially molecular. Most of the secretions originate in the effusion of a fluid into the gland-follicle, which becomes molecular, and gives rise to cell formation. In muscle, the power of contractility is inherently associated with the ultimate molecules of which the fasciculus is composed; and lastly, the gray matter of the sensory ganglia, and of the brain, which furnishes the conditions necessary for the exercise of secretion, and of even intellect itself, is associated with layers of molecules which are unquestionably active in producing the various modifications of nervous force. These molecules are constant and permanent as an integral part of these tissues, as much as cells or fibres are essential parts of others, and their function is not transitory, but essential to the organs to which they belong.

All these facts point to the conclusion that vital action, so far from being exclusively seated in cells, is also intimately associated with the elementary molecules of the organism.

III. This leads me, in the third place, to an enunciation of the molecular law of growth, which a study of the numerous facts previously referred to has induced me to frame, viz.:—*That the development and growth of organic tissues is*

* 'Annals of Natural History,' Jan., 1860, p. 35.

primarily owing to the successive formation of histogenetic and histolytic molecules. We have already seen that development and growth in animals originate in the molecules of the yolk of the egg, or of a germinal molecular mass formed from it. The author referred to numerous careful researches recognised by scientific men as giving a correct account of the development of various animals and textures. From these it would appear that the first form was molecular; that the molecules united to produce nuclei and cells; that these became disintegrated to produce a secondary mass of molecules; that these again united to form secondary nuclei and cells; and that the same process was repeated more or less often in various developments, until the animal or tissue was formed. This constituted the successive histogenetic and histolytic molecules observable in the process of growth—the former building up, to a certain extent, and the product disintegrating to produce the latter, which, after a time, again re-arranged itself and became histogenetic to form cells or tissues, which in their turn broke down and became histolytic. In short, not only development, but growth and secretion, absorption and excretion, were only different names given to histogenetic and histolytic processes, and that these were brought about by formative and disintegrative molecules. As illustrations of this law, the author minutely followed the development of *Ascarix mystax*, as described by Nelson,* and of the process of nutrition in the human body.

In this, and a vast number of similar observations, it must be evident that a certain series of molecular transformations is necessary for the one which follows it. Thereby is produced a continual elaboration of matter—a constant chemical and morphological series of changes—the exact number and order of which, in the production of organic forms, only requires time and perseverance to discover. Doubtless, various conditions, dynamical, chemical, and vital, must co-operate in producing the result, and they must all influence molecular as well as every other kind of combination. Such considerations and facts must convince us of the error of endeavouring to place the source of special vital action in any particular form or arrangement of organic matter, whether fibre, cell, nucleus, or molecule. Each and all of these elements, the author contended, had their vital endowments, which reoperate on the others. But, inasmuch as the molecular element is the first as well as the last form which organized matter

* 'Philosophical Transactions,' 1850, Plates xxviii, xxix, figs. 59, 68, 70, 78.

assumes, it must constitute the principal foundation of organization itself.

The author pointed out that it was not his object, in directing attention to a molecular theory of organization, to interfere in any way with the well-observed facts on which physiologists have based what has been called the cell-theory of growth. True, this last will require modification, in so far as unknown processes of growth have been hypothetically ascribed to the direct metamorphosis of cell-elements. But a cell once formed may produce other cells by buds, by division, or by proliferation, without a new act of generation, in the same manner that many plants and animals do, and this fact comprehends most of the admitted observations having reference to the cell doctrine. The molecular, therefore, is in no way opposed to a true cell theory of growth, but constitutes a wider generalisation and a broader basis for its operations. Neither does it give any countenance to the doctrines of equivocal or spontaneous generation. It is not a fortuitous concourse of molecules that can give rise to a plant or animal, but only such a molecular mass as descends from parents and receives the appropriate stimulus to act in certain directions.

In conclusion, the author remarked that the theory he had endeavoured to establish on histological and physiological grounds is fully supported by all the known facts of disease and of morbid growths, which further serve to show that pathology, so far from being cellular, is in truth molecular.

TRANSLATIONS.

On the Chronispores, *or* Chronizoospores, *of* Hydrodictyon, *and on some* Analogous Reproductive Bodies. By M. N. Pringsheim.

(From 'Ann. d. Sc. Nat.,' IVme Ser., t. xiv, p. 52. Originally published in German in Bericht der Ak. d. Wissenschaft. zu Berlin, 1860.)

The observations of A. Braun and Gustave Thuret, demonstrate that in many families, both of marine and fresh water algæ, the same plant may possess at the same time two kinds of zoospores, of different dimensions.

These two forms of zoospores evidently exist in the Œdogoniaeæ and Saprolegnieæ, and the relations which I have indicated between the existence of similar reproductive bodies and the sex of the parent plant, appear to me to throw considerable light on the morphology and the entire history of these interesting algæ. It may certainly thence be conceived how important it is to study with care the morphological value of these bodies in the other orders of hydrophytes, furnished with two kinds of zoospores; for, doubtless, by this method of research, we should be able to fill up some important gaps in the history of the development of many genera or species, which we can no longer flatter ourselves are well understood, since algology has been enriched by so many new facts.

It was under the inspiration of this idea that I undertook a series of researches upon the zoospores (Schwärmsporen-Keimlinge) of the algæ, the results of which, as regards *Hydrodictyon* and some analogous algæ, form the subject of the present paper. The zoospores of these plants behave in a manner hitherto unknown, and this first discovery promises many others to those who will pursue their investigations in the direction that I have marked out.

Zoospores, so far as science has hitherto shown, have this in common, that they germinate as soon as they cease moving, and, consequently, very shortly after they are set at liberty. This circumstance has even been supposed to furnish a useful character by which zoospores may be distinguished from other reproductive bodies (Samen-Körper).

But, besides those zoospores which germinate immediately, as nearly all those known at the present day do, I have discovered the existence of others whose destination is very different.

These particular zoospores, far from germinating the moment they become still, have the power of remaining nearly in the same condition for a longer or shorter time, according to external circumstances, or even of undergoing an absolute suspension of development.

This phenomenon recalls, by an evident analogy, what is known of the encysting of the Infusoria, to the most simple forms of which zoospores bear such a strong external resemblance that it is difficult to distinguish them without having followed out their development.

The zoospores of which I am about to speak differ from the ordinary zoospores belonging to the same species, not only in the prolonged period of latent and inactive life which succeeds their activity, but also in the nature of the phenomena which mark the end of this period, and their entrance into a new life. In all other respects they resemble ordinary zoospores, they have the same form and the same structure, and as to their morphological signification, they are also to be classed with those reproductive bodies by whose agency the multiplication of the plant to which they belong is effected without the aid of sexes. Side by side, then, with the zoospores which germinate immediately, there are others whose germination may be normally suspended or deferred, and which I propose to call *Chronizoospores* (Dauerschwaemner).*

The plant in which I shall show the presence of this particular kind of zoospore is *Hydrodictyon utriculatum.*

This curious *alga* has been studied by so many naturalists, and its history is so rich in interesting details, that as it will be impossible for me to give them all here, I shall only refer briefly to such as bear directly upon the subject of this notice.

After Vaucher, in the year 1800, discovered that young Hydrodictyons were engendered in the cells of the adult plant, and escaped thence completely formed, M. Treviranus satisfied himself that these new individuals owed their origin to isolated granules, which, before they united into a network, had the power of moving freely within the mother-cell. However, he was not able to demonstrate this

[* Statospore (*Hicks*).]

curious phenomenon satisfactorily. M. A. Braun was the first to recognise the precise manner in which this intestine generation of new plants takes place; and he also first noted the existence in *Hydrodictyon* of two kinds of zoospores, differing in size and produced in distinct utricles. He asserts that the largest, described by him as *macrogonidia*, are specially those which unite into a network in the cellular cavity where they are born; whilst the others, on the contrary, the *microgonidia* more particularly, deserve the name of zoospores; they escape from the generative cell after it is broken up, and it is above all when outside it, that they move about with vivacity, in order to disperse themselves in all directions. M. Braun supposes that these zoospores, when they have become motionless, take the globular form of *Protococcus*; that they live some time longer without perceptible growth, and perish at last without multiplying themselves in any manner.

After these observations, the history of the development of *Hydrodictyon* might be considered to be perfectly understood, at all events as much so as that of many other *algæ* in which the germination of the reproductive bodies had been proved. According to the idea held at that time of the inferior cryptogamic plants, the cycle of their existence was supposed to be complete or thoroughly known, from the moment a mode of propagation was discovered, whatever it might be, by which the preservation of the species was assured in itself; but since our knowledge has been enriched by the discovery of sexuality in the Confervæ, and nobody can be ignorant of the remarkable succession of abnormal or unexpected phenomena brought to light every day by the study of different kinds of zoospores, we can no longer believe in the apparent simplicity or uniformity of the development of the inferior Cryptogamia, but are incited to try and bridge over some of the too evident gaps in their history. With regard to *Hydrodictyon*, another consideration, common alike to many other fresh water *algæ*, might long ago have led to the supposition that its reproduction could hardly be solely attained by the intra-utricular networks. Many observers will, doubtless, have remarked that in the isolated ditches where this plant usually lives, it perpetuates and renews itself indefinitely, in spite of the temporary draining of the water, and the more or less prolonged desiccation thus caused. The smallest experience will suffice to refute the opinion of Vaucher, that *Hydrodictyon* can be entirely dried up without perishing; an opinion, indeed, which it appears to me was not founded on any accurate experiments. The fact that this alga can resist a long desiccation admits of another interpretation; it may be explained, indeed, by the existence of particular germs, possessing those properties wrongly attributed by Vaucher to the plant itself. Now, it appears to me that these germs are no other than the *microgonidia* of *Hydrodictyon,* those zoospores (fig. 1, *a*) which, at a given moment, quit the utricular cavity in which they have been formed, and spread themselves outside in all directions.

Their activity lasts only a few hours; when it has ceased, far from germinating directly, they become round (fig. 1, *b, c*), and their tegument acquires the character of a resisting membrane, of the nature of cellulose. In this transformed condition the *microgonidia* resemble the little granules of *Protococcus,* and are able to endure for many months a complete desiccation, provided they are protected from the action of light. The changes they undergo during this time are inconsiderable; at the end of several months they are still green or yellowish globules, measuring $\frac{1}{200}$, or $\frac{1}{120}$ mm. in diameter, and very much the same as they were after their first transformation.

If they are exposed, on the contrary, to the light during their desiccation, the microzoospores wither and die, and can never be recalled to life by any means.

If they are plunged in water, whether exposed or not to the light, they may be preserved for many weeks, and even months, without any alteration. It is only after a considerable lapse of time, varying, no doubt, according to external circumstances, but never under three months in my experience, that the submerged zoospores give the first signs of a new vegetation. They then behave exactly like those which, after having undergone a prolonged desiccation in the dark, have been just remoistened.

Then all these globular cells, so analogous in appearance to *Protococcus,* begin to grow slowly. During four or five months, at least according to my own observations, their vegetation only consists in an augmentation of size, so that at the end of that time they represent so many large green or brownish-green cells, whose membrane possesses a very appreciable thickness. Their endochrome, rich in green matter, has at the same time increased and thickened, and a large granule may be distinguished in it from the commencement, which appears to play the same physiological part as that attributed by M. Braun to the amylon-cells of the adult *Hydrodictyon.* In the enlarged zoospore, though still retaining the form of a *Protococcus,* a vacuole might be supposed to occupy the centre of its cavity; but, in reality, the granular plasma which it contains, as has been often observed in other vegetable cells, is attached to the walls, whilst the fluid portions of the contents are collected in the centre. The amylon-cell of which I have just spoken is embedded in the granular parietal layer. Ordinarily, no other kind of development takes place until the zoospore has attained a diameter of $\frac{1}{40}$ m.m. But, if during its vegetation it has undergone alternations of dryness and moisture, it increases still more without modifying its earliest form, and its diameter may measure $\frac{1}{30}$ m.m., or even $\frac{1}{50}$ m.m., whilst its cellulose envelope becomes gradually thicker, and the nucleus from which the chlorophyll has entirely disappeared assumes more or less of a brown tinge.

These differences in the globular zoospores do not, however, influence their ultimate development. In all, the endochrome divides successively into different portions, then the external layers of the membrane soon give way, and afford a free passage to the internal layers which are extruded in the form of a gelatinous herniary sac. Into this sac the plastic masses now become separate and distinct from the breaking up of the primitive endochrome, enter, and present the regular form (fig. 8), and all the characters of true zoospores. These new bodies are of considerable size; they differ from the ordinary and well-known zoospores of *Hydrodictyon,* and bear more resemblance to those of *Œdogonium,* but instead of showing, as the latter do, a circle of vibratile cilia, they only possess one or two at their anterior and semi-transparent extremity. The number and size of the fresh zoospores which are thus produced within the primitive ones, vary according to the dimensions of the latter, and the division of their nucleus into more or less numerous portions. According to my own observations, from two to five new zoospores replace the old ones; the size even of those issuing from the same matrix varies considerably, for example, between $\frac{1}{58}$ m.m. and $\frac{1}{30}$ m.m. in length, and between $\frac{1}{48}$ m.m. and $\frac{1}{45}$ m.m. in thickness. The herniary sac of which we have spoken above, is easily ruptured (fig. 9), and allows the new zoospores to escape in a state of as great activity the moment they are liberated, as if they were legitimate zoospores; but after some minutes, frequently within the generative utricle itself (figs. 10 and 11), they become motionless, and assume the shape of almost polyhedral cells, whose angles are produced like horns or long appendages (fig. 12).

These angular cells, or *polyhedrons,* as they may be called, are highly polymorphous; they grow, and the appendages are multiplied at various points on their surface (figs. 13—17).

Their contents increase in like proportion, whilst the granular portion forms numerous amylon-cells, and assumes all the character of the endochrome of the ordinary cells.

Under favorable circumstances, at the end of a few days the same phenomena may be observed within these polyhedral cells which M. A. Braun has so well described as preluding the formation of new networks. As a last result of this vital effort, the endochrome attached to the cell-walls divides into a multitude of distinct zoospores, which remain at first fixed where they were formed, giving to the membrane that supports them a reticulated appearance (fig. 18).

When these zoospores begin to move, the thick membrane which forms the generative utricle undergoes a sort of reduplication, its external layers are broken up and dispersed like the shreds of a cuticle; and the internal layers, of a gelatinous nature, are laid bare (figs. 19 and 20). At the same time the young zoospores, whose activity scarcely lasts from twenty to forty minutes, unite into a little network, which sometimes consists merely of a few meshes forming a single layer, but more often, especially in those large polyhedrons rich in endochrome, in which a great many zoospores are produced, it forms a completely closed sac, like the well-known network of *Hydrodictyon.*

In the same manner as the young networks, engendered within the cells of the adult *Hydrodictyon* are enclosed in a gelatinous envelope, evidently derived from the internal layers of the parent-cell, so also are those produced in the polyhedral utricles. They grow without any increase in the number, but simply by the augmentation in volume of the joints, and at last each of them, in the course of its further development, bursts its mucous envelope, which disappears entirely.

The networks arising from the *polyhedrons* differ in no essential respect from the young *Hydrodictyon;* but, whilst the latter consist commonly of many thousand cells, sometimes of thirty thousand, according to M. Braun, the former rarely present more than two or three hundred.

(*To be continued.*)

NOTES AND CORRESPONDENCE.

Notes from Madras.—On turning over the plates of the new edition of Pritchard's 'Infusoria,' just received, my eye was arrested by the valve in the sheath of *Vaginicola valvata*, Wright, figs. 18, 19, pl. xxix, said to be a marine species.

In April, 1852, I discovered a similar valve in a species differing only from *V. crystallina* by the absence of green granules and its somewhat larger size. It will probably be found in all the genus if carefully looked for. It is easily overlooked, and in my case was only satisfactorily made out when the edge of the valve was turned towards the object glass, and the animal was pushing it open with the anterior part of its body, which it does very slowly, when extending itself to feed. The action of closing the valve was too rapid for the eye to follow. The animal when feeding generally had the anterior half of the body bent at a right angle to the sheath.

It was attached to a common water-weed (of which I have never learned the name) growing in a small tank (or gunta) at Bangalore, in Mysore, 200 miles inland, and 3000 feet above the level of the sea.

As the valve, therefore, is not confined to one species, it will be necessary to alter the specific name given to Dr. Wright's species. I ought to add that I had numerous subjects, and, as my notes show me, I observed them very carefully during several days.

Desmidiaceæ—At page 98 of the Rev. J. M. Berkeley's 'Introduction to Cryptogamic Botany,' I find the following passage:—

"The Desmidiaceæ of other countries than Europe or North America have been at present but little studied, nor does it appear that they are in reality numerous. Dr. Hooker's Indian collection shows but a trace of them."

I have not made a special study of the Desmidiaceæ, but they have fallen in my way sufficiently often to justify me in saying that there is no deficiency of them in those parts of Southern India in which I have used the microscope. I may mention the following genera, viz., Closterium, Tetmemovus, Docidium, Micrasterias, and many others, which, as I write from memory only, I will not name.

I remember some years ago enjoying the spectacle of the rotation in Tetmemovus of which a friend, the late J. Western, Esq., had obtained a large gathering. With a quarter of Smith and Beck's we saw it as easily as we commonly see it in Nitella or Valisneria. It struck us that it was much more vigorous than in similar plants in England, so far as we could judge from book descriptions of the phenomena as witnessed in that country.

Polyzoa, Fresh Water.—A similar statement is made by Professor Coleman in regard to the geographical distribution of the Fresh Water Polyzoa, which want of information has led him to believe are not found in India, or, as he says, "South of the Mediterranean in the old world." I have not had much experience in this particular branch of our science, but in September, or perhaps August, 1857, I had the good fortune to obtain a large supply of the genus Lophopia (I believe). They were in small colonies, attached to the roots of duckweed, in a small garden pond. Unfortunately some ducks got at the Lemma, and devoured it all, and the pond shortly after became dry, it being the end of the dry season. There has been no duckweed on that pond since, and on duckweed from another pond I have not been able to find it. If I had the leisure to make a thorough search, I doubt not I should find not only that, but specimens of other genera. My opinion, founded on nearly twelve years' experience, is that India is very rich in employment for the microscopist. The harvest is abundant, but the labourers are few. Of course I do not blame the talented authors who have written according to their knowledge, and who may retort by saying, "Why, if you are so abundantly supplied, do you keep the knowledge of it to yourselves?" There are many reasons, I have named one—the paucity of labourers. Another, not less important, is the want of books of reference, which makes it impossible for a man to say whether an object he sees for the first time is new to science, or only new to him, and people do not like to run the chance of being snubbed, or something like it, because they have not been able to obtain knowledge of the prior discovery of something which a London editor, with the best libraries in the world to refer to, at last only finds an account of in some foreign publication, of which not one Englishman in a hundred thousand, perhaps, has ever heard.

There is not, that I am aware of, a natural history library in the whole of this presidency, and gentlemen in London "who live at home at ease" and have such ample stores of knowledge to refer to, should have some consideration for us dwellers in the wilderness, when we happen to be ignorant of a subject perhaps not very commonly known even in England.

This want, however, is in the course of being supplied at Madras, which will, I hope, in the course of another year or two, possess at least a respectable natural history library, if not a thoroughly complete one.—J. MITCHELL, Lieut. Madras Veterans.

The late Professor Quekett.—We trust the attention of our readers was directed to an announcement made last week in our advertising columns, to the effect that a subscription had been set on foot for the benefit of the four boys left by the late respected Professor Quekett. Few men were so ready to assist the members of our Profession in their microscopical difficulties, or more willing to give them good advice on matters connected with his department of science. Seldom a day passed without a portion of the late Conservator's time being devoted to the examination of various morbid structures for his Medical friends. Those of us who have the power will surely second the efforts of the *Working Committee.* We may remind our readers that Professor Quekett, about five years ago, succeeded Professor Owen as Conservator of the Museum of the Royal College of Surgeons. Almost ever since he obtained this appointment his health was so bad that he was unable to insure his life, and before this time his income (£300) was too small to enable him to do so. He died at the early age of forty-six, and leaves a widow and four sons. The effort which has been set on foot has for its object the collection of a sum of money for the purpose of starting the four boys in the world when their school education is completed. It is intended to invest the money in the hands of trustees until the boys arrive at an age to require it. The following gentlemen have formed themselves into a Working Committee for the above-mentioned object:—Professor Owen, F.R.S.; the Hon. and Rev. Lord S. G. Osborne; Dr. Bence Jones, F.R.S.; Professor George Busk, F.R.S.; Frank Buckland, Esq., M.A., M.R.C.S.; and Lionel S. Beale, F.R.S., of King's College, London, is Honorary Secretary.

Messrs. Twining, bankers, 215, Strand, will also receive subscriptions. We feel sure that the facts we now lay before them will suffice, without any appeal from us, to plead the cause of the "fatherless and the widow" of our departed brother.—*From the 'Medical Times and Gazette.'*

Memorial of the late Professor Quekett, F.R.S.—The President, Council, and Members of the Microscopical Society of London, desirous of testifying their esteem for the late Professor Quekett, and to commemorate the value of his services rendered to the Society for nearly twenty years, and to the progress of Microscopical Science throughout the world, have resolved upon raising an appropriate testimonial to his memory.

The above having been put as a formal resolution, at the last Council Meeting of the Microscopical Society, the following members have agreed to act as a committee for the collection of subscriptions :—R. J. Farrants, Esq., President; Sir R. J. Murchison, F.R.S., &c.; Thomas Bell, Esq., F.R.S.; N. B. Ward, Esq., F.R.S.; J. S. Bowerbank, Esq., F.R.S.; Dr. Lankester, F.R.S.; Dr. W. Harvey, F.R.S., Dublin; Mathew Marshall, Esq.; Charles Woodward, Esq., F.R.S.; Charles Brooke, Esq., M.A., F.R.S.; Rev. J. B. Reade, M.A., F.R.S.; Rev. F. Wiltshire, F.G.S.; S. C. Whitbread, Esq., F.R.S.; James Glashier, Esq., F.R.S.; Dr. Ansell; Dr. Millar; Dr. Wallich; T. W. Burr, Esq.; F. S. C. Roper, Esq.; E. G. Lobb, Esq.; F. H. Wenham, Esq.; H. Perigal, Esq.; J. Newton Tomkins, Esq.; G. E. Blenkins, Esq.; H. Blanshard, Esq.; J. R. Mummery, Esq.; W. A. Boyle, Esq.; Henry Deane, Esq.; J. H. Roberts, Esq.; Dr. Guy; with power to add to their number. Treasurer, S. C. Whitbread, Esq.—Jabez Hogg, Hon. Sec., 1, Bedford Square.—Bankers: The Union Bank of London, Regent Street Branch, Argyll Place, to account of Quekett Memorial.—*November*, 1861.

On a Nose-Piece.—Another addition to the microscope, which I made about a couple of years ago, and which has been very useful, is a *triple nose-piece.* I had often found Mr. Brooke's double one valuable, but, in the examination of various things, three object glasses are often needful. And, in exhibiting to friends, the additional power is a considerable advantage, while three are, generally, as many as we wish to use for this purpose.

In planning the nose-piece I made patterns of millboard, of various shapes and projections, one of which extended beyond the stage; but this appeared in the way, and, as my object glasses would work together over the stage without danger from touching it, I began on the same scale as the double one, which, also, I nearly copied in the connexion with the body, adding a *heel* (Diagram 2), to secure the objective in its place while being used.

2.

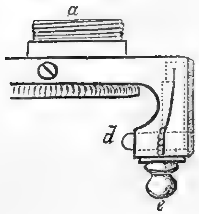
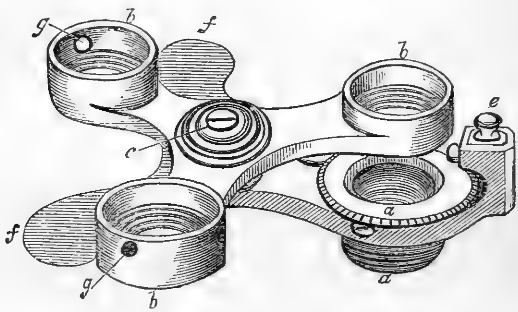


Diagram 1 gives the whole piece (underneath), and as

1.



being moved for change of power. This, and Diagram 2, are about real size.

3.

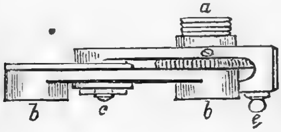


Diagram 3, half size. The letters are the same in all three.

a. The adapter, with milled head, to screw the nose-piece to the body; *b*, the noses, in which the object glasses are screwed; *c*, a pivot on which the piece holding the objectives revolves; screw head regulating its tightness; *d*, (Diagram 2) a small *bolt* passing through the heel, as shown by dotted lines. This bolt is driven by a fragment of watch spring into a corresponding hole in the nose (Diagram 1 *g*), on the object glass arriving at its place. The other dotted lines indicate a hole drilled nearly through, the greater part large enough for the spring to work in freely; the smaller part at the top has brass wire fitted in, which holds the spring. When a change of objective is required, the knob *e* is drawn towards the stand, which withdraws the bolt; *f*, the cover to keep dust out of the object glasses not in use.

In amount of projection, the centre of each "nose" is $1\frac{3}{8}$ inch from centre *c*.

I believe a quadruple nose piece might be made to work well on the same plan; but it is rare that four objectives are needed at one time, and the *weight* of the whole would, probably, be inconvenient.—JOHN BURTON.

Fossil Diatomaceæ.—In the January number of the 'Quarterly Journal,' in a paper communicated by F. C. S. Roper, Esq., F.L.S., F.G.S., &c., on some undescribed species of diatoms, by George Norman, Esq., of Hull, there is one figured on Pl. II, fig. 3, called the *Coscinodiscus fuscus,* and described in the text, the habitat is described as the stomach of marine Ascidians, North Sea.

On examining my slides of Diatomaceæ a short time since, I was struck by finding one similar in appearance; the slide is labelled "Fossil Diatoms from Guano." Having the 'Journal' by my side, I compared notes, and measured my own, and thus describe it: valve convex, depressed in centre so much so that on using an $\frac{1}{8}$th it is impossible to get the centres and edges accurately in focus; at the same time striæ ranged in parallel lines, diminishing in number. At intervals dots about 20 in ·001″; valves variable in size from 002″ to 006″; in colour they are light blue, and in a few darker at the edges. They are by no means rare, as the slide is composed of about 15 or 20 per cent., the remaining portion being the *C. radiatus* figured in the 'Micrographic Dictionary,' Pl. xviii, fig. 32, these are very coarsely marked. I must now differ a little, if I am allowed to hold a contrary opinion to so eminent an observer as Mr. Norman, but what he calls granules I call areolæ or depressions. I have tried the *C. fuscus* with every variety of light, and as seen in some portions they look very much like granules lying upon the surface of the valve; on applying a very high power and humouring the light so as to get it at the proper angle, they are distinctly seen (at least I think so) to be pits quite through the valve. I have been farther led to this conclusion by a careful examination of the *C. radiatus,* a kindred genus of the same habitat. These with a power of 750 diameters, and oblique light, show distinctly to be foramina the light is reflected from the inner edge of each oblong foramen, and in several broken pieces the line of fracture is invariably through the depressions. Thus from analogy we derive our convictions. There is also collateral evidence —in the same slide there are some pieces near the edge that have been accidentally placed in contact with thick balsam, and the fluid has been found to enter the pores by capillary attraction, which it would not have done had they been elevations. But I am perhaps scarcely qualified to form a conclusion; but I have laid before you the premises upon which I have founded my conclusion, and I shall be very glad to send you the slide for your inspection, if you wish. My sole object in troubling you was to show the wide geographical range of this species, the one being derived from the North Sea, the other from the West Coast of Africa, and also the age of the species, as I presume that described by Mr. Norman to be a recent species, mine is fossil.—W. F. Cooper, Sheffield.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *October 9th*, 1861.

R. J. Farrants, Esq., *President*, in the Chair.

W. C. Parkinson, Esq., Edward Richards, Esq., J. R. Burton, Esq., and A. Cattley, Esq., were balloted for, and duly elected members of the Society.

The following papers were read:—"On a Portable Revolving Table," by Mr. Burton. ('Trans.,' p. 9.)

"On a new Cheap Microscope," by Mr. Beck. ('Trans.,' p. 11.)

"On Some Fossil Diatomaceæ," by Mr. W. F. Cooper. ('Journal,' p. 65.)

November 13th, 1861.

R. J. Farrants, Esq., *President*, in the Chair.

Rev. J. H. Dale, F. Abbot, Esq., J. W. Stephenson, and Rev. J. G. Hughes, were balloted for, and duly elected members of the Society.

The following papers were read:—"On the Hairs of Insects," by Mr. T. West.

"On the Further Development of the Coccus," by Mr. Beck. ('Trans.,' p. 16.)

December 11th. 1861.

R. J. Farrants, Esq., *President*, in the Chair.

F. Rizon, Esq., was balloted for, and duly elected a member of the Society.

The following papers were read:—"On some new Species of Diatomaceæ," by Dr. Greville. ('Trans.,' p. 18.)

"On the Microscopic Structures of the Hairs of Vegetables," by Mr. T. West.

Slides illustrating the same, were also presented by Mr West.

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY.

October.

	Presented by
Second Geological Survey of Arkansas . .	Smithsonian Institute.
Transactions of the Academy of Science of St. Louis, 1860	Ditto.
Smithsonian Report, 1859 . . .	Ditto.
Smithsonian Contributions to Knowledge, Vol. XII .	Ditto.

	Presented by
Recreative Science, Journal, Nos. 24 to 27	The Editor.
Journal of the Proceedings of the Linnean Society, Vol. V, No. 20	The Society.
Ditto, Second Supplement to Vol. V, "Botany"	Ditto.
Quarterly Journal of the Geological Society, No. 67	Ditto.
Canadian Journal of Industry, Science, and Art, Nos. 34 and 35	Ditto.
Transactions of the Tyneside Naturalist's Field Club, Vol. V, Part 1	Ditto.
Notes on New Species of Microscopical Organisms from the Para River, South America. By Loring W. Bailey	The Author.
Photographic Journal, Nos. 110 to 113	The Editor.
London Review, Nos. 50 to 65	Ditto.
The Annals and Magazine of Natural History, Nos. 44 to 46	Purchased.

November.

On the Classification and Geographical Distribution of the Mammalia. By Richard Owen, F.R.S.	F. C. S. Roper, Esq.
Quarterly Journal of the Geological Society, No. 68	The Society.
Journal of the Proceedings of the Linnean Society, Vol. VI, No. 21	Ditto.
Recreative Science, No. 28	The Editor.
The Annals and Magazine of Natural History, No. 43	Purchased.

December.

Photographic Journal No. 115	The Editor.
Recreative Science, No. 29	Ditto.
London Review, Nos. 69, 74, 75	Ditto.
The Annals and Magazine of Natural History, No. 48	Purchased.
Seven Slides of Sections of Coal	T. Tupholme, Esq.
Six Slides ditto Various	Tuffen West, Esq.

W. G. Searson, *Curator.*

Southampton Microscopical Society.

This Society gave a Microscopical Soirée on the evening of December 13th, at the Victoria Rooms, Southampton, which was attended by upwards of 600 visitors, who expressed much interest and delight in what they saw, and in the pleasure of the meeting. There were thirty-five microscopes arranged on twelve circular tables, with two members of the Society at each table to demonstrate. The Committee collected slides from the members, selected the best for the purpose, and arranged them according to the animal, vegetable, and mineral kingdoms, appropriating a dozen to each table. Each member who brought a microscope also provided a lamp. A table was allotted for the polarization of light, and another for photographs. Mr. Ross lent some binocular microscopes, and their stereoscopic effect was strikingly beautiful. Side tables with curiosities lent for the purpose were arranged round the room, and assisted in entertaining those who waited their turn at the microscopes. Amongst the curiosities were valuable collections from Egypt, India, and the South Sea

Islands; the original drawings in Captain Cook's voyages; specimens of minerals, fossils, and antiquities; coins, missals, &c. The room was decorated with flowers and greenhouse plants, and as the human flowers were in full evening bloom, the mingling of well dressed ladies, with well-lighted microscopes, made a pleasant tableau. It was strictly an evening party; no lectures, no addresses, nor was there any music, as this would have interrupted the special object of the evening. Tea and coffee were provided by some of the members who lent their servants.

We have admitted this minute description of arrangements as the success of such entertainments consists in arranging everything previously, and, as such meetings must spread a taste for microscopical studies, we trust the example of this provincial re-union may be followed in other towns.

The visitors were of those various classes which do not usually meet in the same evening parties, and this is of social benefit. We want more unity and less division amongst us. Science is a common ground; and in all our leading scientific societies he stands highest who knows the most, or has the greatest gift of insight, whatever may be his social status.

Manchester Literary and Philosophical Society. Microscopical Section.

21st October, 1861.

Professor Williamson in the Chair.

The following gentlemen were elected members of the Section: —Mr. Murray Gladstone, Mr. John Whalley, Mr. William Henry Heys, Dr. William Roberts, and Dr. Thomas Alcock.

The Secretary presented sixty specimens of soundings received since the last Session, from the commanders of various steamers and sailing vessels, amongst which were a number from the South Coast of Ireland, Banks of Newfoundland, Coast of Nantucket, U.S., North Coast of Brazil, &c. The Secretary was requested to write a letter of thanks from the Section to each contributor.

The Chairman remarked that these specimens deserved the best attention of the Section, not only on account of their intrinsic interest, but to show the contributors that their kindness in preserving the soundings for the Section was fully appreciated.

Mr. Dale offered, with the assistance of the Secretary, to prepare the material, by separation from the tallow, &c., and Mr. Nevill, Mr. Heys, and several other gentlemen, offered their assistance in mounting, examination, and reporting to the Section.

The Chairman observed that the method he employed in the preliminary examination of similar specimens, when freed from tallow and dried, was to stir the mass in a vessel of water, when most of the organic forms rose to the surface, in consequence of containing small quantities of air; the creamings off the top of the liquid would be found to contain sufficient indications whether the specimens deserved further attention.

The Secretary read a letter from Mr. Joseph Sidebotham, accompanying a specimen and a drawing of the *Aulacodiscus formosus*, showing the four projecting knobs or handles visible upon that diatom. Mr. Sidebotham states that in all drawings hitherto published, these protuberances appear like simple elevations or bosses, nor could they be seen otherwise until the binocular microscope revealed their true shape. Mr. Dancer first called his attention to this peculiarity.

Mr. Crompton exhibited, and presented to the members, specimens of capillary tubes used by him to collect and preserve fluids for microscopical examination for medical purposes. Mr. Crompton has used such tubes for more than a year, and has preserved specimens of blood, urine, &c., which by any other method would have spoiled. The main feature consists in hermetically sealing the tubes after the introduction of the fluid, by holding their ends alternately in the flame of a candle or lamp until the glass melts, and the orifice closes; the tubes may be about three fourths filled by capillary attraction or immersion, and care must be taken not to allow the fluid to approach the hot end of the tube whilst being sealed. The Edinburgh vaccine tubes answer the purpose well; they may be about three inches long, and a number of them may be carried in a small pocket case at all times ready to be filled. When required for examination, the tube is broken, and the enclosed fluid placed under the microscope.

The Secretary exhibited a specimen of the compound salt of magnesia and copper, prepared by Mr. Thomas Davies, of Warrington. Doubts having been expressed if it were a true compound salt, or a mere mechanical mixture, Mr. Dale, who at the Secretary's request had prepared some of the salt, undertook to report further upon it. Some forms of crystal were exhibited, producing novel effects by polarised light.

Mr. Lynde exhibited a fine specimen of copper ore, with jasper, from Cornwall, the colours of which, when illuminated with the Lieberkühn, were very gorgeous.

Mr. Latham exhibited the ovary of a flea, and portions of the skin and teeth of the dogfish.

Mr. Heys exhibited specimens, mounted specially for the Lieberkühn, of various seeds, hairs, and glands of plants; the tesselated spines on the *Symphytum asperrimum*, or rough comfrey, and the ruby-coloured oil glands of the origamme onites, glowing, like precious stones, with the reflected light from above the object, were very much admired. For certain classes of objects no illumination can compare with that of the Lieberkühn in the use of the binocular microscope, and side lights may be obtained, to some extent all around the object, by manipulation with the mirror.

18*th November*, 1861.

E. W. Binney, F.R.S., F.G.S., in the Chair.

Dr. Edward Stephens was elected member of the Section.

The secretary read a communication from Mr. Thomas G. Rylands, of Warrington, "On the classification of the Diatomaceæ." The author desired to call attention to the want of systematic arrangement which characterises this favorite branch of microscopical investigation, and to the necessity of a thorough revision of the entire classification of the natural order. The author presented to the Section two slides to illustrate his arguments. The predominant form of frustules was first named by Dr. Brebisson *Cocconeis lævis*. In 1857 it was published by Mr. Roper (M. I. vol. vi, p. 22) under the provisional name *Coscinodiscus ? ovalis ;* but in consequence of finding on the valves eight to twelve submarginal obtuse processes with tumid bases, quite distinct from the spines or teeth which occur in the Coscinodisceæ, the author considers this species must be placed in the genus Eupodiscus, and may fitly be called *Eupodiscus lævis*. The specimens were obtained at Llandudno, in ripples in the sand below mid-water; and the paper concludes with a description of some peculiarities connected with their sudden disappearance.

Mr. John Watson read a paper "On certain Scales of some Diurnal Lepidoptera," in which he recommends a new and careful study of this subject. In some genera peculiar scales, called plumules, have long been known; but examination with the binocular microscope shows that they are not flat like the ordinary scales, but cylindrical and hollow. They have been found only in certain genera (named in the paper) at present, and on the males alone: they possess generic resemblances and specific differences, each species displaying its own distinguishing variety. One of great beauty and novelty, found only on two African butterflies, *Pieris agathina* and *Pieris chloris*, was described, and some very fine drawings of it, by Mr. Joseph Sidebotham, were exhibited, and also other figures by him of about one hundred species never figured before. The names and habitats of the insects were given, and the author pointed out the value of these scales for the assistance of the scientific entomologist in arranging genera and species; he then entered into the question of their probable use as air vessels in the economy of the insects possessing them.

The Chairman remarked that the scales of the Lepidoptera may prove as valuable in determining species as the scales of fishes.

Mr. Sidebotham alluded to the value of the binocular microscope in defining the cylindrical form of the plumules, and described the mode of finding them *in situ*, by breaking the wing.

Mr. Watson stated that some of Mr. Sidebotham's excellent drawings were taken under the eighth objective, magnifying 750 diameters. Mr. Watson further said that he had examined the wings of 400 specimens of the Papilionidæ, but had not discovered any plumules in that genera: he also alluded to several so-called species from South America, of which no males have yet been found, others of which no females have yet been discovered, and suggested the possibility of some of these being male and female of the same species; to ascertain which, careful examination of the scales might be useful.

Mr. Watson exhibited a number of mounted specimens of the plumules, and four cases of the Lepidoptera from whose wings the 98 drawings figured by Mr. Sidebotham were taken. They were principally Pieris, Anthocaris, Thestias, Euterpe, and Eronia; amongst the former were some new and unnamed species from Celebes, with rare specimens from Venezuela, Quito, East and West Indies, Africa, and other parts of the world.

Mr. Dale placed on the table a number of washed soundings, of which several members took specimens for examination.

Mr. Dale also reported that the sulphate of copper and magnesia has been long known to be a compound salt. When the magnesian salt is in excess, it has seven equivalents of water; and when the copper salt is in excess, it has five equivalents of water. Mr. Dale had also made for the occasion samples of the double sulphate of copper and potash, the double sulphate of copper and ammonia, and the double chloride of copper and ammonia, which he distributed amongst the members. They were all beautiful polariscopic crystals, the chloride particularly so, and each has its characteristic form.

Mr. Linton exhibited the hairs on the *Loasa coccinea* (Chili nettle), mounted by Mr. Heys.

Mr. Dancer exhibited a specimen of the *Aulacodiscus formosus*, which, in consequence of a fracture since it was mounted, shows more distinctly the form of the projections that Mr. Sidebotham brought under the notice of the Section at the last meeting. These handle-shaped spines, Mr. Dancer observed, seen with the 1-8th power and binocular microscope, are found to project outwards from each of the four elevations on the surface of the valve.

Mr. Dancer also exhibited several ova of the Trout, forwarded by Mr. John Whalley.

Mr. John Parry showed some magnified photographs of fossil woods from the South Lancashire coal field. These displayed beautifully the structure, even to the most minute vessels.

Mr. Brothers exhibited the *Floscularia ornata*, and a fine group of *Lacinularia socialis*.

Mr. Mosley exhibited a specimen of *Amœba diffluens*, and described the peculiarity of its motion. A portion of the one under examination appeared to be blown outwards like a bladder, in which appeared a small animalcule making desperate efforts to escape. The best illumination for observing the internal motion, he considers to be Wenham's parabola and Lieberkühn, with a 4-10th objective.

December 16*th*, 1861.

E. W. Binney, Esq., F.R.S., F.G.S., in the Chair.

Dr. Edward Morgan was elected a member of the Section.

Letters were read by the Secretary from Mr. Sidebotham and Mr. Watson from London, relative to the cost of engraving two plates to illustrate Mr. Watson's paper "On Scales of Lepidoptera" read at last meeting; Mr. Brothers exhibited two photographs of these scales, and reported upon the expense of printing by that method. It was decided that the Secretary be requested to lay the estimates before the Society.

Extracts were read from letters of Dr. Wallich, in which he regretted he could not lend to the Section for exhibition any of the specimens of soundings obtained from the North Atlantic by the expedition of the "Bull Dog." Dr. Wallich looks upon the whole collection as Government property; he has been informed that specimens have been sent out to the public by dealers as his North Atlantic soundings; but with the exception of a few drops of Globigerina ooze, sent to be mounted for exhibition at his lecture to the Royal Institution in London, in February last, some slides of which were said to have been sold by the mounter, Dr. Wallich has made it a rule not to distribute, nor even to exhibit specimens at all, until after the publication of his work on the subject, which is now going into the publisher's hands, and will be ready in the spring; with that exception, in no single instance, has a particle of the material been given out.

Dr. Wallich kindly presented to the Section for mounting several specimens of material from his private collection, containing Biddulphia of various kinds, and other Diatomaceæ from Guernsey, St. Helena, &c.

A letter to the Secretary was read from Jabez Hogg, Esq., the Secretary to the London Microscopical Society's Quekett Memorial Fund. Professor Williamson read a letter from Dr. Lionel S. Beale on the same subject. A subscription list was immediately opened, and will be sent in turn to members who were not present.

Mr. Thomas H. Nevill presented to the Section eight slides mounted from the specimen of soundings No. 131, taken in Lat. 51·48 N, Long. 7·8 W, off the S. coast of Ireland in 40 fathoms, presented by Captain Moodie of the R.M.S.S. *Canada*. Mr. Nevill reported that the specimen contained *Entosolenia marginata*, *Entosolenia squamosa*, *Lagena vulgaris*, *Textularia*, *Rotalina*, *Miliolina*, numerous spines and plates of Echini; calcareous prisms from shells, &c., &c., all water worn. The sand is composed of about half calcareous and half silicious material.

Mr. Latham proposed that the subject for discussion at the next meeting should be "On the Cause of the Metallic Lustre on the Wings of the Lepidoptera, both diurnal and nocturnal," which was agreed to.

Mr. Latham also reported upon the ovum presented at the last meeting by Mr. Leigh.

Mr. Latham presented to the section a slide mounted with a portion of the elytra of the *Platyomus subcostatus*, from Venezuela; also an oak spangle, with stellate hairs.

Mr. Binney exhibited mounted specimens of fossil wood from Standish, near Wigan; *Trigonocarpore oliviforme*, from the lower Lancashire coal-bed; and the palate of the *Psammodus porosus*, from the mountain limestone, county Armagh.

Mr. Joy presented mounted sections of coal from Bohemia, showing woody fibre.

Mr. Whalley exhibited living ova of the trout, one month old.

Mr. Brothers exhibited a section of agate from Siberia; *Stentor Mülleri*, &c.

THE MICROSCOPICAL SOCIETY OF NEWCASTLE-ON-TYNE.

SINCE furnishing you with a report of the proceedings of this Society, up to the time of its anniversary in February last, we have had several excellent meetings, and many interesting excursions in search of microscopic objects.

On March 5th Mr. B. Proctor read an elaborate and excellent paper, "On Micro-chemistry." On April 3rd, Mr. John Brown, "On the Structure and Modes of using the Microscope, and its various appliances." On June 4th, the Secretary explained the principal objects of interest to be found on the sea coast near Tynemouth.

August 6th.—Dr. Donkin read a paper "On the Binocular Microscope;" after which a warm discussion ensued, "On the Relative Value of the Monocular and Binocular Microscopes."

September 2nd: Mr. B. Proctor read a valuable paper "On Binocular Vision and the Binocular Microscope," towards the close of which he introduced arguments for the purpose of showing that the Binocular Microscope, when used with high powers, exaggerates the real elevation of microscopic objects.

September 25: eighteen members of the Newcastle Microscopical Society attended with microscopes at the Microscopical Soirée, in connexion with the South Shields Mechanics Institute. There were thirty-six microscopes exhibited, and much interest was manifested by a very large and respectable audience. There is every prospect of a Microscopical Society being formed in connexion with the institution.

Tuesday, October 1st; Mr. Martin, an amateur optician, delivered a lecture on "How to make a Binocular Microscope." He exhibited a large and very elegant instrument of his own construction, made after the pattern of Ross' best, on the Binocular principle. Much interest was exhibited in contrasting the powers of one of Smith and Beck's Monoculars with Mr. Martin's Binocular.

THE BRADFORD MICROSCOPICAL SOCIETY.

AT the Meeting, October 3rd, being the Annual Meeting, the President and Secretary of the Society were re-elected for the ensuing year, and a vote of thanks passed for their services during the past year.

On the evening of October 15th the Society gave a Soirée in St. George's Hall, which was very numerously attended. About thirty microscopes were exhibited.

Nov. 7th.—At this meeting was exhibited some highly interesting physiological subjects by the President.

Dec. 9th.—At this meeting an excellent paper "On the Structure of the Kidney" was read by George Grabham, Esq.

ORIGINAL COMMUNICATIONS.

An Abstract of Dr. Beale's Lectures *on the* Structure *and* Growth *of the* Tissues *of the* Human Body. Delivered at the Royal College of Physicians, April—May, 1861.

Lectures VI and VII (*Conclusion*).

Certain forms of areolar or connective tissue.—The areolar or connective tissue in connection with many of the higher tissues of the body appears as a delicate fibrous texture, in which the direction of the fibres is not uniform, or as a delicate transparent web, in which granules and irregular fibres are here and there seen, destitute of nuclei, and of any form of yellow elastic tissue, or associated with one or both of these latter structures. These forms are to be distinguished from the well-defined bundles of white and yellow fibrous tissue which possess nuclei, and which are found in the corium and in other situations. The structure we are now considering has been spoken of as indeterminate or indefinite connective tissue. You find it in papillæ, as in those of the tongue and skin, in connection with vessels, nerve fibres, and muscular fibres, between the follicles of glands, the uriniferous tubes, and in the brain and spinal cord, and in many other situations. It is often considered as a bond of union between different textures, and as a support to higher tissues, but it must be remembered that at an early period of development, when the tissues and parts of organs are very soft, and seem to be in greatest need of support, there is no indefinite connective tissue. Moreover, it must be quite obvious that in such an organ as the kidney the different structures support each other. The uriniferous tubes support the vessels which lie between them, and *vice versâ.*

By some it is asserted that this form of connective tissue contains cells or nuclei, while others deny this, and assert that even the higher forms of white fibrous tissue are produced independently of these structures. Dr. Beale endeavoured to disprove the truth of the latter assertion, but feels quite sure that the former statement is true. He has seen certain forms, both of white and yellow fibrous tissue, which are destitute of nuclei. The mode of formation of these structures will be presently discussed.

At an early period of development this form of connective tissue is absent. There are only traces of it in the fœtus at the seventh or eighth month, but it is found in increased quantity in the tissues of the child, and in still greater proportion in the adult. In some situations Dr. Beale thinks he has demonstrated that it increases as age advances, but at the same time it undergoes condensation, and therefore occupies less space. In disease it is often increased in situations where only traces are present in health, and it is found in situations where it is absent in the normal state. It is frequently present in large quantity in situations from which higher tissues have disappeared.

During the process of development tissues which serve but a temporary purpose are constantly being replaced by the growth of higher and more permanent structures. The complex tissue which exists in the adult is represented in the embryo by a much more simple type, which is removed and replaced often by several series of textures before a tissue like that of the adult is produced. The tissues are not developed in their permanent form, and do not simply increase as the body grows, but those textures which perform certain functions in the adult, are represented in the embryo by tissues which perform corresponding, but not exactly similar offices. Not only have the permanent glands certain temporary substitutes, differing from them in important points, but the structure of the different tissues, muscle, nerve, bone, &c., becomes modified as development proceeds, until the permanent type of structure is reached. At the sixth or seventh month of intra-uterine life it is not possible to trace the representatives of all the adult structures, in the finger, for instance ; most active changes are occurring, and it is quite evident that the newly formed tissues are growing and encroaching upon structures which attained their maximum of development at an earlier period. The nerve fibres and vessels alter as much as any other tissues. A space which in a given position in the fœtal finger contains only capillaries and terminal nerve fibres, will, at a later period, contain arteries, veins, and nerve trunks, as well as capillaries and terminal branches, and later still, will contain, and perhaps be entirely occupied with, large arterial and venous trunks, and bundles of trunks of nerve fibres. The Pacinian corpuscles, the sweat glands, and the papillæ are all to be seen, but their structures and relations are very different when development is more advanced. There are no sudden changes, no sudden transitions from one tissue to its immediate successor, but the processes take place very gradually, and the temporary tissues slowly give place to their more perfect and more permanent successors. When the perfect type has been attained, new tissue of the same kind is formed, while the old is gradually removed, and in some textures these changes proceed so quickly that elementary parts of every age are to be seen, from the earliest embryonic state to the perfect structure, and from this to the wasted remains, which enable us to complete the history of the changes which occur.

When an organ which is destined to remain throughout life has been developed, special provision is found to exist whereby the removal of its component elementary organs and the development and growth of new ones is provided for. At every period of life elementary parts and organs are to be met with in every stage of formation, and it sometimes happens that the elementary organs of the kidney, for instance, are impaired when in an embryonic state. No evidence of any change may appear for a long time, but at length the time arrives when these elementary organs should have attained their perfect state, and should be ready to perform the work of the organ. Their predecessors being worn out, and no new parts developed to take their place, the work cannot be performed, and in the case of an organ like the kidney, liver, or brain, death must result.

The fibrous capsules of organs are not composed of a form of connective tissue like fascia, merely required for protecting or supporting the structure which it encloses, but veins and lymphatics are often abundantly distributed in its substance; and in carefully prepared specimens it is not uncommon to meet with portions of the altered structure of the gland even in the very substance of the capsule. The gland substance not unfrequently adheres to the capsule so firmly that in tearing it off portions of the secreting structure are torn away with it. In certain morbid changes in the structure this adhesion is much more intimate than in the healthy state. This fact, and many others which might be brought forward are explained upon the view that the oldest portions of the gland structure lie in contact with the capsule, and are absorbed in this situation, certain portions which are incapable of removal in a soluble form remaining, and thus contributing to increase the thickness of the capsule.

The arteries, veins, capillaries, and nerves, like other tissues, are perpetually undergoing change, and a certain amount of connective tissue seems to be always associated with these structures. It sometimes exists in such large quantities that the important tissue lies completely hidden and embedded in it; while in young small animals, as in the young white mouse, it is in some situations not to be demonstrated. As the animal advances in age, however, this tissue appears. Delicate fibres of connective tissue are found in immediate continuity with some of the finer branches of the nerves as has been already mentioned.

Upon the external surface of a nerve trunk there is often a considerable quantity of fibrous tissue, which is in connection with, or at any rate adheres to, the nerves. It seems as if this had resulted from the development of masses of germinal matter similar to those which produce the nerves. The truth seems to be, that germinal matter, which in the normal state would produce a high tissue like muscle or nerve, may, under other circumstances, give rise to the formation of a degraded structure, not possessing the high endowments characteristic of these tissues, and assuming the form of the simplest and lowest normal textures.

The following specimens were then passed round:

Nerves in the skin of the mouse.—Preparation 53 is the skin of the white mouse, seen from below. The bulbs of the hair and the sebaceous follicles arranged in rows are very prominent objects, and between them and around them in every part of the specimen are seen small arteries, veins, capillaries, and bundles of nerve fibres. As you alter the focus you see nerve fibres at every plane; several may be traced to the hair bulbs which they encircle. A nervous plexus of the most intricate character, in which it is possible to follow an individual fibre for a considerable distance, is seen in this preparation. As the magnifying power is increased a greater number of fibres come into view. Connected with the capillaries, arteries, and veins, are numerous oval nuclei, and nuclei much resembling them are seen at very short intervals along the nerve fibres. Nuclei connected with fat vesicles are also observed. Besides, there are some small spherical bodies, which I believe are either white blood corpuscles in the capillaries or lymph corpuscles. In the crowd of nuclei all the above can be recognised, but besides them there are also nuclei in connection with the fibrous tissue of the true skin. Of all these separate masses of germinal matter, or nuclei, those connected with nerve fibres and capillaries can be readily distinguished. These alone form lines which branch, the branching being of a different character in the nerves and capillaries. In some parts of the specimen the capillaries are injected, and the nuclei in their walls can be most positively distinguished from those connected with the nerves. The latter, which are very numerous, are found in connection with all nerve fibres, and are very numerous, and situated at very short distances from each other in the terminal branches. They are not mere swellings or varicosities, but oval masses of germinal matter, which are coloured by carmine, and are as necessary to the life of the nerve fibre as those of cartilage, or fibrous tissue, or epithelium, or muscular fibre are integral parts of those structures, and necessary to their existence. The nerve fibres are very numerous in every part of the specimen, and as the fibrous tissue of the skin grows as the nerves increase, the latter gradually become embedded in it, and are with great difficulty followed out in ordinary specimens. In this preparation, bands composed of three or four trunks are seen to divide, some of the fibres passing to an adjacent band, so that a most complicated plexus is formed, and it is exceedingly difficult to find a fibre which is undoubtedly single. As the power is increased, fibres are resolved into two or three, which were not visible by the powers in ordinary use (two to three hundred diameters).

Mucous membrane of fauces.—There are few structures more beautiful than those displayed in a thin section, near the surface, of a sensitive mucous membrane from man or the higher animals; but it is so difficult to demonstrate the arrangement of the delicate nervous plexuses in these tissues that the anatomy of these structures has not been fully described. Immediately beneath the epithelium of the mucous membrane of the palate, fauces, and pharynx of man, there exists the most intricate plexus of nerve fibres that can be conceived. Exceedingly thin sections are required, and Dr. Beale has found that these may bemore easily obtained from the mucous membrane covering the epiglottis than from that of other parts. After the parts have been injected with Prussian blue fluid, the epiglottis is removed, treated with carmine, and preserved in glycerine. The mucous membrane adheres pretty firmly to the cartilage beneath. With a very sharp thin-bladed knife the layer of epithelium may be removed in such a manner that the surface of the subjacent membrane is completely exposed in some places, while in others a very thin section of the deepest layers of epithelium remains, and here and there a thin section from the surface of the mucous membrane itself will have been removed. Next, the thinnest possible horizontal section is removed parallel to the cut even surface, and transferred to glycerine. After being carefully covered with very thin glass, the specimen is examined with a power of from five to eight hundred diameters. In favorable specimens an arrangement of nerve fibres so wonderful is brought into view, that the observer will examine the specimen again and again before he can convince himself that what he seems to see, is real. Flattened bands, composed of from two to five or six nerve fibres, are seen crossing the field in every direction, and in the small intervals between them, finer and still finer branches are brought into view by careful focusing. Some of the fibres are of very large size, but others, in their general appearance, very closely resemble the gray, or gelatinous, nerve fibres. It is possible that some few of the fibres observed may be muscular fibres of the mucous membrane, but there cannot be the least doubt, that by far the majority are nerve fibres, which form a most intricate interlacement immediately beneath the epithelium. Moreover, it is to be noticed that there are at least two kinds of nerve fibres in this situation. Although many of the finest fibres are probably the terminal ramifications of branches which are thicker at a distance from their termination, there can be no doubt that the widest fibres are distinct from these altogether, and are not in any way connected with them.

Here and there the nerve fibres may be seen to divide, but from the great number present it is often difficult to isolate an individual fibre in which the division may be seen very distinctly. Dr. Beale believes the divisions of dark-bordered nerve fibres occur pretty frequently. In the palate of the frog, however, where the nerves are very numerous, but not nearly so abundant as in the human subject, this point is demonstrated without great difficulty.

In specimens from which the epithelium has been removed by gentle scraping instead of by section, little papillæ may be seen, and into these nerve fibres may be traced. The branches are seen to be bent upon each other in several places, and may be said to form a loop, the fibres of which are bent sharply at short intervals, so that the body of the papilla is twice or three times as wide as its neck where the nerve fibres pass into it. Several of these papillæ, as far as could be ascertained, were destitute of capillary vessels, but it is possible that very fine capillaries may have existed, which, from not having been injected, were not demonstrable. The papillæ above described may be regarded as a more simple form of the tactile corpuscle present in the papillæ of the fingers, toes, lips, &c. Beneath the plexus, above described, are larger bundles of nerve fibres, with vessels and much yellow elastic tissue. Connected with these nerve fibres are many ganglion cells, and here and there a microscopic ganglion.

The existence of small ganglia and ganglion cells in connexion with the nerves of this and some other mucous membranes is a point of great interest and importance, especially when considered in connection with their absence beneath the skin. Beneath the mucous membrane of the pharynx and palate of the frog, ganglia and ganglion cells are present in great number, but he has never seen one connected with the cutaneous nerves.

Oval nuclei or masses of germinal matter are very numerous, and are seen at very short intervals in all the nerve fibres. They are most numerous in connexion with the finest nerve fibres. They are also numerous on the vessels, as in other parts. In a carelessly prepared specimen nothing but these numerous nuclei, which appear to be imbedded in a slightly fibrous intermediate structure, are observed. Not a nerve fibre is to be made out in some specimens prepared in the ordinary manner, and were the density of the glycerine in the specimens passed round altered a little, the appearance, now so distinct, would at once be lost.

In some places, from carelessness in manipulation, the distinctness of the nerve fibres is lost, and in these situations the nuclei are seen in connexion with very fine fibres, not altered by acetic acid, and resembling in all respects yellow elastic tissue. In the external coats of arteries and in the pericardium, similar appearances have been observed, and from these and other facts, which will be alluded to in a separate memoir, Dr. Beale thinks that certain forms of yellow elastic tissue are the remains of nerve fibres, and perhaps other structures which were in a state of activity at an earlier period of life.

Pericardium, its nerves and ganglia.—This was a specimen of the pericardium of the human fœtus at the seventh month removed from the surface of the heart. The capillaries have been injected with Prussian blue. The bundles of nerve fibres are seen crossing the field and dividing and subdividing into smaller bundles, so that a network of nerve fibres with wide meshes is formed. Numerous oval nuclei are observed at short intervals in connexion with all the fibres forming these bundles. The distribution of the finer branches cannot be made out definitely because the fibres, except when a great number are placed together, appear perfectly transparent. Fibres of white and yellow fibrous tissue can be detected in this specimen, but the quantity of connective tissue present, is very small compared with that existing in the adult pericardium.

In the next preparation, ganglion cells and large bundles of gray, gelatinous, nerve fibres are seen. These have been dissected off from the pericardium of the ox. Three separate ganglion cells situated at the side of the nerve fibre have been placed in the field, and each ganglion cell is surrounded with bands of nerve fibres resembling those of which the trunk of the nerve is composed. Nuclei exactly resembling those in the fibres are seen embedded in the substance of the ganglion.

From this and other appearances one cannot but conclude that the fibres are continuous with the ganglion cells, and are developed from them. The nuclei being formed in the substance of the ganglion cell, as well as subsequently by the division of those connected with the fibres. Dr. Beale believes that the nerve fibre with its nuclei may be regarded almost as an extended ganglion cell. Each ganglion cell is connected with several nerve fibres, and the so-called capsule of these cells, generally described as consisting of areolar tissue, is really composed of nerve fibres which wind round a considerable part of the circumference of the cell, and then divide into bundles, which pass in different directions. The nuclei which are described as the nuclei of the areolar tissue capsule are the nuclei of the fibres and exactly resemble those in unquestionable nerve fibres. Those nerve fibres embedded in the substance of the pericardium seem to contain no tubular or dark bordered nerve fibres (fibres with the white substance of Schwann).

On the external portion of these bundles of nerve fibres in the adult and surrounding the ganglia, a considerable quantity of areolar or connective tissue generally exists, and very commonly the quantity is so great that the nerve fibres and ganglia are obscured by it. A microscopic ganglion embedded in the areolar tissue, just outside the base of the aorta near its origin, from the human subject was shown, and a ganglion embedded in the adipose tissue from the left ventricle of the heart of the pig was also exhibited. The ganglia are numerous in the grooves between the auricles and ventricles in the pig's heart, but they are so completely embedded in the adipose tissue that it is only by making thin sections one after the other that they can be discovered. Numerous microscopic ganglia have also been found in corresponding situations in the human heart.

These preparations prove that the pericardium contains numerous very fine bundles of nerve fibres which form a network situated at the deep aspect of the fibrous pericardium, and on the surface of the muscular fibres. The branches are much more numerous in and near the longitudinal groove of the heart, and the grooves between the auricles and ventricles, but many can be demonstrated over the general surface of the ventricles. At short intervals bundles can be seen to dip down in the spaces in which the vessels also pass, and these from their transparency are soon lost amongst the muscular fibres. Numerous microscopic ganglia, resembling those of the sympathetic, are connected with many of these nerve fibres. In some cases, collections of ganglion cells are seen at the side of the nerve fibre, and in many instances two or three ganglion cells can be made out in the very substance of the trunk. These microscopic ganglia are demonstrated without difficulty and in immense number, in properly prepared hearts, but from the fact that most of them are embedded in adipose and in areolar tissue, they are very liable to be overlooked. They are most numerous at the base of the heart in the grooves between the auricles and ventricles, in the longitudinal grooves, and in the areolar tissue at the base of the large arteries, and in that surrounding the arteries themselves.

In the muscular substance of the heart, the fine branches of the nerves may be followed. Their general disposition resembles that in voluntary muscle, and, as the nuclei of the muscular fibres of the heart are in the very centre of the fibre, there is no fear of mistaking these for the nuclei of the nerve fibre. Many nerve fibres are distributed to the vessels, but by far the greater number certainly ramify on the surface of the muscular fibres. It is impossible to demonstrate these latter points unless the vessels have been, in the first instance, carefully injected with transparent fluid.

These preparations have caused the lecturer to differ from the general opinions now entertained, with reference to the nature of the so-called gelatinous, or gray, fibres. The distribution of these fibres seen in the pericardium, their connexion with the ganglia, their constant appearance, the numerous nuclei connected with them, are all incompatible with the notion of their consisting merely of bundles of connective tissue. It can be shown that many of these fibres are the only fibres connected with most unquestionable ganglion cells, and those who still maintain such fibres to be connective tissue, will, Dr. Beale thinks, find it very difficult to account for the presence of the ganglia in the number in which they are found in connexion with this supposed fibrous tissue. He holds with Remak, and with Todd and Bowman, in this country, that these gray fibres are veritable nerve fibres, and must be altogether removed from the connective tissue series; moreover, the lecturer must add in connexion with this question that the branches of almost all, if not of all, nerves near their termination partake of the characters of the gray, or gelatinous fibres.*

It must be borne in mind, that ganglia are much more abundantly distributed in the body than is generally supposed. Besides the well-known sympathetic ganglia, visible to the unaided eye, microscopic ganglia of the same kind are very numerous, and in many of the trunks of the nerve fibres distributed to internal organs, small collections of ganglion cells, and even a single cell, are not uncommonly seen. Connected with the fibres in the palate of the frog are numerous ganglion cells, and several have been observed in connexion with the nerves distributed to the vessels of the same animal. They are found in the nerves distributed to all the viscera.

Dr. Beale's researches on this subject are not yet sufficiently extensive, to enable him to express himself positively on this point; but he thinks they will prove that the only fibres connected with these round or oval ganglion cells of the sympathetic system are the gray, or gelatinous, fibres. The lecturer has already shown that the oval nuclei are more abundant in fibres of which the trunks of the sympathetic are composed, than in other nerve fibres. Arguing from the inference deduced from observations upon the distribution of the nuclei in nerves generally, that they are the structures by which nerves are brought into relation with other tissues, the grey fibres and ganglia connected with them must be regarded as belonging to a nervous system which forms a complicated network, the branches of which extend to every part of the body, and which contains numerous centres presiding over the action of certain parts, but connected with other centres of this system in such a manner that the action of the whole is harmonised. Many of the sympathetic ganglia are connected with the cerebro-spinal system of nerves, but perhaps not so that the sympathetic can be said to *arise* from any part as from a centre. The experiments of Budge and Waller, and others, however, favour this view. Dr. Beale believes that from any part of one of the grey fibres, branches may grow which will place the parts to which it is distributed under the influence of the ganglia with which the nerves are connected. For instance, suppose a certain number of these fibres distributed to an artery, which gradually becomes larger, and from which an increasing number of branches proceeds. Every one of these will be supplied with nerve

* On the Distribution of Nerves to the Voluntary Muscles. ('Phil. Trans.,' 1860.)

fibres which will grow from the original bundle. In proportion as these branches increase, the trunk and the ganglion, or ganglia connected with it, will increase. The nuclei of these fibres, like those of all nerves near their distribution, undergo division and subdivision, and thus new fibres are formed according to the requirements of the part. A small band of gray fibres cannot be separated into individual fibres, nor can you divide the terminal branches of a cerebro-spinal nerve into distinct and separate fibres. Many of the finest fibres exhibit an indication of being composed of two or more, and this division seems to be continually going on in the peripheral branches of all nerves, and occurs in the trunks of the sympathetic system.

Voluntary muscle.—Connective tissue exists between the elementary muscular fibres of the voluntary muscle of man and animals, and it has been considered as a constant structure, and subservient to certain important purposes, in this situation. The proportion of this connective tissue varies greatly in the voluntary muscles of different animals, and in those of the same animal at different ages. During the early period of development of muscle this connective tissue is not observable, and in the muscles of small animals, such as the mouse, only traces are to be demonstrated. The elementary fibres of the muscles of the young mouse seem to be quite destitute of connective tissue. On the surfaces of the elementary fibres of all voluntary muscles, at all periods of life, are a number of oval corpuscles or nuclei, and these are found in cases where very much connective tissue is observed, and also when no traces of this structure can be found. They are generally considered to be nuclei of the areolar or connective tissue, and are the bodies regarded as "connective tissue corpuscles."

A preparation showing the muscular fibres of the diaphragm of a young white mouse with their nerves, capillaries, and the numerous nuclei connected with them, was passed round. The preparation is destitute of connective tissue, and all the corpuscles are connected with the capillaries, which are injected, with the nerve fibres, or with the muscular tissue itself.

General remarks on areolar tissue.—A certain form of connective tissue not unfrequently results from the imperfect development of elementary parts from which a much higher tissue might have been produced. This was illustrated in the following preparation, in which some of the bundles of muscular fibre cells at the edge of the uterus of the mouse were seen. Those situated most externally were observed to differ from those in the more central part of the bundle. Dr. Beale remarked that the formed material of these marginal elementary parts presents the appearance of ordinary fibrous tissue. A corresponding fact is observed with regard to the bundles of gray nerve fibres. The nuclei situated at the outer part of the bundle do not produce nerve fibres, but they give rise to the formation of a kind of connective tissue only. Up to a certain period of their existence nerve fibres might have been produced, but as a sufficient number had been developed, these marginal cells degenerated and led to the production only of a low form of tissue.

It has been shown that fibres of connective tissue are very often connected with the terminal branches of nerve fibres, this is especially the case in old tissues which are abundantly supplied with nerves. This point can be demonstrated in the frog's tongue to such an extent that it would not, Dr. Beale thinks, be possible to pronounce in certain cases, if a given fibre were in a state of functional activity as an integral part of the nervous system, or were merely a degenerated nerve fibre no longer active, and consisting of what might fairly be termed a form of connective tissue. The question can, however, always be determined by the presence or absence of the little oval nuclei or masses of germinal matter.

In many instances Dr. Beale has proved that these fibres in connexion with active nerve fibres were not acted upon by acetic acid, and beneath the plexus of nerves on the surface of the mucous membrane of the epiglottis, were numerous parallel fibres exhibiting the reaction and general characters of yellow elastic tissue, and amongst the undoubted nerve fibres, were fibres of the same description destitute of nuclei. Similar appearances have been observed in the papillæ of the human skin and tongue. It would seem, then, that by the alteration of nerves and capillary vessels, certain forms of 'connective tissue' are produced, and this has been observed in many different situations and in different animals, man, mouse, cat, frog, and others.

In the dura mater, the coats of small veins have been seen gradually thickening, until they were converted into solid bundles of fibrous tissue, and many have been observed with an exceedingly narrow cavity in the centre corresponding to the calibre of the vessel.

The alteration of nerve fibres into fibrous tissue has been very carefully watched in many localities. In the human organism the sole difficulty in following out the distribution of the nerves arises from this cause. Fibrous tissue also forms the remains of any other structures, in fact, the variety of this tissue which we are now considering is composed of the remains of various structures which cannot be entirely removed by absorption. The areolar tissue between the ultimate follicles of glands, that which surrounds vessels and nerves, and the fibrous tissue of which the so-called capsule of certain organs, liver, kidney, spleen, &c., are all of this nature. No wonder that in man, whose tissues pass through so many stages before he arrives at maturity, and in whom such active changes occur after this period, there should be a large amount of this structure. This particular form of fibrous tissue is absent in the embryo at an early period, exists in very small quantity in the young child, and the proportion gradually increases as age advances. In small animals there is less than there is in large animals, and in young animals there is less than in old animals. In creatures of the simplest organization, whose tissues are, so to say, embryonic throughout the whole period of there existence, there is none. In the higher animals whose tissues pass through so many phases before they attain their perfect form, there is a large quantity. It may result from changes occurring in vessels, nerves, and muscles. In various glandular organs which have undergone degeneration, a form of fibrous tissue remains behind. In cirrhosis of the liver, Dr. Beale believes that the fibrous matter which is present results not from the effusion and fibrillation of lymph, but is simply the remains of the degenerated capillaries and ducts. In livers in this condition, vessels and shrunken secreting structure, can always be demonstrated in the substance of the so-called fibrous tissue. The same remarks also apply to the kidney in certain cases of disease, and to other glandular organs.

Attention was then directed to certain fallacious appearances which may be produced by the mode of preparing specimens of healthy tissues, and which may easily be mistaken for fibrous tissue. Dr. Beale has seen the smaller blood-vessels, both arteries and veins, stretched in one part of their course so that the injection was pressed out of the transparent tube, while its continuity with the other parts containing the blue injection was perfectly certain. Had the stretched portion alone been examined, Dr. Beale stated that he should have affirmed most positively that it was a form of areolar tissue, and the nuclei which belonged to the structure forming the coats of the vessels might have been considered to be the nuclei of the areolar tissue.

Delicate nerve fibres when stretched and pressed could not be distinguished from connective tissue. Under the same circumstances, capillary vessels and the membranous walls of ducts may be set down as 'areolar or connective tissue.'

It would seem, then, that there are—

1. Certain forms both of white and yellow fibrous tissue which are produced directly from germinal matter as other tissues, and in which masses of germinal matter may be demonstrated at every period of life.

2. Certain forms which may be regarded as the residue of higher tissues which have ceased to discharge active functions.

3. Certain forms of fibrous tissue (indefinite connective tissue), as in the papillæ of touch and taste, which result from changes having occurred in the terminal branches of the nerve fibres.

4. Certain forms of fibrous tisue, resulting from degeneration occurring in the course of disease (abnormal).

5. An appearance of fibrous tissue produced by pressure, crumpling and stretching of nerves, capillaries, and other tissues.

The following bodies, composed of germinal matter and generally termed nuclei, are certainly present in the so-called 'connective tissue' of the skin of a young animal :—1. Nuclei of nerves. 2. Nuclei of capillaries. 3. Nuclei of white fibrous tissue. 4. Nuclei of yellow fibrous tissue. 5. Nuclei of fat cells. 6. Lymph, and white blood, corpuscles. In certain papillæ all the nuclei present may be shown to belong to nerves and capillary vessels, and between the elementary muscular fibres of the young mouse this is also strictly true. Dr. Beale does not think that in such situations there are any special corpuscles which could properly be called areolar tissue corpuscles, nor has he succeeded in obtaining any facts which would favour the view that there are corpuscles of any kind which perform special offices connected with the nutrition of these higher tissues distinct from the 'cells' or 'nuclei' (germinal matter) of the tissue itself. If, therefore, the germinal matter of white and yellow fibrous tissue, cartilage, bone, &c., be termed 'connective tissue corpuscles,' the name must be applied to the masses of germinal matter of epithelium, muscle, nerve, and all other textures. The nutrition of the so-called 'connective tissues' is carried on in obedience to the same general laws as the nutrition of other tissues.

Dr. Beale concluded his lectures with the following:

GENERAL REMARKS AND SUMMARY OF CONCLUSIONS.

In this course of lectures I have endeavoured to prove that the changes which more especially distinguish living structures from lifeless matter, take place in the substance I have termed *germinal matter* and in this alone. The particles of which this is composed after passing through certain definite stages of existence, undergo conversion into the peculiar substance or substances they were destined to produce. It is the germinal matter alone which is capable of *forming, producing,* and *converting.* The matter external to it (cell-wall intercellular substance or fluid) has *been formed* or *produced,* and it may be changed, but it has no power to *produce* structure or to alter itself.

There are many objections to the use of the term 'cell' as indicating the elementary unit of structure. The cell-wall is not constant although it is absolutely necessary to the existence and action of the 'cell,' that is, in the sense in which this word is ordinarily used. There are comparatively few instances in which a true vesicle exists at all.

Every living structure, and every elementary part that is living, is composed of matter which is *forming* and matter which is *formed*—germinal matter and formed material. The term cell is short and convenient, and if the definition usually given were modified, I think it would possess advantages over the term 'elementary part.' We might give the word a much more general signification and say that a 'cell' is composed of matter in two states which I have described under the terms germinal matter and formed material.

It appeared to me that great confusion would have resulted if I had attempted to show when describing various structures the exact parts which according to the ordinary nomenclature corresponded to my 'germinal matter' and 'formed material,' and I have therefore purposely omitted to discuss the question at all in detail. It may, however, be well to state now that in some cases the *germinal matter* corresponds to the 'nucleus,' in others to the 'nucleus and cell-contents,' in others to the matter lying between the 'cell-wall,' and certain of the 'cell-contents;' while the *formed material,* in some cases corresponds exactly to the 'cell-wall' only, in others to the 'cell-wall and part of the cell-contents,' in others to the 'intercellular substance,' and in other instances to the fluid or viscid material which separates the several 'cells, nuclei, or corpuscles,' from each other. It may be remarked—

That the 'nucleus' of the frog's blood-corpuscle is *germinal matter;* the external red portion (cell-wall and coloured contents), *formed material.*

That the white blood corpuscle, the lymph and chyle corpuscle, and the pus and mucous corpuscle, are composed entirely of *germinal matter,* with a very thin layer of *formed material;* the viscid matter or mucus between the mucous corpuscles is *formed material.*

That the 'nucleus' of an epithelial cell of mucous membrane, or of the cuticle is *germinal matter;* in a fully formed 'cell' the outer part, 'cell-wall and cell-contents' consists of *formed material.*

That the 'cell-wall' of a fat-cell or of a starch-holding-cell is *formed material;* the 'nucleus' of the former, and the 'primordial utricle' of the latter, are *germinal matter;* while the fat and the starch are the secondary deposits produced by changes occurring in particles of germinal matter in the central part of the mass.

I have chosen the terms 'germinal matter' and 'formed material,' because they serve to express the essentially different nature of the two forms of matter of which every elementary living structure is composed at the time it is under observation. I do not think that it is possible for any living particle to exist without being composed of matter in these two states,—matter capable under favorable circumstances of producing germs from which new germs may be developed infinitely,—and matter which once possessed this power, but which has been formed or converted into a substance endowed with certain peculiar and important properties, it is true, but now totally destitute of the power of producing matter like itself, reproduction, &c.

It may be remarked that by the use of these terms alone, the changes taking place in the development, growth, and nutrition of tissues in health as well as in disease may be described. I have endeavoured to study and describe *actions* and *changes* rather than to give names and definitions to structures which exist at any given period, but which are in a state of constant though gradual and perhaps very slow change. To aim at giving a history of the changes which occur seems to me more likely to lead to useful results than to attempt to define arbitrarily the limits of structures between which there is in nature no observable line of demarkation. In many cases the *germinal matter* passes gradually into the *formed material,* and it would be impossible to describe these by using the ordinary terms,—for there are no means by which we could determine positively which part of the structure was *cell-wall,* and which *cell-contents.* I may, however, be permitted to say that I am quite ready to modify the terms employed, in any way which may be likely to render them more convenient or more useful.

No attempt has been made to define exactly what is an *individual*. It seems to me that as the several component parts of the organism of the higher animals are dependent upon each other for their existence, we cannot look upon any one elementary part as an *independent growing living structure*. The conditions necessary for its existence are such that it cannot live when detached. On the other hand the contents (germinal matter) of what appears to be an elementary part (cell) of a simple fungus may be divided perhaps into many thousand particles, every one of which is capable of existing independently, of growing infinitely, and of producing a structure resembling that from which it has sprung. I have brought forward evidence favourable to the view that living particles exist which are far too minute to be seen by any magnifying powers which have yet been made. Again, there are many instances in which division can be carried to a certain degree of minuteness with the production of a multitude of living particles, each one of which grows into a structure resembling that of which it was but a small part. But if the structure be divided into more minute particles the death of all results. The simpler the conditions necessary for existence the more independent are the several parts or particles of which an organism is composed. As far as structure is concerned, an elementary part of a fungus corresponds to an elementary part of one of the higher tissues. The germinal matter of each is capable of growing infinitely and may be divided into numerous smaller particles, each one of which is capable of growth, but the conditions necessary for maintaining the vitality of the fungus are so simple that each particle will live although separated from its neighbours and exposed, within certain limits, to variations of temperature, moisture, &c. The particles of the germinal matter of the elementary part from any tissue of one of the higher animals, will only live when in contact with the fluids of the body which produced it or those of another body of the same kind. It cannot exist independently for any length of time, and if the conditions under which it is placed normally, be very slightly altered, it dies. Under no circumstances can it produce an independent organism. Neither a portion of germinal matter nor an entire elementary part of a tissue of one of the higher animals can be regarded as an independent structure. It is only a part of an individual whole. On the other hand, a very small portion, far too minute to be seen by the highest powers, of one of the simplest and lowest forms of existence is independent, may produce, though isolated, a structure similar to that from which it sprung, and may be regarded as an individual. The higher organism is composed of an immense number of elementary parts which are dependent upon each other and cannot exist separately. An elementary part of the simplest organism is composed of an immense number of minute particles, every one of which may live and grow and produce its kind independently of its neighbours and of the stock from which it was derived.

It will be inferred that I hold that vital power is not generally diffused over tissues but is restricted to the particles of the germinal matter only. Often a very gradual transition may be traced from the particles of germinal matter to the formed material. It is not possible to define the exact point at which a particle ceases to possess the power of animating lifeless matter and acquires the properties of the formed material. The change is a gradual one. Probably for a certain period particles possess the power of growing rapidly dividing and subdividing into multitudes of new ones. Next the power becomes more restricted. They may divide into two, and the process may continue in the resulting parts, but at length this ceases and the particles become converted into the material, the production of which is the end for which they lived and were produced. One might say therefore that the vital activity of the particles gradually becomes reduced as they recede from the centre at which they become animated. If the term life and vital activity be used, several degrees must be admitted. The particles seem to pass by almost insensible gradation from the highest point of vital activity to a state from which they pass uninterruptedly towards a comparatively quiescent condition which is followed by death and disintegration. Changes in chemical composition as well as in physical properties are associated with the different phases of existence. During the life of the particles as germinal matter, the arrangement of the elements must be altered in such a manner that new combinations may take place while the change into formed material proceeds. It is probable that very many substances of definite composition are produced and undergo conversion into other compounds during these changes.

The most important points which I have endeavoured to prove in this course of lectures may be summed up as follows;

1. That the smallest living elementary part of every living structure is composed of matter in two states, *forming* and *capable of increase,* upon which the active phenomena are entirely dependent,—and a substance external to this, which

existed at an earlier period in the first state, but which is now *formed,* and destitute of the powers referred to.

2. That the only part of a living structure which possesses the power of selecting pabulum and transforming this into various substances of growth, and of reproduction, is the active substance or *germinal matter.*

3. That the germinal matter possesses the power of growing infinitely, but that it always grows under certain restrictions. The rapidity of its growth or extension is determined by certain conditions.

4. In all living beings the matters upon which *existence* depends is the germinal matter, and in all living structures the germinal matter possesses the *same general characters* although its *powers* and the *results of its life* are so very different.

5. An increase in the *number* of elementary parts always results from the division and subdivision of the masses of germinal matter. In many cases portions project some distance from the general mass and then become detached.

6. A mass of germinal matter which is endowed with powers different to those of the germinal matter from which it was derived, always originates as a new centre (nucleus or nucleolus) in pre-existing germinal matter. The origin of new centres is from within centres, or endogenously, but the mass of germinal matter which results multiplies by division.

7. During the life of every elementary part, a movement of the particles of the germinal matter takes place in a definite direction, from centre to circumference, and it is probable that by this movement of the particles *from* centres, the transmission of the nutrient substances in the opposite direction is ensured.

8. The relative portions of germinal matter and formed material vary greatly in different elementary parts, in the same elementary part at different periods of its growth, and in the same tissue under different circumstances. The more rapidly growth proceeds, the larger the absolute amount of germinal matter produced in proportion to the formed material. Rapidly growing structures are *soft* and *easily disintegrated.* Firm dense tissues are of slow growth, and the hardened *formed material* of which they mainly consist, resists disintegration and change.

9. The pus-corpuscle is a mass of germinal matter in direct descent from the germinal matter of an elementary part. The conditions under which the growth of the germinal matter has taken place have been such as to cause its

rapid increase, and to interfere with the production of formed material. For some time before perfect pus-corpuscles were produced, a tendency to the production of elementary parts, like those of the original texture, was manifested.

10. The cell-wall is not a constant structure. The definitions generally given of the cell are not applicable to the elementary parts of many tissues. Pabulum does not pass through the cell-wall to become altered by the action of the cell, but certain of its constituents are converted into germinal matter—the living substance which becomes tissue or is changed into substances which form the constituents of secretions.

11. In the nutrition of an elementary part the following phenomena probably occur. 1. Inanimate pabulum passes through the formed material into the central portion of the spherical masses of germinal matter, while, 2. Particles previously animated move outwards. 3. The outermost particles of the germinal matter become converted into formed material. 4. A corresponding quantity of the old formed material is disintegrated, or the new formed material is added to that previously existing, in which case this structure increases in quantity. In *nutrition,* without growth, an amount of inanimate matter becomes living germinal matter within a given time, exactly corresponding to the proportion of germinal matter which undergoes conversion into formed material, and this makes up exactly for the quantity of old formed material, which being no longer fit for work, is disintegrated, converted into soluble substances, and removed.

Connective Tissues.

12. The connective tissues as a class cannot, by any structural characters, be separated from other tissues of the body.

13. The chief differences between a structure like epithelium (cell tissue) and cartilage or tendon (connective tissue) are these. In the first, the formed material of each elementary part is more or less separated from that of its neighbours, while in the latter the formed material is continuous throughout, but in both cases, the oldest portion of the formed material is that which is farthest from, and the youngest, that which is nearest to each mass of germinal matter.

14. White fibrous tissue and cartilage do not consist of *cells,* and an *intercellular substance* which is produced independent of cells; but the so-called intercellular substance exactly corresponds to the cell-wall of an epithelial cell, and

like this, was produced from the masses of germinal matter (cells). No 'intercellular substance' is produced independently of the living active granular substance in the 'cell,' or *germinal matter.*

15. The 'nuclei' or masses of germinal matter of tendon correspond to the 'nuclei' of an epithelial cell. The fibres of yellow elastic tissue in tendon are neither connected with, nor formed from or by, these 'nuclei. The matter of the 'nuclei' gradually undergoes conversion into the white fibrous tissue, while new nucleus or germinal matter is produced from the pabulum.

16. The 'mucous tissue' of the umbilical cord is a modification of fibrous tissue. No system of communicating tubes for the circulation of nutrient juices can be demonstrated in it.

17. In certain tissues (cartilage, epithelium) the masses of germinal matter produced by division are quite separate and distinct from each other, while in others (tissue of umbilical cord, tendon, periosteum, &c.) they remain for some time connected together. Thus a thread-like or stellate arrangement may be produced, and as the several masses become further separated, the points of communication are reduced to narrow lines and often disappear altogether.

18. The osseous tissue is composed of formed material which is afterwards impregnated with calcareous matter, and corresponds to the matrix of cartilage and to the wall of an 'epithelial cell,' as for instance that of a 'cell' of cuticle.

19. The lacunæ of living bone are occupied with germinal matter (nucleus) and formed material, in which calcareous particles are still being deposited from without inwards.

20. The canaliculi are mere spaces which are left during the accumulation of calcareous matter in the formed material. Through these channels fluids pass to and from the germinal matter in the lacunæ. They are not *processes which grow,* but are merely *channels which are left.*

21. No dentinal '*tubes*' exist in living dentine. The 'dentinal tube' like the lacuna, contains germinal matter and formed material, and the latter is gradually impregnated with calcareous matter from without inwards,—that is, the oldest formed material first undergoes the process of calcification.

22. The so-called gray or gelatinous fibres are real nerve fibres, and there are many ganglia which are connected with these fibres alone. The ultimate ramifications of all nerve fibres closely resemble the gray or gelatinous fibres. These fibres are numerous in the pericardium and are distributed to all the vessels.

23. Certain forms of connective tissue may result from changes taking place in nerves and vessels. The modification of connective tissue met with in the papillæ of taste and touch, is probably, in great part, the remains of nervous structure which is incapable of being removed by absorption. Certain forms of connective tissue are produced by germinal matter but some varieties consist of the remains of structure which were active at an earlier period of life.

24. In some situations in which 'areolar tissue corpuscles' are said to exist, and to form a *special system of tubes and cells* connected with the *distribution of nutrient juices,* the following bodies may be recognised; nuclei of *nerves,* nuclei of *capillaries,* nuclei of *white fibrous tissue,* nuclei of *yellow fibrous tissue,* nuclei of *fat cells, lymph,* and *white blood-corpuscles.* Each of these masses of germinal matter is connected with the production of its own peculiar tissue or formed material, and there are no cells and tubes to be demonstrated which are concerned in the distribution of nutrient matter to these textures. The nutrient fluid permeates the tissue generally, and each mass of germinal matter selects its proper pabulum and undergoes increase, while the older particles undergo conversion into tissue.

Observations *on* Vegetable Amœboid Bodies.

By J. Braxton Hicks, M.D., F.L.S., &c.

In a communication published in 'Microscopical Trans.,' April, 1860, I pointed out an amœboid condition in the zoospore of *Volvox globator,* which I had observed some years previously, and compared this observation with some of a kindred nature by other naturalists.

In the autumn of 1860 I had an excellent opportunity of verifying my notes, and of tracing the change apparently a step further. Out of a large number of Volvox, collected in the South of England, I scarcely found one in which the state alluded to did not exist; in many, twenty of these amœboid bodies could be counted, moving about immediately beneath the transparent sphere. That they could not have derived their origin from any similar or dissimilar existence outside the Volvox, nor could have themselves entered within the sphere by solution, became very evident from observing the different stages by which the ordinary zoospore gradually arrived to the condition now under discussion. As I have before observed, the first change is a slight enlargement of the zoospore, and a tendency to a general homogeneousness in the colour of the endoplast. After a time the zoospore increases to nearly double its ordinary size, becoming colourless, and containing a number of brown or reddish-brown granules; while the vacuoles become much reduced in size and scarcely recognisable in some. When these conditions have been fully attained, the now colourless zoospore detaches itself from the sphere, and then it is for the first time noticed that it has the power of protruding and retracting in various parts portions of the primordial utricle, exactly and to the full extent as a true Amœba. By this power they glide along the inner surface of the sphere, among the unchanged zoospores, and when they come in contact with one, they bend themselves round it, in the manner of the Amœbæ. After the altered zoospore had begun to travel, it was always noticed that for every one such moving body in the Volvox there was the empty space of a missing zoospore. I have figured (Pl. IV, fig. 1) a portion of Volvox, in which will be seen a changed zoospore still *in situ*, and others already in motion. Now this state of things seems not to be confined to the ordinary zoospore, but to be also found in those which have gone on to the early stage of gemmule growth, at least, it is certain, as I shall endeavour to show, that it takes place up to the stage of the formation of reddish-brown particles. Figure 2 shows an enlarged zoospore, which had commenced gemmule growth, formed into a colourless body. Figure 3 shows two in which the changes have proceeded, even during the segmenting process, to the absorption of the chlorophyll; but they are not yet amœboid. I have not noticed them yet in a free state, but judging from the kindred condition above related, it seems highly probable that these appearances belong to the same phenomena, especially taken in conjunction with others, to be presently related, whose nature is less doubtful. In addition to the above, the following facts will probably assist us in our investigations as to the nature and origin of these bodies.

In making observations upon the radicles of mosses kept in water, I arrived at the fact, amongst others not necessary to be here described, that the endoplast of many of the elongated cells, of which they are formed, not unfrequently detached itself from the contact of the cell-wall, and collected into one or more ovoid masses, of different sizes. These possessed all the optical properties of living, healthy vegetable protoptasm, which was made still more probable by the power it possessed in segmenting as gonidia do. By this process the whole of the cell of the radicle was empty, with, of course, the exception of these ovoid bodies (figs. 5 and 6), which other observations, not needful here to be related, proved to be the homologues of the gonidia of other cryptogamic plants.

Some of these masses changed their colour to red or reddish-brown; and gradually lost their colour till no trace of red or green remained, excepting reddish granules, as in the case of the Volvox. These changes are shewn in figs. 6 and 7 *a*. The specimens I had the opportunity of seeing possessed from two to four vacuoles more distinctly than was noticed by me in the Volvox in 1860; and their size seemed to depend somewhat upon the amount of their exposure to water to which they were subjected.

These changes having proceeded thus far, they gradually began to alter their form, and to protrude and retract processes exactly as Amœbæ, and as was noticed in the Volvox. They travelled up and down the interior of the cells, occasionally elongating themselves into almost a linear form. (See figs. 7 and 9.) The movement of their contents presented the same phenomena as those of true Amœbæ. Although generally all the masses of green endoplast simultaneously underwent these changes, yet exceptions might now and then be found, either in the same cell, or in adjoining, where the changed and unchanged masses co-existed. The number of amœboid bodies in each radicular cell would therefore seem to depend either upon the number of masses into which the endoplast is primarily divided, or upon the number of segmentations into which it again resolved itself. I have seen as many as seven in one cell moving freely about.

Anxious to learn what became of these bodies, I carefully watched one for some hours, and observed the following—First, the movement by protrusion became gradually restricted till it was extinguished, the mass returning to the ovoid form it possessed originally. The exterior also seemed to become more rigid, although I do not think there was any distinct cell-wall. Secondly. The whole exterior became covered with very minute ciliæ, in constant vibration, by which the mass was kept in a state of agitation, within the containing cell; the total motion was curtailed of course, but in bodies which I noticed moving in the water undistinguishable from them, the motion was rapid and rolling. Beyond this point I was unable to extend my observations on their life-history. These succeeding conditions are shown in fig. 10; c represents the ciliated condition.

We are now in a position to examine the nature of some bodies I have seen in Volvox, and which I have drawn at fig. 4. In outer appearance they are precisely alike, and covered with ciliæ, and in constant vibration. They occur in smaller or greater groups, which are enclosed in a cavity formed of the mucous layer just underneath the transparent sphere.

Taking the change shown at fig. 3 in the segmenting cell, and that shown at fig. 2, it seems highly probable that the segmentations of the zoospore have become amœboid; and further, comparing them with the facts I have pointed out in the moss-radicles, it seems equally probable that these have become ciliated, and are homologous. That they were derived in some manner from a zoospore seems clear from the vacant space immediately above it, as was noticed in the case of the amœboid bodies.

What the ultimate destination of these ciliated bodies may be, can scarcely be conjectured; the subject is attended with much difficulty in watching throughout. However, I found the change from the amœboid to the ciliated stage in the moss-roots was rapid, taking place within two hours. It might at first sight be conjectured that the collection of endoplast into ovoid masses, and then their becoming colourless, was an unhealthy process. It has been observed in the algæ, and is no doubt in them, as in the moss-roots, one of the many conditions vegetable protoplasm has the property of assuming, in order to perpetuate the species under varying influences; and we are by no means necessarily to conclude that it is a sign of decay, as considered by some. We are, it seems more evident every day, so incompletely informed as to all the means of the preservation of life in the lower orders, through all the varied external conditions of damp and drought, heat and cold, with their numberless transitions, that we should gain much more by following out the changes they produce, than by attempting to make them definite. One can scarcely understand that a process which went so far as to form a ciliated body could be an unnatural or an unhealthy one. It therefore seems highly probable that it is one of the modes by which a portion of living protoplasm is enabled to retain life under certain conditions. That the removal of the colouring matter is not by any means to be considered a sign of impending dissolution, but a physiological state, is to be inferred from the observations of Cohn in *Protococcus pluvialis* and of others;* and therefore the changes above described may reasonably be considered as healthy vital actions.

* 'Botanical and Physiological Memoirs,' Ray Society, 1853.

Now if these points be granted, and if we follow out the further inferences they suggest, it would by no means be a matter of surprise if other portions of the vegetable kingdom exhibited a similar state. Indeed, if observers were carefully to note all appearances of the vegetable cell in its various positions, when divested of its rigid cell-wall by solution or by dehiscense, I believe we should find it a common condition for the endoplast, either coloured or colourless, and possessing a certain amount of density on its external surface (primordial utricle), to have the power of amœboid motion. It is, of course, only occasionally that the cell is placed under these circumstances, and therefore they are to be watched for assiduously.

I have already, in the former paper referred to, pointed out a power of motion in the cells in the gemmule of Volvox, and have noticed another instance, in a vegetable cell with green contents, whose origin I was unable to trace.

These considerations will help much to explain a condition I have noticed many times among a mass of cells, which have (as one of many) passed under the term "chlorococcus," but which, in the present instance, I shall merely refer to as the gonidia of mosses, leaving the description of their origin untouched upon. Amongst these and their segmentations, if placed in water, may be found some in which the natural green colour is becoming paler, or destroyed; and this takes place either universally over the whole contents, as shown in fig. 11, *a*, *b*, or at one part in *c*, or on the whole exterior, as in *d*, *e*, *f*. This colourless protoplasm is endowed with power of protruding and retracting processes; in the latter-mentioned examples the layer is so thin on the whole exterior of the green mass, that it at times can only be recognised except by the slight protrusions which frequently take place. The green contents within are being transformed into the colourless moving mass in all these instances. In the different cells of the same portion under examination, we can observe a gradually progressive change, till at last we find amœboid bodies moving about in all directions, free from all green matter, containing only a few reddish-brown granules, and some vacuoles (fig. 12). I have described the change in its minimum state first, because if the more complete amœboid stage were the earliest under observation, it might at once be conjectured that it was a true Amœba, which had enclosed the green cells, and was digesting them more or less completely. That this latter explanation is scarcely the correct one, the following circumstances tend to show:

Firstly. If it be admitted that the vegetable endoplast of

Volvox can become amœboid, our chief diffiulty of extending the possibility of the same change to that of a free cell, is in the main overcome.

Secondly. The only other way of explaining these phenomena, is by supposing that true Amœbæ had engulphed these vegetable cells, in the cases just quoted, equal to their own size, and then digested them. This explanation seems, therefore, scarcely tenable, especially when it is mentioned that although there was present a variety of other organic bodies, yet these only contained the green matter; and,

Thirdly, the size of these bodies bore a strict relation to the size of the vegetable cells in whose company they were found—that is to say, in specimens where the green cells were large, the amœboid bodies were also, and where they were smaller, then the size of the others agreed likewise.

In recording the observations brought forward in this communication, I have dwelt entirely on the history of the changes, and have purposely omitted anything bearing on their chemical nature, because of the uncertain value of the latter in giving us help in the matter, and because of the much more conclusive character of the evidence of the former. Taken in conjunction with the observations of others, it seems that we are justified in assuming that vegetable protoplasm, under certain conditions, has the property—when deprived of its limiting layer of cellulose—of spontaneous notion, like that of protozoa.

These remarks I make, notwithstanding that Carter has retracted his opinions regarding the explanation he had frequently put forward in the 'Annals of Natural History;'* for it appears to me that the grounds upon which he has rejected his opinions are much slighter than those which supported it. His facts, however, remain the same, but his interpretation is different. Instead of considering that vegetable protoplasm becomes rhizopodous, he now explains the phenomena, which he remarks is common to almost all algæ, to be produced by the growth of a germ of a true rhizopod, which was included by some means within the mass of protoplasm. In alluding to his statement that Acetinæ are thrown off by Vorticella, he writes:—"Seeing, then, the great analogy if not real identity, that exists between the nature of these organisms, I would suggest that the germ of the Acetinæ, like the egg of the Ichneumonidæ, becomes encysted in the Vorticella, and lives upon its host."

Again, "No one can at first sight witness the change

* Carter, "Notes and Corrections on Organization of Infusoria," 'Ann. Mag. Nat. Hist.,' 3rd series, vol. viii, p. 287.

which, almost like a 'dissolving view,' takes place in the protoplasm and chlorophyll of Chlamydococcus, Eudorina, and in that of the cells of the algæ generally, during which these pass from their original form into that of a rhizopod, without inferring that the form produced is nearly another one of that which preceded it, and no absolute change. Hence my description of the fancied passage of the vegetable protoplasm into Actinophrys."

"For the future I would regard all those apparent transformations of the protoplasm, the development of a parasitic genus previously existing in it (where not obviously introduced) which, under favourable circumstances—that is, where the specific vitality of the cell begins to ebb—assimilate its protoplasm, &c., to its own form." . . . . "It is difficult to realise the nature of these changes at first, as before stated; they are inappreciable, but such I am now persuaded is the way in which they must be explained."*

Thus it will be noticed that the frequency of the occurrence is admitted, and these facts of mine, now shown, extend the phenomena to the mosses. Whatever may be the real nature of the case, with the occurrence of Acetina upon Vorticella, and whatever may be the true explanation as to the origin of the Actinophrys from vegetable protaplasm, I cannot discover any arguments brought forward which invalidate the supposition that vegetable protoplasm may become amœboid under certain conditions. In the above quotation, it is confessed that the appearances are so unbroken, that it is difficult to realise the author's new explanation; "they are inappreciable." But this seems a powerful argument in favour of this observer's original explanation; and the case of the Acetina is not, or need not be, a parallel one. That, at least in the instances I have brought forward above, there seem to be many facts which decidedly militate against the parasitic explanation.

1st. The change seems to occur in all parts of the mass simultaneously. In the drawing accompanying my first notice of its existence in Volvox,* it will be seen that the whole mass of the zoospore in the first change is precisely like its original state, losing only its colour. Now had the zoospore been invaded by the germ of an Amœba, it surely would have appeared at first in a definite spot, and not diffused itself equally throughout the whole mass, without being recognised in some way. If it be argued otherwise, then another dilemma appears—how, if the germ and vegetable protoplasm be so much alike, by what means can they at all be distinguished, so as

* Op. cit., Supra.

† See 'Mic. Trans.,' April, 1860.

to prove the essential point of the discussion, namely, that there are in the mass two separate organisms combined?

2. The change takes place in those which are or have been segmenting. The parasitic explanation, therefore, requires that a germ should have been enclosed in each segment.

3. In the case of the gonidia of mosses (fig. 11, *d*, *e*, *f*), it seems very unlikely that the germ should have been enclosed within the moss, when it surrounds it by a thin layer all over.

4. The subsequent fixed oval form and ciliated condition above noticed, has not been, I believe, yet noticed in the true Amœbæ.

5. Besides these points, the power of motion in vegetable protoplasm is not unknown to us; as, for instance, in the ciliæ of zoospores.

6. The want of proof of the "obvious introduction of parasitic germs from without," and the improbability of their having been previously existing in the mass of the protoplasm of the roots of the mosses.

7. I have shown already, in my former paper, that the unchanged cell has a distinct power of movement as an Amœba, and that in cells of the yet incomplete gemmule of Volvox, which, being detached from its fellows, extruded and retracted portions of itself, moving about by that power.

It is for these reasons that I think we are justified in excluding the parasitic hypothesis, and in concluding that the vegetable protoplasm does become directly an amœboid body.

To whatever forms or states these ciliated bodies may ultimately tend, there is an important point still to be determined with regard to the amœboid form; namely, do they include within themselves, and then dissolve, foreign organic bodies? In other words, do they "eat?" The value of any direct observations in this respect need not be enlarged upon here, when it is remembered that upon this peculiar power the true Amœbæ take their rank in the animal kingdom. I have not hitherto had an opportunity of observing these bodies in a free position, in which their origin was unquestionable, and under external conditions perfectly compatible with active vitality. It is probable that the Volvox would afford the most convenient opportunities for watching.

The circumstances under which the moss-roots should be placed to show these phenomena is to float any common moss on a glass of water in the shade; and when the radicles they push out are of considerable length, they may be removed to the slide, and examined. Most specimens, where not too much exposed to the light and heat, will afford many instances of the above.

TRANSLATIONS.

On the Chronispores, *or* Chronizoospores *of* Hydrodictyon, *and on some* Analogous Reproductive Bodies. By M. N. Pringsheim.

(From 'Ann. d. Sc. Nat.,' IVme Ser., t. xiv, p. 52. Originally published in German in Bericht der Ak. d. Wissenschaft du Berlin, 1860.)

(*Continued from page* 59.)

It must be remarked that there are two sorts of zoospores formed in the *polyhedrons*—large and small, (figs. 18 and 19) —differing in size as much as those zoospores do that are produced in the cells of the retiform *Hydrodictyon*, some of which unite into a network, while the smaller ones always remain separate. On the contrary, in the *polyhedrons* all the zoospores are united in a retiform manner; the meshes of those formed from the smaller ones being more numerous and narrower.

The generation of fresh reticulations within the *polyhedrons* is a phenomenon which proves in the most certain manner that the zoospores escaped from *Hydrodictyon* (fig. 1) the green globules resembling *Protococcus* (fig. 2), the zoospores engendered in these globules (fig. 2) differing manifestly from the ordinary well-known zoospores of the adult *Hydrodictyon*, and, finally, the polyhedral cells (figs. 12—17), resulting from the growth of these particular zoospores, are so many organs comprised in the evolution of one and the same individual, or that they characterise so many different stages in the continuous life of *Hydrodictyon*.

I must here draw attention to some natural consequences arising from the facts just stated.

The cells which I have termed polyhedrons, form the first generation of the *Hydrodictyon* on its return to active life after a period of repose. This generation is distinguished from those which follow it, inasmuch as the plants to which it gives rise, are perfectly unicellular; it justifies the view taken by M. Braun of the *Hydrodictyons* which originate the later generations, and which he regards as so many families formed by individuals reunited into one unicellular plant; and in this view I entirely coincide.

On the other hand, by their processes or appendages, in the form of horns, the *polyhedrons* of *Hydrodictyon* denote its affinity with those small kinds of *algæ* whose cells, at all events on their free side, are furnished with similar appendages. Of this number are *Pediastrum* (Meyer), the *Cœlestrum* (Noge), *Sorastrum* (Kütz), and *Scenedesmus* (Meyer), which on account of their appendages have been wrongly classed by some morphologists amongst the Desmidiaceæ. They form, in common with *Hydrodictyon* and some other types, as yet but little known, a special family, which may be called that of the Hydrodictyeæ.

To the important characters drawn from the mode of multiplication and the association of individuals into families similarly grouped, showing a strict analogy of *Hydrodictyon* with the Desmidieæ, we have now to add this other mark of external affinity, and which is only met with in individuals destined to an isolated life; for the appendages are more developed, except at those points of the cells which are intended to unite themselves to other cells, or to be prolonged into processes, if this union does not take place. Frequently, the first-born cells of the *polyhedrons* evince an unequivocal tendency to produce appendages. When, indeed, the new network, instead of forming a complete sac, only constitutes, as I have before said, a single cellular layer, in the manner of *Pediastrum pertusum*, then the peripheral cells or those which are associated in great irregular masses, and above all, those which are joined to at least four of their neighbours, produce usually two appendages, and in this respect resemble exactly the peripheral cells of *Pediastrum boryanum*.

After all this, it can scarcely be doubted that the different genera cited above, as plainly analogous to *Hydrodictyon*, must present similar developmental phenomena.

Two sorts of zoospores have been recognised in *Pediastrum*, the largest of which, according to Braun, re-attach themselves after their birth to the new family, whilst the smaller ones, observed for the first time by M. Bary, are dispersed and remain isolated. The ultimate fate of the latter remains still unknown; yet if the vegetation of *Pediastrum* be compared with that of *Hydrodictyon*, it seems obvious that the microspores of the former are in reality its chronizoospores (*Dauerschwaemner*).

The same morphological value must be given to the microspores that I have seen dispersed in *Cœlastrum*, whilst its micro-spores are united into a new family. These micro-spores are distinguished by their want of movement from the chronizoospores of *Hydrodictyon* in general, in *Cœlastrum* the movement of the spores is retrograde and the largest often form a network, without having previously given any signs of spontaneous motion.

The other genera, which appear to bear some resemblance to the preceding, have at present been too little studied even to indicate the organs that might, in them perhaps, correspond to the chronizoospores; but it is evident that these genera, the generations of which, so far as is hitherto known, are always associated in families which possess other reproductive bodies which have doubtless an isolated existence after the fashion of the polyhedrons of *Hydrodictyon* and under analogous forms, may we not then ask whether those observers who have devoted themselves to the study of microscopic algæ, may not have seen and described these polyhedral bodies whose characteristic form could not but attract their attention.

And this really appears to be the case. The *polyhedrons* of *Hydrodictyon* have, in fact, never, so far as I know, been described by any one; but I think I recognise the *polyhedrons* of other *algæ* of the same family, and especially, perhaps, those of the genus *Pediastrum,* in ths remarkable bodies which M. Nägeli has taken as a type of a new genus of *algæ* and termed by him *polyhedrium.* It is in allusion to this denomination that I have given the name of *polyhedron* to the isolated and enlarged zoospores of *Hydrodictyon.*

Nothing is known of any of the *polyhedron* of M. Nägeli beyond the external form, it therefore appears to me that they are most probably, merely the first isolated generations of different kinds of algæ belonging to the group of *Hydrodictyeæ.*

In the same manner, the solitary and unicellular forms that M. Braun has described and figured in some species of *Pediastrum,* may be regarded as the polyhedrons of this same species, or of others analogous to them. I might say the same of the *Asteriscium caudatum* of Corda ('Alman. de Carlsbad,' p. 238, pl. i, figs. 1, 2).

The spores of *Hydrodictyon* which remain free and became dispersed, and of which I believe my observations have shown the true morphological interpretation, appear from the facts already stated, to belong to a certain order of a sexual generation the products of which, remarkable by their intermittent vegetation, may be classed in two distinct groups. The first group will comprise the chroni-zoospores, such as those of *Hydrodictyon* and *Pediastrum,* which proceed from the transformation of the micro-zoospores ; the second group will contain the chroni-spores of *Cœlastrum* and other allied forms which at no period enjoy any freedom of motion.

Interrupted development and absence of motile power are not therefore necessarily true external characters of the fruit of sexual reproduction in the *algæ ;* we must also admit new exceptions to the generally received rule that the motionless spores, or hypnospores (*Rukesporin*) must be considered in all cases as zoospores.

Further researches on the presence of zoospores in other families of *Hydrodictyon,* and their replacement by immotile chroni-spores, will no doubt permit us one day to separate in a satisfactory manner, the hypnospores which belong to a sexual reproduction from those which are formed without previous foundation. Precise observations made from this point of view must lead to the recognition of other zoospores in many algæ, besides those which germinate immediately, which have hitherto been confounded with the latter, but which do not germinate until they have undergone a definite period of immotility or rest (*Danergustand*). The mode of existence of a vast many species of the genus *Protococcus,* as yet so vaguely and imperfectly known allows us easily to suppose that many of them are only zoospores of other algæ in a state of rest, or chroni-spores. It is even probable that the chronizoospores of *Hydrodictyon* may have been taken for a sort of *Protococcus* and described as such ; nevertheless the distinguishing characters given to the protruded species of these plants are necessarily so insufficient, that it is impossible to affirm anything about them.*

In summing up all that phycologists have written on the spores of algæ, many observations occur tending to indicate the existence of chronizoospores elsewhere than in the *Hydrodictyeæ.*

The hypnospores of *Chlanydococcus pluvialis,* which at once suggest themselves, I believe must be understood quite differently ; they do not arise from the direct transformation of the truncated and active reproductive bodies which are called zoospores though they are, in reality, each of them, a perfect plant, endowed with motile power (*Schoœmunde Pflange*) ; but are engendered in the plastic contents of these same bodies, and the circumstance of their being born solitary and not several together renders their generation exteriorily a phenomenon always analogous to the transformation of the chroni-

* *Vide,* with reference to this, Dr. Hicks' papers in this Journal.

zoospores into motionless cells; beyond this, their nature as to their sexual value, is still uncertain.

This is, perhaps, the best place to introduce an observation made by M. Braun, relative to a new genus *Codiolum*, which that able phycologist has discovered in Heligoland.

M. Braun tells us, that he has seen in the little tufts formed by the plantules of *Codiolum* some rounded scattered cells, the external appearance of which and their chemical nature treated by ordinary agents, led him to suppose that they belonged to *Codiolum;* and he presumes that they probably originated in a particular development of the zoospores.

If these cells do, indeed, belong to *Codiolum*, of which we can only be assured by observing their development from the earliest beginnings, and further growth, it is probable that they should be regarded as have been the chronizoospores of the algæ in question.

Among the species of *Cutleria* again, the second sort of zoospores which do not germinate immediately, and have, for this reason, been ranked as true spores by M. Thuret, may, very probably, after all, belong to this class of bodies instead. In which case, *Cutleria* would not be so far removed as it appears to be from its nearest allies, that is to say, all the other Fucoideæ; and the opinion held by M. Thuret, on the nature and presence of the zoospores in question, would agree better with the idea of their being the chronizoospores of the *Cutlerieæ*, than with their being the true spores of these algæ.

Since the knowledge I have acquired of the chronizoopores of Hydrodictyon has given me a difinite aim to my researches, I have never, with all my efforts, been able to meet with more than one other example, and that in a very different family of the transformation of zoospores into chronispores.

The genera *Ulothrix, Stigeodonium, Chætophora,* and *Draparnaldia,* which all belong to the small and badly defined family of the *Draparnaldieæ* possess, independently of their well known spores, hypnospores, or motionless spores (Rubesporm), whose development presents, according to the genera or species examined, differences only of very secondary importance.

In the genus *Ulothrix*, nearly all the cells of the plants produce hypnospores. In each of the cells a single large hypnospore is formed, which soon fills the whole cavity, and afterwards distends it by its growth. During this generation the contents of the cells and their membranes undergo modifications which betoken an approaching suspension of all the phenomena of development. These modifications are accompanied frequently by a secretion which commences in the neighbourhood of the septa, dividing the filaments of *Ulothrix,* on the outer surface of which its products are deposited. These filaments then acquire a very singular aspect; they become more manifestly pointed, and from being cylindrical, assume rather a moniliform appearance. At last, their joints, considerably enlarged, separate one from the other as so many distinct spores, but still always closely enclosed by the proper membrane of their respective parent-cells.

Similar phenomena are observed in the formation of the hypnospores of *Stigiodonium, Chœtophora,* and *Draparnaldia,* which are all branching algæ. In them also it is the ordinary plant-cells which are transformed into sporiferous utricles. It is further to be observed that the structure of the stem in these algæ, differs from that of the lateral branches, and that the production of the hypnospores appears to concern the cells of these branches, and to have nothing to do with those of the stem. In *Draparnaldia,* the *Chœtophora,* the two genera in which the greatest dissimilarity exists between the stem and the branches, the unmodified basillary cell of the latter is not unfrequently seen supporting a string of sporiferous utricles.

The modifications that the generative cells of the spores undergo, vary in the different species of the genera of which we are speaking, and the uneven appearance of the fertile branches is owing to them. Other differences arise from the variable member of spores that each mother-cell can produce.

In *Draparnaldia glomerata,* the spores are produced sometimes isolated, sometimes binary or quaternary, and this unequal fecundity of the fertile utricles is observed not only in the different branches of the same individual, but also in the various joints of the same branch. The parent-cells have also two modes of existence. Some become moderately elongated, and grow *pari passu* with the single spore that they enclose; they never open, and this spore never escapes from their interior. The branches, in this case, assume in all respects the aspect of the fertile filaments in *Ulothrix*; they become thick, brown, moniliform, and preserve for a long time their first arrangement on the unaltered stem; at length they break up irregularly, and their disconnected elements are dispersed. The spore, like that of *Ulothrix,* remains completely enveloped in the membrane of the mother-cell. According to my own observations, this is always the case where a single spore is produced in the conceptacle.

In other parent cells in the same *Draparnaldia glomerata,* the lateral walls become enormously distended, then break up in an irregular manner, and allow the spores to escape. Consequently the cells are very soon disunited, and all appearance of branches disappears at the same time. The liberated spores spread themselves in all directions around, but they remain immersed in a mucus which envelops the whole plant, and prevents their dispersion. I have observed these particular circumstances as much in the monospore cells as in those which engender from two to four reproductive bodies.

The fertile cells in *Stigiodonium* and *Chætophora Endiviæfolia,* constantly produce from two to four spores. The branches constituted by these cells, undergo different transformations from those *Ulothrix* and *Draparnaldia.* The mother-cells grow rapidly, and are sensibly enlarged in a transverse direction; their surface becomes uneven from a kind of granular secretion; they remain soldered to one another, and do not allow the spores that they contain to escape. But, in a short time, the contiguous walls, those forming the septa of the branch, are detached from the adjacent or lateral distended walls, and quitting their original position, mix with the spores. The branch, consequently, entirely loses its articulated appearance, and is changed into a large irregular sac, in which the spores and the remains of the septa are confusedly intermingled.

The fructiferous plantules of *Chætophora endiviæfolia,* are easily distinguished even by the naked eye, from their crowded appearance, diminutive form, and obscure colour, from the individuals which bear zoospores, and with which they are generally found mixed. Similar external differences characterise also amongst the Draparnaldiæ those individuals which generate hypnospores from those better known which afford zoospores.

Setting out with this idea, that the hypnospores of the Draparnaldiæ were zoospores, I determined to discover, if possible, and to observe the transformations of their reproductive bodies into hypnospores; but I only succeeded after having convinced myself by the study of *Draparnaldia glomerata,* the cells of which allow their spores to escape, that these hypnospores proceed from zoospores which have returned to a state of repose. These observations also afforded the interpretation of those unusual forms of hypnospores which I had previously seen, mixed with the regularly rounded hypnospores.

The zoospores of *Draparnaldia glomerata,* which change into chronispores, are exactly like those zoospores known in the other *Draparnaldiæ,* and which germinate immediately. They present, as do many of the others, the red spot, to which recent observers seem to attribute a great importance. They are produced either singly, or from two to four together, within each parent-cell, and when the parent is distended and broken up, they usually escape, and move about for some time in the mucilage which envelops the plant; but they are unable to wander far from their cradle, and at last become motionless, and are transformed into chronispores by changing their integument. The modifications of their internal plasma and constitutive membranes, which they subsequently exhibit, quickly efface all the distinguishing characteristics of zoospores, and give them, on the contrary, the appearance of the germs which are intended to resist a long suspension of vegetation.

Usually the transformation of the soft envelop of the zoospore into the resisting membrane common to chronispores, takes place only after they have assumed a globular form; but it often happens that the zoospore continues to move; and it is then under the form that it possesses at that instant that it is consolidated or hardened into a chronispore. Such is the origin of those remarkable bodies that are frequently met with among chronispores, and which so closely resemble zoospores. The movement of the zoospores of *Draparnaldia glomerata,* before their metamorphosis into chronispores, resembles completely in its external character that of other zoospores; the corpuscles of which we are speaking, are, however, less lively, and do not spread themselves so far from the place of their birth, which may, perhaps, be attributed as much to the opposition offered by the mucus which surrounds *Draparnaldia,* as to their natural inertness, added to the brevity of their active life. From these reasons it happens to them more frequently than to the zoospores of other algæ, that they never issue from the parent-cell, but remain in them until all motion has ceased, although the dehiscence of these cells permits them easily to make their escape. This circumstance appears to indicate that the period of agility is of little importance to them, and that an insensible transition takes place between the spores of *Draparnaldia* and the other reproductive bodies, as much in these algæ as in their allies, amongst which I have never observed any sign of movement.

As regards the spores of the genera *Stigodium* and *Chætophora,* their form, which is at first elongated and narrow, recalls that of the zoospores and authorises the belief that a certain time at least, however brief, they have possessed motility. The partitions that separate the parent-cells, appear also, in becoming detached, to allow the spores more space for, and greater freedom in their movements.

When on the contrary, as in *Ulothrix* and certain branches of *Draparnaldia,* the fertile cells remain closed, one cannot think that the spore has ever been endowed with motile power; for it has fulfilled all the phases of its development, strictly enclosed within the walls of the parent-cell.

I shall not now discuss, though I may recur to the subject at a future time, whether the slight differences or modifications which are observed in the formation of hypnospores in the *Draparnaldiæ,* betoken germs of unequal morphological value, or, whether the same relation exists between them as in the Hydrodictyeæ, is found between the spores of *Hydrodictyon* and *Pediastum* on the one hand, and those of *Cœlastrum* on the other; and whether, if in the Draparnaldiæ, chronizoospores co-exist with spores of equal dignity, but motionless from their origin, that is to say, chronispores properly so called.

It was sufficient for the object of this notice to show in the mode of existence of the spores of *Draparnaldia glomerata,* a second and very precise example of zoospores passing into the state of chronispores.

REVIEWS.

General Outline of the Organization of the Animal Kingdom. By THOMAS RYMER JONES, F.R.S. Third edition. London: Van Voorst.

THIS work has been, for many years, the most complete manual of comparative anatomy in our language, and we are glad to find that the demand for such a volume has led to the publication of a third edition. Although but a limited number of the subjects embraced in a complete survey of the animal kingdom demand investigation with the aid of the microscope, yet we imagine, at the present day, that few persons study comparative anatomy without using the microscope; and that those who use this instrument do not confine themselves to the study alone of those structures and forms which are invisible to the naked eye. It is on this account that we would draw the especial attention of our readers to this new edition of Professor Jones' book. As a complete survey of the whole field of animal structure, it has long occupied a prominent place in the scientific literature of this country; but it is the extensive additions and alterations, more particularly in the microscopic organisms, in which the work claims more particularly the attention of the student of the microscope. In the opening chapters devoted to the lower organisms, a rearrangement of these forms is presented, and a large quantity of new matter is added. Professor Jones does not follow in this work any particular system of classification, but satisfies himself with indicating the characters and structure which belong to certain great groups of recognised objects. This has enabled him to dispense with a good deal of discussion, and leaves the student free to construct his zoological arrangement from other sources. There may be a difference of opinion as to the desirability of this course, but we have no doubt that each plan has its merits and demerits. It would be impossible, in a volume like the present, to bring together all the observations that have been made on any particular group of organisms; but taking the Protozoa and Infusoria as examples, we think that Professor Jones has been very happy in his selections. We are reminded by his chapter on the Infusoria, that he was one of the earliest writers in this country to throw doubt upon some of the conclusions of the great Ehrenberg. Since the first edition of this book was written an immense advance has been made in our knowledge of microscopic organisms, and the great family of Infusoria of Ehrenberg have been almost threatened with extinction. We are glad, however, to find our author holding by some of the Infusoria as genuine examples, and not following Agassiz in his hasty annihilation of such organisms.

Throughout the work, amongst the higher groups of organisms, we observe abundant evidence of the care which the author has bestowed on this edition of the work. A large number of new woodcuts has likewise been added; for whilst we observe, in the second edition, that the last figure is marked 398, in the present edition it is 423. The additional cuts, like those of the earlier work, are executed with great care, and form some of the best illustrations of anatomical structure with which we are acquainted. In fact, we feel that, in the getting-up of this beautiful book, it would be unfair not to refer to the publisher, whose great care and good taste have enabled him to place the works of his authors in the most attractive and useful forms before the public. We cannot for a moment suppose that a work which has already reached three editions, whilst natural history teaching is advancing, will not have a demand for a fourth; and we are sure we need not remind Professor Jones of the necessity of bringing the information contained in his classical volume in every succeeding edition up to the very edge of the time in which it is published.

A History of British Sessile-eyed Crustacea. By C. SPENCE BATE and J. O. WESTWOOD. Parts I to IV. London: Van Voorst.

THE commencement of this work promises to complete the history of the British Crustacea. Mr. Bell's beautiful work on the stalk-eyed forms has left nothing to be desired in this department; whilst Dr. Baird's volume on the Entomostraca, published by the Ray Society, is a very complete history, up to the time it was published, of the more minute forms of this family. Messrs. Bate and Westwood have now undertaken to fill up the hiatus left by these two works; and from the reputation of these gentlemen in the study of the families they have undertaken to illustrate, there can be no doubt that they will perform their task with equal ability. The present parts include the Saltatorial and Natatorial tribes of the order Amphipoda. The descriptive portion of the work commences with an account of the *Palitrus Locustra,* the sand-hopper of our coasts. A minute account of the structure of this creature is given, as well as of the other species described, and the microscope has been used for the purpose of furnishing the more minute details of their organization. Enlarged and accurate drawings of each species are given, and the work is abundantly supplied with those well-chosen and beautifully executed tail-pieces, which have made the works published by Van Voorst so interesting to the naturalist who has a feeling for the picturesque in nature as well as a love for the investigation of the special forms of animal and vegetable life. From the portion already published, we believe this work will be a worthy companion of the series to which it belongs, and we hope its sale will induce the publisher to go on with the series of volumes dedicated to the natural history of the animals of the British Islands.

Elementary Treatise on Physics, Experimental and Applied. By Professor A. Ganot. Translated by E. Atkinson, Ph.D. Parts I to IV. London: Baillière.

It has often been a matter of regret to us that we had so few elementary works on experimental philosophy. It is true that a large number of our students can read French, and in that language there are several works admirably adapted as introductions to the inquiries of the experimental philosopher. The treatise of Professor Ganot is well known in England; and its acknowledged excellence gives us great pleasure in finding that it is undergoing the process of translation into English, as by this means it will find a much wider circle of students in this country than it could do in its native language. The four parts before us have not exhausted the subject of heat, but the publisher promises that it shall be completed in a post 8vo volume of 780 pages. It will contain upwards of 600 illustrations, and, when finished, will constitute a work in which the student of every department of experimental philosophy will have every reason to be satisfied. We need not point out here how important it is for those who use the microscope to understand the laws of light. From the want of an elementary knowledge of this subject many absurd mistakes are committed by those who use the microscope, and our treatises on this instrument cannot supply the want of a general view of the entire subject. The work is exceedingly well printed, and the woodcuts executed with great care, so that we can cordially recommend this English edition of Professor Ganot's work. As a proof of the popularity of Ganot's book in France, we ought to add that the translation is made from the ninth French edition.

NOTES AND CORRESPONDENCE.

On Mounting Polyzoa, and Hydroid Zoophytes, so as to display the outstretched Tentacles as in Life.—The great beauty of these preparations, and I think I might add their unquestionable value, render it desirable that as public an answer as possible should be given to the numerous interrogations, as to the *modus operandi*, constantly received.

So far as I myself am concerned, the discovery of the process was nearly accidental, and originated in a half jocular attack upon the ebriety of a very coy colony of *Alcyonidiæ*, with spirit of wine, added drop by drop to the salt water bath in which I had been watching their manœuvres. To my great delight I saw them come out one by one, and slowly unfold their arms, till each Briareus among them was as rigid and non-retractile as could be desired.

The specimen upon which I made this first experiment is in my cabinet still, as perfect as it was the day I rejoiced over it at Longland Bay, near Swansea, in the summer of 1859.

There is no need to spend many words in supplementing so simple a matter. The principal points to be observed are these: first, "catch your hare," of course, *i. e.*, secure vigorous and clean polypidoms. Next, mount them as soon as you possibly can, or you will get but a flaccid and feeble development; some will not come out at all. I have generally found it necessary to have two or three baths of different fluids ready, and to assail those who may be proof against one by the potency of another; Thwaites's fluid answers admirably for most. In some cases a deposit of a mucilaginous character takes place at the bottom of the cell; it is therefore well so to secure the covers as to admit of transfer to a second cell, if necessary: hence a memorandum of the original fluid, and its strength, should be kept.

As a mere mechanical matter, it may be added that, when practicable, it is a great security to cut the sea-weed or polypidom of such length as to stretch the entire diameter of the cell; this saves the zoophytes from collision with the sides. I need scarcely say that in no case should the slides be placed otherwise than flat.

It may be interesting to some to know what species have proved amenable to this process.

I succeeded at Ilfracombe, in 1860, in getting perfectly and permanently displayed the polyps of *Bugula, Scruparia, Membranipora, Cellipora, Alcyonidium, Cycloum, Amathia, Vesicularia, Valkeria, Bowerbankia, Farrella,* and *Pedicellaria.* The Hydroids had no more objection to the spirit than their more advanced allies.

I am by no means anxious, however, to claim any laurels of discovery in this matter; my friend, Mr. Leipner, of Clifton, to whose superior experience in zoophytology I have since owed much, having, unknown to me, observed the same thing at Tenby.

On naming to him my success, this transpired, and since then we have worked much together. The specimens mounted by me at Ilfracombe, I showed to Messrs. Smith and Beck, in 1860, and since then have forwarded to them a small number of very beautiful preparations, mostly made by Mr. Leipner, at Tenby. So far as a comparison of notes goes, the variety of species is in favour of Ilfracombe, which will account for the greater number of families with which I have been successful. Mr. Leipner has, however, brought out *Crisia,* at Tenby, which has defied me; and we have both been jilted by the coquettish *Anguinaria,* which in one instance only has condescended to appear to Mr. Leipner, but to me has been obdurate.—J. W. Morris, Bath.

Collection of Microscopic Objects.—As there is great demand for the microscopical productions of our undrained fens in Norfolk, which are so rich in Insects, Infusoria, Characeæ, Algæ, Diatomaceæ, Desmidiaceæ, &c., and being the discoverer of several new species during the past year, I am requested by a number of my best friends to offer my services in the collecting and preparation of microscopical objects of all descriptions in the fens of Norfolk and surrounding sea-coast, feeling sure that they are well calculated to repay those who would wish to contribute a small share towards the expense of working them. I propose to take a small number of subscribers for shares, of the parts of insects, objects, dissections, &c., mentioned; each share to be one guinea; and all the objects to be equally divided among the subscribers in November next. By this means a good supply of slides, all properly mounted in various ways, at the wish of the subscribers, may be secured at a much less sum than is spent in the postage, carriage, &c., of slides by exchange, to say nothing of the expensive process of purchasing objects. Gentlemen who wish to subscribe to the above may send their names and subscriptions as early as possible, the number being limited, to begin from this date and end on the 10th of November, 1862. My object in the above proposition is to be enabled to explore thoroughly the microscopic productions of the fens, and all my time will be devoted to the subject.—Wm. Winter, Alderby, near Beccles.

Transparent Carmine Injections.—I have found no difficulty in remounting the transparent carmine injections, and did so with all of the kind in my collection. If the broad slide is the proper length—above three inches—your correspondent's advice, in your last volume, may be followed by cutting with the diamond to the necessary width and length; but I prefer the remounting, particularly when the German slide is shorter than three inches.—B. Wills Richardson, Dublin.

PROCEEDINGS OF SOCIETIES.

Microscopical Society,

January 8th, 1862.

R. J. Farrants, Esq., in the Chair.

H. J. Slack, Esq., J. P. Bedlake, Esq., George Reade, Esq., J. W. W. Hewitt, Esq., M. C. Hardy, Esq., and F. Bunting, Esq., were balloted for and duly elected members of the Society.

A short notice was read "On the Vegetable Structure to be observed in Common Household Coal," by J. T. Tupholme, Esq. The author commenced by observing that he failed in getting satisfactory sections of coal by grinding, but recommends heating a mass of coal on a slow fire, and taking slices with a razor from the surfaces exposed on breaking it up. He then proceeded to describe some pitted or dotted tissues, apparently identical with those figured by Witham (Tab. xi, fig. 6, 7), and considered they are similar to the structure shown by *Cycas revoluta.* He finds that Pinxton coal gives both scalariform and pitted ducts; Clay Cross chiefly scalariform; the Derbyshire well-defined vascular tissue.

The following papers were read:—"On some new Species of Diatomaceæ," by Dr. Greville ('Trans.,' p. 41); "Some Account of the Martin Microscope," by Mr. J. Williams ('Trans.,' p. 31.)

February 12th, 1862.

Annual Meeting.

R. J. Farrants, Esq., President, in the Chair.

The President announced that William Peters, Esq., had presented to the Society his machine for microscopic writing, with all the apparatus connected with it.

It was unanimously resolved that the most cordial thanks of the Society be given to William Peters, Esq., for this most munificent present.

Charles Borradaile, Esq., Henry Haines, Esq., E. George, Esq., S. S. Wigg, Esq., and George Davies, Esq., were balloted for and duly elected members of the Society.

Reports from the Council on the progress and state of the Society, from the Auditors of the Treasurer's accounts, from the Library Committee, and from the Cabinet Committee, were read.

The President delivered an address, showing the progress of the Society during the past year, and also of microscopical science during the same period. This address and the preceding reports were ordered to be printed and circulated in the usual manner.

The Society then proceeded to ballot for Officers and Council for the year ensuing, when the following gentlemen were declared duly elected:

As President—R. J. Farrants, Esq.

As Treasurer—C. H. J. Allen, Esq.

As Secretaries— { G. E. Blenkins, Esq.
F. C. S. Roper, Esq.

Four Members of Council:

A. Brady, Esq.
Charles Brooke, Esq.
John Hilton, Esq.
Tuffen West, Esq.

In the place of

F. C. S. Roper, Esq.
R. Warrington, Esq.
S. C. Whitbread, Esq.
Rev. T. Wiltshire.

who retire in accordance with the regulations of the Society.

The thanks of the Society were then unanimously voted to N. B. Ward, Esq., for his long services as Treasurer to the Society.

During the time that the ballot was proceeding, Mr. Hodgson called attention to the President's remarks on the cost of the Transactions and Journal; these, as the President had observed, had gone on increasing, and prevented the Society from spending its money on other objects. When he considered the price of other scientific journals, he thought the Society was paying too much for theirs.

Dr. Lankester, as one of the editors of the Journal, said he was exceedingly obliged to Mr. Hodgson for having given him an opportunity of replying to the remarks of the President, which he could not otherwise have done with propriety. He was sorry to find that the President had regarded the interests of the Transactions and Journal as antagonistic; for the Journal had been started in connexion with the Society, and had always been conducted with a view to carry out the objects the Society had in view. It was true the Journal and Transactions were not sold so cheaply to the public as the popular journals alluded to by Mr. Hodgson; but it should be recollected, that the very fact that the Journal contained the highly scientific papers read before the Society, was one reason of its high price; for these papers limited the circulation of the Journal to the small number of persons who worked scientifically with the microscope. The papers in the 'Microscopical Journal' were generally original papers, or translations of foreign papers, with illustrations that had not appeared before, and in point of scientific value, were incomparably more valuable than the papers written for popular instruction in the magazines alluded to. But even admitting this, it was not correct to say that the Journal, which was sold to the public at four shillings, cost more to the Society than the journal named, which cost two and sixpence, for the editors supplied the Journal and Transactions of the Society at the present moment, according to agreement, at a cost of two shillings and fourpence for each number. The editors did not think this an unfair arrangement for the Society, as it barely covered the cost of the Journal. If, however, the members of the Society thought they ought to supply them with the Journal at a loss, it was for the editors to consider whether such an arrangement would be so injurious to the general interests of the Journal as to prevent their being able to comply with such a demand. Individually, he should deeply grieve to see the Journal and Transactions dissevered, and he thought it was for the Society to consider whether such a step would be politic. They should recollect, that when the Journal was started, the Transactions had been published very irregularly, and the Society had on its books only 180 members. Of these, several never paid their subscriptions, so that, as the members were now 317, it might be said that the Society had doubled its numbers under the influence of the Journal. He knew perfectly well that a large number of members had joined the Society on account of the regularity of the publication of their Transactions, and the valuable matter contained in the Journal. It was quite true, as the President had stated, that the expense of the Journal to the Society had gradually increased, but that had entirely arisen from the increase of members. It would be found, indeed, if they compared the expense of the old Transactions without the Journal with the present expenditure on both Transactions and Journal, that, in proportion to the whole income of the Society, the expense was less now than it was then. The large expenditure on the Journal in the accounts of last year depended on some of the previous years' expenditure having been brought into the account, as anybody could ascertain, by calculating the number of Journals required by the present number of members. He hoped the Society would make no demands that the proprietors of the Journal could not concede; for one, he promised the Society that no efforts should be wanting on his part to maintain the union of the Transactions and the Journal which had hitherto worked so satisfactorily for the advancement and prosperity of the Society.

After some further remarks from Mr. Hodgson, Mr. Lobb, Mr. Matthew Marshall, and others, it was agreed by the Society that a committee should be appointed to take the subject into consideration, and report to the next meeting of the Council.

March 12th, 1862.

R. J. Farrants, Esq., President, in the Chair.

Charles Reiner, Esq., J. H. Gent, Esq., George Sweet, Esq., G. L. Paton, Esq., Dr. Harcourt, and Dr. Hingman, were duly elected members of the Society.

A paper was read :—"On the Preservation and Mounting of Microscopic Objects in Tubes," by Dr. Guy ('Trans.,' p. 57).

A Paper

On the Scales *of some* Species *of* Thysanoura, *and more especially the value as* Test Objects *of those* Scales *hitherto considered as belonging to* Podura plumbea. By Richard Beck.

The author first alluded to the diversity of opinion as to the appearance and the structure of the Podura scale, and to the remarkable fact, that, even to the present time, no two authors have agreed upon the subject. After the discovery of the object by Thos. Carpenter, Esq., Mr. Pritchard, in 1832, describes the markings as an "aggregation of dots" when seen under the best single microscopes; but in 1837, Dr. Goring, by the aid of the "engiscope," proves these dots to be "veritable lines." This assertion is somewhat astonishing; for, with our present knowledge of the correct general appearance, it establishes the fact that the first introduction of the compound microscope was a retrograde movement. About the same time, Sir David Brewster, "after a laborious examination," finds that the appearances mentioned are fallacious, the structure of the scales being "composed of a succession of interlocking teeth," analogous to the fibres of the crystalline lens of the eye. In 1852, or after a lapse of fifteen years, the scales appear to Mr. Quekett as covered with "wedge-shaped scales," which, under sufficient power, may be seen "to stand boldly from the surface," and also to "project beyond the edge" of the scale. The 'Micrographic Dictionary,' 1856, under "Scales of insects," supplies the following statement:—That the "longitudinal striæ," of all scales, "consist of elevations or ridges upon the surface, probably representing folds of the upper layer or membrane of the scale." That in the Podura scale "the striæ consist of longitudinal rows of minute, wedge-shaped bodies," their "darkness" being due to "refraction," and that "the other more or less transverse curved striæ" which "exist upon certain scales" are "wrinklings or folds of the under membrane." Dr. Carpenter, one year later, holds yet another opinion, and considers that, as in "the scaly investment" of the Lepidoptera "each scale is composed of two superficial colored laminæ, enclosing a central laminæ of structureless membrane, the surface of which reflects back the light," so in the Podura scale, "the structure does not differ essentially from the ordinary type;" but that in those scales where "the superficial layers have been partly removed" "the dark lines are but the spaces between the minute wedge-shaped particles arranged side by side and end to end, of which those layers are made up."

The author of the present paper considered these differences of opinion to have arisen from various sources, but more especially from the fact that none of the writers quoted here identified the scales they have described with any particular species, and the only attempt that any of them has made to figure the insect, occurs in the 'Micrographic Dictionary;' it is not, however, an orginal drawing, and can only be recognised as a species which has no scales whatever upon it.

In the family Thysanoura there are as many as three genera and seven species at least which have scales, with most distinct features. But satisfactory descriptions of these cannot be given without the illustrations, and they will most probably be published together in future numbers of the Journal.

The best test-scale is that in which the markings are wedge-shaped, very black and brilliant, but with a narrow light space towards the top of each; they are consecutive in the longitudinal direction of the scale, and no transverse lines whatever are present; the stronger the markings the better, as the test consists, not in the mere fact of separating the dots (a result easily obtained with an inch objectg-lass), but in the way in which the markings are shown; this point also requires illustrations, but, without any drawings, the following advantages of the object may be mentioned:—A proper scale will show most distinctly the condition of the chromatic and the spherical aberrations, the latter more especially being evident, by the care that a good object-glass of highest power requires, in its adjustment for the thickness of the covering glass; and when this is correct the appearances presented immediately either within or beyond the focus should be exactly the same. Bad workmanship of any kind is also strikingly evident.

The habitat of these insects has hitherto been described as damp cellars, whereas the drier the place in which this species can be found at all, the more likely are they to be furnished with superior scales.

The best way to remove the scales, is to press a piece of glass very lightly on the live insect, taking care to select those that are in the best condition.

The author's opinion as to structure was entirely confirmatory of that already quoted from the 'Micrographic Dictionary;' and proofs were given of the darkness of the markings being due to the refraction or reflection of light (provided no pigment be present), by an analysis of the appearance of the scale of *Lepisma saccharina,* when moisture was present on either surface.

Especial attention was also directed to the remarkable appearances produced by the alterations in the direction of the light, more especially when the markings of two surfaces were superposed, and crossed each other at different angles; so that under many circumstances it becomes impossible to determine the structure of a transparent object from its appearance only, whether it be illuminated from above or below.

These remarks do not apply to the Podura scale, for only one, and that the outer surface, has structure upon it. Its illumination under a power of 1300 linear, from above, is easily effected by the ordinary side condensers, provided the object be uncovered, as, with the oblique illumination that is necessary, the thin glass cover acts as a most perfect reflector. On examining the Podura scale under these circumstances, and with the aid of the binocular microscope, the author was quite satisfied in his own mind that the markings consist of a series of toothed ridges, the profile of which might be said to resemble the edge of a saw; and he also stated his belief that the markings upon this and all the other scales he had alluded to were more or less elevations or corrugations upon the surface, which serve the simple purpose of giving strength to very delicate membranes.

Manchester Literary and Philosophical Society.

MICROSCOPICAL SECTION.

January 21st, 1862.

Professor Williamson, President of the Section, in the Chair.

Mr. William K. Deane was elected a member of the Section.

A letter was read from Mr. H. A. Hurst, late of Calcutta, making a donation to the Section of his entire collection of mounted microscopical objects, consisting of upwards of four hundred specimens. They comprise 90 slides of diatomaceæ; 100 of algæ, mostly marine; about 30 different kinds of starches, and the remainder an assortment of Desmidiæ, preparations of insects, bone sections, and a variety of other objects.

Mr. Hurst also presented a collection of specimens of Asiatic woods, in small blocks, obtained from the Horti-Agricultural Society of India at Calcutta. They consist of 98 specimens from Arracan; 76 from Upper Assam; 6 from Central India; 8 from the coast of Tenasserin; and 13 from Chittagong; 201 specimens of woods in all, most of them with the native names.

Capt. Penrice, of the ship "Pegasus," from Shanghae, forwarded to the Section a number of soundings taken during his last voyage, amongst which may be noted one each from the mouth of the Yang-tse-Kiang river in China, the coast of Borneo, and Java; and a portion of mud rich in Foraminiferæ, from the anchor fluke, at Gaspar Island.

The Secretary laid on the table 60 specimens of soundings, which had been freed from the tallow "arming" in two evenings after business hours, at Mr. Dale's laboratory, by Mr. Dale, Mr. Dancer, and himself, assisted by Mr. Richard Dale. The system adopted is that described in Mr. Mosley's paper, read to this Section on 21st January, 1861, published in the 'Quarterly Journal of Microscopical Science,' vol. i, new series, p. 143, and is found to answer better than any other method yet made known.

Professor Williamson presented fourteen specimens of dredgings, supposed to be from the mouths of the Ganges.

A communication from Mr. A. G. Latham was read, upon the subject named for the evening's discussion, "On the cause of the metallic lustre on the wings of the Lepidoptera, both diurnal and nocturnal."

Mr. Latham believes that the metallic lustre may be simply referred to the presence of a pigment in the substance of the wing, in some cases light-absorbing, and in others light-reflecting; all the scales seem equally adapted for reflecting the prismatic colours, consisting of three distinct membranous films, covered with minute irregularities. Mr. Latham sent to be exhibited a number of slides for illustration.

A communication was read from Mr. Dancer, in which he referred to a paper, read by Sir D. Brewster at the last meeting of the British Association, containing the following remarks by Professor Dove:

"In every case where a surface appeared lustrous there was always a transparent or transparent-reflecting stratum of much intensity, through which we see another body; it is therefore externally-reflected light in combination with internally-reflected or dispersed light, whose combined action produced the idea of lustre. * * This effect we see produced when many watch-glasses are placed in a heap, or when a plate of transparent mica or talc, when heated red-hot, is separated into multitudes of thin layers, each of which, of inconceivable thinness, is found to be highly transparent, while the entire plate assumes the lustre of a plate of silver."

Mr. Dancer sent for exhibition several pieces of talc, which in places, by the action of the blowpipe, had been heated to redness; the films were thereby separated, and the raised or blistered portion gave a metallic lustre like silver.

Mr. W. C. Unwin believed that the metallic lustre was due not to pigment but to the reflection of light from internal surfaces of the scales through the transparent outer layer. The light so reflected appeared to be modified in two ways—by the ribs or striæ; it was dispersed by them so that the scales were lustrous at various angles, and it was also in some cases coloured by interference caused by them. Iridescence appeared to be also produced in some scales by the thinness of the laminæ through which the light was refracted causing interference. Mr. Unwin exhibited a number of specimens to illustrate his arguments.

Mr. Dale referred to beautifully coloured films which arise upon various chemical solutions, the metallic brilliancy of which may arise from similar causes.

Mr. Sidebotham observed that the metallic appearance was not due to any colouring matter in the scales, as chemical agents, which destroy the coloured scales, have no effect whatever on these metallic ones; he also mentioned a curious polarizing effect produced by crossing the metallic scales of *Plusia bractea*.

Mr. Sidebotham exhibited the metallic scales from *Plusia orichalcea*, *Plusia bractea*, *Plusia Festucæ*, *Plusia concha*, &c., illustrative of his remarks.

It was ultimately resolved that the discussion should be adjourned so as to enable the proposer of the subject, and other gentlemen not present, to express their views.

Mr. Sidebotham also exhibited a new finder for high powers. It consists of squares formed by crossing lines, one hundredth of an inch apart, enclosing progressive numbers, executed by photography. He promised to prepare a number for the use of the members, all to be exactly alike.

Mr. Joy exhibited a nose-piece, made for him nearly two years ago, consisting of a diaphragm plate, under which are screwed four objectives of different powers; the centreing is so true, that he can use the three-inch as a finder for the $\frac{1}{4}$th or even $\frac{1}{8}$th-inch power. Several members of the section have nose-pieces made upon the same principle.

February 17th, 1862.

Professor WILLIAMSON, F.R.S., President of the Section, in the Chair.

Soundings were acknowledged from Captain W. B. Hall, of the P. and O. S. S. "Tagus," taken off Ushant, Coast of France, and from Captain J. R. Husband, ship "Florence Nightingale," taken off the Coasts of Patagonia and Tierra del Fuego.

Professor Williamson called the attention of the section to the new rotifer (*Cephalosiphon limnias*), recently discovered by Mr. H. J. Slack, in a pond at Hampstead, and an account of which appeared in No. 1 of the 'Intellectual Observer,' of the present month. Attention was specially directed to the fact that the animal only possesses *one* of those organs that have been designated "respiratory tubes," "calcars," and "tactile organs;" whereas, the Floscularian rotifera, when furnished with them, have two. It remains to be ascertained from a study of the embryo, whether this is the typical condition in the Cephalosiphon, or whether there were primarily two, the missing one having been suppressed during the development of the embryo, as sometimes occurs amongst higher animals.

The Secretary read a Paper, by Mr. Thomas Davies of Warrington on Crystallization.

Mr. Davies treats more particularly upon some of the double salts, which show beautiful combinations of form and colour by polarized light; and upon his method of obtaining determinate flower-like, forms, surrounded by a film of the uncrystallized salt. The novelty of the author's system, consists in the following particulars:—He makes a nearly saturated solution, say of the double sulphate of copper and magnesia; he dries rapidly a portion on a glass slide, allowing it to become so hot as to fuse the salt in its water of crystallization; there then remains an amorphous film on the hot glass. On allowing the slide to cool slowly, the particles of the salt will absorb moisture from the atmosphere, and begin to re-arrange themselves on the glass, *commencing from points*. "If then placed under the microscope," says the author, "we shall see points starting up here and there, and from those centres the crystals may be watched as they burst into blossom, and spread their petals on the plate." Starting points may be made at pleasure by touching the film with a fine needle, to enable the moisture to get under it; but this treatment renders the centres imperfect. If allowed to go on, the crystals would slowly cover the plate, or if breathed upon they form immediately; whereas, if it is desired to preserve the flower-like forms on a plain ground, as soon as they are large enough, development is suspended, by again applying gentle heat; the crystals are then covered with balsam and thin glass, to be finished off as usual. The balsam must cover the edges of the film, or moisture will probably get under it, and crystallization go creeping on.

Many crystals which produce similar forms cannot be preserved in balsam; in the hyposulphite of soda they are very fine, and the author is endeavouring to preserve them in castor oil.

Mr. Sidebotham referred to the vegetable forms produced by Mr. Petschler, with bichromate of potash in gelatine, exhibited at the British Association Microscopical Soirée. Since then flower-like shapes had been obtained from nitrate of silver amongst the ramifications of the bichromate; as it is an interesting subject, he should endeavour to bring it before the next meeting.

The discussion "On the cause of metallic lustre upon the wings of the Lepidoptera" was resumed. Mr. Latham stated that he saw no reason to alter the views he had expressed; but since the last meeting Mr. Watson had called his attention to an article in the 'Annales des Sciences Naturelles' for February, 1835, by Bernard Dechamps, "Sur les Ailes des Lepidopteres," which contains much information upon the scales and the cause of their brilliance; he (Mr. Latham) had translated and printed extracts from the paper; copies were handed round to the members present, and may be had (gratis) at the Society's rooms, or from the Secretary of the Microscopical Section.

A paper was read by Dr. Thomas Alcock "On the Tongues of Mollusca."

The author remarked upon the great variety and beauty of these objects, and pointed out their scientific value as a help in the classification of shells. On investigation, the tongues were shown to arrange themselves into four groups, according to the pattern or type of the lingual dentition, and these groups were stated to correspond with four of the orders established by Cuvier, on the characters of the breathing organs. The four orders illustrated were the Pectinibranchiata, the Scutibranchiata, the Cyclobranchiata, and the Pulmonata; and he believed that, on the evidence of the teeth, it will be necessary to re-establish the order Cyclobranchiata as distinct, instead of including it in the Scutibranchiata, as is done by our latest authorities.

The author had examined many specimens of *Buccinum undatum* of both sexes, a series of which were exhibited to prove that the number of points on the central teeth in this species varies, from five to seven, but without reference to sex. The very close agreement both in the lingual teeth and in the general internal anatomy of Fusus and Buccinum was mentioned, and a doubt was expressed as to the propriety of their wide separation in our present systems of classification. The association of Fusus with Murex, and of Purpura with Buccinum, was also commented upon, and shown by the evidence of the tongues, as well as the general anatomy of the animals, to be clearly incorrect.

In conclusion, some remarks were made on the method used by the author, of extracting the tongues from the different kinds of mollusca, illustrated by specimens, some of which were many times longer than the bodies of the animals, being coiled up near the neck, and brought forward as the teeth are worn away. The paper was illustrated by beautifully executed drawings of the different types, and a series of dissected animals.

Professor Williamson asked the author if he proposed to include the Chitons in the order Cyclobranchiata.

Dr. Alcock was satisfied the Chitons ought not be so placed; but, judging from the general character of their teeth, he thought they might possiby remain with the Scutibranchiata, or, perhaps, it would be necessary to establish a new order expressly for them.

Professor Williamson was glad to learn that this was the result of Dr. Alcock's observations; for the animals certainly appeared very distinct, and the Chitons, which he remarked have the form of a gigantic woodlouse, were evidently not Cyclobranchiata, as they have a separate gill down each side of the body.

On adjourning to the microscopes, Dr. Alcock exhibited mounted spcimens of tongues from thirty different species of Gasteropoda, with the shells from which they were extracted. One of the lingual ribands was two and a half inches long.

Mr. Latham exhibited scales from the wings of the *Catarrhactes papua*, a Penguin from the Falkland Islands, which appear to be intermediate between feathers and scales.

Mr. Edward Lund exhibited two forms of stands for holding a microscope, condenser, lamp, &c.; one in the form of a tray fixed on four castors, to run upon an ordinary table, and the other a small round turn-table, thirty inches high and fifteen inches diameter. The lamps were for paraffin oil, fitting into wooden cups secured to the stands.

ORIGINAL COMMUNICATIONS.

On the Development *of* Synapta inhærens, O. F. Müller (sp.) By Wyville Thomson, LL.D., F.R.S.E., M.R.I.A., F.G.S., Professor of Natural History, Queen's College, Belfast.

I have had an opportunity during the past summer, through the kindness of my friend Captain Wethered, of observing with care some of the earlier stages in the development of *Holothuria inhærens* of O. F. Müller, so well known to microscopists from the remarkable character of its calcareous armature. This singular Holothurid is abundant, buried in mud banks, at, and a little above, low water mark on the shores of Belfast and Strangford Loughs. I had long been most anxious to trace its mode of reproduction, but every attempt, whether by sifting the surface of the water with a towing net for a swimming larva, or by examining the plants growing on the banks for an early creeping stage, signally failed. In the mean time, Captain Wethered contrived thoroughly to domesticate three or four mature Synaptæ in a small tank; and after they had been upwards of a year in confinement, he was rewarded for his care and patience by a brood of young. He was absent from home for some days in the beginning of June of the year 1861, and, on his return, he detected several extremely minute transparent bodies moving on the surface of the glass of the Synapta tank. On examining these with the microscope he found that they were young Echinoderms, and, even at this early stage, their mode of using their rudimentary tentacles was so characteristic as to leave but little doubt of their parentage. Captain Wethered kindly placed these embryos at my disposal, and I examined them carefully from time to time. There still, unfortunately, remains a doubt, whether there may not be a still earlier condition of swimming larva. The embryo, however, when first observed, was extremely minute (·8 mm. in length); its structure was very rudimentary, and even in the simplest and most minute embryos there was not the slightest trace of larval appendages. I am, therefore, inclined to believe, that no independently organised pseudembryo is produced, but that the Echinoderm is developed at once from a simple ciliated germ. I shall not, however, consider my task completed, till this point be fairly cleared up; and, in the mean time, I merely offer the present communication as a contribution to the history of a limited period in the development of the young.

The two most important memoirs on the structure of the genus Synapta are those of De Quatrefages ("Mémoire sur la Synapte de Duvernoy" 'Annales des Sciences Naturelles,' 1842), and of Johannes Müller ('Ueber Synapta Digitata,' Berlin, 1852). *Synapta Duvernœa* (A. de Q.) must be regarded as a synonym of the species under consideration, and Müller's observations refer to a closely allied form which has been frequently met with on the English coast.

I have had an opportunity of dissecting *Synapta inhærens* with care, and as a general knowledge of the mature form is necessary before we can understand fully the structure and development of the young, I shall briefly abstract my own results and those of previous observers, so far only as they bear upon this point.

Synapta inhærens is provided even more richly than *S. digitata,* with the remarkable ciliated trumpets described by Müller.

I hope to have an opportunity of illustrating fully this anomalous respiratory apparatus and the organs of reproduction in a future paper. It is unnecessary to allude to them at present, as no trace of either system is perceptible in the most advanced embryos which I have yet examined. For more minute anatomical details I refer the reader to the memoirs above cited, and for certain special points, to the papers of Grube, Duben and Koren, Held, Leydig, and Woodward.

SYNAPTA INHÆRENS, *O. F. Muller* (sp.)

Holothuria inhærens, O. F. Müller, Zool. Dan, taf. xxxi, figs. 1—7.

Chirodota pinnata, Grube, Aktinien, Echinodermen, &c., p. 41.

Synapta inhærens, Rathke, Nov. Acta Nat. Cur. T. xx.

Synapta Duvernœa, A. de Quatrefages, Ann. des Sc. Nat., 1842.

Synapta inhærens, Woodward and Barrett, Proc. Zool. Soc. Lond., 1858.

The body is cylindrical and vermiform; a full grown specimen, moderately distended, is about a foot in length, by five eighths of an inch in diameter.

Small specimens, from clear sand, have the integuments very transparent and nearly colourless; but large specimens, from low water-mark on the mud banks, where they specially abound, are of a pale-reddish brown. The mouth is unarmed, and is placed in the centre of a disc of circular muscular fibres, which forms the anterior extremity. The mouth is surrounded by a circle of twelve pinnated tentacles, five digitations on either side and on the oral surface of each tentacle eight minute sucking papillæ are arranged in a double row. The body consists of an external wall, bounding a cavity filled with sea water, in which the organs of assimilation and of reproduction float freely. Three distinct elements enter into the structure of the external wall. The outer layer is of considerable thickness, transparent, and with a seemingly structureless basis.

Imbedded in the structureless sarcode are groups of thread cells; scattered masses of the carmine pigment-cells, to which the colour of the surface is due; minute endoplasts, slightly blue by transmitted light; and the remarkable calcareous plates of various forms, which are so highly characteristic of this group. These latter consist, in the present species, of the "anchors" and "anchor plates," which have been so frequently described, and whose development we shall discuss hereafter; of thinly scattered miliary granules; and of peculiar irregular plates, like skeleton keys, or more like old Celtic "fibulæ," grouped in masses near the bases of the tentacles, and scattered more sparingly over their surfaces. The entire outer surface of the body is roughened by innumerable low tubercles, at whose apex the carmine pigment-cells and the thread-cells are specially accumulated. The outer layer passes into a firm sheet of delicate felted elastic fibres, to which the consistency of the wall of the body is chiefly due; and this layer is lined by a continuous membrane, formed of delicate transparent, transverse muscular fibres, ·005 mm. in diameter. Powerful rythmical contractions of this coat are perpetually passing along the animal, contracting its body at intervals to half its normal diameter, while between the contracted portions the integuments are distended with sea-water, and usually rendered so transparent as to show clearly the viscera within. This inner muscular layer, and indeed the whole of the interior of the visceral cavity, is as it were *varnished* with a thin coating of transparent, structureless sarcode, studded here and there with oval endoplasts, and continued into various mesenteric straps and membranes.

The mouth is a simple round orifice, surrounded, in a state of contraction, by the epidermis thrown into folds by the action of the sphincter muscles. The œsophagus is short and highly muscular, and a second constriction separates it from the alimentary canal. There is scarcely any distinction between stomach and intestine; the tube is nearly uniform throughout. Its walls consist of three well-marked layers—an external structureless epithelium, a portion of the general epithelial lining of the body cavity; a muscular layer, consisting of a uniform bed of transverse fibres and of four delicate longitudinal bands; and of an inner layer, of variable thickness, and finely granular.

The alimentary canal passes nearly straight from the œsophagus to the terminal anus; it is, however, somewhat longer than the body in its ordinary state of rest, and it is kept in position, and its slight convolutions are supported, by a delicate mesentery of transparent fibres, with endoplasts projecting from their surface, and by scattered transparent cords of similar structure, which pass from the mesentery to the walls of the body cavity, with whose structureless inner lining they seem to be continuous. Twelve transversely oblong plates form a regular calcareous dodecagon round the œsophagus within the body-wall, and to these the fibrous and muscular layers of the integument are attached. Five of the plates are perforated. I have been unable to detect any nerve-filament passing through the perforations, though Müller has observed that such is the case in some of the large exotic species. Five longitudinal muscular bands, strongly marked and shining white through the skin, and projecting as raised straps about 3 mm. in width and 1 mm. in thickness into the body cavity, stretch from the five perforated plates of the œsophageal ring, into which they are inserted, along the whole length of the body, and are lost in the fibres of the anal sphincter. The centre of the ambulacral system consists of an annular canal, girding the œsophagus immediately within the calcareous ring. Twelve cæcal processes from the upper surface of this canal form the special lining membranes of the twelve tentacles, and from its lower surface a long, flask-shaped Polian vesicle on one side, and nearly opposite it a single madreporic tubercle, capping a short, twisted canal, hang freely into the cavity of the body; and a delicate straight vessel follows the course of each of the five longitudinal muscular bands.

In *Synapta inhærens* I have observed no organs of special sense. Müller describes twelve eye-spots of the usual form between the tentacles on the oral disc of *S. digitata*, and in the young of *S. inhærens* vesicles will be described which must, I should imagine from their structure and position, be rudimentary organs of hearing; but I have been unable to detect the slightest trace even of these in the mature form. The sarcode covering of the intestine, of the ambulacral vessels, and of the reproductive tubes is richly ciliated.

When first observed, the young was only about ·8 mm. in length, and ·6 mm. in diameter. It had the form of a minute rounded sac, of glassy transparency, slightly constricted towards the upper extremity, and above the constriction a rudely vandyked frill indicated the rudiments of the five primitive tentacles. Pl. V, fig. 1, represents the young at this stage, slightly compressed, and viewed by transmitted light. The internal organs are seen perfectly, through the transparent outer envelope. The outer wall of the sac is very thick, and formed of transparent sarcode. Under ordinary powers the sarcode appears perfectly structureless, but with a high power extremely minute spaces are seen scattered through its substance, and apparently connected by excessively delicate transparent threads or canals, the whole structure resembling somewhat the lacunæ and canaliculi of bone. Groups of very minute greyish granules are observed imbedded in the sarcode, and, scattered over the surface are large lenticular cells, ·03 mm. in diameter, filled with a fluid with a low refractive index, and slightly brown by transmitted light. I am inclined to regard these cells, which are permanent during all the stages of the development of the young, and which seem to be specially abundant in the neighbourhood of developing calcareous plates, as reservoirs of calcareous solution; I cannot imagine, however, that they correspond with the calcareous glands of Müller. Close to the posterior extremity there is a small group of calcareous granules coloured yellowish by organic matter. Some of these concretions seem to be irregular rhombic crystals, but the prevailing form is a rosette of irregular wedges. These granules increase for some time in number; they disappear, however, entirely, when the young has attained a certain stage in development.

Five glistening longitudinal muscular bands, as yet of extreme tenuity, traverse the sarcode sac from the œsophageal ring to the anal extremity. The transverse muscular fibres cannot as yet be traced. A continuation of the outer sarcode layer forms the tentacular fringe, and round the end of each tentacle there is a thick border of pyriform cells imbedded in the sarcode. The rudimentary tentacles move actively, the animal uses them alone, and indifferently, as organs of progression, and they adhere firmly even to a surface of smooth glass.

Ten minute symmetrical calcareous spiculæ form a ring round the œsophagus. Each spicula consists of a short trunk, dividing at one end into two branches, which in some cases divide again. The spiculæ are arranged in pairs, each undivided end turned towards the simple end of the spicula next it. Immediately within this ring the circular canal of the ambulacral vascular system forms a delicate annular lacuna in the transparent sarcode. Five short cæcal processes pass towards the salient angles of the tentacular frill, and a finely granular discoid mass, nearly sessile on the lower surface of the ring, indicates the madreporic tubercle. The five delicate ambulacral branches can already be detected from their separating the longitudinal muscular bands into two bundles, but there seems to be no trace of a Polian vesicle.

At this early stage ten vesicles, one on either side of each of the longitudinal muscles, close to its origin in the calcareous ring, are remarkably prominent. These vesicles are oval, ·025 mm. in long diameter, and contain large secondary vesicles, containing in turn large vesicular nuclei; viewed by light transmitted obliquely in certain directions, the contents of the outer and inner vesicles are dark, the intermediate cell appearing as a bright ring, while by a change in the direction of the light the middle vesicle is darkened, and the outer and inner brightly illuminated, leaving it in doubt whether the transparent colourless fluid contents of the several vesicles have the same or different refractive indices.

I have little doubt that the oval vesicles are organs of special sense, probably rudimentary organs of hearing. They evidently correspond with the vesicles with double vibrating nuclei, described by Müller in young Holothuriæ, and with the marginal vesicles of the Hydromedusæ.

The mouth is a simple orifice in the centre of the tentacular ring, and a delicate, slightly curved alimentary canal ends in an obscure anal pore at the opposite extremity. The middle of the alimentary canal is dilated into a distinct stomach cavity, and its walls are granular, indicating a distinct differentiation of a special assimilating surface; but the alimentary canal is perfectly motionless, and there appears to be no free space between the sarcode of the body wall and its outer surface, so that at this stage the embryo has the special character of the coelenterate type. Very shortly, however, there is a softening and absorption of the sarcode immediately round the canal, which then begins to exhibit, though for some time only feebly, its characteristic vermicular motion.

The general development of the young, and the differentiation of the various organs, takes place from this point steadily, but in a tank in the house extremely slowly. I have now before me (February 10th, 1862) one of the original brood still living, 1·9 mm. in length, and with only seven tentacles. The want of perfect aeration, and the insufficient supply of organic matter in the water are undoubtedly among the causes of this slow progress. I have every reason to believe, however, from the analogy of other cases of development, that the stages of the process are the same in the tank, and when the animal is free. A body-space gradually becomes more and more perceptible between the alimentary canal and the body wall, while the latter assumes the form of a consistent membrane of two layers—an outer, thick, structureless and transparent; and an inner, delicately striated transversely, and highly contractile. The five tentacles become more definite in form, a waved lateral outline indicating the origin of the pinnules; groups of the calcareous fibulæ and minute miliary granules accumulate in the sarcode layer of the tentacles; and usually three anchors, with their anchor-plates, make their appearance simultaneously at irregular points on the surface of the body.

The first indication of an "anchor" is the trend, a delicate calcareous style (Pl. VI, fig. 3, *a*), hollow, and pointed at both ends. By addition of fine calcareous laminæ to the surface, the style becomes blunt at one end, a short transverse crown is gradually formed (*b*), which lengthens (*c*), and each arm curves slightly inwards towards the shank (*d*). When the form of the anchor has been thus far indicated, the ring end of the rod becomes slightly dilated, and a short, blunt, calcareous spicula may be detected lying across the centre of the shank and beneath it. This spicula bifurcates at either end, and this process of dichotomous division goes on (*e, f, g, h*) till the anchor-plate is gradually mapped out of full size, but the network is as yet smooth and extremely delicate (fig. 4).

While the extension of the network is going on, the old calcareous laminæ seem to be absorbed within, as new layers are applied without, for the network appears always to form a continuous tubing. Afterwards the tubes are much thickened by the addition of external layers, and in the fully-formed plate the outlines of the rounded spaces are serrated with blunt calcareous teeth.

The form of the mature anchor has been often described. Young anchors have the arms curved and the centre depressed, like a Cupid's bow (Pl. VI, fig. 3, *d, e, h, k*). Sometimes the crown projects into a point (fig. 3, *l*), and to have the throat widened and perforated is a common malformation. The flukes of old anchors are often serrated.*

Brownish rosettes, granular and with striæ radiating, from a centre, the larger ·03 mm. in diameter in a state of rest, and at irregular intervals of a quarter to half a minute, suddenly contracting to half that size, and then more slowly expanding, are scattered in an irregular row below the calcareous ring. It is very difficult to make out the position of these rosettes. They are certainly not superficial, for the outer surface of the sarcode moves independently over them. I am inclined to think that they are imbedded in the inner transverse muscular layer, and to regard them as the sphincters of pores allowing the passage of water out of the body cavity.

Similar structures have been observed several times in young echinoderms.

The wall of the central ring of the ambulacral system becomes more defined, and shortly it may be traced as a special contractile membrane.

The cæcal processes to the tentacles enlarge, and are likewise bounded by a special wall. The cavity of each tentacle communicates with the ring by a perpendicular slit-like valve (Pl. VI, fig. 1, *c*), which remains open when the tentacle is retracted or at rest; but when the tentacle is in motion, the cæcum is turgid with fluid injected from the ring and Polian vesicle, and the valve is closed. In the space between two of the tentacular canals, a single large Polian vesicle is gradually developed from the lower surface of the ring. The vesicle hangs loose in the body-cavity, and communicates freely, without any valve, with the ring. Its walls are highly contractile, and it changes form continually, now hanging, long and vermiform, into the body-cavity; and now injecting

* For excellent figures of the anchors and anchor-plates of this species see the papers of Duben and Koren, and of Woodward and Barrett, cited above.

I did not happen to see Mr. Woodward's figures of the development of the anchors till after mine were drawn, or I should have thought it unnecessary to repeat them.

the ring and tentacles by contracting suddenly into a short flask.

Nearly opposite the Polian vesicle, on the other side of the ring, the madreporic tubercle gradually increases in size and distinctness. It appears at first as a greyish granular hood, capping, apparently, a very short branch from the ring, which takes a sort of curve in the hood, and to which the hood acts, I should think, as a valve (Pl. V, fig. 3, *f*). A delicate canal goes through the valve, and I have frequently observed a current of water passing in through it; sometimes I could not detect any current, but I never saw one passing out. The madreporic tubercle is at first imbedded in the sarcode of the outer wall, and I believe the canal then communicates directly with the water outside. Afterwards the tubercle becomes separated, apparently by the liquefaction of the sarcode round it, and hangs in the body-cavity. In the most advanced individuals which I have examined, there is no appearance of any calcareous deposit in the madreporic tubercle. The ambulacral vessels contain a perfectly colourless fluid, slightly opalescent, with minute molecules held in suspension; large, structureless granules likewise float in the liquid, and with them bodies of a very peculiar and definite form. These are globular masses of transparent granules, and have stiff cirri standing out from their surface. They are large, and not very numerous. The interior of the vessels seems to be ciliated; at least, one would imagine so from the motion of particles within, and the cirrated granules course round the ring and into its cæcal processes with great rapidity, sometimes passing through a valve into a tentacle, whirling round its cavity till the valve opens to let them out, popping into the Polian vesicle, which is sometimes half stuffed with them, apparently in a state of hopeless congestion, till a rapid contraction of the vesicle drives them all out again into the general circulation. The five delicate, almost rudimentary ambulacral vessels passing down from the lower surface of the ring within the longitudinal muscles, are now very distinct.

Immediately above the origin of each of the ambulacral vessels, above the junction of the simple ends of each pair of spiculæ of the œsophageal ring, a pale yellow crescentic granular nervous ganglion (Pl. VI, fig. 1, *h*) gradually acquires form and consistency. In an individual a month old (Pl. I, fig. 2), the ganglia are very distinct, but no trace of nervous filaments can be detected proceeding from them. No great change occurs in the structure of the alimentary canal. The œsophagus becomes more defined and muscular, and the whole canal increases in length, at last forming a partial convolution in the body cavity. I have said that the growth of these animals was extremely slow. It was not till about three months after they were first observed that the number of tentacles increased. One could easily imagine a second series of five, raising the number to ten, but I was curious to know how twelve could be produced. The two odd tentacles came first. The shafts of two of the spiculæ of the calcareous ring, almost at opposite sides of the ring, began to look spongy, and at length divided into two; and opposite each point where the division occurred, a cæcal process, easily recognised by its small size, passed up to the angle between two tentacles; the sarcode gave way and projected before it, and in three or four days the two new tentacles were scarcely distinguishable from the primitive five.

One or two general observations are suggested by the different steps in this process of development.

As explained above, the first stages in the development of the embryo from the egg were unfortunately lost; still, the water in the tank had been, up to a few days before the appearance of the young, most carefully watched for a swimming stage. The young, when first observed, were all crowded together at one spot, as if they had just emerged from a batch of eggs. They were very small, and showed no traces of the provisional alimentary system of an Auricularia, or of the ciliated bands of a "pupa." They presented, in fact, all the appearance of a very early stage, in the differentiation of the organs of the perfect form from an oval sarcode embryo.

The great mass of the later observations on Echinoderm development seem to tend to the conclusion that the peculiar mode of development with the intervention of a highly organised "pseudembryo," first detected by Sars in the Stelleridæ, and afterwards established for all the recent orders by the wonderful researches of Johannes Müller, is confined to comparatively exceptional cases, whose frequency has probably been exaggerated by Professor Müller's mode of observation. In almost every instance in which the development of an Echinoderm has been traced from the egg, it has been found to present no such extreme anomaly, although it has usually shown a certain deviation from the ordinary mode in the same direction, in the formation of deciduous lobes or processes, provisional appendages, apparently, of the ambulacral vascular system. The observations of Derbés on *Echinus*, form however, a marked exception to this rule. Information on the development of the Holothuridæ is very meagre. I shall give a short abstract of the few careful observations as yet on record.

During the years 1849, 1850, 1851, Johannes Müller made a most important series of observations. He referred several closely allied larvæ which he met with at various localities on the Mediterranean and Adriatic to the Holothuridæ, and grouped them, from a common peculiarity in form, under the general term "*Auricularia*."

Externally, an Auricularia is somewhat like a frilled toilet pincushion. It has a dorsal and a ventral surface, and two lateral surfaces; the latter deeply grooved. The line of junction between the dorsal and ventral, and the lateral faces is continued into an undulating border, prolonged into various appendages. The length of the body is nearly twice its width, and its width about twice its thickness. At one end the dorsal, the ventral, and the lateral surfaces form a four-sided pyramid, and at the opposite extremity, which is thicker and softer, the dorsal surface passes round to join the ventral; the dorsal and ventral fringes thus becoming continuous, and spreading out right and left into ear-like appendages. The dorsal surface is smooth; the ventral surface is bisected by a transverse groove, at the bottom of which lies the mouth. The muscular œsophagus opens into a distinctly dilated stomach, and a short curved intestine, following the median line, curves round to the anus, which is placed on the ventral surface, close to the thickened (posterior) extremity of the body. The ciliated band so characteristic of Echinoderm-larvæ, coincides throughout with the frilled border. It is continuous along the margin of the dorsal surface; it passes round the auricular appendages, following the undulations of the border and crossing the ventral surface, along the posterior edge of the oral groove; at the apex of the pyramidal extremity it also becomes deflected on either side to the ventral surface, passing back along the inferior angles of the pyramid, and crossing by the anterior edge of the oral furrow. As Mr. Huxley remarks, notwithstanding the appearance of longitudinal prolongation, the ciliated fringe, crossing the body before the mouth and before the anus, is, so far as the axis of the alimentary canal is concerned, actually transverse, encircling it only once. I do not, however, attach much significance to the distribution of these fringes.

Before the Auricularia undergoes any metamorphoses, a flask-shaped vesicle appears above and somewhat before the stomach, connected by a delicate tube, with an umbilical depression on the dorsal surface of the Auricularia. A calcareous ring, sending off spiny branchlets, shortly encircles this dorsal tube about the middle of its course. The vesicle gradually becomes a rosette of ten or eleven cæcal processes, and at length five of these processes declare themselves as the rudiments of the first five tentacles, five more indicate the five ambulacral vessels, and the eleventh the Polian ampulla; all of these cæca, with the dorsal vessel, branch from a common vascular ring, the circular canal of the ambulacral system. The Auricularia now alters rapidly in form. The sinuous lateral fringes disappear, the body losing its bilateral symmetry, becomes lengthened and cylindrical, and encircled by five transverse ciliated bands; the provisional mouth and œsophagus are obliterated, and the ambulacral circular canal passes round the anterior extremity of the stomach. The stomach, the intestine, and anus of the larva, seem to be adopted by the rudimentary Echinoderm. The calcareous ring bisecting the dorsal canal becomes more complicated, assuming the structure of the madreporic tubercle; the portion of the tube external to it appears, at all events in one species, to be obliterated; and the internal portion remains as the sand-canal, an appendage to the vascular ring. The anterior extremity of the body still forms a closed dome over the sprouting tentacles. In this, which Müller calls the "pupa" stage, the embryo Holothuria thus becomes gradually developed within a closed, transparent, ciliated sarcode-cylinder. In the next stage the anterior vaulted end of the cylinder opens, the tentacles are protruded, the new mouth comes into operation, the ciliated bands disappear, and the animal assumes its final form.

Professor Müller's observations were made upon two forms of Holothurian larvæ, which he believed he could always recognise by characters which they severally retained through all their metamorphoses.

In one, eleven large transparent vesicles appeared in the young Auricularia imbedded in the substance of the sarcode, and a peculiarly formed echinated calcareous spherule occupied the posterior extremity of the body. It was in this species that Professor Müller was able to trace the later metamorphoses with accuracy. In the other form, very perfect calcareous wheels ornamented the frills and auricular appendages.

From the close resemblance which these wheels bore to the wheels of *Chirodota*, Professor Müller thought himself justified in referring the second Auricularia to that genus. Dr. Krohn ("Ueber die Entwickelung der Seesterne und Holothurien," 'Müller's Archiv,' 1853), afterwards succeeded in rearing some of the larvæ with calcareous wheels, in a tank.

They nearly doubled in size, lost their ciliated bands, and became vermiform. As in Synapta, rapid peristaltic expansions and contractions passed along the body. At this stage the mouth opens into a short œsophagus, which is inserted into the wider stomach, with a slight inflexion. The intestine is suspended in the cavity of the body by a plexus of delicate muscular cords, which seem to have a share in producing the perpetual expansions and contractions to which this organ is subjected. The anus is in the axis of the body, and terminal. Two pulsating vessels pass along the surface of the intestine, from the œsophageal extremity. One of these, the wider, lies close along nearly the entire length of the intestine, loosens itself from it during its course, and continues free to the anus. From this free portion a short cross branch passes to the intestine.

Eleven days after capture no essential change could be detected in the "Kalksack" or dorsal canal, and the pore of the dorsal canal seemed not yet obliterated. Dr. Krohn had, in one case, an opportunity of observing the development of three new tentacles. They originated in cæcal processes from the circular canal of the ambulacral system, close to the pairs of vesicles, with tremulous double nuclei. They gradually increased in length, till they reached the membrane, which forms a duplicature between the bases of the originally formed tentacles. They penetrated between the two walls of this duplicature, and, at length, reached the free border. Though still much smaller than the primitive tentacles, they had all their characteristic structure. Dr. Krohn was unable to pursue their development further.

On the 9th of March, 1852, Messrs. Danielssen and Koren ("Bidrag til Holothuriernes Udviklingshistorie," 'Fauna littoralis Norvegiæ.' Second part, Bergen, 1856), observed certain minute spherical bodies floating on the surface of the water in Bergen bay. Under the microscope these bodies proved to be eggs undergoing segmentation, embryos rotating within the vitelline membrane, and free embryos. The embryos were oval, were entirely covered with cilia, and presented a slight depression at the anterior extremity. Two days later the embryos were more pyriform, a buccal orifice had been formed at the bottom of the anterior depression, and a distinct digestive cavity was observed containing moving granules. The external wall was soft, homogeneous, and finely granular. Five days later the margin of the body seemed thrown into undulations. The external wall was slightly opaque, and on the dorsal surface, at some distance from the mouth, a minute umbilicoid depression, punctured by several very small apertures, might be detected.

From this point a delicate tube arose, encircled near its origin by a branched calcareous ring, and continued into a circular water-canal round the œsophagus. On the 18th of March the cilia had disappeared, and the embryos had sunk to the bottom of the jar. Five cæca from the circular canal formed a row of rudimentary tentacles round the mouth, and several branched calcareous plates indicated the position of the calcareous œsophageal ring.

On the 25th of March the tentacles had become furnished with minute marginal sucking papillæ, and by their means the embryo crawled on the surface of the glass. Two large hollows, the first trace of the ambulacral feet, were perceptible on the ventral surface near the posterior extremity. On the circular canal between each pair of tentacles there was observed a minute round vesicle. These vesicles the authors regard as the origin of the second series of tentacles; their figure, however (op. cit., pl. vii, fig. 14, *a*), certainly represents them as nucleated vesicles, closely resembling in position and appearance the vesicles which I have regarded in the corresponding stage of Synapta, as rudimentary organs of special sense.

Five delicate longitudinal canals might now be traced from the circular canal to the posterior extremity of the body, and from one of these, two lateral branches ended in the ampullæ of the two water-feet. A short, narrow intestine passed from the stomach to the excretory cloaca.

On the 28th of March the tentacles were still more fully developed, and calcareous plates were found in their walls. The feet were very apparent on the ventral surface; the Polian vesicle was fully formed; and the tube described above as connecting the dorsal umbilicus with the water-canal had separated from the outer wall, and hung free in the body cavity, its free portion, the rudimentary sand-canal, filled with loose calcareous rods. The external integument was rapidly becoming opaque, from the development of a network of cribriform, calcareous plates.

During the month of April the development of all the essential characters of the genus *Holothuria,* advanced steadily with certain special peculiarities, which referred the young, without doubt, to a well-known Norwegian species—*H. tremula*. On the 6th May, from a neglect of some necessary precautions, the whole brood died. The authors observe specially that towards the close of the period during which these young Holothuriæ were under observation, the structure and appearance of the calcareous framework changed remarkably, a fact which invalidates to a great extent the reference of an embryo to a certain species, on account of the form of the calcareous bodies first produced.

Professor Oersted ('Videnskabelige Meddelelser fra den Naturhistoriske Forening i Kjöbenhavn' for the year 1849)* states that *Synaptula vivipara* (Oersted) produces its young living, and somewhat similar in form to the parent.

It appears, then, that in the Holothuridæ, the germ-mass, the product of the complete segmentation of the yelk, changes either entirely into sarcode, or into a thick wall of sarcode still containing some of the granules of the germ-mass within.

The body thus formed is oval, and becomes covered with cilia developed upon the structureless sarcode surface; it is of course locomotive, and absorbs nourishment through its whole surface. In some cases a depression at one extremity now indicates the mouth of the embryo, an alimentary canal, which contains the unaltered granular matter of the germ-mass, if there be any, passes through the long axis of the oval; the outer sarcode covering is studded with plates and spiculæ, losing its cilia; and the whole germ-mass takes the form of a young Holothuria, which proceeds to its complete development, by a mere differentiation of its organs from its sarcode substance, and without any further metamorphosis. In other cases the ciliated sarcode-germ increases rapidly in size, and sends out symmetrical lobes and borders, which are clothed with a ciliary fringe, disposed doubtless with reference to the position of the centre of gravity of the body. A mouth and anus, united by a loop-like alimentary canal, indicate a special absorbent surface, and the peculiar intermediate being is formed, which I have called in this paper a pseudembryo, and which I have regarded as analogous to the provisional embryonic appendages in the higher animals. This zooid enjoys for a certain time a perfectly independent existence. Its fringes and lobes then contract, it becomes simply cylindrical in form, the cylinder hooped by bands of cilia. The provisional mouth and œsophagus disappear, and the development of the Holothuria from this sarcode-cylinder now proceeds, exactly as it did in the former case from the sarcode-germ.

I have little doubt that we shall find in the Holothuridæ gradations between these, by no means extreme, forms of development. At present I know of only one case which appears to be perfectly intermediate. In *Comatula* a sarcode-cylinder closely resembling the pupa of Müller's Holothuria,

* Quoted by Daniellsen and Koren, op. cit.

but with a provisional alimentary canal more rudimentary than that of an Auricularia, is developed at once from the ciliated germ; and sometimes after only a few hours of independent life this zooid passes, by simple metamorphosis, into a stalked Crinoid.

It is impossible to doubt that the tentacles of the Holothuridæ, in whatever form they may be developed, are the equivalents of the minute oral tentacles of the Echinidæ, and it is equally evident that the ambulacra of a *Cucumaria* or of a *Holothuria* are homologous with the ambulacra of an *Echinus*.

As in *Echinus*, then, according to Müller's view, nearly the whole of the body in *Holothuria* must be regarded as ambulacral; the antambulacral region being restricted to a small disc immediately within the anal vascular ring. The same relation must hold for *Synapta;* for the five longitudinal muscular bands, with their accompanying vessels, must represent the ambulacra of the higher forms, though the vessel is now reduced to a mere filament, and though the characteristic ambulacral suckers are totally gone. Thus the oral tentacles coexist in *Echinus* and in *Cucumaria* with highly developed ambulacra, and in *Synapta,* with ambulacra represented by mere rudimentary vascular twigs.

No one who observes the development, the structure, and the mode of action of the tentacles in a genus such as *Ocnus,* in which these organs are highly developed, and mailed with calcareous plates; can fail to be struck with their resemblance to the arms of Crinoids. I have no doubt whatever that we must consider the pinnæ of *Comatula* as the equivalents of the tentacles of *Cucumaria,* that there is no reason to regard the arms of Crinoids as free ambulacra, but that the calyx is the true ambulacral region, and that in *Comatula* and in many of the fossil genera, the ambulacra, as in Synapta, are undeveloped.

Many of the Cystideans and some Crinoids seem to have possessed both arms and ambulacra; and there is clearly no reason why they should not, if we look upon the Crinoids as I am inclined to do, as partaking much more of the character of stalked Holothurids, than of stalked Urchins or Stellerids. I have mentioned above, that the Crinoids approach much more closely in their mode of development to the Holothuridæ than to any of the other Echinoderm groups; and I regard this as a strong additional fact in favour of the close affinity of the two orders.

On Micro-Geology; *an* Abstract *of a* Paper *read before the* Bristol Microscopical Society. By W. W. Stoddart.

Since in the present day the naturalist is engaged with ever-increasing zeal in revealing the relics of an ancient fauna and flora, the slightest contribution is welcome which adds a link to, or gives a review of those organisms which are usually denominated "fossils."

The utility of the miscroscope is not confined to recent organisms, nor is it a help merely, but actually necessary to the minute examination of many animal and vegetable structures entombed in shales and rocks, that lived and died in ages so remote that we have no adequate conception of their antiquity.

When we look at that borderland of ancient days, the post-pliocene period, with its beautiful polythalamia, its zoophytes and other microzoic wonders, we fail to compute how long it is since they moved and had their being; nevertheless we know from their structure that they obeyed the same laws and died the same death as creatures of our more modern days. If, then, the pliocene period be so old, what must we say of the mesozoic and palæozoic ages? A feeling of reverence may be said to steal over one, when the lineaments and sculpture of the minute brachiopods and protozoa are traced that ushered in creation.

The telescope has, indeed, in the most wonderful manner revealed the outline, and penetrated the hidden mysteries of worlds so remote, that their very distance is actually inappreciable by the most acute mind; and the gigantic instrument of Lord Ross has shown that what speculative astronomers once thought the nebulous beginnings of other worlds, are, in all probability, complete systems, revolving and moving as our own.

Splendid, however, as these powers are, yet they are very much surpassed by the revelations of a good achromatic microscope, without which we could have no conception of the unbounded world of minute beings surrounding us. When the utility of the microscope is called into question, how often do we hear it summed up,—"That it is to enable us to see minute parts of organisms, their great beauty, and surprising motions," &c. But to use the instrument only thus is merely to amuse and gratify one's curiosity. How few comparatively know its invaluable aid in scientific research! Even at a meeting of scientific persons in London only two years since, one of them is reported to have risen to deny its utility.

It may, perhaps, be asked, what has all this to do with the present subject?—how can a rock or mineralogical specimen be a microscopic object? Can we discern their component parts? can we distinguish between a sulphate or a carbonate, a nitrate or a chloride? Yes, and much more. Ask pure chemistry what is contained in the slice of a rock. It will analyse it to the $\frac{1}{2000}$th of a grain, and tell to a fraction the amount of carbonate of lime, silica, iron, and trace of organic matter; but here its information will end. Now ask the microscopist, and he will tell you that it is formed of coatings of carbonate of lime, one over another, till many tons of pin's-head like bodies arise, each imprisoning in its centre an exquisite little rhizopod.

Almost every stratum, more or less, abounds in objects that cannot be studied by the unaided eye. The Silurian and Carboniferous Corals, the Cretaceous Foraminifera, or Crag Polyzoa, alike attract our attention. It therefore is seen that the microscope is a necessary adjunct to the geological apparatus. By the microscope it was that the so-called Basilosaurus (the supposed king of reptiles) was deposed and placed at the bottom of the mammals. The Saurocephalus was another so-called reptile, till the microscopic examination of its bones proved it to be a fish.

We frequently find shells so much alike that it is often difficult to say whether or not they are the same species; but a piece of a valve placed under the lens determines the question, showing one dotted, another striated, spinous, reticulated, or covered with innumerable but always constant patterns. The Cambrian, or oldest fossiliferous strata known, were for a long time supposed to be barren of all organic remains, and were thought to be nothing more than mud deposits of the earliest Silurian beds. At length in some of the bottom rocks near Bray Head were found some curious little zoophytes, named, after their discoverer, Oldhamia. This is the oldest animal known, and, so far as yet discovered, was probably the first being created on the face of our globe.

After the most ancient period had passed away, we find the animal kingdom to progress considerably; and as the Silurian system passed over the terrestrial scene, a large mass of limestone was gradually formed, in which are corals, encrinites, and Polyzoa of the most beautiful structure, frequently requiring a high power to bring out all their delicate mouldings.

It was the Silurian period that first gave birth to the entomostracous and foraminiferous races, curious forms of which lie in such profusion that they actually divide strata from strata with layers of their valves. In these early deposits we find scales, spines and teeth of fishes, whose markings are so fine that they would entirely escape notice without the microscope. Then, again, there is the compound eye of the marvellous trilobite, with its thousands of facettes, each capable of transmitting a faithful picture of an object to its possessor.

In the succeeding era (the Devonian) we find abundance of microscopic work in the remains of zoophytes many feet thick, and so beautifully preserved that they are, when polished, among our choicest objects. The microscopist here will delight in the delicate Fenestella, the extraordinary scales of the Holoptychius and Cephalaspis. The spine of the Cheiracanthus, and bony plates and teeth of the Coccosteus, make very good sections.

The Carboniferous deposits are of much greater interest to the microscopist. In almost every part of this system we have numerous and astonishing examples of what changes a little creature may affect in the surface of our globe, and that creature, of so lowly an organization that it has but few of the attributes of an animal. Ranges of solid rock, many miles in length and depth, owe their existence to the lime-eliminating power of a little coral. The beds exhibited by the fine section at Clifton are most excellent localities from which very rare specimens may be abundantly obtained. From it are collected Millepores, Madrepores, Seriatopores, Spongiolites and Polyzoa of the most varied shapes and forms. In the Oolitic beds of limestone, ten genera of Foraminifera have been found. It is at the base of the Clifton beds that the author noticed the most extraordinary deposit of limestone ever known to the geologist. It is described in the 'Ann. Nat. Hist.,' Dec. 1860, and consists of a rock twelve feet thick, every pound by weight of which contains more than two millions of perfect Microzoa, Cytheridæ, Gasteropods, and very beautiful cylindriform Polyzoa, the latter being so perfectly preserved as to show the cells and thin apertures. Coal is another well-known and striking instance of what may be deduced from microscopic observations. On looking at a bit of the substance, especially that from Derbyshire, its woody structure, with its beautifully preserved cells, will be easily recognised. On examining it more closely, you will notice that between the fibres is a total absence of interposed vessels, but instead, small glandular dots are arranged in one or more rows. From this peculiarity we at once conclude that the tree was a conifer, and, from the disposition of the dots, that it belonged to the genus Araucaria Then on looking carefully over the beds in which this woody growth occurs, we find the shale dotted all over. On magnifying these dots, the observer is startled at finding thousands of the valves of Cypridæ and the little coiled shells of Spirorbis, with many others that inhabit fresh waters. From just such microscopic evidence we learn the fact that coal is derived from coniferous trees, ferns and allied plants, and also that those trees grew in marshy places, or covered the estuary of some carboniferous river.

The Triassic and Permian formations are nearly void of microscopic fossils, except in a very few localities.

In the Jurassic strata, which extend for many miles over the counties of Gloucester, Somerset, and Dorset, are rocks entirely made up of shell debris, Entomostraca, corals, and Echinoderms. In the outskirts of Bristol are two such beds, reaching over a very wide area full of the plates, spines and jaws of sea-urchins. The whole bed is scarcely distinguishable at first sight from the shore of many parts of our present sea-coast. In many places we find the shale-partings covered with Cytheridæ and Estheridæ. The slabs of Oolite at Bath, Minchinhampton, and Dundry, afford perfect specimens of minute forms. It is, perhaps, in the Jurassic rocks, that the miscroscope is especially valuable in the reading of shell markings, for many Pectens, Limas, and Myaridæ so nearly resemble each other, that the principal specific distinction is the shell pattern; for in the fossil we have not the same facility for specifying that we have in the recent animals. Perhaps the most interesting of all to the micro-geologist, for perfect and beautiful objects, are the fossil remains from the Cretaceous and Tertiary beds. Whole countries are composed of organic forms. A bed of hard limestone, traceable from Africa to North America, is composed of Nummulites and Orbitolites agglutinated together with powdered particles of the same or other equally small creatures, each a wonder in itself. The towns of Richmond and Petersburg, in Virginia, are built on soil consisting of siliceous marl, twenty feet thick. A microscopic examination shows this earth to consist of frustules of Naviculæ, Gallionellæ, Actinocycli, Coscinodisci, and others too numerous for mention, the largest of which will not exceed $\frac{1}{300}$th of an inch.

The pyramids of Egypt and immense beds of the Pyrenees and Alps are built up of foraminiferous limestone.

These small microzoa seem to be the most ubiquitous of any known beings; their flinty remains if diatoms, or calcareous if foraminifers, are found in the present day in countless numbers filling up rivers, as the Elbe and Nile; choking up harbours, as on the Amazon, and Wersinar in the Baltic, just as they did in olden time, as shown by the Bergmehl of Sweden, the edible clay of the North American Indians, and polishing slates of Bohemia and Africa. An exact counterpart of the *Calcaire grossier* of the Paris basin is now in the course of formation on the coast of Australia, a characteristic fossil being the Orbitolite, which proves to be the same species as that of France. All these will furnish hundreds of the most beautiful slides, especially when mounted in balsam.

No deep-sea soundings can be taken, whether Indian, Atlantic, or Pacific, without the lead showing that the bottom, whether of 60 or 2000 fathoms depth, is one entire mass of the most exquisite forms of Polythalamia, Polycystina, Diatoms, or Spongiolites. The late soundings for the Atlantic cable prove of great interest. Dr. Wallich's report has revealed the fact that the whole floor of the "true Atlantic," which commences about 230 miles west of Ireland, is entirely covered with a tenacious substance, nine tenths of which are Foraminifera and Polycystina. In the Chalk, Foraminifera are so well preserved, that when acted on with an acid, the casts of the sarcodous bodies are seen as perfectly as the recent ones of our own shores. These are also well seen in the dark-coloured grains of the Upper Green Sand.

Tripoli, which is an earthy-looking substance, is a good example of the incredibly numerous microzoa that are present in some of the earth's strata. The bed in Bohemia from which a sample was taken was fourteen feet in thickness, and each cubic foot was calculated to contain more than forty-one millions of Gallionella and other diatoms.

The author has himself procured Polycystina from the Barbadoes earth at the rate of more than ten millions per avoirdupois pound. These beautiful little gems differ from Foraminifera, not only in their nature, but also in having siliceous instead of calcareous shells.

Very beautiful microscopic objects are the fossil Chara seeds; they are found in the Tertiary strata of the Isle of Wight, and, particularly under the binocular arrangement, show the spirals in a very perfect manner. The author has found three or four species, all of which are equally good.

Even this short and hasty sketch will show how true the observation of Lamarck was, that it is by no means the largest objects that Nature uses to produce everywhere the most remarkable and astonishing phenomena. The remains of minute animals have added much more to the exterior crust of the earth than those of all the mammals and cetaceans that ever existed.

Nay, more, it is perfectly true to say that organic creation itself began with "*a microscopic specimen.*"

On the HULL PLEUROSIGMA FASCIOLA.

By WM. HENDRY, Surgeon.

RELATIVE to this diatom, Mr. Sollitt, in the 'Microscopical Journal' for October, 1860, p. 48, remarks:—"Of this diatom, the kind we find near Hull, *are very small, and, consequently, the markings extremely fine*; the finest being 90 in ·001″, but the Fasciolæ we get from Boston in Lincolnshire, are many of them so large, that there are not more than 50 striæ in ·001″. I have frequently seen in the largest-sized Fasciola of Boston, the longitudinal and transverse striæ, at the same time, with the half-inch objective."

"The length of the finest Hull Fasciola (Mr. Sollitt states) is under the $\frac{1}{300}$th of an inch, while some of the Boston Fasciolæ measure more than the $\frac{1}{160}$th of an inch."

I do not deny that the *usual* character of the *P. fasciola* obtained in the neighbourhood of Hull, may be of the finer description, and the same may be equally true of most other places. The coarser, or so-called "Boston" variety, may, however, also be found at Hull; and only a few weeks since, when out in company with Mr. Harrison, we obtained a copious gathering in the Hull timber-ponds, containing specimens of the larger kind, in which the longitudinal and transverse striation were simultaneously shown with great boldness under a $\frac{1}{4}$-inch, and were very evident also with the $\frac{4}{10}$th-inch objective. Hence the hitherto somewhat hackneyed phrase of "Hull *fasciola,*" and "Boston *fasciola,*" the former being regarded as exclusively fine and the latter as exclusively coarse, is no longer admissible. And as regards the number of lines in each kind respectively, this must be henceforth regarded as indeterminate, or as merely embraced between the two extremes above stated.

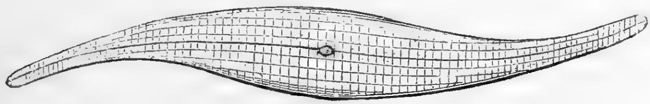
The Hull Fasciola, thus widely ranging between fine and coarse, only furnishes another link to the chain of evidence contained in my former published communications on the irregular development of striation of the usually considered high order of test-objects amongst the diatomaceæ.

Turning to the elaborate list of diatoms published in the 'Microscopic Journal,' for April, 1860, as occurring in the neighbourhood of Hull, by George Norman, Esq., it is also therein stated that *Pleurosigma fasciola* is found at " Grimsby much larger than on the north side of the Humber."

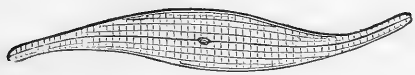
I have also latterly, and since the gathering to which this article chiefly relates, found the largest Fasciola at Stone Ferry, near Hull.

Relative Magnitude of the Large and Smaller Hull Fasciola, magnified 483 diameters; the outline taken by camera lucida.

Large Fasciola.



Small Fasciola.



The measures obtained of several diatoms of sizes under consideration, are as follow:

Hull recent Gathering.

Slide 1.—Large and Small Variety.

Full length of shell	$\frac{1}{168}$ inch	to $\frac{1}{250}$ and $\frac{1}{320}$ inch
,, body	$\frac{1}{249}$ and $\frac{1}{292}$,,	to $\frac{1}{350}$ and $\frac{1}{500}$,,
Width of shell	$\frac{1}{1458}$ to $\frac{1}{1750}$,,	in large variety
Transverse striæ ...	52 in ·001″	,, ,,
Longitudinal do. ...	35 in ·001″	,, ,,
Number of striæ in body, about	180	,, ,,

Old usual Gathering.

Slide 2.

Full length of shell	$\frac{1}{265}$ of an inch
,, body	$\frac{1}{437}$,,
Width of shell	$\frac{1}{1950}$,,
Transverse striæ	54 to 56 in ·001″
Longitudinal striæ	66 in ·001″
Number of striæ in body	about 110 to 130.

P.S.—What is implied by the body is about the point of convergence of the exterior outlines; otherwise the transverse striæ are doubtless continued to the very extremity of the filiform processes, seemingly bracing them together.

On comparison of the above measures, it may be observed that the recent Hull gathering contains both the smallest and the largest recorded varieties of *Pleurosigma fasciola;* and I am yet sceptical as to the existence of 90 striæ in ·001″ as published by Mr. Sollitt, or even as to the possibility of counting such high numerical quantities, with anything like approaching to accuracy, with the best $\frac{1}{12}$th inch objective yet to be found in Hull.

The recent gathering was obtained by a few sweepings of the spoon, within the limited range of a few inches; so that the latter circumstance, when taken into consideration with the latitude of development and comparative striation, is a matter of no small importance. Had the two kinds of large and small been obtained at some distance apart, one might have imputed the difference to some diverse developmental agency, as the nature of soil—quality of water—greater or less abundance of silica present—influence of light, currents, gaseous emanations, or other modifying influences upon the cell-germs or sporangia, or some chemical, vital, or molecular forces of whatever kind; but the *questio vexata* may yet remain as to these extreme developments being due to different stages of growth of the same species, or to the same species under "peculiar idiosyncracy of the sporangial frustule" (Wallich), or to their belonging to some other variety of Fasciola not yet recorded as possessing any distinguishing features.

One important distinction between the large and small Fasciola consists not so much numerically in the transverse striation, as in the coarse and widely distant longitudinal striæ; the one tabulated above as having 35, and the other 66 longitudinal striæ, in ·001″.—A difference which at once accounts for the ready resolution of the former with comparatively low powers of objectives, and for the difficulty of effecting the resolution of the finer or latter variety (longitudinal and transverse striæ simultaneously), even with the highest powers, although, in solitary instances, the $\frac{1}{8}$th or the $\frac{1}{12}$th inch will occasionally resolve the twofold striation of the latter in a faint degree.

The interlinear spaces or areolæ, from the nature of the markings and corresponding measures thus afforded in the large Fasciola, necessarily constitute parallelograms having the longer axis disposed in the transverse direction of the diatom; whilst in the smaller Fasciola, from the numerical estimate of its longitudinal striæ, equalling or otherwise exceeding that of the transverse, the interlinear areolæ must form either squares or parallelograms having the longer axis placed in the longitudinal direction of the diatom; and hence probably the direction of the parallelogram may constitute a distinguishing feature in the variety or species.

I consider the shaded lineation to represent the striæ, the interlinear spaces or areolæ being of lighter hue. I also resolve unequivocally certain dots in the course of such lineation without staying to inquire into their character or nature, as to whether they are elevations or depressions, puncta, papillæ, granules, or canaliculi. Nor do I at present enter into an investigation as to their relative coarseness or delicacy of structure, or course of fracture; nor touch even on the question of focussing.

It has been stated by some authorities that striæ are not to be seen until the diatoms have been boiled in acid; but this must be an error, as it is common, in most gatherings, to find here and there such a disposition of endochrome as to present no impediment to observation.

I have recently also found a coarse (42 in ·001″), and variable striation upon a slide of *Nav. rhomboides,* obtained by Mr. Harrison, of Hull, only a few days ago, from a gathering at Thorne Moors, near Doncaster; so that thus far our finest reputed striation, especially, is subject to extreme deviation in every instance of careful examination.

NOTES *on new and rarer species of* DIATOMACEÆ *of the* UNITED STATES SEA BOARD. By F. W. LEWIS, M.D.

THE present communication contains brief notices of some of the rarer and hitherto undescribed species of Diatomaceæ of the United States sea board, which have fallen under my observation during the last three years, together with a list of a few of the more characteristic and generally distributed coast species.

The forms to be described are mostly salt-water or brackish. A few species, however, known as fresh-water will be noticed where these have been found domesticated along with the marine.

I have endeavoured, as far as possible, to avoid describing species unless from perfect specimens; carefully rejecting all doubtful and imperfect forms. I have also endeavoured to guard against sources of error arising from the great variation in size, outline, and striation, and from the absence of certain and positive indications whereby the sporangial may be detected and classified with its typical variety. The want, however, of several important consulting authorities on this branch in the Academy's library, together with the not always satisfactory character of the material furnishing the data of this paper, often consisting of muds and mixed gatherings, must be my excuse for any errors or inadvertencies which may be found in its pages.

Among those to be described will be introduced one or two doubtful forms, probably sporangial, as *Amphiprora pulchra*, Bailey, and extraordinary varieties of *Surirella ovata* and *Triceratium alternans*, both of which last are figured.

It is proposed to consider the species to be noticed in the following order:

1. *New species and sporangial forms.* 2. *Rare species and species not hitherto noted as belonging to this country.* 3. *Species characteristic of the American coast.* 4. *Species of universal distribution.*

The precise locality and nature of the gathering from which specimens have been derived will be indicated, excepting where species are of general distribution and very abundant along the coast, along with such other distinctive characters as may be necessary for the definition of new or doubtful species; and as it is not intended that the summary shall present a complete resumé of native marine species, mention of many forms known to me, but not referable to one or other of the above four divisions will be omitted.

It may not here be out of place to add, that the result of my limited investigations convinces me that a rich and unexplored field lies open in the United States for those whose time and attention may hereafter be directed to this branch of microscopic research, a branch, until very recently, comparatively neglected in this country. Perhaps a reason for this neglect may be found in the great interest attaching to the less laborious study of the numerous *fossil* diatomaceous deposits of our country, and of the new and ever varying guanos so frequently finding their way to our shores. Without any intention of undervaluing the importance of researches on fossil botany, it may yet be doubted whether results so satisfactory and important to science are likely to accrue as when the *living* forms are the subject of study. Nothing certainly would seem so well calculated to damp the ardour of physiological inquiry as prolonged and laborious examinations of the minute details of the siliceous skeletons of these organisms, without reference to the kind and manner of life they once invested.

As an additional argument in favour of the study of *living* species, it may here be mentioned that many of the fossil forms are still to be found as *living* species on the coast, or under circumstances which prove them to have been alive at no very remote period. It is not unusual to meet with some of these in the Delaware tidal mud, and a still larger number are to be found in the blue clay—(old estuary) deposit immediately underlying it. Among these a few of the most common are *Eupodiscus Ralfsii, E. argus, Coscinodiscus gigas, C. ocul-iridis, C. centralis, Triceratium striolatum, T. punctatum, Actiniscus sirius,* &c.; *Sceptroneis caduceus* occurs living on algæ at Riviere du Loup, St. Lawrence River, *Goniothecium obtusum* at Black Rock Harbour, L. I.

The important question, too, of the influence of locality on the growth and development of species nowhere presents itself in so interesting a point of view as in this country. The large extent of its sea board, embracing every variety of climate, the continuous chains of estuaries and sounds along the entire line of coast, and the many rivers, large and small, traversing every kind of soil from the southern alluvial to the granite ranges of the north-east, offer an unsurpassed field for the study of this influence.

Although not able to pursue the subject at this time, I cannot refrain from alluding to a fact which forces itself on the mind at an early stage of these investigations, viz., the great distance from the sea at which marine influences continue to make themselves felt. Philadelphia is situated nearly a hundred miles from the ocean, and even at the period of spring tides at least fifteen miles above the faintest suspicion of brackish water, and yet quite a number of the diatoms in the Delaware at this point are purely marine, and a still larger number brackish. The agency of migratory fish, as the shad and low-swimming sturgeon, in bringing about this result, is no doubt important, but will not serve to explain the presence of brackish and marine species in the ditches adjoining Cooper's Creek, a tributary of the Delaware, and in Fox Chase Run, some ten miles above this city, at points not within tidal range. The old estuary bed of the Delaware, (blue clay) before alluded to, was very rich in these forms, and by digging down a short distance at any part of the meadow land bordering the river the blue clay which contains them may be exposed. An idea which naturally suggests itself under these circumstances as a solution of this paradoxical difficulty is, that possibly the telluric impression of the subjacent soil may continue to make itself felt in the development of species for a long period after the other surroundings have ceased to be favorable.

At all events, it needs some other explanation than that ordinarily had recourse to, viz., the hardihood of these low forms of organic life, and the agency of birds and fish to account for the permanent localization of marine species at points apparently so unsuited to their existence.

I. *New species and sporangial forms.*

1. *Triceratium alternans*, Bailey, *sporangial?*—This somewhat doubtful form has so few of the characters of *T. alternans*, that, but for the occurrence of intermediate varieties, the propriety of its reference to that species might seem questionable. The structure of the valve is distinctly cellular, in the smaller varieties indistinctly so, and that of the obtuse processes faintly punctate. The largest pustules attain the size of *T. favus*.

Hab.—St. Mary's river, Ga., in scum of a salt marsh.

2. *Surirella pulchra*, n. sp.—F. V. linear narrow, often somewhat twisted. V. ovate or elliptical; alæ distinct; canaliculi numerous, marginal inflated as in *S. fastuosa*, 6 in ·001, extending for about two fifths of the distance to centre of valve; central portion smooth, circumscribed on either side by a coarsely striated, arcuate band, with harshly defined edges, and connected with its fellow at a short distance from the end of the valve. Immediately exterior to these bands, and separating them from the inner termination of canaliculi throughout the entire length of the valve, is a corresponding, only somewhat narrower, arcuate, smooth space. Length of valve ·005 to ·009.

This very beautiful form, evidently allied to *S. fastuosa* and *S. eximia*, 'Mic. Journ.,' differs from both in the greater number of its canaliculi and the presence of the striated bands. In this respect it closely resembles the species next to be described.

Hab.—St. Mary's River, Ga., salt marsh and in tidal mud. Wharf at Fernandina, Florida, tidal deposit. Pier at St. Augustine, Florida. Rare.

3. *Surirella Febigerii*, n. sp.—F. V. as in last described. V. elliptical to linear ovate, sometimes broadly sphenoid; alæ inconspicuous; canaliculi 6 *a* 7 in ·001, straight or slightly convex, linear, reaching from the margin to a striated, arcuate band, situated relatively to the valves as in the preceding.

Interspaces of the canaliculi strongly punctate. Central portion similar in outline to that of *S. ornata*, elevated above the surface of the valve and coarsely striate. Length of valve ·006 *a* ·010.

The striking similarity in outline and number of canaliculi of this to the last-described species, together with the correspondence in both of the arcuate, striated bands, at first led me to regard these forms as merely different aspects of the same frustule (valve); but after careful examination of several detached valves, by reversing the slides and other manipulations, I am led to believe that they belong to different species. Both are very striking and showy forms, more particularly the last, whose strongly marked intercostal puncta, and the generally ornate character of its valve, make it a singularly beautiful microscopic object. *S. Febigerii* is pretty generally, but not abundantly, distributed along the Atlantic coast. The first specimens were detected by me two years ago in mud dredged from New London Harbour, sent me by Mr. Febiger, of Wilmington, Del., in honour of which careful and industrious observer I have named the species.

Hab.—New London Harbour, mud; St. Mary River, mud from oysters. Wharf at Fernandina, and more recently at Cape May salt marshes, by Mr. Febiger. From its wide range of locality it will doubtless prove a common form on the coast.

4. *Surirella ovata*, Kütz, *sporangial?* This variety is not uncommon in salt marshes along the Jersey coast, although specimens of the size figured are very rare. A comparison with the typical species will show considerable points of difference, but these become less in frustules which approximate to the normal size, although never altogether lost. It is, perhaps, entitled to rank as a variety of *S. ovata*. Length of valve ·0009 *a* ·0050.

5. *Cymatopleura marina*, n. sp.—F. V. linear, slightly inflated ends more or less truncate. V. lanceolate, very acute, undulations from 6 to 13. Surface of valve irregularly punctate. Length of valve ·0007 *a* ·00.

This inconspicuous little form, although not yet found in quantity, occurs at various points along Long Island Sound. As far as is known to the writer, it is the only marine species.

Hab.—On algæ at New London. New Haven and Black Rock Harbours. East River (Mr. Febiger), in mud.

6. *Amphiprora conserta*, n. sp.—Frustules adherent in curved bands, often to the number of twelve or more. Frustule straight, membranaceous.—F. V. linear oblong, slightly

dilated. Keel or ala central or subcentral, constricted, costate, spathulate at extremities. V. lanceolate or lanceolate with produced extremities.

The great variation in size, outline, and general configuration of the frustules of this species, together with the fact of their being so imperfectly silicious that a boiling in weak acid either distorts or entirely destroys the specimen, renders it not improbable that this may be an early developmental form, although of what known species, if any, would be difficult to say. A smooth and very diaphanous variety of *A. paludosa* occurs in the same gathering.

The "plates" alluded to by the late Prof. Gregory ('Marine Diatomaceæ of Clyde'), as characterising *A. lepidoptera*, and others of the genus, are strongly marked in this species, and serve as a point of attachment between the various frustules. Arising from the surface of the valve at a short distance from its extremity, they are broadly convex and incline somewhat outwards. By the central portion of the outer aspect or margin of these plates, each frustule is united to the adjoining one on both sides, the keels or alæ of all three overlapping for about one half their breadth. A nearly perfect circle is thus often formed by a union of from eight to twelve frustules. I am not aware of any description heretofore given of the union of the frustules of Amphiprora into bands or otherwise. In consequence of this arrangement, an end view of the frustule can readily be obtained.

Hab.—On marine algæ (*Ceramium*), off Light House Rocks, New London, abundant. The bands of frustules are often moulded around the smaller stems of Rhodospermeæ.

7. *Amphiprora Nereis*, n. sp.—Frustule usually twisted, hyaline, very inconspicuous. F. V. elliptical, with rounded ends, constriction of keel or ala very deep. V. striated, striæ from 50 *a* 60 in ·001, extending to margin of ala. Supplementary plates? crenulate or undulating, at the margin appearing as though perforated with small puncta. Length of valve ·002 *a* ·0045.

Hab.—On algæ (*Dasya elegans*) from a brackish lake at Narragansett.

This beautiful and delicate little form I have found only at Narragansett. Its very small size and faint markings make it so inconspicuous an object that a 1-12th inch is required not only to define but even to detect the balsamed specimens on a moderately crowded slide. The only indication of marking arresting the eye is the lines of puncta or dots seen. These I at first supposed were portions of the ala, but after examining several specimens and fragments of broken valves it seems more probable to me that they form supplementary plates, arising from the ala at or near its junction with the body of the frustule, and occupying the same plane as the former.

This Amphiprora most nearly resembles *A. ornata,* Bailey, in size and markings. Many of the frustules present a good deal of the rectangularity of that species, but in other respects widely differ from it.

8. *Navicula marginata,* n. sp.—F. V. oblong, slightly constricted, with rounded ends. V. panduriform, deeply and abruptly constricted. Segments lanceolate, with subacute extremities. Surface of valve very convex, striate; striæ moniliform, distinct, about 28 in ·001. Margin of valve bordered by a series of numerous small and beautifully distinct arches, apparently due to the absence or depression of the outer silicious plate, 6 in ·001. Length of valve ·005 to ·006.

The only two specimens of this beautiful diatom yet found by me were derived, the one from Black Rock Harbour, (Light House Point), on the roots of harbour grass; the other, an imperfect frustule, from the blue clay of the old Delaware estuary (fossil). The former was a perfect frustule, and has furnished the drawings. It is very likely that this will hereafter prove a widely distributed species on the coast, from the fact of its occurrence with recent and fossil at points so remote from each other.

The characteristic ornate border and the peculiar striation serve to distinguish it from any of the panduriform species yet figured or described.

Hab.—Blue clay, Delaware River (fossil). Light House Point, Black Rock Harbour, on algæ.

8. *Navicula,* n. sp.? or sporangium of *N. rhomboides?* or *N. fossilis,* Ehr.—F. V. linear slightly inflated. V. lance elliptic, striate; striæ parallel, very clear and sharp, 50 *a* 60 in ·001; central line, together with nodules, very prominent. Length of valve ·004 to ·013.

This large hyaline species occurs in salt and brackish localities. It is found in the St. Mary's River, within two miles of the ocean, and on the Savannah River, below the city. *Triceratium favus* is found living in the same localities. In many of its characters it is nearly allied to *N. rhomboides* and *crassinervia,* more particularly to var. β of the first named, and, perhaps, notwithstanding its marine habitat, ought to be regarded as a sporangial variety of one or other of these species.

On the Parasitic Nature *of the* Fry *of* Anodonta cygnea.

By the Rev. W. Houghton, M.A., F.L.S.

The fresh-water Mussels, or the family of the *Unionidæ,* have received a considerable share of attention from zoologists. The facility with which the different species may be obtained, and the highly interesting embryonic forms of these molluscs, whether during the time they remain within the folds of the external branchiæ, or after they have been excluded, render them favorite subjects for investigation. The whole question of the development of the fry is one of considerable interest; but it appears that all investigations that have hitherto been published on this point relate to their intra-branchial existence, while we are left entirely, I believe, without information on the condition and development of the young Anodontas during the period that elapses between their exclusion and their assumption of those characters that belong to the mature animal. The young Anodonta, at the time it is ready for exclusion, bears a form very different from that which it is destined ultimately to assume. This, no doubt, holds good in the case of the other British members of the group; it is certainly true of *Unio pictorum,* which, however, appears to be later than the Anodonta in parting with the fry. So different, indeed, is the form of the young animal during its intra-branchial state, that M. Rathke,* in 1797, actually regarded it, not as the young mollusc, but as a veritable parasite, to which he gave the appropriate name of *Glochidium* (γλωχίς), in allusion to the two curious serrated *points* or *hooks* which it possesses. Rathke's opinion was endorsed by M. Jacobson, in a paper published in the Danish 'Transactions' in 1828.† But the real nature of the bivalves found in the branchiæ of Anadonta and Unio was fully proved by C. G. Carus in 1830.‡ In his valuable memoir on this subject, which may be regarded as the fountain-head of all that is really known concerning the anatomy of the Glochidium-

* 'Naturhistorie Selskabets Skrifter,' tom. iv, i, p. 139. Copenhagen, 1797.

† "Undersögelser til naernere Oplysning af den herskende Mening on Damuslingernes Fremarling od Udvikling." Translated in the Memoirs of the French Academy, under the title of "Observations sur le Developpement prétendu des Œufs des Moulettes ou Unios et des Anodontes dans leur branchies."

‡ "Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel." 'Nov. Act. Nat. Cur.,' tom. xvi, part i, p. 3. 1831.

embryos, the true relations of these creatures to their parent are clearly made out. It also contains observations upon many points of considerable general interest with respect to the structure and early stages of development of the molluscan ovum; and it is in this paper that Carus for the first time clearly describes the curious phenomenon of the rotation of the embryo within the egg-membrane, although it had doubtless been observed in the ovum of some species of Unionidæ by Leeuwenhoek, and was also noticed by M. Bauer; who absurdly attributes the movement to the incessant attacks of an invisible worm, which he imagined was devouring the vitellus.

The views of Carus respecting the nature of the *Glochidium*-larvæ were too well founded not to receive general adoption; but since his time nothing has been really added to our knowledge of their structure or habits. M. de Quatrefages,* it is true, took up the subject in 1836, but, strange to say, apparently in total ignorance of what had been done by Carus, although he cites Rathke and Jacobson. This paper contains nothing of the least importance, and is filled with the most curious statements, and the figures accompanying it, so far as relates to the internal structure of the young animal, are equally fanciful. M. de Quatrefages, although he enters pretty fully into the development of the ovum, does not appear to have noticed the rotation of the embryo; and among other strange propositions, he propounds the extraordinary notion that the byssus-filaments of the young Anadontas are umbilical vessels, and actually figures two umbilical cords, each consisting, as it would seem, of an artery and vein going to each embryo, and keeping up a communication with the mother.† He comes, however, to the same conclusion as the German naturalist as to the true nature of the *Glochidia*, although he allows that "les differences de forme et d'organisation sont certes assez grandes pour justifier ceux qui, comme MM. Rathke et Jacobson ont considéré ces petits bivalves comme tout à fait étrangers à l'animal qui les nourrissait."

This remark is very just; and, indeed, although there is not a shadow of doubt that the *Glochidia* are really the young of the *Anodonta*, the peculiar serrated tooth at the point of each valve may be deemed sufficient to authorise the

* "Memoire sur la vie intrabranchiale des petites Anadontes." 'Ann. d. Sc. Nat.,' 2nd sér., tom. v., p. 332. 1836.

† J. T. Kohlreuter appears to have entertained the same singular idea with regard to the byssus-filaments (Observationes Anatom.-physiol. *Mytili cygnei*, L., Nov. Act. Pet., vi, p. 236, 1790).

opinion that the *Glochidium* is a parasite. The object of this paper is to show that the so-called *Glochidium* of Rathke is an undoubted parasite, though not in the sense in which he and M. Jacobson understood it. My attention was lately turned to this subject by my friend Mr. Busk, who, on the occasion of a recent visit last April, informed me that the young fry of the *Anodonta* had, some years ago, been observed by Mr. Pollock to be parasitic upon fish. Mr. Pollock, it appears, never published anything, and did not care to make further investigations into this interesting subject. As good luck would have it, the season for the exclusion of the fry from the maternal branchiæ had not passed over, and I set to work immediately, with the following results, which, however, are not to be regarded as establishing anything like what remains to be investigated on the subject of the parasitic nature of the *Glochidia*. On the 8th of May I examined five or six specimens of *Anodonta cygnea*, and found that, in some instances, the branchiæ were destitute of the fry, while in others they were half emptied, showing that now was the time for observation. On the 9th of May I opened one of the *Anodontas*, and detached with the point of a knife a portion of the contents of the branchiæ, and put it into a vessel of water, in which was a small stickleback (*Gasterosteus leiurus*), with a number of young fish recently hatched. On the 11th of this month I examined the fish, and found several *Glochidia* attached to the ends of the pectoral fins, their valves being closed upon the fin rays, as shown in the accompanying figure (Pl. VII, fig. 10). This fact sufficiently proves the correctness of Mr. Pollock's assertion, who is, in all fairness, entitled to the merit of the discovery. Having several Sticklebacks in vessels of water in my rooms, I repeated the experiment of placing *Glochidia* in the same water with them. Some young Eels, about three inches long, soon had their under surfaces completely *beaded* with the parasites; the tail of the tadpole is also a favourite object of attachment; to the larvæ of insects the *Glochidia* seem to have no affection; I endeavoured to inoculate the larva of *Dyticus marginalis* for instance, by drawing clusters of *Glochidia* upon their bodies, but to no purpose. The fins are *the* parts of the fish upon which the parasites are chiefly found; but they are also parasitic on any other projecting part of the body, as upon the lips, the skin of the nostrils, and the orbit of the eyes;*

* From an observation of Dr. W. C. M'Intosh, it would seem that the young of *Mytilus edulis* may also be parasitic. ('Observ. and Expts. on *Carcinas mœnas*,' p. 17.)

nor are the parasites only external in their nature, they may be found abundantly within the gills of fish; the small stickleback I alluded to above, owed his death, I have no doubt, to their presence in the gills. One day I observed my poor fish to be gasping, and quite unable, it appeared, to close his mouth; he died, and, on a *post-mortem* examination, I found about sixty *Glochidia* fastened with closed valves upon the gills; there were also several specimens of the strange and interesting *Gyrodactylus elegans* disporting themselves between the opercula; but the *Glochidia* were doubtless the *causa mortis.* So far, the parasitic nature of the *Glochidia* after their exclusion was established beyond question; but I was anxious to discover instances of fish with the attached *Anodonta*-fry in a thoroughly natural state out of the canal and pond. Through the kindness of T. C. Eyton, Esq., of Eyton, to whom I am much indebted for facilities of natural history investigation, I was enabled to examine a great number of fish caught in a net out of the canal at Eyton, but most disappointingly discovered not a single fish with anything like a *Glochidium* attached; the fish I examined were roach, pike, and perch. About a week later, however, I obtained from the canal not far from my house a small perch, upon whose anal fin was a veritable *Glochidium.* The comparative absence of these parasites from fish taken from the canal, and the pool in which the *Anodontæ* abound is very striking; it yet remains to be seen how far this parasitic condition of the fry is essential towards their growth and final development. So far as my investigations have hitherto gone, I am inclined to believe that the above named condition is necessary to ensure their ultimate growth; for my attempts to keep the fry alive beyond a few days in vessels of water in which there were no fish quite failed; the young died, and became the prey of numerous Infusoria, as Leeuwenhoek, De Quatrefages, and other observers have remarked; but further observation is necessary before we can arrive at any safe conclusion on this point.

None of the sticklebacks, which had several parasitic *Glochidia* on their fins, &c., on the 11th of May, afforded a single example of a parasite on June 9th. During a greater part of the intervening time I examined my attached specimens almost daily. As far as the external form of the shell of the young mollusc is concerned, I was unable to detect any difference, even up to June 2nd; the internal animal, however, was becoming more developed. If a *Glochidium,* at the time of its exclusion, is gently broken in the compressorium, little more is to be seen than a multitude of round particles, which readily separate from each other; these and the well-marked adductor muscles of the valves are about all that can be detected. But if the same experiment is made upon a specimen three weeks after it has become a parasite, it will be found that the animal is of firmer consistency; ciliary action is very distinct, and there can be no doubt that the organs are beginning to assume, by degrees, their ultimate form; but it is almost impossible to say definitely what are the various stages of development, owing to the opacity of the closed valves.

The young *Anodontæ*, at the time of exclusion, keep constantly snapping together their valves, reminding one of the somewhat similar action of the bird's heads (*avicularia*) of some of the marine Polyzoa. This is a most curious spectacle to witness, and its meaning is now explained by the parasitism of the young creature, which, after it has once snapped upon the fin of an unfortunate fish, appears to be quite stationary. In fact, the peculiar barbed nature of the hooks of the *Glochidium* would appear to render it impossible that the valves of its shell should ever reopen, so long as they remained attached to the tissues of the fish. And this seems to be still more probable from the circumstance that there is no muscular provision for the opening of the valves, which depends solely upon the elasticity of the ligament.

Much remains to be yet investigated, but it was thought advisable to publish the foregoing remarks, as they will doubtless tend to set inquirers to work on a subject full of curious interest.

The parts most remarkable in the young *Glochidium*, when the valves are open, are—first, the curious barbed or serrated hooks (figs. 3, 4, 5, 6) at the margin of the shells, each of which appears to be furnished with a muscle on either side, though it is not easy to determine whether these supposed muscles may not be simply membranous folds. We may also observe the strong adductor muscle by which the valves are closed (figs. 3, 4, 6). Each valve is filled up with a soft, granular-looking mass, representing, perhaps, the rudimentary mantle, and the space near the angle is occupied by a more distinctly granular substance, out of which it is probable the visceral mass is subsequently developed. From the middle of this visceral mass arises a small eminence, from the summit of which proceeds the long, slender byssus-filament, which, whilst the embryo is still within the egg-membrane, is coiled up, and fills the greater part of the space between the lateral lobes (fig. 3). After the embryo has escaped from the egg-membrane, and the byssus-filament has become uncoiled, there may be observed, on each side, three, or perhaps in some cases four, curious tentacular-looking organs, which spring from the middle of the rudimentary mantle-lobes. The two of these organs, placed nearest the opening of the shell, are larger than the third, which is situated very near the angle (fig. 6). Carus notices these curious appendages, but was unable to make out their nature satisfactorily. He supposed the two larger pair to represent the future branchiæ (external and internal), and the smaller pair to be the rudiments of the labial tentacles. Their structure, however, would hardly seem to justify this supposition, though it is not easy to replace it by one at all more probable, and I shall not, therefore, attempt to do so. M. de Quatrefages makes no allusion to these organs, and they are not to be seen in all specimens. I have observed them in one or two instances, but without paying any minute attention to their structure. Mr. Busk, to whom I sent living specimens, thus speaks of these organs:—"They are not simple prolongations of the substance, nor are they soft filamentous tags, but organs of a very peculiar kind. Each appears to consist of a very fine pencil of hairs, or rather to present the striped aspect of a camel's hair pencil, which arises from a granular mass in the interior of a strong capsule, which is partly imbedded, as it seems, in the granular matter of the visceral mass." (Fig. 7.) This is a subject worthy of extended observation, but all is over for this season. I have, since the receipt of Mr. Busk's letter, opened three or four dozen *Anodontæ*, but all had parted with their branchial contents. I think the Unios are later in depositing their fry, but I have only been able to obtain a few living specimens, as they are not common in the canal, whence I can obtain any number of Anodontas.

I must just allude to the fact first mentioned, I believe, by MM. Baër and Pfeiffer, of the occurrence of a curious species of *Hydrachna* (*Hydr. concharum*, Baër) that I invariably find in the palleal cavity of these molluscs. These little acari, with heads something like a pig, "to compare great things with small," are not simply occasional visitors; for I have discovered both ova and the larval form of the animal. See on this subject a paper by C. Vogt ("On some Inhabitants of the Fresh-water Mussels," 'Ann. and Mag. of N. H.,' 2nd series, v., p. 450), who has also recorded the occurrence as parasites in the branchiæ of these molluscs of a number of fish with the vitellary sac concealed in the abdomen, which this author is satisfied were hatched from ova that had been introduced into the gills by the respiratory current of the mussels. M. Vogt thought these fish were the young of the Bullhead (*Cottus gobio*, Linn.).* The subject is a curious one, and merits further investigation.

The following queries may suggest inquiry into those points of the economy, &c., of the fresh-water mussels which require elucidation:

1. How long do the *Glochidia* remain attached as parasites, and what is their development during this interval?
2. Is the parasitism absolutely essential to its growth and final development.
3. What are the different stages of growth and form of the shell between the time of the *Glochidium* quitting the fish and its assumption of those characters which belong to the adult mollusc?
4. Do other members of the *Unionidæ* exhibit any differences in habit, form, &c., from what obtains with the *Anodonta cygnea*.

DESCRIPTION *of a* NEW PARASITE *found in the* HEART OF THE EDIBLE TURTLE. By ARTHUR LEARED, M.D., M.R.I.A.

WHILE dissecting the heart of the common turtle in August, 1860, I observed certain elongated, flattened white bodies, upon the interior of the cavities, and on the valves. The number of the bodies was considerable, and they existed in all the chambers of the organ, but I had no opportunity of examining the blood-vessels. Their average length was a line and a half, and the breadth about one third of this. On examining with the microscope, I found them to be fluke worms which presented some novel features.

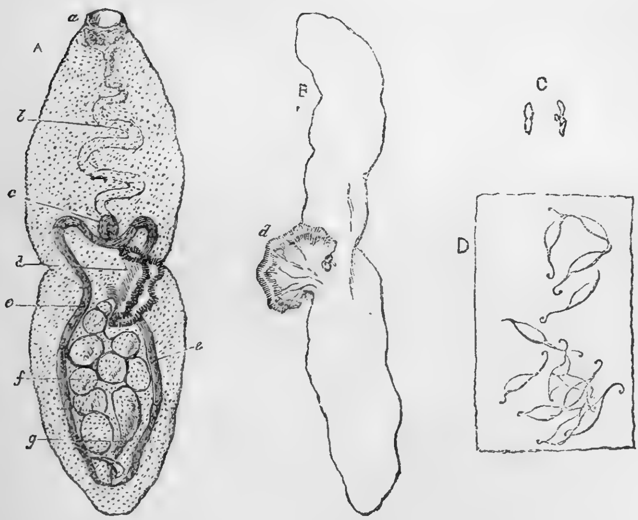
As may be seen in the engraving, the body is indented at each side near the centre, the posterior segment being slightly longer than the anterior. The worm is furnished with an oral sucker and also with a large and peculiar-shaped ventral sucker, which is semi-detached from the body. The oral sucker presents a somewhat radiated appearance, at first giving the idea of an armature of hooklets, but after attentive examination, I have decided that no such armature exists. The œsophagus is remarkably long and tortuous, leading to a double intestine, which at the outset forms two remarkable curves. The separate portions of intestine then pass down

* This, however, can scarcely be the case; the spawn of the Bullhead consists of a compact mass of agglutinated ova, and is firmly attached to the under sides of stones and other submerged bodies; these fish, moreover, love a gravelly bottom, and are not generally found in the same company with the mud-loving swan-mussel.

each side of the posterior segment of the body, and after having approximated closely, as happens in other species of fluke worms, end in cæcal extremities. The intestine is of a deep brown colour, from containing blood of the turtle, and I was able, by pressure, to expel some blood discs. The space enclosed by the intestine is occupied by large cells. No ova can be seen, but certain apparently rudimentary organs may be detected. The edges of the body show a finely serrated appearance. I propose as a provisional name for the worm *Distoma constrictum*, taking the term *constrictum* from the central indentations.

A, B, *Distoma constrictum* magnified 20 diameters. C, the same, natural size.

a.—Oral sucker.
b.—Œsophagus.
c.—Œsophageal bulb.
d.—Ventral sucker, folded.
e.—Intestine.
f.—Large cells.
g.—Rudimentary organ ?



Having submitted the worms to Dr. Cobbold for examination, he has kindly favoured me with the following valuable remarks.

"The parasites which you have recently forwarded for my inspection do not appear to have been noticed by any helminthologist with whose writings I am acquainted. They are undoubtedly larval flukes, and may therefore possibly be referable to one or other of the adult tremadode worms already known to infest the common turtle. They present all the general characters of a Distoma. The reasons which I have for believing these flukes to be immature animals, are grounded not only on the general larval-like aspect of the specimens, but upon the circumstance that the sexual organs are not yet formed, although there is a distinct grouping of the cellular parenchyma in the centre of the lower half of the body, such as would indicate the commencing development of a large pair of testes. Traces of the uterine organs, on the other hand, appear to be altogether wanting. Possibly I have overlooked them, because (as Professor J. P. Van Beneden has shown to obtain in the larval condition of *Distoma militare*) the development of the two sets of organs usually occurs simultaneously, and the series of cells specialised for the purpose of developing both, display precisely the same characters at the outset, though the male and female organs differ so essentially in the mature state. There is one more peculiarity in your preparations of this fluke which has particularly struck me, namely, the unusual length and tortuosity of the œsophagus, before it divides near the middle of the body, into the two well-marked intestinal tubes. This of itself would suggest to me the larval state of the animal, but its length is comparatively greater than I have ever observed in any other fluke, young or old. The œosophageal bulb is also carried remarkably low down, even to the point where the canal bifurcates. The course of the two cæcal intestinal tubes is also worthy of remark, and their peculiar manner of bending upwards, to form graceful curves on either side, at once reminded me of the very similar arrangement which Dr. Guido Wagener has shown to occur in an adult fluke (*Distoma xanthosomum*), infesting the gall-bladder of the little Grebe (*Podiceps minor*)."

These immature worms being found in the heart, would imply that they were in the act of migrating, as we can hardly suppose the cavities of the organ to have been their resting-place.

It is an interesting circumstance that I found in blood from the heart which contained the worms, and also in that from another turtle's heart, certain minute fusiform ova, represented by fig. D, as magnified 20 diameters. The same kind of ova were found adhering to the conjunctivæ of the eyes of several turtles, by Mr. E. Canton, and as they have been fully described by him in vol i, new series, p. 40, of this journal, do not require further notice.

TRANSLATIONS.

Experiments *on the* Migrations *of* Entozoa. By MM. A. Pouchet *and* Verrier.

('Comptes rendus,' May, 1862, p. 958.)

In a work published by one of us in 1859, a close comparative examination was made of the doctrines of those observers, who in Germany and Belgium had occupied themselves with the subject of the metamorphoses of the Entozoa and their peregrination through the living organism. The obvious result of this examination was to excite very weighty doubts in every thoughtful mind. M. Davaine, in his remarkable 'Traité des Entozoaires,' also says that the conclusion in his mind, from the agreement in the facts and the divergence in the opinions of the experimenters, was "that the question still demands sound criticism and fresh researches."

One observer states that, on nine different occasions, he has succeeded in producing *Tæniæ* in the intestine of the dog, by causing it to swallow some *Cænuri* of the sheep. It will be seen that we also have been as successful as this experimenter, and that, in fact, it is the great amount of this success that has given rise to our doubts—we have occasionally reaped more than we have sown.

But before giving an account of our experiments, let us recal briefly what are the Entozoa upon which they have been instituted. The first is the *Cænurus cerebralis,* a vesicular, polycephalous worm, common in the sheep, in which its presence causes the disease termed "staggers." The second is *Tænia serrata,* a cestoid worm, extremely abundant in the dog.

According to the experiments above referred to, this is what takes place:—The dogs devour the heads of the diseased sheep, and the *Cænuri* are by this means introduced into their stomachs. Having reached this locality, each of the polycephalous helminths separates itself from the parent cyst, elongates enormously, and becomes a *Tænia.* The entozoon returns to the sheep in this wise:—When the *Tæniæ* of the dog have attained their full development, the rings which they throw off are passed with the excrement, fall upon the grass, and are swallowed by the ruminant. Soon afterwards the ova contained in these segments are hatched in the intestines of the sheep, giving birth to microscopic larvæ, which perform what may truly be termed a prodigious journey. From their native seat they force a route into the interior of the head, and, in the course of the journey, are obliged to penetrate through the most various living tissues—the base of the skull even does not stop them. Instinctively they find one of the openings, and tear through the resisting tissue which fills it up. Having thus finally reached the brain of the sheep, they take up their abode in it, and there produce the *Cœnurus* by which the host will infallibly be destroyed. This closes the cycle of existence of the helminth, and the shepherd's dog incurs the grave suspicion of infecting the flock committed to his charge.

Nevertheless, however great may be the complications attending a migration of this kind from one animal to another, and the subsequent journey through its tissues, if it is shown actually to take place, however mysterious the proceeding may appear, logically we are bound to admit its reality. But it is precisely at this point that we meet with, we will not say insurmountable, but with, at any rate, enormous difficulties. Let us see what these are.

The *Cœnurus cerebralis*, according to V. Siebold, Van Beneden, and other naturalists, would be the larva of *Tænia serrata*. But, on the other hand, this *Tænia serrata*, according to Küchenmeister, Van Beneden, Baillet, and V. Siebold himself, would appear to be the product of *Cysticercus pisiformis*, or of *Cysticerus cellulosæ*, and *C. tenuicollis*, according to what V. Siebold further says.

Here we find ourselves in the utmost embarrassment. It must be allowed, however, that zoologists have exhibited great ingenuity in this matter, if they have not been very exact. Immediately a *Tænia* is met with in any carnivorous animal whatever, the evil is at once imputed to his victim. The cat derives its worms from the rats and mice it devours; the wolf and the dog find theirs in the rabbits and sheep; man is indebted to the pig. But a scrupulous examination of the facts excites some doubts with respect to all this. It may be asked, for instance, how is it that the sheep, which does not eat the flesh of any animal, sometimes has its intestine filled with such a multitude of *Tæniæ* as to have it completely obstructed by them? In an epizootic malady, which carried off many sheep in the neighbourhood of Rouen, in 1852, this was the case in almost every instance. If the tapeworms find themselves so well off in the intestine, why should the larvæ of some of them quit that locality, and be obliged to take a compulsory journey to the brain?

The importance of this question, as regards agriculture, has not escaped M. Le Roy, Préfet of the Seine-Inférieure; and by him we have been instigated to experiment on a large scale on this grave subject.

Several causes have evidently contributed to throw a degree of uncertainty on the results of experiments of this kind. In the first place, must be placed the natural frequency of the Entozoa which are employed upon the animals to which we profess to communicate them. We may notice, also, the circumstance that certain physiologists are accustomed to administer worms at several doses, and at more or less distant intervals—a course which allows of all kinds of interpretations. Lastly, we must not leave out of account the unsuccessful results, which have not always been recorded.

But, let us not delay with these logical considerations; let us see what experiment teaches, which is alone competent to pronounce a positive judgment.

We will, once for all, state that we have taken the greatest precaution to induce precision in our experiments. Thus, when we have sought to implant *Cænuri* of the sheep into other animals, we have not been content simply to administer them *en masse*, as has been done by various experimenters. In order to obtain accurate results, we have determined, on every occasion, the number of the heads or *scolices* which have been given, by which means we have been able to decide, with unusual precision, with respect to certain results which, in any other way of proceeding, might have led us to erroneous conclusions. Again, whenever we have made use of these same *scolices*, we have taken pains to assure ourselves that their development was as far advanced as possible, and that they were actually alive.

Physiologists have grievously erred in not giving comparative tables, showing the length of their experiments, and the size of the Entozoa which they have found. The consequence is, that we sometimes observe inexplicable differences in the length of the Entozoa found on inspection after death.

In a dog which had been made to swallow some *Cænuri* sixteen days before, we found a certain number of *Tæniæ* not more than 2 millimetres long, whilst others were 20. After a similar interval of time, an experimenter even obtained some *Tæniæ* which had reached the length of 80 millimetres. In another case, at the end of twenty-three days, we found in one and the same dog *Tæniæ* 4 millimetres long; and others, which had reached the enormous length of 60 centimetres. Is it possible that the *scolices* of the *Cœnuri* implanted on the same vesicle, having the same degree of development, and absolutely of the same age, after having been introduced into the intestine, should exhibit, in so short a time, such a prodigious difference of size, from 4 to 60 millimetres? It is inconceivable. If we had followed the usual plan, and administered *Cœnuri* at different times, such a result would apparently have afforded an evident demonstration. But, following the plan we did—one both more rational and more rigorous—it seems calculated only to give rise to doubt.

If, however, in other experiments, we compare the number of Cænurus-scolices administered with that of the *Tæniæ* met with, the same uncertainty under which we labour will also be experienced by all serious thinkers. It is impossible, in this case, to reject the evidence of ciphers.

In one experiment, we administered to a dog 60 heads of *Cœnurus*. Eleven days afterwards, on examining the body, we found 36 *Tænia* in the intestine. In another, 60 *scolices* were also given, and at the end of eleven days 51 *Tæniæ* were discovered. This shows nothing. But in a third experiment, in which a dog was also made to take 60 *Cœnurus* heads, when it was killed, sixteen days afterwards, we found 78 *Tæniæ* in the intestine—that is to say, 18 more than we had administered. This is inexplicable.

Another experiment afforded results of such a nature as to raise still deeper doubts. We gave 100 Cænurus-heads to a sucking puppy, which was carefully secluded in our laboratory. When killed, twenty days afterwards, we found in the intestine 237 Tapeworms, varying in size from 4 to 60 centimetres—a result doubly perplexing, because we found 137 *Tænias* more than we had sown, and because, having administered *scolices* from the same vesicle, and in the same stage of development, we found, at the end of no more than twenty days, the inexplicable difference of length of from 4 to 60 centimetres. This appears to us calculated to afford ground for serious objections.

Other experiments have afforded only absolutely negative results. A full-grown Danish dog swallowed at one time a *Cœnurus* having about 100 *scolices* on its surface. Killed at the end of forty-five days, it did not afford a single *Tænia*. Another full-grown dog devoured a *Cœnurus* upon which were counted about 100 lively *scolices*. When killed, forty-five days afterwards, it afforded also only a negative result.

But if we admit that some serious doubts still require to be dissipated, with respect to the transmigration of the *Cœnurus cerebri* of the sheep to the intestine of the dog, we are infinitely more decided with respect to the peregrination of the ova of the *Tœnia* of the carnivora to the brain of the ruminant.

Our experiments were made upon two lambs, to each of which we administered ten segments of *Tœnia serrata*, all of which contained a number of perfectly matured ova, in which might be distinguished the embryo with its hooks. The sheep, which had been carefully selected as in perfect health, never presented the slightest symptom of "staggers." Experimenters say that the symptoms of this disease are ordinarily manifested from the fifteenth to the twentieth day; but in order to avoid any precipitancy, we kept our animals for four months. Though still in perfect health, they were then killed, in order to ascertain whether the brain contained any vestige of *Cœnurus;* but on the autopsy that organ was found perfectly sound. Consequently, in these cases there had been no transportation of the progeny of the *Tœnia* of the dog to the brain of the sheep.

Considering, therefore, the doubts which arise when we regard attentively the assertions of experimenters, and those also which arise upon a rational examination of the proofs, and lastly, the results of our experiments, we do not hesitate to assert that the offspring of the *Tœnia* of the dog never reaches the brain of the sheep.

But although we deny thus strongly the transmission of the entozoon of the dog to the brain of the sheep, we should not be astonished—without admitting that this is the normal course—to find that it may be possible that the *Cœnuri* of the latter animal were individual *Tœnias,* which have undergone an arrest of development, owing to the situation in which they have been born, and which aborted *Tœnias,* being placed by the experimenter in a more propitious place, there elongate themselves, and attain a larger size than they present in the brain. This opinion has been already sustained.

We are continuing our experiments, and shall, without doubt, be able to arrive at a solution of this interesting problem.*

* In the 'Comptes rendus' for June 2nd, 1862, is a letter from Prof. Van Beneden, in answer to some of the statements in the observations of MM. Pouchet and Verrier, and in the number for June 16th is a rejoinder from those authors, maintaining their former propositions. Of these papers an abstract will be given in our next. [Ed. M. J.]

REVIEWS.

On True Sexual Reproduction in the Infusoria.—Recherches sur les phénomènes sexuels des Infusoires. Par le Docteur BALBIANI, 1861.*

THE *Infusoria* have long been known to multiply by spontaneous fission, external germination, and the production, internally, of variously formed bodies, which many observers, somewhat hastily, have described under the name of "embryoes." The phenomena of "encysting," "conjugation," and "alternate generation" (so called), which these animals frequently exhibit, and the relation, real or supposed, between such processes and their various modes of propagation, have, from time to time, afforded subject-matter for not a little controversy. Stein's theory of Acinetism, once universally received, then skilfully assailed by Lachmann and Cienkowsky, and again defended by D'Udekem, has now virtually been abandoned by its distinguished author. But, although some knowledge was gained, and many false notions dispelled by these and other investigations, it is surprising how little, before 1858, had really been done towards proving the occurrence among the Infusoria of a true reproduction, similar to that which takes place in all the higher classes of animals. An English anatomist had, in 1851, recorded the presence of ova and spermatozoa in one of the marine sponges (*Tethya*), thus, for the first time, showing that the Protozoa formed no exception to the four remaining sub-kingdoms of animals in the possession of these essential elements. Five years later his observations were corroborated by Lieberkühn, in the case of the fresh-water sponge (*Spongilla*). Even then, the existence of generative elements still remained to be demonstrated in the Infusoria—a class which might well be considered as ranking above sponges in the scale of organisation. Ehrenberg, it is true, had described their "nucleus" as a male organ—an opinion which received a qualified support from

* Published, with three plates, in tom. iv, of Dr. E. Brown-Séquard's 'Journal de la Physiologie,' pp. 102, 194, 431, and 405.

Stein, though it met with less favour at the hands of other observers. And the late Johannes Müller, with some of his most able pupils, took note of various minute filaments seen by them within the bodies of several Infusoria, which filaments they were disposed to regard as spermatozoa. Such researches and conjectures, in themselves by no means useless, were very far from settling the questions really at issue; for it has now conclusively been shown that the nucleus does not perform the function of a testis, and that Müller's filaments were, in all probability, parasitic organisms, belonging to the lower Algæ.

Now, however, the whole aspect of this subject has been changed, and for the vagueness which, less than four years ago, characterised all attempts to explain the generative functions of the Infusoria, has been substituted that clear and complete survey of their leading phenomena, which science has just received from the pen of M. Balbiani. In his excellent summary, just brought to a conclusion, a concise, yet sufficiently detailed account is given of the structure of the sexual apparatus, male and female, among the principal subdivisions of the class. The changes which this apparatus undergoes in the course of its development—the evolution of the essential elements to which it gives rise, and many other particulars of interest, are all in their turn described with laudable minuteness and precision. Compelled, at times, to correct the mistakes of others, he in no wise shrinks from avowing the errors into which he himself fell at the commencement of his inquiries; nor does he hesitate to point out the difficulties of interpretation which beset him at each successive stage of their progress. Perhaps future investigators may, in some degree, require a more qualified statement of views which M. Balbiani, in common with most of his readers, now considers as beyond the reach of cavil. Yet, even with this restriction, it does not seem too much to say that a single observer has done more to establish on a secure basis a right knowledge of the sexual phenomena of the Infusoria than the collective body of his predecessors in the same field of inquiry.

We shall, therefore, without further preface, proceed to lay before our readers the chief facts and opinions of M. Balbiani's memoirs, whenever the occasion demands it, translating the very words of their precise enunciator.

Parts of the Reproductive System.

The Infusoria are hermaphrodite, but not self-impregnating; they copulate, though destitute of copulatory organs. The "nucleus" of these animals is, in truth, an *ovary;* the "nucleolus" a *testis.* Each of these parts may have its special *excretory duct,* opening on the outer surface of the body. Thus the whole reproductive apparatus forms a system distinct in itself, and there is no internal generative cavity.

The Nucleus or Ovary.

The ovary varies much in form and size, less so in position. Always somewhat excentric, it appears, in many cases, attached to the cortical layer, from which it freely projects into the mass of soft tissue, forming the inner substance of the Infusorium. This attachment may be of such a nature as to allow the ovary very little power of shifting itself about within the interior of the animal. Or it may engage so trifling an extent of surface that the female organ seems to undergo considerable changes of place, sometimes making its appearance about the middle of the body, sometimes towards one of its extremities.

Von Siebold, in describing the nucleus, states that "it appears to lie very loosely in the parenchyma, and sometimes individuals may be observed turning their bodies around it as it rests motionless in the centre." But M. Balbiani shows that this immovability of the nucleus is only apparent, not real. For in certain *Infusoria* the body is remarkably depressed, and the ovary so large, as almost to be in contact with its opposite sides. To convince ourselves that this organ takes part in the general rotation, we have only, he says, to examine some large Infusorium when much dilated with water and other ingesta. "As the animal turns round on itself we clearly perceive the nucleus describe a circle about the axis of revolution, and by turns approach and withdraw itself from the focal plane of the microscope."

Histologically, the ovary consists of a number of very fine granular particles, held together by a pretty compact gelatinous tissue, the whole being enclosed in an outer membrane of extreme tenuity, and destitute of any apparent structure. So transparent is this envelope that, when examined *in situ,* it is at first impossible to distinguish it from the granular mass which it invests. A drop of dilute acid, however, soon causes this mass to contract, and the delicate ovarian wall, thus separated from its contents, becomes clearly visible. The same result may be obtained, though more slowly, by the endosmotic action of water on the ovary previously removed from the body of the Infusorium, and allowed to remain in contact with the surrounding fluid.

The granular substance, which so completely occupies the interior of the ovary, is itself nearly transparent, and of a yellowish-grey tint when seen by direct light, but appears, at times, sufficiently refractive. Its colour is heightened by the addition of acetic acid. From this stroma the future eggs are developed. "Often we may perceive within it clear rounded spaces, more or less concealed beneath the granules which cover them. These transparent particles can evidently be nothing else than germinal vesicles, scattered throughout the midst of a common yolk-mass. At other times each of these vesicles appears to be surrounded by a special granular zone, which indicates the first separation of the young ova from one another. This appearance almost always coincides with an increased scarcity of the granular particles in the common mass between the ova, and the existence of a narrow transparent border around each of these first rudiments of the egg. Very dilute acetic acid, and an aqueous solution slightly tinted with carmine dissolved in ammonia, are the two best reagents wherewith to study these diverse aspects of the ovary. The granular and transparent portions of the latter organ, by attracting with different degrees of intensity the colouring matter of the carmine solution, display in a very clear and beautiful manner their mutual relations. But, without the aid of any preparation whatever, by simply selecting the most favourable species for the observation of such phenomena, the arrangement and the signification of these particles become, so to speak, of their own accord, sufficiently obvious. The nucleus of *Chilodon cucullulus* is particularly favorable for the demonstration of what we seek here to establish. In the midst of the granular substance which fills the greater portion of this organ, may be seen a large and beautiful, perfectly transparent vesicle, bearing at its centre an opaque and rounded corpuscule. It is impossible not to be at once struck by the complete resemblance to a cell which the nucleus, viewed as a whole, presents. This comparison, made for the first time by the illustrious leader of the unicellular school, M. V. Siebold, led him to designate the central corpuscle under the name of *nucleolus*.* Yet one may venture

* "This *intra-nuclear* nucleolus must not be confounded with the bodies which, in other Infusoria, bear the same name, but are situate on the exterior of the nucleus. These last belong to the male sexual apparatus, according to the view above laid down; while the first is, in truth, an element of the cell which the egg represents. *Chilodon* itself possesses, in addition, a nucleolus or testis, placed on the outside of the nucleus."

to suppose that, in making it, the eminent professor did not himself consider it altogether correct. What, then, is the real nature of this nucleus? For ourselves, we see in it but an egg with its constituent elements, namely, its granular yolk, its germ-vesicle, and its germ-spot." That such is the corrrect interpretation, M. Balbiani further shows by an appeal to the changes which the nucleus of *Chilodon* undergoes, previous to each reproductive epoch. Its entire contents then group themselves "into one elementary cell, into a germ which sums up in itself the whole plastic force of the organ. And what is, perhaps, more singular still, this germ shares the same changes as its possessor, divides, like it, at each spontaneous fission, and transmits itself to the successive generations which result from this mode of propagation, to an extent almost unlimited."

The Nucleolus or Testis.

Of somewhat similar structure, the nucleolus or testis is always much smaller than the ovary to the surface of which it adheres. "Often the two corpuscles, male and female, are merely in contact by their outer membranes; but, in other cases, not less numerous, the first is received into a more or less deep depression on the surface of the second, within which it sometimes seems wholly to disappear. Each, nevertheless, preserves its own envelope. The blending together of these two bodies is frequently so complete that, in order to discover the concealed position of the male corpuscle, it is necessary to make use of reagents which, like dilute acetic acid, determine the condensation of their substance, and bring their walls into view. A tiny clear circle then becomes formed around the nucleolus, which isolates it from the mass of the ovary, and serves to render it visible. But, in many cases, whatever be the means employed, we cannot prove that it exists; hence we may conclude that it is reduced to nothing in the intervals of the reproductive periods. It is not rare, in fact, to see it make its appearance at these epochs, in individuals in which its presence had been vainly sought until then. Another very serious difficulty accompanying the discovery of this organ results from its close resemblance at times to the fatty globules so abundant in the bodies of all Infusoria, almost every optical character of which it shares. It has the same smooth and rounded form, the same homogeneity, the same refractive aspect, especially after treatment by acids which determine the contraction of its substance. Much experience, therefore, is necessary, in order not to confound the nucleolus with the fat globules scattered around it. But the little circle which surrounds it under the circumstances mentioned above, its constant presence, and the—in all cases—identical conditions, both as to number and position, which it offers in a large number of examples belonging to the same species and examined in succession, are so many characteristics which hinder our confounding it with the other elements of the body. Its colour is always of a bluish-grey, while that of the ovary is constantly of a dirty yellow, more or less conspicuous, especially after treatment by acetic acid—a circumstance perhaps associated with a different chemical composition of the substance which forms the mass of the two organs. Concentrated acids and very dilute alkaline solutions readily dissolve it. Iodine tinges it yellow, and a very weak aqueous solution of carmine, previously dissolved in ammonia, imparts to it pretty quickly a colour far more intense than that of the solution itself."

There is little constancy in the relative position of the reproductive organs among the various forms of *Infusoria*. The testis may be either situate about the middle region of the ovary, or nearer one of its extremities.

"The figure of this little body is often perfectly globular, at other times more elongated in one direction than in the other, or like a grain of barley, the pip of an apple or raisin, &c. This form becomes modified at certain periods, that is to say, when the animal multiplies itself by fission or sexual reproduction."

The careful examination of the nucleolus in the enlarged condition which it exhibits at these periods has led M. Balbiani to the discovery of one or two curious peculiarities in its structure. "Such (he writes), are the striæ which it presents on its surface before fission; striæ which I attribute to the existence of ridges or thickened portions of the outer membrane, rendered more distinct by the increase of size referred to above. These ridges may readily be separated from one another by crushing the organ, and they then show themselves as parallel, fusiform rods, slightly curved, from ·1 to ·2 mm. in length, few in number, and following the direction of its greater axis. This fibrous structure of the testis, little, if at all, visible at other periods of the year, makes its appearance contemporaneously with the first stage of its evolution at the sexual epochs, and might be mistaken for a development of seminal corpuscles. But these do not appear until afterwards, and give rise to a far more delicate striation of the gland than that which results from the rod-like organs in question.

Modifications of Ovary and Testis.

The most striking diversities of form which both kinds of reproductive bodies present have next to be considered. In accordance with these modifications, the numerous species of the class have been arranged by M. Balbiani, under three principal divisions, as follows:

1.—" Species whose *ovary* has the form of a small rounded or ovoid cell, containing an undivided yolk-mass. *Testis* (where it exists) presenting a like aspect."

2.—" Species having the *ovary* elongate, cylindrical and tubular, variously curved or twisted, containing an undivided yolk-mass. *Testis*, as in the preceding species."

3.—" Species having the *ovary* elongate, straight or curved, containing a yolk-mass divided into two or more distinct parts (bi- or multi-locular ovary). *Testis* usually made up of an equal number of elements, accompanying the yolk segments. More rarely a single male element."

These characters are more briefly exhibited in the subjoined table:

Yolk-mass, continuous. Testis, single.	§—1	Ovary ovoid or spheroid.
	§—2	Ovary elongate.
Yolk-mass, divided. Testis like ovary, being single.	§—3	

1. To the first division belong all the PARAMECINA proper (*Colpoda, Glaucoma, Paramecium, Cyclidium, Pleuronema*), with various species and genera referable to other families, e. g., of TRACHELINA, *Nassula, Chilodon, Holophrya, Enchelys, Prorodon teres;* of BURSARINA, *Plagiotoma, Balantidium, Leucophrys, Frontonia* (*Bursaria leucas*, Ehr.), *Ophryoglena* (*B. flava*, Ehr.), &c.

In these *Infusoria* the reproductive system may be said to occur under its least complex conditions. The simple rounded ovary, completely filled by its yolk-mass, appears always situate about the middle of the body, and lodged in a depression of its surface is the oblong or spheroidal testis, the length of which is most frequently from one sixth to one eighth that of the female organ. In *Paramecium bursaria* it is somewhat larger, nearly equalling the ovary in size. The generative apparatus for this species is liable, occasionally, to certain curious monstrosities; a double ovary being associated with a (or absent) testis, or *vice versâ*. "It is an interesting circumstance to note that all these abnormal individuals came exclusively from media nearly putrid, which had become transformed into genuine infusions, and were, consequently, very rich in nutrient matters." The earliest *Paramecium aurelia* has a very soft ovary, and a pale, rounded, inconspicuous testis. In large specimens of *Chilodon cucullulus*, the ovary (to whose simple structure reference has already been made) attains a length of ·032 mm., and a breadth of ·021 mm., the mean diameter of the testis being ·003 mm. The following table exhibits, in fractions of a millimeter, the average dimensions of these organs, in various other *Infusoria* belonging to the same division:

	Ovary.			Testis.
	Length.		Breadth.	
Paramecium bursaria	·043		·014	·014
" aurelia	·050		·025	·007
Nassula flava		·02		
Ophryoglena flava	·106		·079	
Plagiotoma lateritia		·025		
Prorodon teres	·054		·038	·018
Spirostomum teres		·043		

2. The second arrangement holds good in the Euplotina, Aspidiscida, and most Vorticellina; also, in certain isolated members of other families, as *Trachelius ovum* and *Prorodon niveum* among the Trachelina, and, of the Bursarina, *Bursaria truncatella*. "In the two first groups the ovary is almost always simply bent like a horse-shoe, and its convexity looks sometimes to the left, as in *Euplotes*, or forwards, as in *Aspidisca*. Among the Vorticellina this gland presents the most numerous variations as to length, longitudinal or transverse aspect in relation to the axis of the body, and the number and direction of its curves." The male organ resembles that of the preceding division, and is either free or more or less united to the ovary. In *Euplotes* it is usually placed on the left margin of the latter, in the anterior half of the body. In *Cothurina imberbis* it is sometimes situate towards the top of the ovary, sometimes against its side, or it may be received into a depression of its surface.

3. In the last division are placed *Oxytricha* and its immediate allies (*Stylonychia*, *Kerona*, *Urostyla*, &c.) together with various other forms of widely different affinities, as *Stentor*, *Kondylostoma*, and some species of *Amphileptus* and *Loxophyllum*.

The Oxytrichina proper have both ovary and testis divided, each into two similar parts, and "in the ovary these parts are situate one behind the other, under the form of little elongated masses following the axis of the body, and separated by an interval occupied solely by the membraneous wall, equal to once or twice the length of each segment." Hence some observers have not hesitated to ascribe a pair of independent nuclei to these animals. Yet, M. Balbiani is convinced that, in spite of this apparantly complete division of its contents, the delicate ovarian wall still remains entire, being alike continuous over the separated yolk-masses and the interval which lies between them. Great practical difficulties, however, attend the actual demonstration of its presence in this intermediate region. "But with the aid of high magnifying powers and the use of suitable reagents, such as tincture of iodine diluted with water, I have more than once succeeded in perceiving it under the form of a clear band, bordered on each side by a very dark line, running from one nucleus to the other. Under these circumstance, the two bodies may sometimes be seen to approach one another by a quick simultaneous movement, as soon as the action of the reagent has commenced. This effect, which obviously can only be due to the sudden contraction of a membrane connecting the two nuclei, affords a physiological proof of its existence not less convincing." Frequently, also, the addition of an ammoniacal solution of carmine demonstrates the existence, within this connecting membrane, of a delicate commissural thread, radiating between the two yolk-masses, and composed of the transparent tissue which binds together their numerous fine granules.

Some Oxytrichina occasionally exhibit an abnormal transverse segmentation of each of the two ovarian elements, similar to that already noticed in the case of *Paramecium bursaria;* four nuclear masses being thus produced.

"But this quadripartite division of the intrá-ovarian substance, which appears as a pure accident in the great majority of Oxytrichina, becomes a permanent and normal condition in other members of the group." Thus, in *Onychodromus grandis* of Stein, the ovary consists of four equivalent portions, arranged in longitudinal series, one behind the other.

In other cases a still further multiplication of the yolk-masses occurs. So numerous do its fragments become in *Urostyla grandis* of Ehrenberg that, at the first glance, this species might be looked upon as having no nucleus at all, its numerous divisions being scarcely distinguishabie amid the small pieces of food and other miscellaneous particles lying in the parenchyma of the body. As many as fourteen or fifteen distinct masses may be counted in the ovary of adult examples of *Stentor*. "In *Spirostomum ambiguum* and in *Rhonchylostoma patens*, other species belonging to the family of *Bursarina* and allied to *Stentor*, the ovarian elements are still further multiplied than in these last, and form, collectively, a long band which, according as its divisions are more or less distinctly indicated, presents sometimes an aspect simply nodose, sometimes that of a bent chaplet made up of from thirty to more than forty elements, extending without interruption throughout the entire length of the body.

The number of male elements is usually equal to that of the female, though, in rare cases, a multiple ovary coexists with a simple testis, or the reverse arrangement may present itself, as in *Stylonychia mytilus* and *Urostyla Weissii*, in which each division of the bi-partite ovary supports a testis at either of its two extremities.

Before fission or sexual union, the elements of the sexual apparatus may be observed to separate from one another, and to a greater or less extent, to change their previous position within the interior of the body.

The three kinds of reproductive apparatus above described differ, as we have seen, in a marked degree from one another. But the existence of many intermediate conditions, establishing a gradual connection between one principal form and another, forbids our drawing too absolute a line of demarcation between them. Even the same infusorium, at different periods of its existence, may exhibit all three of the modifications in question. The young individuals of *Stentor* have, at first, a simple rounded ovary; while, in adults of the same genus, this organ, as already mentioned, presents the aspect of a beaded chaplet. Previous to each act of fission, however, the ovary assumes the second, or cylindrical form; a fact which would seem to hold good in the case of all Infusoria, whether their female organ be simply ovoid or moniliform. *Stentor Rœselii* of Ehrenberg scarcely differs from *St. Mülleri* of the same author, save in the unarticulated condition of its nucleus, a condition which, in this instance, M. Balbiani asserts to be of a wholly transient nature, and quite unworthy to be made the basis of a specific distinction. On the other hand, those Infusoria in which the simplest kind of reproductive apparatus exists exhibit a division of the nucleus into two (or, it may be, more) parts, about the time of sexual union, so that the chief difference between the ovary of such forms and of the Oxytrichina becomes, at length, reduced to this,—that the requisite division of its yolk-mass which, in both, precedes the reproductive act, in the one takes place at a late, in the other at an earlier period.

To determine, therefore, the exact degree of likeness or unlikeness between the generative organs of any two Infusoria, it becomes necessary to examine both immediately before the occurrence of fission and of sexual reproduction, as well as in the intervals between these periods.

Age, too, affects the general aspect of the ovary, more especially in its beaded forms. Still, M. Balbiani thinks that the number of articulations which this organ presents "is almost always in relation with the species or genus of the animal."

It follows, also, from what has been said, that any classification of the *Infusoria* founded on the resemblances or differences between their reproductive apparatus would be, to a greater or less extent artificial, even in the absence of intermediate modifications to connect together the three leading forms mentioned above. Examples of all these might, without difficulty, be taken from the different members of the family Trachelina, which can hardly be considered an unnatural group; or, to confine ourselves to a single genus, *Prorodon,* we find one species (*P. teres*), with an ovoid nucleus, another (*P. niveus*), with a cylindrical one. In *Spirostonum teres* the ovary is undivided; in *S. ambiguum* moniliform.

And in this regard we think that special credit is due to M. Balbiani, for the simple clearness with which he has reflected the anatomical facts which lay before him. In the present somewhat confused state of opinion as to what are the most appropriate subdivisions of the Infusoria, how plausibly might he not have sent forth a new arrangement of these animals, based, too, on his own original observations. Let it not, however, be said that the negative result to which he has been led is without its proper value; for, has he not brought forward a new and striking proof of the doctrine, that parts of high import in the vital economy of an organism may, to the pure systematist, be of little value, because their various modifications fail to furnish characters of sufficient definiteness or constancy?

The Act of Sexual Union.

It has already been stated that the *Infusoria,* though hermaphrodite, are not self-fertilizing, in which respect they resemble certain of the higher animals. But, unlike these, they do not possess special organs for copulation. What, then, are the parts concerned in that act of sexual union which must, of necessity, precede the fecundation of the ovarian contents? To answer this question intelligibly, M. Balbiani has premised a brief account of the form of the body in these animals, with particular reference to the position of the mouth.

"All the *Infusoria* may be arranged under two great categories, according to the position which the mouth occupies in these animalcules. In the one it is situate at the anterior end of the body, and in the direction of its longitudinal axis; in the other, which constitute the great majority, this orifice is placed excentric to that axis on one of the sides of the body, and usually in its anterior moiety."

Let us first examine the specialities which may be observed in the latter case. Very frequently the entrance to the alimentary canal occupies the farthest part of a longitudinal furrow, traversing the whole surface of the body, one of whose margins, sometimes both, is furnished with a row of of cilia more or less developed, and destined to excite in the water a whirlpool which may bring particles of food towards the commencement of the digestive cavity. A number of modifications, varying with the species, mark the shape of this depression. Thus, in *Stylonychia, Oxytricha,* and most other genera of the same family, as also in several Paramecina, it takes on the form of a triangular demi-canal, much spread out in its anterior portion, and becoming narrower posteriorly, in the direction of the mouth. In other species, as *Spirostomum, Plagiotoma,* &c., it may be compared to a straight groove, extending from the summit of the body up to the buccal orifice, into the interior of which it penetrates, and describes a spiral, accompanied by the row of cilia fringing one of its margins. Besides these principal modes of arrangement the above depression presents a great number of intermediate on which it would be useless here to dwell. I shall, however, point out the peculiar position which it assumes in *Vorticellina* and *Stentor,* among which, instead of being situated, as in other Infusoria, longitudinally on the side of the body, and, consequently, parallel to its axis, it is placed, on the contrary, perpendicularly to the axis of the summit of the animal, and constitutes the wall which limits on this side the urn- or trumpet-shaped body of these latter species. This wall, in fact, repeats all the essential characters of the buccal groove in the Oxytrichina and other Infusoria, with this difference, that its floor forms a kind of moveable plateau, which constitutes what has been termed the disc in these species, and is susceptible of raising or lowering itself to a greater or less extent, by means of the contractile stalk on which it is supported.

If, now, we examine the manner in which copulation takes place among the animals presenting the above type of conformation, we shall remark that they always place themselves parallel to one another, uniting by the depressed region placed in front of the mouth. When, as in some Paramecina, this region occupies a considerable extent of the ventral surface, which is itself deeply excavated, the two individuals receive one another mutually into this hollow, holding together as if embraced by the lateral walls of their bodies. When, on the other hand, the buccal depression exists simply under the form of a tiny pit or straight and superficial groove, their contact takes place only in the space occupied by this pit or groove, and they remain free for the rest of their surface. The exudation of a glutinous substance at the point of contact of the two animals, serves to strengthen their union by fusing them intimately together, so that their separation becomes completely impossible, in spite of the sometimes very strong pulls which, under certain circumstances, they exercise against one another.

Infusoria of nearly cylindrical or oval form, unite by their oral depressions alone, the rest of the body remaining free. And even when this depression is very short, in consequence of its close proximity to the anterior pole of the animal, the viscid secretion of the parts connects them firmly together, notwithstanding the slight extent of the apposed surfaces.

If the body be much compressed, as in *Amphileptus* and *Loxophyllum*, the mouth appears as a mere slit on its ventral margin, and though, in such cases, the surrounding depression is wanting, yet we find, as before, a row of peculiar cilia running along its site towards the anterior extremity, whose distance from the mouth, therefore, determines the length of the region along which, by simple contact, sexual union takes place.

Having witnessed in so many species the important share which the oral region seemed to take in copulation, M. Balbiani was led to seek in this region for some mode of communication between the sexual organs of the two conjoined individuals. Long he sought in vain, until, from frequent observation of the peculiar position which the mouth assumes during this act, the two oral orifices being not merely opposite, but closely applied to one another, he was induced to ask himself the question, does the mouth itself act the part of a genital duct? This he was the more disposed to answer in the affirmative, from having once, as he thought, seen a seminal capsule entangled in the buccal cavity of one or two copulating individuals. But further researches failed to bring confirmation. At length his patience was rewarded by the actual discovery of what appeared to be true sexual apertures in several distinct forms of the class.

In a pair of copulating *Paramecium aurelia* a distinct excretory duct, was seen to run from the ovary and testes of each, to a point just above the mouth, towards the posterior end of the buccal depression. Whether these two ducts were furnished with orifices of their own, or together opened into the same cloaca, M. Balbiani could not exactly determine. Such an orifice, he thinks, must exist under the form which that of the digestive apparatus presents in many *Infusoria*, among which, except while feeding, the sides of the mouth are so closely apposed to one another, that the very existence of this aperture remains for a time doubtful, until, in fact, the special stimulus of food causes its dilatation. Of this nature is the generative orifice of the Oxytrichina, though the canal which serves to connect it with the reproductive organs, has not as yet been satisfactorily determined. In *Trachelius ovum*, however, all parts of a *very* complete genital system are clearly discernible. As in *Paramecium aurelia* there are two distinct ducts, which connect the ovary and testis with a well marked aperture situate, like that of the Oxytrichina, in front of the mouth. The layer of cuticle which clothes the general surface of the body, stops short just before reaching the margin of the aperture, so as to leave exposed a projecting rim of granular tissue, which, in its various states of construction, causes the orifice itself to vary much in form, so that, occasionally, two distinct apertures appear to be present.

In *Stentor*, also, and especially in *S. cœruleus*, when the body is fully extended, a cleft like that of the Oxytrichina, may be noticed on the depressed region of the cleft surrounding the mouth; and, by the margins of this cleft, as well as throughout a certain extent of the oral depression, two of those animalcules have been seen to unite in copulation. But, the mouth itself takes no part in this act, so that the pair of conjoined *Infusoria* continued to feed as before, while in such forms as *Paramecium aurelia* feeding becomes impossible, by reason of the close apposition of their two mouths during the period of sexual contact.

Seeing, therefore, that a genital orifice appears in several varied forms of the class, it might be inferred that it exists in all, for, although its actual presence still remains to be demonstrated in by far the majority of Infusoria, yet the sexual union of these last is not known to differ in any essential respect from that of the others. Its position, also, would seem to be equally constant, namely, in the ventral surface of the body, between the mouth and the anterior extremity. *Stentor* cannot be said, to present an exceptional case, if we admit, with M. Balbiani, the homology between the 'front' of these animalcules and the large depressed region about the mouth in other Infusoria.

With regard to Infusoria of the second great category, among which the mouth is situate at the anterior pole of the body, M. Balbiani has nothing to say on the subject of their genital aperture, save the fact that in *Coleps*, sexual union seems to be effected by the large orifice which occupies this extremity.

It would be an error to conclude that M. Balbiani has been the first to witness the act of copulation among the Infusoria. This had, indeed, already been done by others, who, so far, however, from rightly interpreting the facts before them, mistook the pairs of animalcules thus found united for a single individual undergoing development by longitudinal fission. And many *Infusoria* were said to divide indifferently, either in a longitudinal or transverse direction. Ehrenberg's figures, so often copied, representing *Chilodon cucullulus* in both these supposed states of fission, must be familiar to many of our readers. But, although longitudinal division occurs in some Infusoria, more particularly the Vorticellina, yet, in by far the majority of the class, voluntary fission seems always to be effected transversely. While the changes induced thereby in the conditions of the sexual organs, are very different from those determined by reproductions.

Many subsidiary phenomena of great interest either accompany or precede the copulatory act, among the several tribes of Infusoria. Into these, want of space forbids us now to enter, for it would scarcely be *just* to maim, by imperfect quotations, the complete descriptions of M. Balbiani. Our readers should consult for themselves the interesting account which he has given of the sexual act in the Oxytrichina, which, without the aid of his excellent illustrative figures, we could hardly hope to render intelligible. In these a most curious and complete series of changes occurs, and a very intimate degree of union establishes itself between the two animals, which lose a number of their appendages, shifting the relative positions they had at first assumed, so that the ventral margins of both which, when copulation commenced, were exactly opposite one another, become quite everted, so as to face in the same direction. But the pair of Oxytrichina still remain united laterally for about one third of their length, and that, moreover, in so complete a manner, that if viewed in this region alone, no observer, ignorant of what had previously taken place, would hesitate to acknowledge that only a single organism lay before him.

The length of time during which the sexual act continues, may vary from twenty-four hours to five or six days, and depends upon the degree of development at which the reproductive organs have arrived, when the first symptoms of union become manifest. Of this development, we shall now proceed to trace the principal stages.

Evolution of the Ovary and its contents.

When first the ovary becomes observable in the body of a young Infusorium, it appears under the form of a colorless transparent mass, with difficulty distinguished from the parenchyma in which it lies as a somewhat paler and very minute circular spot. By reason of its extreme softness it cannot readily be examined out of the body, or submitted to the influence of reagents. Dilute acetic acid shows its apparently homogeneous tissue to be made up of numerous pale granules, loosely united together by a colorless, gelatinous substance. The whole is invested by a delicate outer membrane, and this, with the intermediate substance, soon dissolves in the acid, whereupon the great molecules make their escape.

Not very dissimilar to this is the case of an adult animalcule, from which the fertilized eggs have been just extracted. For a great change now takes place in the aspect of the generative apparatus. In many Infusoria, in fact, it seems to vanish altogether, soon however again to make its appearance, though, at first, in a very rudimentary condition. Its evolution now takes place with extreme rapidity, and is at length consummated by the performance of another act of reproduction.

Such forms are far better suited than young Infusoria for the study of the successive changes which the reproductive apparatus undergoes, not only because in the former, these parts are larger and more distinct, but they are also better able to bear the action of reagents. Thus, a little acetic acid, brings clearly into view the several structures above described as existing in the ovary of a young Infusorium, and, in addition, a transparent circular space, very distinct from the surrounding granular ovarian mass, which has become of a greyish-yellow color, under the influence of the test-liquid. M. Balbiani infers that this space indicates the presence of an internal vesicle, but all his efforts to isolate it from the surrounding tissue proved fruitless, in consequence of the extreme delicacy of its supposed wall.

In *Chilodon*, as already shown, the ovary constantly appears under this simple form, merely increasing in size, and undergoing no further differentiation of structure. A central corpuscle becomes visible within the clear space, so that the entire ovary of this organism presents all the parts of a single egg, viz., outer membrane, yolk-mass, germ-vesicle, and germ-spot.

But this condition of the nucleus, which in *Chilodon* is permanent, represents only a temporary stage of its development in other Infusoria. For the solitary egg which is first formed, after previous elongation, divides transversely, and thus two eggs are produced. In some species this is the ultimate number, but much more frequently, the process of division is repeated, and, in some cases, so often, that a long chain of eggs is the final result.

The internal vesicle is always the first part to divide, and each of its halves forms a centre of aggregation for its own share of the granular ovarian contents. The little rounded masses which result may either forthwith separate from one another, or remain connected by longitudinal commissures of the granular yolk substance. The length of time during which this connection is maintained, as also the diameter of the commissure itself, in relation to that of the eggs between which it lies, is subject to considerable variation, and hence a corresponding diversity in the aspects which the reproductive apparatus of different Infusoria presents.

It is necessary to bear in mind that the outer membrane of the ovary is not affected by the division of its contents, but still continues to enclose them all; appearing in the interspaces between the eggs, "sometimes as a more or less narrow tube, sometimes as a slender filament." Since the eggs, after their first formation, increase in size, "and acquire a more abundant yolk-mass," M. Balbiani conjectures that their common envelope is, perhaps, analogous to "that portion of the reproductive apparatus of other animals, whose function it is to supply the ovules with the materials of their growth and nutrition."

The following table, copied from M. Balbiani, well shows the principal variations as to size and number which the eggs present:

Name of Species.	Number of eggs.	Diameter of eggs.	Average length of body.
		Millimetres.	Millimetres.
Trachelius ovum . .	2	0 120	0·45
Amphileptus gigas . .	20—25	0·018	0·50
,, anas . .	2	0·008	0·06
Loxophyllum meleagris .	12—15	0·015	0·30
Loxodes rostrum . .	15—20	0·015	0·30
Chilodon cucullulus . .	1	0·005—0·020	0 036—0·125
Bursaria truncatella . .	4	0·057	0·50
Ophryoglena flava . .	4	0·018	0·18
Spirostomum teres . .	2—3	0·018	0·30
,, ambiguum .	20—50	0·014	0·55—0·65
Stentor cœruleus . .	8—15	0·018	0·30—0·50
Euplotes patella . . .	2	0·014	0·09
Kerona polyporum . .	4		0·15
Stylonychia mytilus . .	4	0·018	0·25
,, pustulata . .	4	0·010	0·12
Paramecium aurelia . .	4	0·018	0·18
,, bursaria . .	2—4	0·014	0·10
,, ? . .	20—25	0·007	0·08
Urostyla Weissei . .	4		0·20
,, ? . .	100 & +	0 007	0·29

"Usually the number of eggs which divide at once increase in an inverse ratio to the number of eggs already formed, and to their degree of maturity, while the time required for a given egg to divide, increases directly with the same conditions. It would seem that the eggs placed towards the ends of the chain divide more frequently than those which occupy an intermediate position. Their multiplication does not completely cease until the moment of sexual union, and just up to this period, that is to say, at all times, we meet with individuals in which one or two of these, often a much greater number, present more or less advanced traces of division."

As a general rule, if two Infusoria of about equal size be compared, the eggs (as might be expected) are largest when least numerous.

In the Vorticellina, and some other forms (*Prorodon niveus, Bursaria truncatella, Trachelius ovum,* &c.), each division of the internal vesicle, or its parts, is not immediately followed by that of the other contents, so that the vesicles appear by themselves in the axis of the ovary, the granular substance of which lies between them and the external membrane. Just before sexual union, however, (rarely later), the yolk mass divides in its turn, and, arranging itself round each of the vesicles, gives rise to eggs like those of other Infusoria. "The number of these vesicles, and, consequently, that of the eggs which, at a later period, come to maturity, is not always in proportion to the length of the cylindrical yolk mass. It is thus, for example, that, in spite of their long nucleus, variously bent or twisted, certain *Infusoria* produce but a small number of eggs. Such is *Trachelius ovum,* which contains but two at the time of reproduction; *Bursaria truncatella,* which has only four at the same period, &c. In other cases, on the contrary, instead of breaking up into only two or four parts, as in the species just cited, the yolk mass divides into fifteen or twenty fragments, each of which forms itself, separating into a complete egg (*Prorodon niveus*)."

"In some *Infusoria* the vitelline band does not divide throughout its entire extent at each reproductive epoch, but only at one of its extremities, and merely becomes shorter, without undergoing any further modifications. Such is the case with *Euplotes,* in which the eggs withdraw themselves at this period from the common mass, ripen separately, and become fit for fecundation."

What has been said may serve to show the more remarkable variations as to size, form, and number of parts under which the ovary occurs, and how its three principal modifications merge into one another by numerous intermediate conditions.

As its contents ripen, the granular mass of the ovary becomes more cohesive throughout, and at length adheres so closely to the outer membrane, that, when the eggs are ready for fecundation, this appears to be wanting. Such, however, is not really the case in some Infusoria at least, for, in *Stylonychia* and *Stentor,* distinct traces of its presence are still discoverable.

"Another characteristic which the yolk of the ripe egg presents is that of acquiring, under the action of acetic acid, a far brighter tint than at preceding periods; this color is light-yellow or blue, and never the dirty yellow shade, more or less deep, which this reagent imparts to the vitellus before the ripening of the egg."

The fully developed eggs appear as clear spherical spots amid the darker parenchyma, and are of nearly equal size in the same individual. They are still, however, so transparent, that the addition of reagents is necessary to exhibit their structure. Acetic acid communicates a bluish-grey, or clear greyish-yellow tint to their substance, which is then seen to possess considerable refractory power. "The vitellus, of apparently homogeneous or finely granular consistence, shows itself after compression to be made up of granules more or less large, loosely adhering together, and united by a mass composed of fine molecular granulations. The germinal vesicle is usually altogether concealed by the vitelline granules, and cannot be recognised. Yet we may sometimes succeed in detecting it by employing successively a very weak solution of caustic potash, which partially dissolves the vitellus, and renders it more transparent, and tincture of iodine diluted with water or weak acetic acid. We may even use for the same purpose, the aqueous solution of carmine in ammonia, which gives to the yolk a roseate tint, more or less deep, and causes the vesicle to appear under the form of a more distinct central spot."

In *Paramecium aurelia* an exceptional mode of egg-formation occurs, the details of which, as given by M. Balbiani, derive an additional interest from the very complete manner in which they have been observed. The simply ovoid nucleus, consisting of the usual membrane and granular contents, which this species is seen to possess at the commencement of the sexual act, soon has its surface furrowed by a number of wavy lines, which, becoming deeper and more numerous, quickly divide the yolk-mass into several irregular lobes. These lobes are, at first, very indistinct, and more or less confused with one another, but they gradually separate in such a manner, that "at length the entire mass slowly unrolls itself into a continuous cylindrical band, sometimes simple, sometimes made up of several branches, variously bent or folded." As yet it exhibits no apparent change in its minute structure. A short interval of repose succeeds, after which the cylindrical yolk-mass breaks up into a succession of large fragments, which in their turn divide, and so on, until the whole is resolved into a considerable number of rounded corpuscles, varying in diameter from ·010 mm. to ·014 mm. Some of these, under acetic acid, display a clear centre surrounded by granulations, others granulations only. Meanwhile the membranous envelope, obliged to keep up with its contents, becomes so excessively attenuated, that its presence is no longer susceptible of actual demonstration.

Besides the corpuscles just mentioned, there are others which, about this time, make their appearance within the ovary. Their number is usually four, rarely two or eight.

Each is a homogeneous, transparent, spherical vesicle, at first quite free from granulations, and having a diameter of not more than ·007 mm.

These four corpuscles are the rudiments of the eggs, destined ere long to undergo fertilization. And there can be little doubt that, notwithstanding their apparent diversity of position in different specimens, they are enclosed within one end of the same delicate membranous tube which contains the other more numerous ovarian fragments. For, when examined at maturity, with the aid of reagents, a faint line may be detected in the intervals between the eggs, passing into the clear border on either side of each.

In spite of their minute size, M. Balbiani succeeded in extracting uninjured some of the young eggs from the parent-body, and subjecting them to the action of the surrounding water. Thereupon each egg resolved itself into two hollow membranous spheres, the smaller being enclosed within the other, and separated from it by a considerable interval. Other reagents, such as acetic acid or iodine, produced the same result more rapidly. These (of course much diluted), could even be applied to the egg while yet within the body of the animal, provided the movements of the latter were first restrained by means of a little gentle compression.

Of the two spheres, the outer would seem to represent a vitelline membrane; the inner a germinal vesicle. A few free granules may sometimes be seen within the latter; but, as yet, no other egg contents are to be observed. The evolution of one egg always keeps pace with that of its fellows, no one of the four being in a more advanced stage of development than the others.

(*To be continued.*)

NOTES AND CORRESPONDENCE.

On the Microscopes in the International Exhibition.—In the English department there are about one-and-twenty exhibitors of microscopes and microscopical objects or apparatus, and it will be interesting to inquire how far, and in what directions, improvements or novelties have been introduced in these matters since 1851. Upon the whole, a very great advance is observable. Firstly, in the general style, as it were, and elegance, arising from the accurate adjustment of parts to their purpose, and in the various proportions of the instruments. Secondly, the observer will be struck with the numerous specimens of binocular microscopes, mostly on the construction of Mr. Wenham, to whom microscopists are so much indebted for the great improvement thus introduced in the production of a really efficient binocular instrument, so long a desideratum among opticians. Thirdly, a striking feature in the microscopes of late construction more especially, is the great attention that has been paid to the mode of illumination of objects. The various and ingenious ways in which this important object is carried out, are well worthy of remark. Fourthly, in the construction of object-glasses a marked advance in one direction, at all events, has been manifested in the period that has elapsed since the last Exhibition—this is in the amplification of the aperture, and the improvement thus affected in the definition and detection of minute surface-markings. The utmost limit, perhaps, has been reached in this respect, and it is very creditable to our opticians that they should have so far succeeded in arriving at the limits of perfection. But at the same time it cannot be denied that for really practical purposes, in most cases, object-glasses of less aperture than those which can now be made are far more serviceable. The great object with opticians should be to produce object-glasses of moderate aperture, and the shortest possible focal distance, so as to place in the hands of the anatomist and physiologist a really useful lens of the highest possible magnifying power, and yet with a capacity of penetration which is incompatible with an extremely wide aperture.

Amongst English exhibitors we observe scarcely any new names; but in addition to the four or five well-known and world-famous London makers, we are glad to perceive those of several others who, though not unknown even then, have, since 1851, deservedly acquired a distinguished provincial reputation.

In the following hasty remarks upon what we have noticed in the Exhibition, we beg merely to be understood as expressing our first impressions, and by no means as passing judgment upon all that is exhibited. Many excellent things, and several worthy names have been passed over, without doubt; not because what they exhibit is not deserving of all praise, but because our space will only allow of our noticing a few of those things which strike us as showing more prominently the directions in which advance in the making of microscopes has proceeded of late years.

In the case of Mr. Ross, we notice as particularly worthy of remark a new form of stand, in which the stage arrangements appear, so far as we can judge, without actual experience, extremely admirable, from the great facility they afford for the employment of oblique light in any direction at once from the mirror, combined with the readiest movement of the object in all directions. In other respects, also, this stand seems to us to be the most complete and perfect perhaps of any in the whole Exhibition. Messrs. Powell and Lealand's stand, it is needless to observe, with respect to what is well known and so highly appreciated, is also one of great excellence, and it has the merit, amongst others, of being as light as is compatible with due stability. But the most striking object exhibited by them is an object-glass of $\frac{1}{25}$th inch, certainly, so far as we are able to judge, the most marvellous production in its way we have ever met with. In clearness of definition and penetrating power it is admirable; and it has, farther, the remarkable advantage in a lens of such short focal distance, of allowing sufficient space between it and the covering glass. So far as object-glasses are concerned, this may not improperly, perhaps, be regarded as showing the greatest advance in the construction of very high powers, great as that advance generally has been, since the Exhibition of 1851.

Messrs. Smith and Beck exhibit a magnificent display of microscopes, all useful, and many of them admirable forms of instruments; but these have already been described, and are, moreover, too well known to demand special notice. They exhibit, it may briefly be said, three distinct classes of microscopes, comprising seven different forms of stand, each instrument differing not only in size, but in construction also. The greatest novelty exhibited by them, is what is termed a museum microscope, and which might also be named a monster microscope. This extraordinary instrument consists of a large brass cylinder, with a microscope body seated on it; and in the interior of the large cylinder are eight others, upon which are fixed, in all, 504 objects, each cylinder being devoted to a special class of objects. By simply turning a nut at one end of the outer cylinder, each of the objects in the series to which it belongs is successively brought into the field of view, whilst at the same time, its name appears on a small label. By very simple means the position of the internal cylinders can be changed; and thus, in succession, all the objects may, one after another, be brought into view. The object sought in the construction of this machine is to afford an easy means of exhibiting, to numerous persons, microscopic objects in museums, lecture-rooms, &c.; and it is constructed in such a substantial manner, and, at the same time, is so easy of employment, that it is not liable to injury by the uninformed observer, like a common microscope.

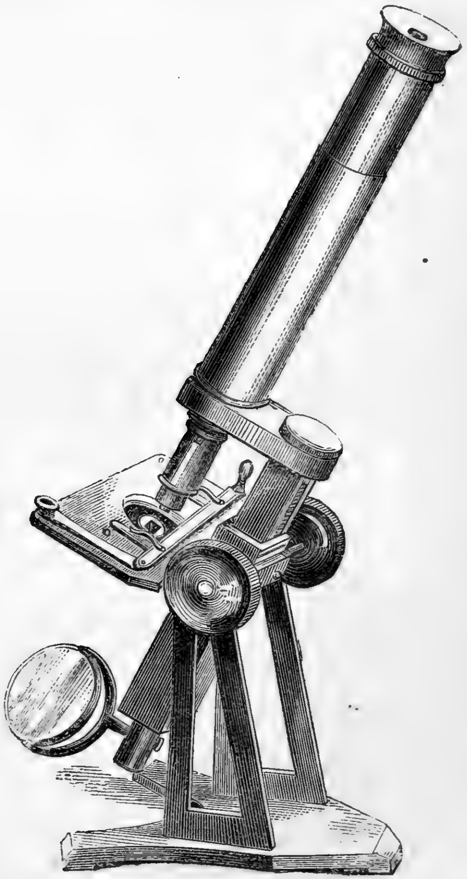
Among the minor novelties exhibited by Messrs. Smith and Beck, is an ingenious little apparatus for the support of objects under the simple microscope or when viewed as opaque objects in the compound, and by means of which any part of the object can be turned into view with the utmost ease.*

In the other stands we do not notice anything of striking novelty, though in all it is pleasing to remark the general excellence of workmanship, and ingenuity of contrivance. Mr. Baker has a good display of instruments of various kinds, and in one we notice a very neat mode of supporting three different objectives on a circular plate, a mode which seems more compact, at any rate, than that usually adopted by means of one or more arms.

But there is one feature more in which the present Exhibition shows a considerable advance over the former one, viz., in the numerous specimens of microscopes of a cheaper form than the splendid instruments we have above referred to. Nothing shows so strongly the increased popularity of microscopic pursuits than the earnest efforts made by almost every optician to produce an instrument capable, from its price, of being brought within the reach of the great mass of the people. Among the more conspicuous of those who have striven for this useful object, it is needless to refer again to Messrs. Smith

* A description of this useful little instrument is given in the 'Trans. Mic. Soc.' in the present number.

and Beck who have done so much in furnishing us with excellent instruments at a comparatively low price. A striking specimen of this kind is shown in the present Exhibition, in their so-termed Universal Microscope, which has been already described in this journal. Another form of instrument, which in our opinion appears to combine almost all that is desirable or that can be expected in an instrument of moderate price, is exhibited by Mr. Pillischer, of which, as somewhat of a novelty, we give a figure. This shows that the instrument is of a compact



and convenient form, and on inspection it will be found to be constructed with excellent finish. The stage movement is effected by means of an ingenious yet simple sort of jointed lever, which really in great measure supplies all that can be done with a moveable stage. But the most remarkable part of the instrument is the combination of object-glasses, three in number, from, we believe, an inch up to a quarter-inch, so constructed that when combined they constitute a really excellent quarter, whilst the simple removal of the end lens leaves a combination equal to a half-inch; and the removal of the second leaves the inch or lowest power. The only defect we have remarked in the working of these powers is in the middle or half-inch combination, which appears to require still some adjustment to render it as good as the other two, and which might probably be effected by shutting off some of its aperture after the removal of the quarter lens. The instrument is capable of being adjusted as a binocular, and on the whole may be regarded as a favorable specimen of the advance made in cheap, and at the same time good microscopes since 1851.

As we have before observed, several provincial opticians have eminently distinguished themselves on the present occasion, among whom may be named, Mr. Dancer, of Manchester, who exhibits a very good form of binocular microscope, with a refracting achromatic prism and symmetrical bodies. This is a very neat instrument to look at, and all its arrangements appear to be excellent; but with respect to its optical performance, as we have not had an opportunity of testing it, we are unable to express any opinion. We must also notice the microscopes exhibited by Parkes and Co. of Birmingham, who show an almost infinite variety of instruments, all well finished and well constructed, and at such extraordinarily low prices, that if their performance, even as stands merely, is at all commensurate with their appearance, they seem to us to be marvellously cheap. Among them we remark one with a magnetic stage, well deserving of notice, and especially note a simple and compound dissecting microscope, which appears a very useful form of instrument. Mr. Field whose cheap microscopes, it will be remembered, gained the recommendation of the Society of Arts, also appears in force. In the same department of popular instruments should also be noticed those exhibited by Mr. Highly, very neat and useful instruments, and well adapted for medical purposes. Nor can we pass over the ingenious portable microscopes shown by Dr. Beale, and in which simplicity of construction is combined with great utility and convenience as clinical instruments.

On the whole, English opticians may well be proud of the present Exhibition. In the foreign courts, we must say that we have seen nothing, in many respects, to compare with their productions; but as our observations on these have as yet been very superficial, we must reserve any remark they may require to a future opportunity.

Hints on the Mounting of Diatomaceæ.—It is a matter of importance to those who are interested in the study of the Diatomaceæ, their distribution and habitats, that they should be able to say, with some degree of certainty, that the specimens contained on a given slide contain no mixture, but really belong to the locality from which they are supposed to be taken. These forms of life are, however, so minute, that it is a matter of difficulty to wash either the test or dipping-tubes so thoroughly as to free them entirely from the diatoms remaining from previous examinations. The following plan has been found simple, successful, and much less troublesome than washing. Label the test- or dipping-tube with the name of the deposit under examination, and never use it for any other until it has been cleaned. To clean the tubes it is only necessary to boil a number of them in a strong solution of caustic potash, and then wash them in distilled water.—T. G. Stokes, M.A.

The Collection of Microscopic Objects in the Norfolk Fens.—I have received a number of applications for collections of microscopical productions in the undrained fens of Norfolk (see 'Journal' for April, No. vi, p. 117). The project has been taken up much better than I could have expected, and I now beg to thank all those gentlemen who have come forward to assist me in my plans. The objects will consist of Insecta, Characeæ, Algæ, Diatomaceæ, Desmidaceæ, &c., and dissections from the objects which so richly abound in the undrained fens and surrounding sea-coast. A list of the subscribers, with all the objects to be supplied, will be sent to each subscriber on the 1st of July; and another list of all the objects procured before the distribution in November, when all the objects will be equally divided among the subscribers, and each one's share sent to him about the 10th of November. The list is not quite complete. I shall be happy to answer any inquiry through the post on the subject. I have bred the fly which attacked the leaves of mangold-wurzel in the summer of 1861. There are two distinct species, and neither of them are the *Anthomyia betæ* of Curtis. The flies are in the hands of Mr. Walker, the Dipterologist, by whom they will be exhibited at the next meeting of the Entomological Society of London. They came out of the pupa-state, May 1st, and are still coming out. I shall be happy to send some for exhibition at the London Microscopical Society, or to any gentleman who may wish to see them.—WM. WINTER, Aldeby, near Beccles.

The Mangold-wurzel Fly.—I am sorry to announce the unwelcome news that this fly (*Anthomyia betæ*), which occasioned so much damage to the mangolds last year in several parts of the country, and which I described in the January number of the 'Microscopical Journal,' has again made its appearance, and that the crops are suffering very considerably. The *larvæ* attack the leaves of the plant earlier this year than last. As soon as the cotyledonous leaves are above ground, there may be found upon them the ova of this pest. We may anticipate very serious mischief, I am afraid, to the mangolds, for the above reason, but cannot be surprised, when it is remembered how exceedingly mild last winter was.

Beetroot in gardens—which is also attacked—may be saved by crushing the ova on the under surface of the leaves from time to time, but large fields of mangolds are out of the reach of so simple but effectual a cure.—W. HOUGHTON, Preston Rectory, Wellington, Salop.

PROCEEDINGS OF SOCIETIES.

Microscopical Society.

April 23rd, 1862.

The annual soirée was held at the rooms in King's College, when about 700 persons were present.

May 14th, 1862.

R. J. Farrants, President, in the Chair.

Septimus Ellis, Albany House, Old Kent Road; and Benjamin Williams, Esq., 11, Canonbury Park, were ballotted for and duly elected members of the Society.

The following papers were read:—"On a New Parasite found in the Heart of a Turtle," by Dr. Leared; "On Micro-Stereography," by Mr. James Smith; "On a Curious Discovery connected with a Nitrate Bath," by Dr. Maddox, communicated by Mr. Shadbolt.

June 11th, 1862.

R. J. Farrants, Esq., President, in the Chair.

E. Jaques, Esq., 5, Hargreave Terrace, Upper Holloway; F. H. Bowman, Esq., Halifax; J. W. Ward, Esq., Halifax; William Webb, Esq., 3, Eaton Grove; T. G. Rylands, Esq., Warrington; and Douglas Biggar, Esq., Dorking, were balloted for and duly elected members of the Society.

The following papers were read:—"On Fungous Destruction of Lozenges in a perfectly dry atmosphere," by F. M. Rimmington, Esq.; "On a Revolving Disc-holder for Opaque Objects," by R. Beck, Esq.; "On some new Species of Diatomaceæ," by J. Staunton, Esq., who also presented twelve slides illustrating the same.

The meetings were then adjourned until the second Wednesday in October.

PRESENTATIONS, ETC., TO THE MICROSCOPICAL SOCIETY, 1862.

January 8th.

	Presented by
The Proceedings of the Natural History Society of Montreal, Vol. VI, No. 5 . . .	The Society.
Recreative Science, No. 30 . . .	The Editor.
Canadian Journal of Industry, Science, and Art, No. 36 .	Ditto.
Photographic Journal, No. 116 . . .	Ditto.
London Review, Nos. 78 to 80 . . .	Ditto.
Annals and Magazine of Natural History, No. 49 .	Purchased.
Das Mikroskop, von A. Hannover, 1854 . .	Ditto.
Die Süsswasser Diatomaceen, von Dr. L. Rabenhorst, 1853	Ditto.

February 12th.

Popular Science Review, Nos. 1 and 2 . .	Publisher.
Quarterly Geological Journal, No. 69 . .	The Society.
Intellectual Observer, No. 1 . . .	The Editor.
Transactions of the Tyneside Naturalists' Field Club, Vol. V, part 2 . . .	The Society.
Photographic Journal, No. 117 . . .	The Editor.
London Review, Nos. 82 and 83 . . .	Ditto.
Annals and Magazine of Natural History, No. 50 .	Purchased.
J. Du Mesnil-Marigny on the Free-Trade Question .	The Author.
Beitrag zur Bestimmung des stationären Mikroskopischen Lebens. C. G. Ehrenberg, 1859 . .	F. C. S. Roper.
Two Slides: Calcareous Plates in Tentacles of Synapta, and Skin of Synapta	J. Hilton.

March 12th.

Intellectual Observer, No. 2 . . .	The Editor.
Journal of Linnean Society, Vol. VI, No. 22 . .	The Society.
Journal of Photography, Nos. 157 to 161 . .	The Editor.
London Review, Nos. 85 to 88 . . .	Ditto.
Annals and Magazine of Natural History, No. 51 .	Purchased.
Seven Slides of Scales of Insects . . .	R. Beck.

May 14th.

The Intellectual Observer, Nos. 3 and 4 . .	The Editor.
The Canadian Journal of Science and Art, No. 37 .	Purchased.
The Popular Science Review, No. 3 . .	Ditto
The Journal of the Geological Society, No. 70 .	The Society.
Proceedings of the Academy of Natural Sciences of Philadelphia	Ditto.
Transactions of the Linnean Society, Vol. XXIII, part 2	Ditto.
Bulletin des Séances de la classe des Sciences, 1861 .	Ditto.
The Annals and Magazine of Natural History, Nos. 52 and 53	Purchased.
Bust in Plaster of the late Andrew Ross, Esq. .	T. Ross. Esq.

June 11th.

	Presented by
The Intellectual Observer, No. 5 . . .	The Editor.
London Review, No. 95 to 100 . . .	Ditto.
Journal of Photography, Nos. 164 and 167 . .	Ditto.
Photographic Journal, No. 121 . . .	Ditto.
Canadian Journal of Science and Art, No 38 . .	Ditto.
Journal of the Proceedings of the Linnean Society, No. 23	The Society.
Proceedings of the Boston Natural History Society, 1862	Ditto.
Annals and Magazine of Natural History, No. 54 .	Purchased.

THE FOLLOWING WORKS WERE PURCHASED AT THE SALE OF THE EFFECTS OF THE LATE PROFESSOR JOHN QUEKETT, F.R.S., &c. &c.:

ADAMS (George) An Essay on Vision. 8vo, London, 1789
——————Micrographia illustrata. Second edition folio, London, 1747
BELL (Sir Chas.) An Account of Sir Charles Bell's Discoveries in the Nervous System. Edited by A. Shaw. 8vo, London, 1860
BOUCHER (C. F.) Recherches sur la Structure des Organes de l'Homme et des Animaux. 8vo, Paris, 1848
BOWMAN (Wm.) Lectures on the Eye. 8vo, London, 1849
BREWSTER (Sir David) The Kaleidoscope; its History, Theory, and Construction. 8vo, London, 1858
BRIGHTWELL (Thos.) Sketch of a Fauna Infusoria of East Norfolk. 8vo, Norwich, 1848
BROCKLESBY (John) Views of the Microscopic World. 8vo, New York, 1851
BURGGRAEVE (A.) Anatomie de Textures, ou Histologie. 8vo, Ghent, 1845
CODDINGTON (H.) An Elementary Treatise on Optics. Second edition 8vo, Cambridge, 1845
CUNO (C. C.) Observationes microscopicæ. folio, Augsburg, 1784
DALYELL (J. G.) On the Planariæ. 8vo, Edinburgh, 1814
DICK (Dr. Thos.) The Telescope and Microscope. 8vo, ——
DILLWYN (L. W.) British Confervæ. 4to, London, 1809
DUJARDIN (F.) Manuel de l'Observateur au Microscope et Atlas. duo., Paris, 1843
GILL (T.) Technological Repository. 8vo, London, 1827-30
GLEICHEN (Baron G. F. de) Observations microscopiques. folio, Nuremberg, 1763
GOODSIR (J.) Anatomical and Pathological Observations. 8vo, Edinburgh, 1845
GREENDELIUS (J. F.) Micrographia Nova. folio, Vienna, 1687
GREW (Dr. N.) Anatomy of Vegetables. 8vo, London, 1672
HANNOVER (A.) Om Mikroskopets bygning. 8vo, Copenhagen, 1847
——————Recherches Microscopiques sur le systeme nerveux. 4to, Copenhagen, 1844
JOBLOT (J.) Observations d'Histoire naturelle faites avec le Microscope. folio, Paris, 1754
KITCHENER (Dr. Wm.) The Economy of the Eyes. Second edition 8vo, 1825-6
KÖLLIKER (Dr. A.) Mikroskopische Anatomie. 8vo, Leipsig, 1850
LEREBOURS (N. P.) Instruction pratique sur le Microscope. Third edition 8vo, Paris, 1846

LANGER, HYRTL, and WEDL. Anatomie. folio, Vienna, 1849
LECOUNT (P.) Experiments on the Polarization and Inflection of Light. 8vo, London, 1841
LEEUWENHOEK (Ant.) Opera Omnia. 4to, 1695-1719
——— ——— Arcana Naturæ. 4to, 1722
LEDERMULLER, (M. F.) Mikroskopische Gemüths, &c. folio, Nuremberg, 1736
——— ——— Essai d'employer les Instruments microscopiques dans la saison du printemps. folio, Nuremberg, 1764
MALPIGHI (M.) Opera Posthuma. folio, Vemer, 1698
MOHL (H. von) Mikrographia. 8vo, Tubingen, 1846
MURRAY (J.) Natural History of the Silk Worm. Second edition 8vo, London, 1838
NEEDHAM (T.) Nouvelles Decouvertes faites avec le Microscope. 8vo, Leyden, 1747
PAGET (J.) Report on the chief results obtained by the use of the Microscope in Anatomy and Physiology. 8vo, London, 1842
Pamphlets, Microscopic, 35 vols.
PEASLEE (C. W.) Human Histology. 8vo, Philadelphia, 1857
PHILLIPS (Sir R.) The Wonders of the Microscope.
POWER (H.) Experimental Philosophy, with Observations by the Microscope 4to, London, 1663
PRITCHARD (A.) The Microscopic Cabinet. 8vo, London, 1832
——— ——— Physiology of Plants. 8vo, London, 1833
——— ——— Physiology of Vegetable Life (Sketches of) 8vo, London, 1811
QUEKETT (Prof. J.) Practisches Handbuch der Mikroskopie und Atlas. 8vo, Weimar, 1850
RASPAIL (M.) Essai de Chimie microscopique. 8vo, Paris, 1847
RAY (S.) The Wisdom of God manifested in the Works of the Creation. Sixth edition 8vo, London, 1714
RICHARD (A.) Nouveaux Elemens de Botanique. 8vo, Paris, 1833
ROBIN (Charles) Des vegetaux qui croissent sur l'Homme et sur les Animaux. 8vo, Paris, 1847
——— ——— Du Microscope et des Injections. 8vo, Paris, 1849
SCHACHT (H.) Das Mikroskop. 8vo, Berlin, 1851
SCHOTTE (P. G.) Magia universalis naturæ et artis. folio, 1677
SIDNEY (E.) Blights of Wheat and their Remedies. 8vo, 1846
THOMNI (M.) Traité d'Optique mechanique. 8vo, Paris, 1749
TURNER (Dawson) Muscologia Hibernica. 8vo, London, 1804
VALENTINI (M. B.) Amphitheatrum Zootomicum. folio, Frankfort, 1720
WAGNER (R.) Elements of Physiology, parts 1 and 2 8vo, London, 1841
WATKINS (F.) L'exercise du Microscope. 12mo, London, 1754
WARD (S. H.) On Wardian Cases for Plants and their Application. 8vo, London, 1854
WILSON (E.) On Diseases of the Skin. 12mo, London, 1849

W. G, SEARSON, *Curator.*

Manchester Literary and Philosophical Society.

MICROSCOPICAL SECTION.

March 17th, 1862.

E. W. Binney, Esq., F.R.S., F.G.S., in the Chair.

Twelve specimens of soundings were received from Captain George Randall, of the barque "Brazil," taken on the north coast of Brazil; also five specimens from Captain George Murray, of the ship "Finzel," taken off Robin Island, Table Bay; coasts of Sumatra, Java, and St. Helena.

Mr. H. A. Hurst made a donation of eight slides of diatomaceæ of various kinds; also specimens of fibre from the Bombax, or East Indian cotton tree, and the fibre of the *Asclepias Syriacus*, from Bengal. Some conversation arose upon the adaptation of these fibres as substitutes for cotton, but, although fine and silky, there is not sufficient strength in the staple to render them fit for manufacturing purposes.

Mr. Blandford presented, through Mr. Hurst, a number of specimens of the tongues of mollusca from Burmah, upon which Dr. Thomas Alcock reported that there were four species, two being fresh-water—*Melania variabilis;* a species of Paludomus; and two land shells, different species of Cyclophorus.

Cyclophorus belongs to a section of the order Pulmonata, distinguished by having an operculum or door to the mouth of the shell, and by having a type of teeth similar to that of the Pectinibranchiata. *Cyclostoma elegans* is a British representative of the same group.

Mr. Cheetham exhibited a prism, which he uses to illuminate objects under the microscope with the variously coloured lights of the spectrum in succession, instead of ordinary light. He finds that details of structure are more distinctly brought out by some of the colours than others; the blue and green rays are also very pleasant to work with, and easily varied by throwing the required part of the spectrum on the mirror below the stage.

Mr. Sidebotham brought before the notice of the meeting Mr. Petschler's process for producing vegetable forms with crystals of bichromate of potash in gelatine, which was discovered by him in the preparation of glass plates for photographical purposes, and exhibited at the microscopical soirée given to the British Association at the last meeting. Specimens on large glass plates were handed round, which, when magnified, aptly represent mosses, ferns, and algæ, in beautiful ramifications, which vary in many ways, dependent upon the strength of the solution, temperature, state of the atmosphere, and other causes. Mr.

Sidebotham called especial attention to the peculiarity of the form of crystallization, and to the fact that an inorganic salt, in contact with organic matter, should produce vegetable forms.

The Secretary then read a paper by Mr. Petschler, describing the plates and the process.

Glass plates, Nos. 1, 2, and 3, were coated with collodion, on the surface of which a hot mixture of gelatine and bichromate of potash had been poured, then allowed to cool and to dry spontaneously. In a few hours the crystals began to form and ramify themselves over the plate. The mixture was composed of three parts of gelatine and water twenty grains to the ounce, to one part of a saturated solution of bichromate of potash.

Plate No. 4, the same mixture spread hot without collodion. On a corner of the plate the crystals have been dissolved out with water, showing skeleton traces in the gelatine left behind.

Plate No. 5 is covered with collodion and a solution of bichromate without gelatine.

Plate No. 6 was first covered with the mixture and then with glycerine, but no crystallization took place. It was then dried with strong heat, gelatine and bichromate poured over hot, and then allowed to crystallize.

Plate No. 7 prepared as No. 4, with gelatine and bichromate without collodion. After the crystals were formed, the plate was dipped into a solution of nitrate of silver, which changed the salt into the red chromate of silver, insoluble in water, but soluble in hyposulphite of soda, ammonia, &c. In one corner the crystals were dissolved out, leaving their casts in the gelatine.

Plate No. 8 was prepared as 1, 2, and 3, by collodion and the mixture, and after the formation of the crystals changed into red chromate of silver as No. 7.

Plate No. 9 prepared as No. 6, with glycerine, dried with great heat, then coated with the mixture and treated with nitrate of silver as No. 7.

The great variety and beauty of these forms of crystals could with difficulty be represented by drawings.

The author believes that no chemical combination takes place between the salt and the gelatine, but that the latter acts simply as a medium. The gelatine, when firm, retains a certain quantity of moisture, which is favourable to crystallization; but when the moisture is driven off by heat the crystallization is suspended.

In the course of the conversation which ensued, the Chairman referred to the ramified form in which the salts of some metals were found naturally, in agate, slate, and even trap rock, where the oxide of manganese was frequently found to have assumed similar forms.

Mr. Mosley suggested that the arborescent forms might perhaps arise from the tenuity of the solution, from the resistance of the gelatine to allow of crystallization in the usual rhombic form, and possibly to the subtle electrical or galvanic action supposed to be excited during crystallization. Some years ago he had obtained from solution of bichromate of potash, tree-like forms, with spreading branches and pendant rhomboids, which under the polariscope appeared like a tree with gems of rich colours for fruit.

Mr. Mosley exhibited an edition of Baker's work "On the Microscope" (London, 1785), with many engravings of vegetable forms in crystals of manna, salts of antimony, copper, &c.

Mr. Brothers exhibited a drawing of a small animal he found leaping on the surface of the water in his aquarium, supposed to be identical with the species of Podura found last year by Mr. Lynde.

April 27th, 1862.

E. W. Binney, F.R.S., F.G.S., in the Chair.

Contributions were acknowledged from Captain James Clarke, of the ship "Lightning," consisting of a specimen of mud, from Hobson's Bay, Australia; a specimen of *Fucus natans*, or gulf weed, from the Sargasso Sea, and sand, &c., from a sounding off the south coast of Ireland. Captain Contente, of the Portuguese steamer "Lusitania," forwarded a sounding taken between Cape Carvoëiro and the Berling Islands, off the coast of Portugal.

Professor Calvert presented to the members of the Section a number of bottles containing carbolic acid in crystals, for the purpose of experimenting upon its utility as a preservative fluid for microscopical objects, as well as for specimens of natural history. Carbolic acid, or hydrate of oxide of phenyle is the pure creosote from coal-tar; the deliquescent crystals are soluble in water to the extent of only two per cent, and any excess will remain as a heavy oil at the bottom of the water.

The antiseptic qualities of this substance are, however, so powerful, that the above solution in water, used in place of spirits of wine, glycerine, &c., is sufficient to preserve organic substances from decay. It has the property of coagulating albumen, which may render it unsuitable for certain anatomical preparations, but, for many purposes, it will no doubt prove to be of much value to naturalists and microscopists.

Mr. Thomas D. Toase, of Jamaica, presented through Professor Calvert, specimens of Diatomaceæ, from Kingston Harbour; pollen of a West Indian lily; a portion of a plantain leaf, with two mounted slides of the same, showing cells, raphides, &c. Mr. Toase also sent drawings and description of a Rotifer, found upon Conferva, at Jamaica, which was not known to any of the members present. It consists of an oval body or outer case of a brownish colour, $\frac{5}{1000}$ths of an inch in length; from *near one end* of the oval is protruded a transparent neck or contractile body, furnished, when protruded, with four hairs or feelers, a lip, and a kind of operculum, around which Mr. Toase recognised the presence of cilia by the current of water, but he failed to discover the cilia for want of defining power in his microscope. There is not sufficient detail either in the description or the drawings to be of much use to the microscopist, but further information has been written for.

Mr. Brothers presented to the Section photographs of the four drawings by Dr. Alcock, illustrating his paper "On the Tongues of the Mollusca."

Mr. Sidebotham exhibited a drawing of an undescribed species of Zygnema, found by Mr. Watson and himself, at Southport, in brackish water. It exhibited no appearance of conjugation, and the spores were like balls covered with spines, which when released from the cells move rapidly through the water like Volvox.

Mr. Mosley reported upon the specimen of the outer coating of a bulb, received through Dr. Fairbairn from Mr. Niven, of Jeffrey's Bay, Cape of Good Hope.

On examination with the microscope, he found that the leaf is about $\frac{1}{100}$th of an inch in thickness; that between the outer and the inner cuticle a number of tubes or vessels run longitudinally through the structure of the leaf; and that these tubes are composed of very delicate fibres, coiled up so as to form spiral vessels. On breaking the leaf, the fibres may be uncoiled and drawn out to an almost indefinite extent. From the thicker middle portion Mr. Mosley had drawn out fibres to the extent of 18 to 20 inches without breaking; they are beautifully fine, but are in his opinion too weak and delicate, as well as too long, to be used as a substitute for cotton. He considers it possible some application may be found for the fibre if a sufficient sample were sent for experimental trials. Desirous of knowing the botanical history of the plant, he wrote to Sir W. J. Hooker, director of the Royal Gardens at Kew; but it was not possible to classify the plant with certainty from a specimen so imperfect. Sir William observed that in all probability it is one of the Amaryllidaceæ, and possibly of the genus Buphane.

Mr. Mosley also exhibited the leaf of a species of Digitalis, brought by Mr. Hurst from the Hazaree-bagh, Bengal, upon the surface of which the poison glands are closely set in groups of four glands, placed in a lozenge form.

Mr. Nevill exhibited a new form of microscope, by Matthews, of London, for field use or class instruction, which can be used with either transmitted or reflected light.

Mr. Nevill proposed that the subject for discussion at the next meeting should be, "On the Motion of the Naviculæ," which was agreed to.

Hull Micro-Philosophical Society.

The sessional course of bi-monthly meetings, held at the Royal Institute, terminated on March 21st last ; the various papers usually occupying about fifteen to twenty minutes in delivery, followed by the exhibition of slides and preparations in illustration, aad also by discussion, were of an interesting and advancing scientific description. Attendances were generally good, and a pleasing feature to observe is the zeal and assiduity with which non-professional members prosecute research.

The president, George Norman Esq., on the *questio vexata* of the markings upon Diatomaceæ, as to their being elevations or depressions, after duly considering the cellular or areolar theory, assigned reasons for his arriving at the conclusion—derived from the exhibition of Coscinodiscus, Triceratium, Aulacodiscus, &c. &c. —that such structures, though at first view appearing cellular, yet after more careful study and examination, are evidently granular, the granules being in some species isolated and round, in others more closely crowded and compressed, causing an appearance of hexagonal cellulation.

The president was well aware of opposite views being entertained and promulgated by experienced microscopists, yet did not despair eventually of gaining many recruits to the granular theory, trusting that the members generally would prosecute this interesting branch of enquiry in natural history.

Mr. Hunter delivered two excellent papers on the structure of bone and teeth, illustrated by a number of well-mounted preparations of the bones of various mammals, birds, reptiles, and fish, both recent and fossil, &c. &c.

Dr. Kelbourne King delivered an interesting theme, with illustrations, on nervous matter, exhibiting the corpuscles and tubuli of the various parts of the brain and spinal cord, chiefly from the fresh subject, as also a variety of splendidly mounted slides.

Mr. Stather gave an article on the Italian bee, in comparison with the common honey and wild bees, with a variety of mounted specimens.

Mr. H. Prescott submitted an able paper on tobacco and its adulterations in commerce, which included a sketch of vegetable tissues generally, and the ordinary structure of the stems and leaves of plants, particularly the peculiar form and character of the minute hairs usually found thereupon. The specimens selected in illustration were from rhubarb, foxglove, dock, burdock, and coltsfoot.

The views of Mr. Hendry on *Navicula rhomboides* have already appeared in the pages of this journal. Another paper was also introduced by Mr. Hendry on Prussic acid, with the exhibition of the action of the usual tests—that of Prussian blue under the microscope (1-inch objective), the volatilization of cyanide of mercury from the ordinary glass slide into the thin glass cover (a method which Mr. Hendry also employs for arsenic, &c.), and the NOVEL exhibition of hexagonal crystals, derived by the spontaneous evaporation of the blood-red compound of sulpho-cyanide of iron, arrested at a given period.

Mr. Ball of Brigg, read an article on the tongues of the Gasteropoda, illustrated by numerouse home-mounted slides of considerable interest, value, and beauty. The position and general structure of the "so-called tongue," was demonstrated from an examination of the common snail; the different purposes it serves, and its utility in classification, were duly treated upon; also the method employed in the preparation and mounting, &c. &c.

The papers also of Mr. Harrison on Acari; Mr. Sleight, Dr. M'Millan, and others, contributed largely to the interest of the session; and during the summer months several rural excursions were in contemplation.

The Microscopical Society of Newcastle-on-Tyne.

This Society, which was established at the conclusion of a series of meetings connected with a microscopical class formed for mutual improvement, entered upon its third year in February last. During the past year, meetings either out-door or in-door have been held fortnightly, and various interesting papers have been read, and addresses delivered; the out-door meetings consisted of excursions to the sea-side and the country, on which occasions the members, provided with requisites for making microscopic gatherings, obtained such objects of interest as the various localities afforded.

At its regular in-door meetings, besides practical discussions on various subjects connected with the microscope and the exhibition of many valuable microscopic objects, the following papers were read by the members:

Mr. John Brown, "On the Structure of the Microscope and the modes of using its various Appliances."

Mr. T. P. Barkas, "On Objects of Microscopic Interest to be found on the Sea-coast."

Dr. Donkin, "On the Binocular Microscope."

Mr. B. Proctor, "On Binocular Vision, and the Binocular Microscope."

Mr. John Martin, "On how to make a Binocular Microscope."

Mr. B. Proctor, "On the Advantages and Defects of the Binocular Microscope."

Mr. John Brown, "On Petals of Flowers."

Mr. T. P. Barkas, "On Fresh-water and Marine Aquaria, and their Microscopic Inhabitants."

Mr. John Brown, "On Aphides."

Several valuable works have during the year been added to the library of the Society, and the members are indebted to the President of the London Microscopical Society, to Andrew Pritchard, Esq., and others, for presents of several valuable slides.

The members and their friends held a microscopical soirée, in the Royal Assembly Rooms, Grainger Street, on Tuesday evening, May 6th.

There was a tolerably numerous and highly respectable attendance, upwards of forty excellent microscopes were exhibited, and nearly every object of popular microscopic interest was presented to the view of the visitors.

Mr. H. B. Brady, during the evening, delivered an excellent address "On Flowers and their Microscopical Teachings."

The following is a list of the objects exhibited and the names of the exhibitors:

Atlantic Soundings, containing Foraminifera (1070 fathoms) . . .	Dr. Legat.
Fossil Teeth of Ichthyosaurus, Plesiosaurus, &c.	Mr. Geo. Lyall.
Colletonema, Schizonema, &c. (Diatomaceæ) (Binocular) . . .	Mr. John Martin.
Spine of Echinus, and Spicula of Synapta	Mr. J. W. Lawson.
Crystals under Polarized Light, and Photographs	Mr. Thos. Oates.
Desmidiaceæ and Marine Polyzoa .	Mr. Joseph Davison.
Volvox globator, Circulation of Sap in Vallisneria, and Amœba . . .	Mr. T. P. Barkas.
Rotifera with Dark Ground Illumination (Binocular)	Dr. Armstrong.
Physiological and Pathological Specimens of Tissues	Dr. C. J. Gibb.
Circulation of Blood in Tail of Stickelback, and Foot of Frog . . .	Mr. W. Lyall.
Pond Life, including Vorticella, Daphnia, Cyclops, &c.	Mr. John Brown.
Saw of Saw-fly, and Palate of Whelk .	Mr. Geo. D. Robson.
Linen, Cotton, Silk, &c., under Polarized Light	Mr. B. S. Proctor.
Pollen of Flowers, and Wood Sections .	Mr. John Reed.
Fructification of Ferns, and Vegetable Tissues (Binocular) . . .	Mr. C. Bass.
Volvox globator, and Various Hairs .	Mr. Smith.
Various Objects	Mr. T. B. Winter.
Diatomaceæ from Shells of Deep Sea Mollusca	Mr. D. H. Goddard.
Crystallization of Salts under Polarized Light	Mr. M. Watson.

Aquatic Larva, Floscularia, &c.	Mr. James Davidson.
Marine Infusoria, and Cilia on Fan of Amphitrite	Mr. G. Hall.
Wood Sections and Algæ	Dr. Stokoe.
Miscellaneous Objects (Binocular)	Dr. Donkin.
Micro-Photographs and Insect Preparations	Mr. John Cail.
Cilia of Mussel and Filamentous Diatoms	Dr. Kennedy.
Sections of Coal, and Carboniferous Fossils	Dr. Frain.
Crystalline Lens of the Eye of a Codfish	Mr. Jos. L. Thompson.
Circulation of Blood, Human Blood Discs, &c.	Mr. Harkus.
Tongues of various Mollusca	Mr. Jos. Wright.
Anatomical Injections and Micro-Photographs	Mr. John Mawson.
Wings of Butterflies (Binocular)	Mr. Mennell.
Wings of Moths (Binocular)	Mr. H. B. Brady.
Phytozoa and Protozoa	Mr. W. T. Carr.
Spiracles, and Antennæ of Flies, &c.	Mr. John Stokoe.
Diatomaceous Earth from Richmond	Dr. Bruce.
Marine Zoophytes, and Balani	Mr. Dunn.
Nuggets of Gold, Quartz, and Gold Dust	Mr. Geo. Dodds.
Fossil Remains, from Irish Peat Bogs, &c.	Mr. Gilbert Robertson.
Vegetable Tissues, by Polarized Light	Capt. Noble.
Marine Polyzoa	Mr. Dees.
Injected Lung of Frog, &c.	Mr. Ellis.
Living Entomostraca	Mr. William Robson.
Anatomical Preparations	Mr. Murray.
Perspiratory Glands, &c.	Dr. Dawson.

A very useful glossary of terms for the use of the unscientific visitor, was published by the committee.

The members of the society have resolved to divide themselves into sections, for the purpose of devoting their attention to special branches of microscopic study. The following circular, a copy of which has been sent to each member, will more fully explain the design in view. Much interest is now being manifested in microscopic pursuits in the district, and branch societies are being formed in remote village districts. The colliery village of Cramlington may be instanced as an illustration.

"The Microscopical Society of Newcastle-upon-Tyne.

"Dear Sir,—With the view of promoting original investigation and systematic co-operation among our members, the committee have determined upon dividing the Society into the following sections:

"*Medical Section*—Comprising those departments of Anatomy, Physiology, Pathology, &c., which require the microscope for their elucidation.

"*Zoological Section*—Comprising similar departments in the study of the lower animals.

"*Botanical Section*—Devoted to the Microscopical departments of Vegetable Anatomy and Physiology.

"*Inorganic Section*—In which the Microscope is applied to the study of unorganised bodies, and of Chemical and Physical Phenomena.

"*Technological Section*—Including such applications of the Microscope to the Arts, Manufactures, and Commerce, as do not strictly belong to any of the previous sections.

"*Mechanical Section*—Devoted to Microscopical apparatus, manipulation, &c.

"The sections will be subdivided according to the replies received to this circular; for example, the Natural History section will have subdivisions for Insects, Infusoria, &c.; the Botanical will have subdivisions for Algæ, Diatomaceæ, &c., so that any class of objects broadly isolated as microscopical studies will form subsections.

"Subjects upon which further information is desirable will be referred to these several sections for elaboration.

"It is perhaps needless to remind our Members that satisfactory progress can only be made when each individual pays special attention to a special department.

"You will oblige by informing the Secretary to which division or subdivision of Microscopical Science you are willing more particularly to devote yourself.

"I am, yours truly,

"T. P. BARKAS, *Hon. Sec.*

"A Microscopical Museum is in process of formation; the Committee will gladly receive any duplicate specimens you may have at your disposal. As interchange of objects will form one feature in the working of the Museum, several specimens of an object will be acceptable."

ORIGINAL COMMUNICATIONS.

OBSERVATIONS *on* BRITISH PROTOZOA. By T. STRETHILL WRIGHT, M.D., F.R.C.P.E.

ZOOTEIREA RELIGATA (Pls. VIII and IX).

I FORMERLY described *Zooteirea** as found on oyster shells dredged from deep water in the Firth of Forth, near Edinburgh. Although the animals are not common, yet we occasionally meet with a shell completely covered with a dense forest of them, each consisting of a clear, glassy stalk, surmounted by a silvery star; and it is difficult to imagine a more gorgeous microscopic display than such an assemblage affords, especially when illuminated by oblique sunlight of various colours under low powers.

Zooteirea is an Actinophrys mounted on a contractile pedicle, and consists of two parts—the body, or star-like head, and its supporting stalk.

The body, like that of Actinophrys, is formed of two very distinct tissues, to which I have given the terms *ectosarc* and *endosarc,* terms since adopted by Dr. Carpenter in his recent learned work on the Foraminifera.† The ectosarc, or external layer, is a transparent "sarcode," possessing some amount of opalescence, being of a blueish-white when seen by reflected light and tinged with the complementary pale yellowish-brown by transmitted light. This colour is probably the result of interference, and due to molecular matter disseminated through the clear sarcode. The whole of the ectoderm is capable of being produced into a thick, radiating brush, of most delicate contractile "palpocils,"‡ like threads of spun glass, which

* 'Edin. New Phil. Journal,' July, 1859.

† 'Introduction to the Study of the Foraminifera,' p. 14.

‡ I have used the word "palpocil" for the motionless prehensile cilia which are found extensively on the bodies of many of the lower animals, such as the Hydroida, Acalephæ, and Annelida, very frequently associated with thread-cells.

become so attenuated at their extremities that, like the finest "pseudopodia" of the Rhizopoda, they can only be brought out by the most careful "black-ground" illumination. The animal remains for days with its palpocils sometimes stiffly extended, at other times slightly relaxed and yielding in gentle curvatures to the currents in the water, and again, at other times, all thickened or clubbed at their extremities. When any small animalcule comes in contact with a palpocil it is instantly taken prisoner, and the appendage recoils inwards with its prey to the body of the *Zooteirea* like a released thread of caoutchouc. In this way the whole of the body is sometimes studded with captured animalcules, over which a film of ectosarc slowly creeps and ingulfs them.

The endosarc consists of exceedingly dense granular sarcode, of a deep-brown colour by transmitted, and silvery white by reflected light. This tissue is more completely and sharply differentiated from the ectosarc in *Zooteirea* than in any other of the Actinophryans, and appears as a smooth sphere through its more transparent outer covering. I have not been able to discover in it the existence of a nucleus.

I formerly stated that the stalk was formed of a prolongation of the ectosarc similar to those of the palpocils, but I afterwards found that its tissue had a much greater refractive power, and an examination of an individual in which the appendage had accidentally imbibed, and was distended by water, showed that the stalk consisted of a tube traversed along its axis by a dense muscular band, which was studded with several (nucleolar?) protuberances, and surrounded by a network of soft (areolar) fibres. After very careful and frequent examination of the muscle, I discovered traces of a canal occupying its whole length, and on one occasion observed a slow flow of fluid and irregularly shaped globules, like that which takes place in the large pseudopodia of *Gromia*. The foot of the stalk was found to be buried in a flocculent mass of jelly, often containing great numbers of diatoms and minute algæ, and into this gelatinous tube the whole animal was capable of retiring.

Freya obstetrica and *Freya stylifer*, n. sp., T. S. W. (Pl. IX).—Several species of a genus of Protozoa were described by me several years ago under the generic title of Lagotia. It appeared, however, that Claparède and Lachmann had already constituted the genus *Freya* for animals evidently belonging to my genus *Lagotia*, in a memoir which they had communicated to the French Academy, which memoir, however, was not published until after the publication of my paper constituting the genus *Lagotia*. The species of *Freya* discovered by Claparède and Lachmann* differ from any of those at present found on our coast, and I have now to notice two other species of this genus, so remarkable for the peculiar hippocrepian shape of its members and the cells which they inhabit.

Freya obstetrica.—"Lobes of rotatory apparatus very broad, not folded, the tips bluntly rounded and incurved, so as to resemble the blades of the obstetric forceps. Body fusiform, scarcely longer than the rotatory lobes. Nucleus large, colourless, surrounded by dense, blackish-green pigments. Body and rotatory lobes covered with coarse, longitudinal striæ, carrying fringes of cilia. Cell flask-shaped, without a trumpet-shaped mouth. Colour of animal and cell, pale bluish-green."

Found on oyster shells from deep water in the Firth of Forth.

Freya stylifer.—" Rotatory lobes short, narrow, and widely expanded, one of the lobes bearing at its tip a fleshy prolongation or style as long as the lobe. Cell tubular, without trumpet-shaped mouth; cell and animal colourless."

Freya stylifer is the smallest species I have yet seen of the genus to which it belongs. When contracted within its cell it projects the curious style, probably a sense-organ, beyond the opening, only entirely retracting it when rudely disturbed. The lower part of the cell was not seen.

Freya producta, T. S. W. (Pl. IX).—During the summer of 1861 I had an opportunity of watching this animal as it constructed its remarkable cell. The cell of this species is furnished with an immensely prolonged neck, formed of a ribbon of chitine spirally wound into a tube, cemented by a thick, internal, gelatinous layer, from which it derives its green colour, and covered by a thin layer of that peculiar glutinous secretion which is used by various classes of aquatic animals to attach themselves and their habitations to the sites where they dwell.† The tube thus forms a hollow spring, like the spiral tubes formerly used for conveying gas to moveable burners, and will bend aside like a willow twig on any rude contact from the numerous animals which are constantly dashing about.

The young *Freya producta,* which is a free-swimming larva, fixes itself and secretes the lower part or flask of the cell from the surface of its body; it then begins to build up the neck, by depositing its materials on the upper edge of the con-

* 'Études sur les Infusoires et les Rhizopodes.' Livraison i, p. 220.

† I have elsewhere named this substance as it exists on the hard coverings of the Hydroid zoophytes "colletoderm" or "gluing coat," for the secretion itself I propose the term " colline."

stantly lengthening ribbon, carefully moulding the plastic matter with its two immature rotatory lobes, which it uses as a pair of hands, just as Sabella and Serpula mould their tubes with their secreting leaflets. Having erected its tube to the requisite height, it finishes it off with a handsome trumpet-shaped mouth, and then retires to develop its long, rotatory lobes. Occasionally the animal outgrows its dwelling-place, and finds it necessary to lengthen its tube. For this purpose a large quantity of dark-green matter is collected in the body a little below the rotatory lobes, and from this part material is secreted, which is instantly moulded into shape by the lobes, and a new spiral tube arises from within the trumpet-shaped mouth of the old one.

Chætospira maritima, n. sp., T. S.W.—Two species of *Chætospira* have been noted by Lachmann, *C. Muelleri* and *C. mucicola*,* both inhabitants of fresh water near Berlin. *Chætospira* is defined as a *Stentor*, in which the ciliary spiral and the parenchyma of the body supporting it are drawn out into a long, thin process. When the animal issues from its tube it protrudes the ciliary organ as a fleshy column, fringed along one side by a row of long, motionless cilia, but in an instant the column is twisted into a spiral, round which the ciliary wreath twines, and the cilia are set in violent motion, urging currents of water towards the mouth. *C. maritima* approaches in character, as to the number of spires in its rotatory organ, to *C. Muelleri*, while it inhabits a tube of "colline" like that of *C. mucicola*. Found at low water, Largo.

Oxytricha longi-caudata, n. sp., T. S. W. (Pl. IX.).—This remarkable animal, resembling very much *Oxytricha retractilis*, described by Claparède and Lachmann,† was found in great numbers in the sea at Largo, Fifeshire. The tail in this species is fully twice as long as that of *Oxytricha retractilis*, and is dragged after the swimming animal like a trailing rope, when suddenly it is fixed by the long cilia at its extremity, and the *Oxytricha*, by violent contractions of its tail, jerks itself on all sides in the most violent manner. The structure of the tail, under an excellent power of eighty diameters, presented a peculiar streaked or plaited appearance, like that of voluntary muscular fibre, but the incessant movements of the animal prevented my obtaining a satisfactory examination of it under higher powers.

Ophryodendron abietinum.—Since the publication of my paper on *O. abietinum* occurred in this Journal, I have

* Müller's 'Archiv,' 1856, p. 362.

† Op. cit., p. 148.

received the last published part of Claparède and Lachmann's work,* and find that my *Ophryodendron* is altogether a different species from that described by those authors, although their former specific description† applies to both. It will, therefore, be necessary to describe the genus and species more distinctly, which I propose to do as follows:

Ophryodendron, Claparède and Lachmann.—Generic description:—"Body attached to *Sertularias* and *Campanularias,* furnished with an extensile proboscis, terminated by a brush of moving tentacles."

1. *Ophryodendron abietinum,* Claparède and Lachmann.—"Body turbinate, attached by a suctorial disc at its lower extremity. Trunk conical, arising from a deep excavation in the upper surface of the body. Body covered with thread-cells."

Found on *Campanularia* —?

2. *Ophryodendron sertularia,* T. S. W.

Corethria sertularia, T. S. W.‡—"Body oblong, cushion-shaped, attached by its side. Trunk, when extended, a flat ribbon more than twenty times as long as the body, attached within a slight depression on the upper surface of one end of the body. Body destitute of thread-cells."

Found on *Sertularia pumila.*

On the Reproduction *of* Thaumantias inconspicua. By T. Strethill Wright.

I have for several years taken much interest in the reproduction of the naked-eyed Medusæ, and have endeavoured to obtain the polypoid larvæ of these creatures; hitherto, however, with very indifferent success, having only succeeded in hatching two, *Æquorea vitrina* and *Turris neglecta.* Various species of *Thaumantias* swarm in the Firth of Forth, near Edinburgh, but when confined they almost invariably "cast" their ova, which never become developed into planuloid larvæ. This summer I have succeeded in obtaining the polyps in the following manner.

Three glass vessels, each containing about two gallons, were filled with clean sea-water, and carefully examined for two or three days. On the fourth day six individuals, two males and four females, of *T. inconspicua* were placed in

* Op. cit., livraison iii.

† Op. cit., livraison ii, p. 394.

‡ 'Edinb. New Phil. Jour.,' July, 1859.

one of the vessels. In a few days afterwards a considerable number of planulæ were found in this vessel alone, and were carefully removed with a glass syringe into a small vessel of filtered sea-water. Of these, two affixed themselves to the side of the vessel, and developed each a disc, branching into four symmetrical lobes, spreading over the glass. From the juncture of these lobes sprung the polyp-stalk, which put forth the polyp from its summit.

The polyp of *T. inconspicua* resembles very closely *Campanularia raridentata*, Alden, the stalk being ringed at its root and again just beneath the cell; the cell toothed with seven denticulations. The polyp, with a trumpet-shaped mouth and fourteen alternating tentacles.

After a few days one of the lobes attached to the glass of one of the young zoophytes began to enlarge, and extended itself into a creeping fibre, from which a second polyp-stalk sprung. This stalk was crowned with a cell having nine denticulations, and its contained polyp had eighteen tentacles. The other young zoophyte also put forth a creeping fibre and second polyp in like manner, but its cell had only seven teeth and its polyp fourteen tentacles. At this stage both specimens died. In the meantime the planulæ in the larger vessel had covered the side of the vessel with a great number of young zoophytes, but none of these put forth a second polyp*.

On the Development *of* Striped Muscular Fibre *in* Man, Mammalia, *and* Birds. By J. Lockhart Clarke, F.R.S.

In pursuing the histological investigations which form the subject of the present communication I have endeavoured to discard from my mind every kind of theoretical bias, and to record only what was actually experienced as the results of purely practical observation. The drawings are not intended to illustrate any *interpretation* of what was observed, but are faithful representations of the objects seen, and served for the following descriptions, which will be as concise as the nature of the subject will permit. The tissues obtained for examination were used in a perfectly fresh state, and with the addition only of water or dilute glycerine. I shall begin with the muscular fibre of the bird.

* See "Notes and Memoranda."

In the domestic fowl, on the fifth day of incubation, the (so-called) voluntary muscular tissue is of a gelatinous consistence, and when examined by means of a sufficient magnifying-power is seen to consist of the following three elementary parts :—1, a granular, semifluid blastema or matrix; 2, free nuclei; and 3, nucleated fibres.

1. The granules of the blastema vary considerably in size; the largest (Pl. XI, fig. 1 *a*) are but little inferior to the smallest nuclei (*b*), as if they formed a transition from the one to the other.

2. The free nuclei (fig. 1 *b, c,* and fig. 3 *a*) are thickly crowded together in every part of the tissue, and are either globular, oval, triangular, pyriform, fusiform, or somewhat crescentic. Each contains one or a pair of globular nucleoli of variable size, and frequently gives off one or two separate processes from different sides (fig. 3 *a*). During the development of the muscular fibres these nuclei multiply by subdivision, and undergo considerable alterations in shape.

3. The nucleated fibres at this period, according to their relative state of development, present a considerable variety of appearance. Some of them (fig. 3 *b*) are but little more than oval or fusiform nuclei, with elongated processes. Amongst these the smaller kind appear to belong to the tendinous and aponeurotic tissues. The majority, however, which are more fully developed have a proportionately different aspect.

The process of development may be divided into two stages—

1. That in which the fibres are formed and isolated from the surrounding substances.

2. That including the changes which they subsequently undergo to complete their development.

At the beginning of the first stage, or the formation of *fibres,* granular processes of variable breadth and length, resulting *apparently* from the condensation or coagulation of the surrounding blastema, extend from the opposite sides or ends of a series of nuclei, until they meet and coalesce to form continuous fibres. In these fibres the nuclei are at variable distances from each other, and the processes which grow from them and coalesce are consequently of variable length. In general, the greater the distance between the nuclei the narrower are the processes which unite them. Sometimes they are ranged at considerable intervals in a straight and single series, the processes growing toward each other until they meet, as at fig. 4 *a*; or they are placed irregularly and sometimes in close apposition, as at fig. 5 *a, b,* the processes of one overlying and coalescing with those of another. Occasionally I have seen a number of nuclei arranged in a single linear series, and in contact, but slightly overlapping each other, and held together by a common layer of condensed blastema, formed by the coalescence of their processes (fig. 5 *c*). Such an arrangement is only a repetition of that which takes place at *a* and *b* in the same fig. In some cases it may be seen that granular processes have grown from opposite sides of the nuclei, and thus formed with them bodies which have the shape of fusiform, nucleated cells, but do not appear to be enclosed by a distinct wall. A number of these bodies may become applied to each other at their sides, but in such a way that one is in advance of the other. Fig. 5 *d* is an exact representation of a fibre so formed, from the anterior extremity of a chick, between the fifth and sixth days of incubation, and magnified 670 diameters.* After a time the separate bodies coalesce, and, apparently, by a longitudinal growth, the fibre straightens and assumes the appearance of a band, while the distances between the nuclei become increased. At fig. 6 *b* four such fibres are represented. In the muscles of the trunk, however, the nucleated fusiform bodies from which these fibres are formed are seldom so well defined and arranged with so much uniformity as in the case just described. More frequently a series of nuclei, at variable distances from each other, are partially or wholly surrounded and united by an irregular condensation of blastema, as represented at fig. 4 *b*. At the same time the column thus produced is isolated on one side by a further layer of material, in the form of a distinct border, which is probably effected under the influence of the nuclei (fig. 4 *b*). A similar border is subsequently formed along the opposite side, until the fibre is completely isolated from the surrounding substance.

In some instances, but less frequently, nucleated bodies, having the shape of fusiform cells, taper at their extremities into long, slender fibres, by which they become united in linear series (fig. 6 *a*). These appear to belong to tendinous tissues.

Besides the muscular fibres above described there are other fibres of a different nature found in the same field, and which belong apparently to the muscular sheath, as they are mostly seen along the borders of dissected portions of muscles. Their nuclei are small, but of uniform size, and are oval, fusiform, and pyriform. In the formation of these fibres (fig. 4 *f*) the oval

* The edges of the bodies, however, at their lines of junction, have been intentionally made a little sharper and more distinct than they were seen to be in the preparation.

variety unite nearly end to end by means of short but broad granular processes or tails, which overlap each other and coalesce, as in the case of the muscular fibre represented at fig. 5 *d*. But those of a more pyriform shape, arranging themselves in a line, with their corresponding ends turned in the same direction, are attached to each other by slender filamentous processes proceeding from their points, each of which rests on the same side against the shoulder of the next succeeding nucleus, so that the entire series appears to be connected on that side by a continuous fibre. This arrangement, however, is less frequently seen than the other.

In the *heart* of the chick, between the third and fourth days of incubation, the fusiform, nucleated bodies are much more numerous and more distinctly marked than in the voluntary muscular tissue. When a portion of either of the ventricles is dissected under the microscope by means of fine needles, it is found to consist—1, of a granular, semifluid blastema; 2, of free nuclei, both round and oval, containing one or two globular nucleoli; and 3, of the same kind of nuclei, either partially or wholly surrounded each by a granular mass of more or less definite outline and shape (see fig. 7). Sometimes only a small conical projection of granular substance grows from one side of a nucleus, and tapers into a fibre of variable length. By a similar growth on its opposite side a fusiform body begins to make its appearance, and is sometimes prolonged until it assumes, to a certain extent, the form of a nucleated fibre. Pyriform, oval, and circular bodies are produced by the same process, according to the direction which it takes. Sometimes the granular mass enveloping the nucleus is not definitely circumscribed (see fig. 7); in many cases its surface is smooth and its outline well defined, while in others it is partially or wholly surrounded by a slightly condensed layer, which presents more or less the appearance of a separate envelope or border, as at *a*. In their normal position these elementary bodies are arranged side by side with considerable regularity, as represented at fig. 7 *b*, and by their union and growth constitute bundles of muscular fibres.

Towards the end of the sixth, or at the early part of the seventh, day of incubation, a striking difference or modification may be observed in the process of development of the muscular fibres of the trunk. The free nuclei are still exceedingly abundant, and the nucleated fibres already described are also present in great numbers. But in addition to these a multitude of others, somewhat different in their form and mode of development, begin to make their appearance. These new structures originate in a fibrillation of the blastema between the densely crowded nuclei, with which they become, as it were, encrusted through a condensation of the surrounding blastema, which also cements them together. Sometimes these masses assume a cylindrical shape, although the elements which compose them have but little regularity of arrangement (fig. 9). Much more frequently, however, the fibres first formed, having increased to a variable degree of thickness, become connected together by the intervening substance, in which new fibres are also developing, to form bodies or masses of different shapes (fig. 9 *f*). Sometimes a number of fine and more or less wavy fibres are cemented side by side, and encrusted with groups of nuclei, which carry on the process of fibrillation in the intervening blastema, as at fig. 10 *a* and fig. 9 *b*; or fibres of different diameters wind their way through groups of nuclei, which surround them like clusters of grapes, as at fig. 10 *b*. In some instances they resemble the loosened or untwisted fibres of a rope, entangling a number of nuclei (fig. 9 *a* and *b*); while in others they are arranged in a kind of plexus of a more or less uniform character, and supported by the intervening and condensed blastema, in which new fibres are forming (fig. 9 *c*). Occasionally, but not often, at this period of development, I have found some of these fibres distinctly and beautifully striated, as shown at fig 10 *c*. The large fusiform bodies (fig. 9 *e e'*) have often a striking resemblance to organic muscular fibre-cells, but enclose a variable number of nuclei. Some of them are comparatively short and broad, and contain two or more nuclei, like those by which they are surrounded. Similar appearances, however, are frequently assumed by portions broken from a longer mass. Many of them are apparently in different stages of transition into long, nucleated, and nearly cylindrical fibres. In the course of this transition their surfaces become plain and smooth, their nuclei multiply by division, and are disposed in more regular series, with their longer axes sometimes transverse. Frequently they are much dilated in the middle, from which they contract into broad but tapering fibres (fig. 9 *e*). In many cases, however, the transition is more gradual, as at *e*; while a great number have assumed the form of large fibres of nearly uniform diameter, and lie side by side in close apposition (*h*). As incubation proceeds, these fibres increase both in number and development, but at any one period until the thirteenth or fourteenth day they assume a great variety of forms. On the twelfth day many of them have still the appearance of long, fusiform cells, which taper into long and comparatively narrow fibres (fig. 11). Their dilatations, in general, according to their length, contain a variable number of nuclei, disposed in regular series, with their longer axes often in a transverse direction. In a few instances, however, as at fig. 11 *a*, I found only a single and remarkably large nucleus, which occupied the entire breadth of the dilatation, and contained a well-defined, granular nucleolus, of a correspondingly large size. Sometimes the dilatations were seen to be repeated twice or even thrice in the course of the same fibre, which, at variable intervals between them, contained nuclei of an oval form and of a breadth equal to themselves.

But besides these fibres of later formation there was also a considerable admixture of the kind first described. Many of the latter were slender and delicate, with round and oval nuclei as broad as the fibres themselves, and sometimes raised from their surface (fig. 11 *b*). Others were thicker, with sharply defined borders, and enclosed a granular axis, with round or oval nuclei, which in some places were disposed in straight, longitudinal series, but collected in others into small groups (fig. 11 *c c*). Here and there they were found in the earliest state of development, as represented at *d*. At *e* a succession of round nuclei, in contact with the side of a slightly undulating fibre, were each enveloped in a delicate and nearly fusiform mass of condensed blastema, which converted them into what had somewhat the appearance of nucleated cells.

At this period of incubation both transverse and longitudinal striæ exist in some of the fibres, but are entirely absent in others. The longitudinal are the first to make their appearance on the surface, and in the form of simple or plain fibrillæ, which subsequently break up into series of dots or granules. These granules are much coarser in some fibres than in others. When they are small, on the same level transversely, and in close proximity, they present, under a moderate power, the appearance of transverse lines, which, however, by the use of higher powers, may be resolved into separate granules that belong to the longitudinal fibrillæ. So long as the fibrillæ remain undivided or plain, the striations, therefore, are only longitudinal. When the fibres are fusiform, these appearances are most conspicuous, or perhaps visible, only in the course of the dilatations (see fig. 11 *f*, *g*).

On the thirteenth or fourteenth day of incubation * some of the fibres are more or less in the condition of those which first made their appearance, but by far the greater number

* At any given period of incubation there is generally, as the result of accidental circumstances, some little difference in the degree of development in eggs hatched under different hens. This I found to be the case with regard to the three hens employed for the purposes of this inquiry.

have now assumed the form of nucleated cylinders of a more peculiar character, and arranged side by side with much regularity (fig. 12 *a*). These fibres differ from each other considerably in diameter, and each of them varies in the same respect at different parts of its course.

At their widest portions, which are nearly uniformly cylindrical, their walls are of considerable thickness, and on each side have the aspect of a broad band or contour, enclosing an axis of delicately granular substance and a series of nuclei. The nuclei assume a variety of shapes and positions. They are round or oval, pyriform or crescentic, and turned with their longer diameters either more or less transverse or parallel to the course of the fibre. Sometimes they are crowded closely together, sometimes the interval between them is variable, while in a great number of instances they lie at moderate and nearly equal distances from each other, and occupy the whole axial breadth of the fibre, which is then constricted between each pair in such a manner as to resemble a jointed or knotted cane (see fig. 12 *a*). Some of them are quite on the surface, the convexity of which is occasionally embraced by a nucleus of a crescentic form (fig. 12 *b*).

After a certain course these fibres are frequently seen to change their character, in consequence of a further development. They gradually diminish in diameter to a variable extent, and assume a more cylindrical shape. At the point where this change is taking place the granular axis tapers off; the fibre, contracting in the same proportion, acquires a uniform structure throughout its entire thickness, and the lateral contours disappear (fig. 12 *b*). The nuclei also, as if by pressure, become frequently much more elongated longitudinally, and raise the surface in the form of alternate nodes. At the same time some of the fibres exhibit indications of longitudinal fibrillation and even of transverse striæ. Sometimes a fibre tapers for a considerable length without any other alteration of structure, in consequence of the absence of nuclei, which allows the walls to approach each other and the granular substance to form a narrower axis; and in such instances the walls now and then are seen to have resolved themselves into fibrillæ, and these again into granules. (See fig. 12 *c*.)

By the fifteenth day of incubation the fibres lose entirely their plane structure, and become wholly resolved throughout their thickness into bundles of fibrillæ (fig. 13 *a*). These fibrillæ, however, are not perfectly parallel, but overlie each other here and there in a loose kind of way, and, in consequence, apparently, of this arrangement, the bundles have increased a little in average diameter. Some of them, however, are very small in this respect, and consist of not more than three or four fibrillæ (fig. 13 *b*). In the majority of cases the fibrils, in turn, have, either wholly or in part, become resolved into a succession of granules, which, under certain conditions, assume the appearance of transverse striæ. Fig. 13 *a* represents one of the larger fibres, in which each of these appearances is seen at different parts of its course; and *b* is one of smaller diameter, in which the fibrillæ are only here and there resolved into granules. Every fibre bears on its *surface* a variable number of nuclei, which are frequently disposed alternately and with much regularity around it. From these nuclei granular processes creep along the surface and begin to develop into new fibres.

In mammalia the development of muscular fibre proceeds on the same plan, and in all essential details is carried out in nearly the same way as in birds. My observations were made chiefly on the fœtal ox and sheep, especially on the latter. In the fœtal sheep of half an inch in length the structure of the muscular tissue has much resembrance to that of the chick near the end of the fifth or at the beginning of the sixth day of incubation. The free nuclei contained in the blastema are rather larger, but similar in all other respects. In the midst of these lie a multitude of fibres, which, when undisturbed, appear to be nearly parallel, and when seen under a power of about 400 diameters resemble pieces of coarse thread (see fig. 14 *a*). Between these, and often in connection with them, finer fibres are formed by a more irregular condensation of the blastema, or coalescence of its granules from the sides or ends of the nuclei, which therefore appear very thickly clustered around them (see fig. 14 *b*). When the coarser fibres are sufficiently isolated by dissection, their connections with the nuclei, though all on the same plan, present some differences of appearance in different cases. At first a certain amount of blastema *apparently condenses* all around or at the ends of nuclei into masses of more or less definite shape, and becomes bounded, as already described, first on one side and then on the other, by a distinct fibre or border. Sometimes the nuclei fall into a single linear series, and if they happen to be pyriform, assume an imbricate arrangement, so that their smaller ends or granular processes, each overlaid by the next, are connected in a continuous line to form a lateral band or fibre (fig. 14 *d*). If the blastema condense at each end of the nuclei in such a way as to constitute fusiform bodies, and these be arranged in the same imbricate manner, it is easy to perceive that their opposite ends by their coalescence will form a border on their opposite sides. Sometimes a fibre bifurcates here and there to enclose an oval or pyriform nucleus, as shown at *d*, and sometimes the branches are connected beyond the nucleus by an expansion of condensed blastema in which still finer fibres may be observed.* Frequently the nuclei are disposed in irregular groups around the fibres, to which they are cemented (fig. 14 *e*).

As development advances, fibres of different diameters are produced in the way already described. Fig. 16 *a* represents one of the smaller kind in progress of formation. The majority, however, are of much larger diameter than this, but differ from it only in having a thicker coating of the condensed material, which, when seen on each side, presents the appearance of bands enclosing a granular and nucleated axis (fig. 16 *c*). That these fibres are more or less cylindrical, and sometimes *entirely surrounded* by this condensed coating, is rendered probable by the fact that the apparent bands are seen *always* and *only* at their sides, just as in nerve-fibres the medullary sheath or white substance is seen only on each side of the axis-cylinder; but if any doubt exist on the subject it may be set at rest by examining a transverse section of a long muscle, the cut ends of which show that the fibres are more or less cylindrical, with an axis sometimes entirely surrounded by a thick, tubular sheath. Fig. 17 represents a transverse section of fibres from the leg of the fœtal sheep, two inches long. The substance of this coating or sheath is easily injured, broken up, or displaced, even by careful manipulation; and this tendency, under exactly similar circumstances, is greater in mammalia than in the chick. Sometimes it separates into small pieces or coarse granules, which are more or less round, square, cylindrical or discoid, and are very distinctly seen along the sides of the fibres. When these pieces become confusedly heaped together with the nuclei which the sheath contained, without destroying the cylindrical shape of the fibres, these fibres might be supposed to be in the first stage of development by means of an irregular aggregation of their elements. But that this condition is a breaking up, and not a process of development, any one may convince himself by a sufficiently

* When the muscular tissue is subjected to the action of even a weak solution of chromic acid, these appearances are very common. The fibres become connected by a kind of network, which seems to be caused by the action of the acid on the blastema, and must be looked upon with caution.

careful examination. The smooth and apparently structureless investing substance, however, by the action of certain reagents, is prone to separate into regular longitudinal fibrillæ, and these again into granules or sarcous elements. Such a separation may be readily produced by a short maceration of the muscles in a weak solution of chromic acid. This change, however, is very different from the irregular breaking up of the fibre to which I have just alluded, and is in every respect identical with the fibrillation and striation which takes place at a little later period in the natural course of development.

These fibres are rather larger in mammalia than in the chick. They differ also from those of the latter in not being so frequently constricted at short intervals between the nuclei. The nuclei, moreover, are rather larger, and in general disposed with greater regularity along the axis.

In a fœtal sheep of $3\frac{3}{4}$ inches in length, the fibres were in nearly the same condition as those of the chick on the fourteenth day of incubation. The central granular axis had entirely or almost entirely disappeared, for the tubular substance which invested it now constituted the whole or nearly the whole thickness of the fibre. Now, also, it divided longitudinally into fibrillæ, and these in turn became resolved into granules or sarcous elements, which were so small and close together that at first sight the fibrillæ appeared to be plain, and no indication of transverse striæ was perceived. Moreover, the nuclei had enlarged, had become much more elongated in the direction of the fibre and nearer the surface, but were still as perfect as before. *On* the surface were a number of others, which were smaller, and round or oval, and evidently engaged in contributing new fibres by the process already described. As the fibres advance in development the internal nuclei disappear, and the sarcous elements and striæ become larger and more distinct.

(*To be continued.*)

Descriptions *of* New *and* Rare Diatoms. Series VII.

By R. K. Greville, LL.D., F.R.S.E., &c.

Synedra.

Synedra Normaniana, n. sp., Grev.—Valve linear-club-shaped, with side view unequally curved, attenuated towards each obtuse extremity; maximum of breadth at about one third of the length from the upper end; striæ very fine. Length ·0060″ to ·0193″. (Pl. X, figs. 1—3.)

Campylostylus striatus, Shadbolt, MS.

Hab. On mahogany logs imported from Honduras; G. Shadbolt, Esq. On mahogany logs from the same country; George Norman, Esq.

This most singular diatom resembles a long, curved club in shape, the line of the curve being somewhat modified by the length of the frustule. In the small variety (fig. 3) it was aptly compared by Mr. Norman to the bill of the common curlew. The valve is nearly linear for about a third of its length from the base, when it begins to widen, rapidly in the small variety, more gradually in the longer one. The greatest breadth in the former is about ·0005″, in the latter about ·0006″; the extraordinary difference in the length not appearing to have much effect on the breadth. The upper extremity is less rapidly attenuated, and is never so narrow as the lower. The striæ are very fine, but with careful manipulation come sharply out. There is no trace whatever of a pseudo-nodule.

I had prepared a description of this species for publication in my last communication, from specimens presented to me by Mr. Norman, when, through the kindness of Mr. Roper, I received a slide of the same diatom which had been discovered on mahogany logs in the docks by Mr. Shadbolt as long ago as in 1849, and had been provisionally named by him. Mr. Shadbolt's gathering is quite pure, while that made by Mr. Norman is less so, but extremely interesting on account of the very dwarf habit of the frustules. I am not aware that Mr. Shadbolt ever prepared a definition of his proposed genus *Campylostylus*. The *prima facie* aspect of the frustule is so very peculiar that no one can be surprised at its being hastily taken for a new genus; but on a rigid examination I cannot perceive any good ground for separating it from *Synedra*, which contains a number of arcuate species. The inequality of the curve and the club-shaped form, cannot be regarded as alone sufficient to furnish a generic character.

Triceratium.

Triceratium Davyanum, n. sp., Grev.—Valve with slightly convex sides, rounded angles, and large, punctate pseudo-nodules; border and the central triangular space largely cellulate, the former divided into compartments by transverse lines. Distance between the angles ·0068″ to ·0080″. (Fig. 4.)

Hab. Chimborazo, Barbadoes deposit; C. Johnson, Esq.

There can be no question but that this magnificent species, for beauty and interest, stands at the very head of the genus, distinguished, as it is, for many fine forms. The only two examples as yet known were both discovered by my acute and indefatigable friend, Mr. Johnson. The first is a fragment; nevertheless, as it possesses a perfect angle and centre, and the greater part of two sides, admits of being correctly described. The other is entire, and, although considerably smaller, is a splendid object. Both enrich my cabinet—the first by the kindness of Mrs. Bury, the second by the no less generous donation of the discoverer. It is at once evident that this unrivalled species belongs to the small group of *Triceratia,* of which *T. marginatum* of Brightwell has been considered the type, the valve having a central triangular space, and a broad border, divided into compartments by transverse lines or costæ. It further belongs to the section of that group containing the species just named and *T. pulcherrimum,* which have the central triangular space filled up (not blank), suggesting the idea of a small *Triceratium* being laid (after the manner of patchwork) in the middle of a larger one. It is, however, essentially separated from those previously described by the conspicuously cellulate, lace-like structure of the whole valve. The pseudo-nodules are very large, more or less ovate, filling up the rounded angles, densely punctate, the puncta becoming larger and passing into evident cellules at the base. Beneath the pseudo-nodules is a broadly obconical vacant space, equivalent to the part which has been called a second pseudo-nodule in *T. marginatum,* as well as to the unpunctate portion of the pseudo-nodule in *T. pulcherrimum,* but has so little in common with the pseudo-nodule that it will be more correctly described (when present) as the pseudo-nodular blank space. The central triangular compartment is very similar in outline to the same part in the two species above mentioned; but, instead of being filled with radiating costæ, is largely cellulate, with the addition of a few costæ radiating from the centre. The two specimens now before me indicate a considerable range of variation. In the valve first discovered (the largest) the angles are much less rounded, the sides straighter, and the cellulation more oval. The pseudo-nodules are ovate, and the somewhat undulating costæ are eleven or twelve on each side. In the specimen figured, the pseudo-nodules are obovate, the cellulation rounder, and the lateral costæ only five or six. In this example the cellulation at the base of the pseudo-nodule extends into the blank space, and has the appearance of being torn at the edge as if it had been originally continued throughout the space and was in the process of becoming obsolete, which is not improbable. There is, however, no trace of the remains of cellulation attached to the rest of the boundary of the blank space. The remarkable spine-like process which occurs in *T. marginatum* and *pulcherrimum* at the apices of the central triangle is very conspicuous in the present diatom. I have great pleasure in dedicating this rare species to Dr. Davy, who collected and brought home the material in which it was discovered.

Cocconeis.

Cocconeis cœlata, n. sp., Walk.-Arn., MS.—Valve oval or oblong, with two longitudinal lines (one on each side the median line), constricted opposite the nodule, and forcipate towards the apices; transverse costæ distant, flat, and continuous in substance with the median and longitudinal lines. Length ·0005″ to ·0018″. (Figs. 5, 6.)

Hab. New Zealand, on *Ballia;* Professor Walker-Arnott.

A most singular and beautiful species. The markings are arranged upon the plan of *Navicula forcipata* and its allies. There is a median line and two longitudinal ones; the latter constricted opposite the nodule, and connected together by means of the nodule, which is expanded into a broad, stauros-like bar. They then curve outwards and become forcipate towards the ends. The transverse lines or costæ are remote (about 10 in ·001″), somewhat concentric, with extremities. All the lines are flat or compressed and continuous in substance with each other, the whole having a curious skeleton-like appearance, as if an epidermis had been removed.

Glyphodesmis, n. gen., Grev.

Frustules united into a filament; lateral view naviculoid, with a central nodule, median line, and transverse rows of granules; structure clathrate, the granules being developed within square cellules, arranged in parallel series.

At first sight the filament of this diatom might almost pass for that of an *Odontidium.* It also resembles a *Plagiogramma,* wanting only the pervious costæ. Indeed, the likeness between it and *P. ornatum* ('Mic. Journ.,' vol. vii, Pl. X, fig. 9) is, with that exception, very striking. But the side view of the frustule exhibits a totally different structure. There is a large, prominent, central nodule, a decided median line, and thick, transverse moniliform striæ, which, when closely examined, are found to be composed of prominent granules, each planted within a little square compartment; so that when the valve is focussed to bring these spaces or compartments into view, nothing is seen but a simple clathrate structure, in which it differs from *Odontidium, Diadesmis,* and other genera, with which, in one aspect or another, it may be compared. In the front view are seen double longitudinal rows of minute dots, as in *Plagiogramma ornatum,* and as the period of division approaches additional rows make their appearance.

Glyphodesmis eximia, n. sp., Grev. (Figs. 7—10.)

Hab. In scrapings of conch shells from Nassau, New Providence (communicated by Mr. G. Norman), Jamaica; R. K. G. Dredgings off St. Helena, in from fifteen to forty fathoms; Dr. Wallich.

The lateral view of this beautiful diatom is obtusely elliptical; the central nodule very large and umbonate; the median line generally expanding somewhat as it approaches the nodule, while a small, vacant space surrounds the latter, as in many *Naviculæ* and *Pinnulariæ.* The transverse moniliform striæ are robust and equal, the number of granules composing them being not more than three or four in the widest part of the valve. The clathrate structure is very similar to the quadrangular cellulation observed near the margin of *Triceratium margaritaceum* and its allies, and the granules are also very similar to those of that diatom, only relatively larger and more compactly arranged. At each extremity of the frustule is a small vacant space, caused by the abrupt termination of the transverse striæ. Like most diatoms whose frustules are disposed in filaments, the present one varies greatly in point of size, being occasionally both smaller and considerably larger in length and breadth than any of the frustules I have represented. The ordinary dimensions, however, may be said to be intermediate between figs. 6 and 7. It is very satisfactory to find that my drawings of this species from West Indian specimens are confirmed by careful sketches made by Dr. Wallich from those dredged by him at St. Helena, and kindly placed in my hands.

Mastogloia.

Mastogloia capitata, n. sp., Grev.—Valve elliptic oblong with produced, distinctly capitate apices, and 7—11 (rarely more than 8 or 9) loculi; striæ very obscure. Length about ·0015″. (Figs. 11, 12.)

Hab. Fresh-water tank, near Calcutta; Dr. Macrae.

Mastogloia Smithii, var. β, which has produced and inflated extremities, is the only species with which *M. capitata* can possibly be confounded. But what constitutes an exceptional character in *M. Smithii* is constant in the Indian species, the apices being invariably truly capitate, the neck conspicuously constricted. But more important distinctive characters are found in the much smaller number of loculi and in the very obscure striæ. I have examined a very large number of individuals, and find that, although the loculi vary from seven to eleven, the average number is eight or nine; whereas in *M. Smithii* the range extends from six to twenty-four, according to Professor Smith.

DESCRIPTION *of a* NEW SPECIES *of* MICRASTERIAS (Ag. *et aliorum, non* Ehr.), *with* REMARKS *on the* DISTINCTIONS *between* MICRASTERIAS ROTATA (Ralfs) *and* M. DENTICULATA (Bréb.). By WILLIAM ARCHER.

To those who in this day advocate the non-existence of species it must doubtless seem but a profitless task and an illusory effort to try, by a definition or diagnosis, to fix a boundary to that which they assert is only imaginary; but they who defend this bold and sweeping hypothesis, however justly celebrated some of their names may be, are, I imagine, still in the minority, though that circumstance, I admit, is in itself far from proving that they have not truth on their side. But, as far as I can at present see, their case, however plausibly put, seems far indeed from proven; but, on the contrary, geological data, and our experience of the world around us, seem hitherto, at least to my humble judgment, to combine in subverting and disproving it. Species, as usually understood—some more, some less variable—I, for the present at least, conceive to exist, and not less amongst the microscopic forms than amongst those of larger growth.

It is true that, unless an organism can be traced through its whole course of life, that is, that its development from the resultant germ of a generative act, until, in its turn, by another generative act, it assists to give rise to a new germ, be observed—just as an oak is known to produce an acorn, which acorn will by and by produce another acorn-bearing oak—it cannot be affirmed that any such given organism is in reality a true species. That is, it is not proved that some other form, which in the present state of knowledge we are constrained to suppose a distinct species, may not in truth be only a phase of variation, or of development, or an "alternation of generation" of the actual species, whose extremes of variation, or whose life history, are as yet unknown. Now, in the family of Algæ, to which I have the pleasure to make a small addition (the Desmidiaceæ), this whole course of development has not been traced, except in two or three instances; whilst in many species even the characteristic form of the sporangium following conjugation, which here represents the reproductive condition, is unknown, although frequently met with in other species. But even in regard to the numerous Desmidian species which have not been so traced up to the development of new individuals, but only so far as the conjugative act itself, and the formation and perfecting of the resultant sporangium (frequently, indeed, met with in certain species), I would draw attention to a circumstance I am disposed to look upon as an almost unimpeachable argument as to their actual specific distinctness. I allude to the fact that, no matter how numerous or how few the fronds, the conjugating specimens always conjugate like form or species with like form or species—the abundant with their abundant neighbours of the same species, the rare seeking out the rare of the same species, and overlooking the possibly more numerous specimens of a perhaps closely allied species. And it is marvellous, however few a certain species may be amongst the mass of others, by what attraction or force these little vegetable organisms, not endowed with a special locomotive power, are impelled to seek only their fellows when about to conjugate, avoiding other more abundant species, themselves even, perhaps, conjugating with each other at the time. The same may be said to be true of other Conjugatæ. Such, at least, is my own experience; yet, at the same time, that a *hybrid* (so to speak) might occur amongst these lower Algæ, as well as amongst higher plants, is perhaps not impossible; but even if it did, it does not appear to me that such a circumstance would weigh as an argument against the existence of actual species in this family. But, further, I believe if the development of new individuals from a generative act has been traced in a few, even in one species, and the result of such investigations has been to prove that the so observed parent form or species, after passing through its reproductive stages, gives birth to its own complete likeness, that its specific rank has, to all intents and purposes, been established. Now, this has been done by Professor de Bary * in regard to at least two species

* 'Untersuchungen über die Familie der Conjugaten,' t. vi, p. 52.

of Cosmarium, *C. Botrytis* and *C. Meneghinii;* and it is worthy of remark that these are both forms whose specific distinctness has been called in question by some observers, merely because they considerably resemble certain allied species of Cosmarium. To my mind, indeed, they seem, in a word, to possess only common generic characters; and for my share, while both the above species are frequent, I believe there is not the smallest difficulty in distinguishing them from any of their allies. Now, analogy seems to me to be here an irresistible argument. *Cosmarium Botrytis,* as some may maintain, only a variety of *Cosmarium margaritiferum,* or of *C. tetraopthalmum,* or *C. Brébissonii,* &c.—all of which they, perhaps, would lump together—reproduces *itself* from the sporangium, conjugation being a true generative act, as I conceive. My new Micrasterias differs by more salient and striking characters from its nearest neighbouring forms than do those species of Cosmarium, though it is to be mentioned that the development from the sporangium of any species of Micrasterias is unknown. It is therefore reasonable to conclude that my new Micrasterias and its allies are distinct *species,* as they certainly are abundantly distinct *forms.* I consider, then, if certain well-defined forms occur, differing from their congeners as much as do already acknowledged species, and which may be met with the very next day by other observers, it is imperative that such be duly recorded under a careful description. And I would remind you that this is the necessary course in all departments of natural history. Constantly recurring identical forms must be assumed to be the descendants of similar progenitors, whatever be their intervening phases of development, of alternation, or of metamorphosis; and, as it seems to me, in the absence of the various stages of the development of each from the germ generated from the parent, there is no more difficulty in believing such forms in the microscopic world to be good species than in the case of any of the higher plants or animals, in the absence of tracing their growth from the ovum or germ, though in one case we may possibly know the stages, and in the other we may not.

Therefore, on all these considerations, I believe I am not premature in describing the following new species of Micrasterias; and I make the preceding few observations, and direct attention to the foregoing facts, for the purpose of trying, in, I fear, a very inadequate manner, to meet the objections of those who seem to carry a prudent precaution as to making new species too far, and thus, as it appears to me, to outstep the truth in one direction as much, or nearly so, as do those who over-multiply species in the other. And those who may be disposed to question the actual distinctness of certain of these Desmidian species, and who may draw their arguments from a hasty or a single examination, or from figures, or from preconceived ideas, I would just beg to suspend their judgment until they make a careful comparison of the living specimens side by side, drawn from different sources and on different occasions; for, with the greatest deference, I maintain that it is Nature that should speak, and by Nature that we should be guided, and not by opinion or theory, nor by any preconceived scheme, however ingeniously devised, by which, after all, probably good species are unwittingly grouped together into what are nothing but small subgenera (though, without adopting that name, called indeed species), the so-called varieties, Nature compelling the distinctions at last to be acknowledged, being the true species. I do not, however, mean to convey that I at all imagine species to be invariable, and that authors, in disallowing certain so-called species, in so doing always fall into the error I have alluded to; far from it. I am convinced that, in many departments of natural history, very many of the species described in books exist there only, and are not supplied by Nature; and I only mean to say that it appears to me the opposite mistake is more frequently fallen into now-a-days than is generally thought; and my remarks are more especially with reference to the Desmidiaceæ.

Class—ALGÆ. Order—CHLOROSPERMEÆ.

Family—DESMIDIACEÆ.

Genus—MICRASTERIAS (*Ag.* et aliorum, non *Ehr.*).

Micrasterias Thomasiana, sp. nov. mihi.

Specific characters.—Frond orbicular, smooth; segments five-lobed, furnished at the base with three stout, conspicuous, prominent, hollow projections, the middle conical, rounded, the outer tapering, curved, elongate, emarginate, divergent; lobes closely approximate throughout, each bearing two or three superficial, regularly disposed, apiculate elevations, their apices directed outwards; the lateral lobes dichotomously divided, their ultimate subdivisions bi- or tri-dentate, or sometimes quadridentate, not tapering; end lobe wholly included, acutely emarginate, its angles acute. End view—the body of the segment lanceolate, the projections very conspicuous, together presenting a doubly hastate outline.

Locality.—A large pool near the "Old Gable," Featherbed Mountain, and sparingly elsewhere in the vicinity.

Measurements.—Length of frond, $\frac{1}{125}$; breadth of frond, $\frac{1}{140}$; greatest depth of frond, $\frac{1}{450}$, inclusive of the projections; exclusive of the projections, $\frac{1}{660}$ of an inch.

General description.—Frond orbicular, smooth, segments in front view five lobed, having the lateral lobes dichotomously incised, furnished at the base with three conspicuous hollow projections or protuberances, the middle one conical, rounded; the outer distant from each other rather less than one-third the diameter of the frond, tapering, curved, somewhat elongate, emarginate at the extremities, sometimes with a tooth on the upper margin, laterally divergent from each other, but approximate to those of the opposite segment; basal lobes with two little apiculate, conical elevations on the surface, apparent only on the empty frond, their apices directed outwards, equidistantly placed at the base of each of the primary subdivisions of the lobes, and on a level with the extremity of the primary incision; middle lobes with three similar elevations, two placed at the base of each of the primary subdivisions, on a level with the extremity of the primary incision, and the other placed at the base of the lobe, distant about as far beneath the other two as they are from each other, the two elevations of each of the basal and the two outer of each of the middle lobes forming regular series semicircularly disposed; end lobe with two similar elevations, one placed beneath the other, the outer somewhat within the semicircular series of elevations of the basal and middle lobes—the inner at the base on a level, and horizontally forming a nearly straight series of three, with the inner elevation of each of the middle lobes. (Plate XII, fig. 2.) Basal and middle lobes mostly thrice dichotomous, the primary incisions deep, linear, about one half the depth of the lobes; the secondary incisions linear, about one third the depth of the primary; tertiary incisions shallow, triangular or rounded, scarcely one half the depth of the secondary; the ultimate subdivisions bidentate. Sometimes the tertiary incisions are obscure or obsolete, when the basal and middle lobes are therefore but twice dichotomous, and the ultimate subdivisions then mostly tridentate or quadridentate. End lobe narrow, with nearly parallel sides at the base for nearly half its length, thence suddenly widening, wholly included, acutely emarginate at the end at the middle; outer margin concave at each side close to the notch, beyond which it is convex, its angles acute. (Figs. 1, 2.) In side view the frond rather more than three times longer than broad, segments somewhat pyramidal; in general outline inflated at the base, sides concave immediately above; again dilated about half way up, the central lateral projections directed upwards, with a sinus on each side immediately above; sides again contracted, and above again exhibiting a lateral projection at each side; end truncate, the upper edge (in empty frond) showing the extremities of the various lobes and subdivisions. (Fig. 3.) In end view the segment narrow-lanceolate, presenting at each side, at the middle, the central, rounded basal projections, and beyond it, at each side, the pair of large, conspicuous, curved, emarginate, divergent projections, the general outline presenting a doubly hastate appearance, the rounded projections intervening, the upper edge (in empty frond) showing the extremities of the various lobes and subdivisions, the lobes presenting a somewhat obcampanulate outline, with a lateral minute projection at each side, its apex directed outwards. (Fig. 4.) In transverse view of a segment it is lanceolate, presenting much the same outline as the end view, save that, the outer edge being turned away from the observer, the subdivisions of the lobes are not now apparent, the foramen and basal projections being now uppermost, and in this position very strikingly displayed. (Fig. 5.) Endochrome rich green, sometimes not reaching to the margin of the frond, and thus leaving a hyaline border, and containing numerous conspicuous, rounded, scattered, large granules.

Plate XII, fig. 1, front view; fig. 3, side view; fig. 4, end view; fig. 5, transverse view. All magnified 200 diameters.

This complex form is very pretty, but, without obtaining a side and end view of an empty frond, is difficult to understand. Indeed, the outer semicircular series, and inner series of three little apiculate elevations, are not discernible when the frond contains its endochrome; but the large, curved projections at the base of the segments, even in front view, are readily seen, and under a low power, owing to the greater depth and consequent greater opacity, appear like two darker portions at the base of each segment; by focusing under a higher power, they are most easily made out; they are quite conspicuous on the empty frond. (Fig. 2.) That these curved projections are hollow is indicated by my having seen, in an empty segment, an infusorium making its way up into and down again from one. On the empty frond, also, the superficial apiculate projections are readily seen; occasionally one appears emarginate or divided, showing a double apiculus. It is not, however, until an end or transverse view is obtained, that all these projections, which render this form so remarkable, stand out in all their striking prominence, giving the general outline which suggested to me the term doubly hastate. (Figs. 4 and 5.) In end view, too, are seen the summits of the superficial projections directed outwards, imparting to the boundary of each lobe, the outer edge of which is now towards the observer, a somewhat inversely subcampanulate outline. In a somewhat oblique, partially front, partially lateral view, the several projections stand out in a crowded, mixed, very puzzling manner. In by far the greater number of examples the basal and middle lobes are thrice dichotomous, the ultimate incisions being, however, shallow, but mostly quite distinct; the ultimate subdivisions are, therefore, eight to each lobe, and rather acutely bidentate. But it occasionally happens that the tertiary incisions are obsolete, or not appreciably deeper than the intervals between the teeth, when the lobes cannot be said to be more than twice dichotomous, causing the ultimate subdivisions to be but four in number, and then mostly tridentate or quadridentate. The end lobe is narrow, acutely emarginate at the middle, its lateral angles acute, and wholly included—indeed, slightly beneath the general periphery of the frond.

It is with great pleasure I avail myself of the privilege kindly accorded to me to name this species after Mrs. Herbert Thomas, whose paper on "Cosmarium,"* has, doubtless, been perused with much interest by every student of the Desmids, and I am happy at having the opportunity of thus evincing my own humble appreciation of her researches. I consider that all praise is due to those ladies who honour our studies by a personal co-operation; and I feel, indeed, that I am far more complimented than complimenting in being permitted to dedicate this species to Mrs. Thomas.

Affinities and differences.—I believe there are only two species with which there is any chance of this Micrasterias being confounded, and they are *M. rotata*, Ralfs, and *M. denticulata*, Bréb., but with the latter I conceive it has the greater affinity. But as I imagine there is some misapprehension prevalent in regard to the differences and distinctions of the two species just mentioned, it may not be out of place, if, before contrasting them with this new species, I should draw attention to their own mutual points of similarity and of difference. *M. rotata*, Ralfs, and *M. denticulata*, Bréb., *agree* in having an orbicular frond of large size, smooth, without spines, papillæ, or granules, their segments five-

* 'Quarterly Journal of Microscopical Science,' Trans., vol. iii, pp. 33, 36.

lobed, the basal and middle lobes dichotomously divided; the lobes closely approximate throughout, widening the entire way from the base, the ultimate subdivisions not being attenuate, their end lobes narrow, and the endochrome containing scattered, rounded, large granules, and frequently retracted from the margin of the frond, so as to leave a hyaline border. *M. rotata* and *M. denticulata differ* in the following particulars:—The former is notably a larger species than the latter; in front view, in the former, the basal lobes are twice, the middle lobes thrice, dichotomous—in the latter both basal and middle lobes are but twice dichotomous, thus making in the former the ultimate subdivisions of the middle lobes eight (and this additional dichotomy makes itself apparent at an early stage in the growth of the young segments), and making in the latter the ultimate subdivisions of the middle lobes but four only (in the former, therefore, the middle lobes are wider in proportion than in the latter); in the former the ultimate subdivisions of the basal and middle lobes are acutely bidentate—in the latter they are truncato-emarginate, with more or less rounded, sometimes subacute, angles; in the former the end lobe is greatly more distinguishable in character and appearance from the others than in the latter; in the former the outline of the end lobe is narrowed below, inflated above the base, again contracted, and again dilated and spreading at the extremity,—in other words, more or less of a narrow, campanulate outline (the adjoining upper margin of the middle lobes closely approximating thereto by a corresponding outline)—in the latter the end lobe is simply cuneate, with the sides somewhat concave; in the former, the end lobe is distinctly exserted beyond the general periphery of the frond—in the latter it is not exserted, its outer margin being continuous with that of the frond; in the former the angles of the end lobe are produced, divergent and bidentate—in the latter its external angles are bluntly rounded; in the former the central emargination of the end lobe is not so deep as in the latter; in the former, the endochrome is more dense within the end lobe, especially at both of its margins, than elsewhere in the frond, giving it a turgid appearance, and rendering the campanulate outline more striking—in the latter it is not so. In the side view in the former (fig. 9), the frond is stouter and more turgid than the latter (fig. 6), its sides less concave. In the end view the former is stouter, and the outline is broadly fusiform, with a solitary central, slightly elevated, rounded projection at each side (fig. 10)—in the latter the outline is more slender, and is lanceolate, with three slight, less rounded and less elevated projections at the middle at each side (fig. 7). In my mind, *M. rotata* is a handsomer and more striking species than *M. denticulata.*

I am thus particular in contrasting these two species with one another, because, while I believe them to be quite as distinct as any two allied species need or can be, and while (though having seen multitudes of specimens of both) I have never seen one in which there seemed any difficulty in deciding to which species it belonged, I imagine, nevertheless, as before intimated, that there appears to be some misconception prevalent as to their distinctness or as to their actual characters. Mr. Lobb,* in his interesting paper, describing the growth of the nascent segment in dividing fronds of Micrasterias, throughout *calls* his specimens *M. denticulata,* but he *figures M. rotata.* Again, Dr. Wallich,† in the first two—and only two as yet published—of a series of papers descriptive of Desmidiaceæ discovered in Bengal, affirms his belief that *M. rotata* and *M. denticulata,* met with by him very sparingly in that country, are really but varieties of one species. But he adopts the same course, indeed, with many other allied species. I am compelled, however, very deferentially to differ from him. Mr. Ralfs himself,‡ indeed, expresses "some doubt whether this plant [*M. rotata*] is not a variety of *M. denticulata,* as the angles are sometimes merely acute, instead of being prolonged into teeth; but I surely think the claims of each to specific rank do not depend upon this one or upon any one character, but, as I have indicated above, are founded on many and constant points of difference. It is certainly not an argument for their specific identity that they possess several characters in common, and, so far as I see, I have above indicated all such, leaving out of question those that are strictly generic. Surely the ultimate, constant, and obvious characters, possessed by one and not by the other, are those upon which we must rely, and I conceive those I have above pointed out are abundantly sufficient to separate those two species. It is to be at once conceded, indeed, that sometimes with them, as with other species, slight variations occur, such as a greater interval between the lobes, more or less acuteness of the teeth, or such like accidental circumstances, but I aver that there is always a *tout ensemble* rendering the identification a matter of no difficulty. I am glad to say I am sustained in this view by that of so distin-

* 'Quarterly Journal of Microscopical Science,' N. S., vol. i, p. 1, January, 1861.

† 'Annals of Natural History,' 3rd ser., vol. v, p. 280.

‡ 'British Desmidiæ,' p. 71.

guished an authority as M. de Brébisson. That naturalist, indeed, was the first to discover and name *M. denticulata* as distinct from *Euastrum rota,* Ehr.=*M. rotata,* Ralfs; and I am pleased to find that, with his accumulated experience, he still thinks them good species, and, moreover, concurs with me in thinking my *M. Thomasiana* to be a species quite distinct, and very remarkable. M. de Brébisson ingeniously remarks, in reference to *M. rotata,* "Si l'on voulait exprimer le *M. rotata* par la designation symbolique de M. Dixon, je crois qu'il faudrait ajouter un lobe et dire: *a, b, c, d,* 'radial.'"* But I should not be disposed to acquiesce in this, as it seems, I think, evident that the middle lobes in *M. rotata* have the primary incision merely very deeply carried down, and that the primary dichotomous subdivisions cannot be said to represent two lobes; this portion in this species and that in *M. denticulata,* in which the external (middle) lobes are only twice dichotomous, are homologous (if that term can be applied to an unicellular plant without special organs), and represent the same "subdivision" (Dixon). I have to thank M. de Brébisson's kindness for dried specimens of each of those species from France, and they appear to me to be quite identical with our own.†

I now come briefly to contrast my new species with *M. rotata* and *M. denticulata;* and, as in the instances of those two species, it will be better first to point out where the new species agrees with them; but as that is, indeed, precisely in the characters in which *they* agree with one another as detailed above, it will be, therefore, quite unnecessary again to narrate those characters (vide *supra*). I say *M. Thomasiana* agrees with all the common positive and negative characters of *M. rotata* and *M. denticulata* given above, for the superficial apiculate projections on the former cannot be called either papillæ or granules; they are the summits of the eminences disposed over the frond. The former seems to me to have a greater affinity with *M. denticulata* than with *M. rotata*; indeed, in front view there is a liability of the former being confounded with it. I shall first

* 'Natural History Review,' O. S., vol. vi, p. 464; 'Proc. Nat. Hist. Soc. Dub.'; also 'Quarterly Journal of Microscopical Science,' O. S., vol. viii, p. 79, "On a New Genus and Species in the Desmidiaceæ, with some remarks on the Arrangement of the Genera and Species of Micrasterias and Euastrum," by the Rev. R. V. Dixon, A.M., Ex. F.T.C.D.

† Since this paper was read I have had an opportunity, through the kindness of my friend, Mr. W. Keay, of examining a gathering made near Dundee, in which *M. denticulata* occurred, and in no point did his specimens differ from that species collected in this country; and the same might be said of the other forms therein common to Scotland and Ireland.—W. A.

draw attention to the distinctions between them. *M. Thomasiana* is notably smaller than *M. denticulata* (as *it* is smaller than *M. rotata*); in the new species the basal and middle lobes are mostly thrice dichotomous—in *M. denticulata* they are but twice dichotomous; in the former, the ultimate subdivisions of the basal and middle lobes, when eight, are bidentate, when four only, tridentate,—in the latter they are four only, and truncato-emarginate, with rounded, or sometimes subacute, angles; in the former, the terminal emargination of the end lobe is rather deep and acute—in the latter it is more shallow and more rounded. To compare *M. Thomasiana* with *M. rotata*, the former is much smaller than the latter (which, indeed, is larger than *M. denticulata*); in the former the basal and middle lobes are mostly thrice, sometimes twice, dichomotous—in the latter the basal lobes are constantly twice, the middle lobes thrice, dichomotous; in the former the teeth of the ultimate subdivisions are not so lengthened as in the latter; in the former the middle lobe is narrow, and with nearly parallel sides below, widening above—in the latter the end lobe is more or less campanulate; in the former the end lobe is wholly included, its angles acute, the central notch deep, acute—in the latter, the end lobe is slightly but distinctly exserted, its angles somewhat produced and bidentate, its central notch shallow and rounded. But, above all, the new species is remarkably distinct from *both M. denticulata* and *M. rotata*, and, indeed, every other species, by the striking projections at the base of the segments, and by the superficial eminences. No distinctions can be drawn from the sporangium in these species, as, unfortunately, it is unknown, that of *M. denticulata* excepted. It does not appear at all requisite to compare *M. Thomasiana* with any other species, as there is none other for which there seems any chance of its being mistaken. Indeed, the only other species of Micrasterias with which I am acquainted that possess any processes or projections directed in a different plane from that of the frond, are *M. muricata*, Ralfs, and *M. Americana*, Ralfs. In those species, however, the projections are at the external margin of the segment, not at their base; and the entire form and structure and appearance of the frond is wholly and completely different, any characters in common being, of course, those only of generic value.

Some may think, I fear, that I have gone to unnecessary length in carrying out the intention of this paper. I can only apologise by saying I am anxious that these common species of Micrasterias, *M. rotata* and *M. denticulata*, remarkably beautiful and favorite microscopic objects, should be regarded in what I humbly conceive to be their true light; and if *Micrasterias Thomasiana*, with these remarks of mine, should afford any student of the Desmidiaceæ the smallest interest, and in so doing should at all contribute to the end alluded to, my purpose will have been attained.

DESCRIPTION *of a* NEW SPECIES *of* COSMARIUM (Corda), *of* STAURASTRUM (Meyen), *of* TWO NEW SPECIES *of* CLOSTERIUM (Nitzch), *and of* SPIROTÆNIA (Bréb.). By WM. ARCHER.

Family—DESMIDIACEÆ.

Genus—COSMARIUM, *Corda.*

Cosmarium tuberculatum, sp. nov.

Specific characters.—Frond very minute, constriction very obtuse and shallow; segments in front view broadly elliptic, outer margin bordered by a few very minute, opaque tubercles or granules; end view broadly elliptic.

Locality.—A small pool, near the ice-houses, on the Piperstown road, county of Dublin.

General description.—Frond very minute; in front view about one fourth longer than broad; constriction wide, shallow, forming an obtuse angle; isthmus wide; segments broadly elliptic, outer margin bordered by a few (5—7, often 6) very minute opaque superficial tubercles or granules; side view narrower, about twice as long as broad; constriction a mere gentle depression or concavity at each side, segments forming about two thirds of a circle, outer margin, as before, bordered by a few minute, opaque tubercles; end view broadly elliptic. Sporangium unknown.

Measurements.—Length of frond, $\frac{1}{2000}$ to $\frac{1}{1550}$; breadth, $\frac{1}{2330}$ to $\frac{1}{2000}$; depth, $\frac{1}{2750}$ of an inch.

Plate XII, fig. 11, front view; fig. 12, side view; fig. 13, end view; figs. 14 and 15, dividing fronds. All magnified 400 diameters.

Affinities and differences.—The very minute size, combined with the obtuse, shallow, but decided constriction, and, above all, the outer margin of each segment being bordered by the minute, opaque, or dark granules, render this little species very distinct, causing it to be almost unnecessary to compare it with any other.* It is intermediate in size between *C. bioculatum* and *C. tinctum;* but, besides the tubercles, it is quite distinct from them by its broader isthmus and more broadly elliptic segments.

Genus—Staurastrum, *Meyen.*

Staurastrum lanceolatum, sp. nov.

Specific characters.—Frond minute; segments smooth, broadly lanceolate, extremities acute, minutely apiculate; end view triangular, angles minutely apiculate, sides concave.

Locality.—Sphagnum ponds, Featherbed bog, county of Dublin, coating the moss.

General description.—Frond minute, about as broad as long, constriction forming a deep, acute notch at each side; supposing the constriction absent, the frond would present an orbicular outline; segments smooth, in front view broadly lanceolate, the outer margin slightly more convex than the inner, their opposite lateral extremities acute, minutely apiculate (though the apiculus is sometimes difficult of detection); end view triangular, angles somewhat inflated, minutely apiculate, sides concave at the centre. Sporangium orbicular, spinous; spines numerous, somewhat inflated at the base, their extremities subulate, acute.

Measurements.—Length of frond, $\frac{1}{1000}$; breadth, $\frac{1}{1000}$; diameter of sporangium, including spines, $\frac{1}{630}$; not including spines, $\frac{1}{1000}$ of an inch.

Plate XII, fig. 16, front view; fig. 17, angular view; fig. 18, end view; fig. 19, dividing frond; figs. 20, 21, 22, conjugating fronds; fig. 22, showing mature sporangium. All magnified 400 diameters.

Affinities and differences.—This species agrees somewhat with *Staurastrum orbiculare,* Ralfs, in its general external outline; but it differs therefrom in its segments being lanceolate, not semiorbicular (the constriction being not linear, but a gaping notch), and in the opposite lateral extremities not being rounded, but acute and apiculate. Its lanceolate apiculate segments separate it from *S. muticum,* Bréb. The same characters separate it from *S. Pygmæum,* Bréb., which latter has cuneiform segments, as well as the extremities of the spines of the sporangium being bifurcate, not subulate

* Unfortunately the figures (figs. 11—14) are incorrect in representing the tubercles as so large and elevated. They do not stand out, nor do they appear of the nature of the "pearly granules" of other species. They are more minute, less elevated, and more opaque than in the figure.

and acute, as in this species. From *S. dejectum*, Bréb., it may be known by its lanceolate, not elliptic, segments, and its merely apiculate, not spinous, extremities. Its lanceolate, pointed, not elliptic or reniform, segments separate this species from *S. brevispina*, Bréb., while the mucrones of the latter are rather larger, though not more conspicuous.

Genus—Closterium, *Nitzsch.*

Closterium directum, sp. nov.

Specific characters.—Frond rather slender, scarcely curved, nearly straight, linear, ends truncate; fillets indistinct; empty frond, very finely and closely striate.

Locality.—Several pools, Dublin mountains.

General description.—Frond rather slender, about fifteen to twenty times longer than broad, scarcely tapering, lower margin very nearly straight, upper also very nearly straight, but slightly depressed towards the truncate ends, giving the frond a nearly straight outline. Endochrome with indistinct fillets and a conspicuous series of large granules. Empty frond generally colourless, sometimes faintly reddish near the ends, very finely striate, the latter character sometimes difficult of detection in mounted, but quite evident in fresh, specimens. Sporangium unknown.

Occasionally a distorted specimen is met with, slightly geniculately bent, or a segment sometimes presents a somewhat irregularly curved form; but a similar circumstance is not unfrequently to be noticed in *Docidium Ehrenberghii*, which is a straight form.

Measurements.—Length of frond, $\frac{1}{91}$ to $\frac{1}{55}$; breadth, $\frac{1}{1400}$ of an inch.

Plate XII, fig. 23, frond with endochrome; fig. 24, empty frond. Magnified 200 diameters.

Affinities and differences.—This species is decidedly the straightest and most linear in form of all the genus Closterium, and it will therefore be necessary to contrast it with those only whose curvature and tapering are the most slight.

It may be advisable to contrast this species with *C. didymotocum*, Corda, *C. obtusum*, Bréb., *C. amblyonema*, Ehr., *C. intermedium*, Ralfs, *C. angustatum*, Kütz., and perhaps *C. juncidum*, Ralfs, and *C. gracile*, Bréb. This species agrees with *C. didymotocum* in its nearly straight frond and truncate ends, but they differ in the following particulars:— In the former the frond is far more slender than in the latter, which is stout, and in the former the upper and lower margins are parallel or nearly so—in the latter the lower margin is frequently curved upwards at the end, and the upper margin is convex; and in the former the empty frond is far more finely striate than in the latter, while it is more nearly colourless. *C. directum* is a more slender, more linear, more bacillar form than *C. didymotocum*, and, so far as comparative outward form merely and length and breadth are concerned, may be said to bear a relationship to that species somewhat similar to that which *Colsterium juncidum* does to *C. angustatum*, or which *Docidium Ehrenberghii* does to *D. nodulosum*. Indeed, I do not think there would be a possibility of confounding these two Closteria if seen side by side. *C. directum* agrees with *C. obtusum*, Bréb., in its scarcely tapering frond, but it differs from that species in its truncate, not rounded, ends, as well as in its striate, not smooth, empty frond. The latter, indeed, appears to me more to resemble a somewhat slightly curved Penium (so to speak) than a Closterium, as, indeed, M. de Brébisson himself remarks, nor does he refer to moving granules at the extremities. *C. directum* agrees also with *C. amblyonema*, Ehr., in its scarcely tapering frond; but the former differs from the latter in its smaller size, in its straighter outline, in its truncate, not broadly rounded, ends, and in its striate, not smooth, empty frond. *C. directum* agrees with *C. intermedium* and *C. angustatum* in its scarcely tapering frond, but differs in the ends being truncate, not rounded, and the striæ far more fine and close; moreover, those species are considerably more arcuate. *C. directum* differs from *C. juncidum*, Ralfs, and *C. gracile*, Bréb., by its straight frond, not curved downwards at the ends, and by its much less slender fronds.

Closterium Pritchardianum, sp. nov.

Specific characters.—Frond gradually tapering, curvature slight; lower margin very slightly concave, inclined upwards at the tapering, conical, truncate ends; endochrome with several fillets, and a single longitudinal series of large granules; empty frond very finely striate, reddish near the ends.

Locality.—A pool at the top of Howth, conjugated; several pools, Dublin mountains.

General description.—Frond from about ten to fourteen times longer than broad, somewhat stout, slightly curved, tapering very gradually from the centre, towards the ends more rapidly; lower margin slightly concave, and inclined upwards near the conically attenuated, truncate, reddish ends; upper margin gradually convex, sometimes very slightly depressed near the ends, owing to the upward inclination of the apices; endochrome bright green, reaching near the ends, and having beyond it, close to the apices, the active granules —large granules in a single series, longitudinal fillets several; empty frond frequently slightly reddish, especially near the ends—longitudinal striæ very fine and very numerous, in mounted specimens very difficult of detection, but in recent very readily made out. Sporangium large, orbicular, or very broadly elliptic, smooth, placed between the empty fronds, which are for some time persistent. Conjugation taking place soon after self-division, one, the younger segment of each conjugating frond, is much shorter than the other, the older, longer segment, each of which lies in a parallel position, pointing in the same direction.

It is with much gratification that I take the opportunity to name this species after a well-known microscopist, Andrew Pritchard, Esq., author of several valuable additions to microscopical literature. When, at my request, Mr. Pritchard did me the honour to permit me to dedicate this species to him, he quaintly added that his only objection was that he thought his *name* too long. I do not assent to this; but, even if it were, I might reply, that his services in the cause of microscopy have indeed been *long*, and far more than deserving of this inadequate compliment.

Measurements.—Length of frond, $\frac{1}{65}$ to $\frac{1}{48}$; breadth, $\frac{1}{750}$ to $\frac{1}{650}$; diameter of sporangium, $\frac{1}{330}$ of an inch.

Plate XII, fig. 25, frond with endochrome; fig. 26, empty frond; fig. 27, conjugating fronds with sporangium. All magnified 200 diameters.

Affinities and differences.—To me it seems that there are only four species with which there is any likelihood of this Closterium being confounded, and those are—*Closterium turgidum*, Ehr., *C. attenuatum*, Ehr. (opposed as may seem the specific names of those species), *C. acerosum*, Ehr., and *C. lanceolatum*, Kg. *Closterium Pritchardianum* agrees with *C. turgidum* in its gently curved but slightly tapering frond, in its lower margin being curved upwards towards the reddish apices, in its endochrome possessing longitudinal fillets and a single series of large granules, and in its empty frond being finely striate; but the former differs from the latter in its less stout and less curved frond, in its conical and truncate, not broadly rounded, ends, and in the striæ seen on the empty frond being far more fine and close. *C. Pritchardianum* agrees with *C. attenuatum* in the size and general curvature of the frond; but the former differs from the latter in its conically tapered, truncate ends, not suddenly contracted (more or less like the handle to an oar) into a conical point, and in the striæ on the empty frond being far finer. The lower margin being curved upwards near the extremities, seems to give this new species some resemblance to *C. acerosum*, Ehr., and to *C. lanceolatum*, Kg.; but I believe the somewhat reddish, truncate apices and longitudinal striæ will readily distinguish it from both. It is less slender in proportion to its length than *C. acerosum*, more so than *C. lanceolatum*, and the upturned conico-truncate ends seem to me very characteristic. There appears to me no danger of mistaking this form for *C. Ralfsii*, so decidedly distinguished by its turgid, ventricose body, and prolonged, beak-like extremities.*

Closterium is a genus in which it is difficult always accurately to define in words the specific distinctions, resting in allied species, as they frequently do, on more or less stoutness or slenderness of frond, more or less degree of curvature, more or less rapidity or slowness of tapering, more or less acute or more or less broadly rounded or truncate apices, and, in the striate species, on more or less fineness or coarseness of, or distance between, the striæ. But I believe such distinctions to be here equal in value, and quite as reliable, as more striking characters in other genera, different allied species of Closterium possessing such in different and constant degrees of combination; and I cannot admit, because

* Notwithstanding that, when reading this paper, I had almost thought it unnecessary to compare my *Closterium Pritchardianum* with *C. Ralfsii*, I have been not a little puzzled to find, in a collection of dried Desmidians which I lately had the pleasure to receive from M. de Brébisson, certain specimens marked "*Closterium Ralfsii*," which, upon examination, I cannot perceive to be distinguishable from my *C. Pritchardianum*. I have not myself met with living specimens I could by any means refer to *C. Ralfsii*, relying, of course, on the description and figures in 'The British Desmideæ,' and from which, beyond any question, my plant differs completely. Indeed, the prolonged, beak-like extremities, as described for *C. Ralfsii*, would at once justify an assumption that the sporangium would be cruciately lobed, not orbicular, that is (supposing the genus to be admitted), it would fall under Stauroceras, Kütz., whereas my plant is perfectly distinct as regards the form of the sporangium, besides differing in that of the frond. But in order to more completely satisfy myself, I requested Mr. Ralfs to allow me to see some of his specimens of *C. Ralfsii*, and I have to thank him for his kind compliance. Having, then, compared Mr. Ralfs' specimens, and the description and beautiful figure in 'British Desmidieæ' with my plant, I think there cannot be a shadow of doubt but that *C. Pritchardianum* is wholly distinct in every respect from *C. Ralfsii*, and I feel satisfied the former has not been before described. There must, therefore, be some mistake in regard to M. de Brébisson's specimens, but which I have not yet had an opportunity to clear up, and under the circumstances I have thought it advisable to append this note.—W. A.

the distinctions between certain neighbouring species, as compared with each other, may sometimes depend on a *more or less* as regards certain common characters, that therefore good and quite distinguishable species do not exist in this genus. Difficult as it may be (to me at least) to define those distinctions, there is at least always a *tout ensemble*, a general *contour*, a certain definite combination of characteristics in the same species, whenever met with, which, when they impress themselves on the eye and memory, render the identification by no means difficult. I have never seen even a solitary instance of conjugation except of like admitted species with like. I therefore imagine, on the whole, it may be quite possible that certain of the Closteria described by Continental writers, which (if erring, at least, I apprehend, erring on the right side) I have been disposed to think are identical with previously described forms, may be really quite distinct, could one but see the actual specimens. But be this as it may, however I may fail to convey by my description the valid distinctions which I conceive to exist between the foregoing Closteria and the nearest allies of each, I have no doubt of them myself, from a careful examination of the living specimens; and I am glad to say that, having had the honour to submit specimens to M. de Brébisson, my own opinion is coincided in by that high authority.

Genus—Spirotænia, *Bréb.*

Spirotænia truncata, sp. nov.

Specific characters.—Frond cylindrical, but tapering near the truncate ends; endochrome a single, rather closely wound, spiral band, leaving a minute clear space at each end, often containing one or more free granules.

Locality.—Featherbed Mountain, co. Dublin, in small pools; rare.

General description.—Frond minute, five to eight times longer than broad; cylindrical, but tapering towards the extremities, ends truncate; endochrome at first a single, rather closely wound, spiral band, its revolutions few, frequently afterwards scattered and indistinct in each fully grown frond, leaving at each end a minute, semicircular, clear space, in which there occur one, or perhaps two, free granules; gelatinous investment very evident.

Measurements.— Length of frond, $\frac{1}{500}$; breadth, $\frac{1}{3500}$ of an inch.

Plate XII, figs. 28, 29, mature frond; figs. 30, 31, recently divided fronds. All magnified 400 diameters.

Affinities and differences.—The cylindrical frond tapering towards the ends in this species renders it somewhat like in outline to that of *Spirotænia obscura*, Ralfs, with which it also agrees in having a clear space containing often one, occasionally two, or even three, free granules; but it differs from that species in its greatly more minute size, in its truncate, not broadly rounded, ends, and in its endochrome forming a solitary, not several spiral bands. With *S. condensata*, Bréb., *S. muscicola*, De Bary, and *S. erythrocephala*, Itzigsohn, it agrees in its single-spired endochrome; but its tapering, truncate ends well distinguish it from the broadly rounded ends of the two former and from the acute ends of the latter, besides other characters in each instance, as is readily seen by the foregoing description. From *Endospira closteridia*, Bréb.,—a species which I apprehend ought to be referred to the genus Spirotænia—this form is distinguished by its larger size, by its straight and cylindrical, not arcuate or sublunate, outline, as well as by its truncate ends and terminal clear space. Its larger size, truncate ends, and broad spiral band, readily separate this from the following new species.

Spirotænia parvula, sp. nov.

Specific characters.—Frond very minute, slender, fusiform, ends subacute; endochrome obliquely parietal, scarcely spiral.

Locality.—Featherbed bog, Dublin mountains, in Sphagnum pools, on the moss. Not unfrequent, but readily overlooked on account of its very minute size.

General description. — Frond very minute, five to eight times longer than broad, fusiform, ends subacute; endochrome a single, oblique, parietal band, often scarcely forming a spire, but frequently presenting to view apparently three darker portions of elongate form, one towards each end at the same side of the frond, the other at the middle at the opposite side, thus leaving between them a very narrow, eccentric curved, clear space; gelatinous investment of great tenuity, and rendered evident only by preventing the contact of foreign bodies and by holding together the recently divided fronds.

Measurements.—Length of frond, $\frac{1}{636}$ to $\frac{1}{1400}$; breadth, $\frac{1}{5600}$ to $\frac{1}{7000}$ of an inch.

Plate XII, figs. 32 to 43, mature and recently divided fronds. All magnified 400 diameters.

Affinities and differences.—The scarcely spiral, sometimes scattered, endochrome, at first made me hesitate to consider this plant as belonging to Spirotænia; but as it frequently seems to form an oblique parietal band, and the self-division, as in other species of the genus, is oblique, and the divided fronds held together by a gelatinous investment, there can, I apprehend, be no doubt but that in this genus this minute little form finds it proper location. Moreover, I have seen *some* specimens in which the endochrome clearly made a spiral turn, though in the majority of instances the condition I have tried to describe above is seen; and not unfrequently, as in other species, a confused or irregular condition of the endochrome exists. Its very minute size, subacute extremities, and without a clear space, easily distinguish this from other described species of Spirotænia. It really appears to approach more to *Endospira closteridia*, Bréb., Kg. (which plant, as I before stated, I apprehend should fall under this genus); but it is distinguished by its fusiform, not at all arcuate, and by its narrow, outline, as well as by its obscurely convoluted, not distinctly and smoothly spiral, endochrome.

On a New (?) Species *of* Ankistrodesmus (Corda), *with Remarks in connexion therewith as regards* Closterium Griffithii (Berk.) *and* C. subtile (Bréb.). By William Archer.

I have, on the present occasion, to draw attention to a very minute organism, but which, indeed, so far as I can see, I can scarcely allude to as a new species; for I conceive that it has been more than once previously described, but I think I shall be able to render it probable that it has been so under an erroneous designation. Of course, the truth of this assumption depends on my being right as to the identity of my plant with that of the authors alluded to, as well as upon my own proper appreciation of its characteristics and the correctness of my own conclusions in regard to them. I shall now, however, give the characters of the plant according to my own view, adopting, in doing so, the same mode that I have done in other species, reserving the reasons why I venture to differ from those who have previously described what, as I before stated, I conceive to be one and the same organism, for the paragraph which I, as previously, head "Affinities and differences."

Genus—Ankistrodesmus, Corda.

General characters.—Cells minute, smooth, elongated, attenuated, more or less numerously aggregated, forming fasciculi or families, each family resulting from the self-division of a single cell, which commences by the formation of a somewhat oblique septum at the middle, continually rendered more and more oblique from the young cells growing alongside one another longitudinally until they each attain the length of the original parent cell, the process being again and again repeated by each, till the aggregated family consists of at most thirty-two cells, the family finally again breaking up into single cells (Nägeli).*

Ankistrodesmus acutissimus, mihi.

Specific characters.—Cells fusiform, straight, very slender, gradually tapering, very acute.

Locality.—I have noticed this curious little production for two successive years in bog-water kept for some time in the house, and obtained from pools in the Dublin mountains.

General description.—Cells very minute, twenty to twenty-five times longer than broad, fusiform, very slender, straight, very acutely acicular, solitary, or forming fasciculi of two or four cells; endochrome light-green, mostly with a minute parietal, semicircular or rounded (nuclear?), pale body or space placed near the middle of the cell (that is, equidistantly from each end, but close to one side), otherwise usually apparently homogeneous, sometimes slightly granular.

Measurements.—Length of cells, $\frac{1}{500}$ to $\frac{1}{700}$; breadth, $\frac{1}{10000}$ to $\frac{1}{14000}$ of an inch.

Plate XII, figs. 44 to 56, mature and dividing fronds; fig. 57, for some time mounted in "Thwaite's fluid." All magnified 400 diameters.

Affinities and differences.—I have no doubt but that the plant at present under consideration is identical with *Closterium subtile*, Bréb.,† and, I am strongly inclined to suspect, also with *Closterium Griffithii*, Berk.;‡ hence, of course, that those writers have described one and the same thing under the names mentioned. Neither author, however, has described or figured the mode of cell-division in his specimens,

* 'Gattungen einzelliger Algen,' pp. 82, 83.

† 'Liste de Desmidiées observées en Basse-Normandie,' p. 155.

‡ 'Annals of Natural History,' 2nd ser., vol. xiii, p. 256.

a character, as I apprehend, of primary importance in separating Closterium from Ankistrodesmus. Conceiving that I am right in supposing my plant to be specifically identical with theirs, and as I think my account of the cell-division to be correct, I believe I am justified in referring the plant in question to Ankistrodesmus, and not to Closterium. To adopt the plan I have pursued in regard to *species*, let us compare and contrast for a moment the *genera* Closterium and Ankistrodesmus; the latter genus, I think there can be no doubt, is quite equivalent to Raphidium, Kg., and I cannot see why Kützing should reject a prior name.

Closterium and Ankistrodesmus agree, then, in the cells having an elongate, more or less attenuated, often arcuate, form; but they differ in several striking points. In the former genus there is always a pale *transverse* band at the middle of the frond or cell, and arising from a suspension or interruption of the denser endochrome at this region; and this pale space is apparent, no matter what side of the frond is towards the observer. In the latter genus there is, indeed, often a clear space at the middle (as indicated in the form under consideration), but it seems to me of a different nature. Here, in fresh specimens, it does not form a transverse band, due to interruption of endochrome, but a rounded or semicircular or oblique, smoothly defined spot (of nuclear import?), laterally disposed, and closely approximated to the boundary wall, that is, eccentric and parietal. It is true that it sometimes looks as if it were not so; but I am disposed to think that this appearance is only when it is uppermost, and consequently towards the observer; while, on the other hand, as is frequently the case, it may appear absent when it is on the side turned away from the observer. In Closterium it is true that a rounded body occupies the middle of the clear space (possibly nuclear); but it is, at all events, not parietal, but placed in the very centre of the contents, and it looks, indeed, scarcely different in nature from the scattered or longitudinal series of amylaceous large granules frequently present, of which it seems but to form one. Again, in Closterium there is always a clear space at each extremity of the endochrome, in which a greater or less number of opaque, very minute, but sometimes variably sized, granules exert a remarkable constant active movement (as is well known), which apparently is maintained during the whole life of the organism. In some species there appears a special vacuole in which these occur, in others they merely occupy a vacant space immediately beyond the rest of the endochrome, leaving the rest of the frond clear. In Ankistrodesmus there are no such granules. It is true that Mr. Berkeley alludes to a circulation of fluid contents in his *Closterium Griffithii* (seen only under a power ranging from 1000 to 1500 diameters); but this circumstance is of no generic or specific importance. It is common, indeed, in Desmidiaceæ. Again, in Closterium the self-division is transverse, taking place at the middle of the frond; and, when completed, a new segment is merely a rounded or somewhat triangular protuberance, and the frond, consequently unequal (figs. 61 and 62 afford an example), presently the new, short, rounded segment elongates into a complete counterpart of the older segment, assuming whatever may be the mature characteristic specific form. In Ankistrodesmus the self-division commences in a slightly oblique manner, presently rendered more and more oblique by the younger portions growing alongside one another longitudinally, the process being again and again repeated, until an aggregated fasciculus of cells, greater or less in number, is produced. Now, the aggregated fasciculated character of the cells in this genus has been, I apprehend, looked upon as one of primary importance. I imagine it is only of secondary, and in its place as primary, I should think, the obliquely dividing, slender, attenuated cells should come, and the circumstance of those cells being aggregated into fasciculi (in *A. falcatus,* forming dense, fagot-like bundles) be regarded rather as an accidental or secondary, but very far from unimportant, character. Free cells are frequently met with of even *A. falcatus,* in which, on the other hand, the fagot-like bundles are often very large, many cells (thirty-two at most, Näg.) being combined together. It is only the most minute species of Closterium that are comparable in dimensions with any Ankistrodesmus.

Now, my plant has not a transverse band at the middle (in recent living specimens), but only a rounded, clear spot at one side of the cell; it has no clear space near or at the end containing moving granules; its self-division is oblique, and the cells frequently remain combined in twos or fours; therefore, I believe it is an Ankistrodesmus. It is true that, unlike *A. falcatus,* the aggregated families do not form fagot-like bundles, a character given as generic;* but in that species solitary cells, as well as small families of two or four cells, are frequent, the larger number eventually arising from the self-division of a smaller. I have not been able to follow out Nägeli's observations as to the mode of growth in *A. falcatus,* but in a plant which I refer to *Ankistrodesmus*

* Ralfs, 'British Desmidieæ,' p. 179; Kützing, 'Species Algarum,' p. 195 (Raphidium).

convolutus, Corda—a form I presume to be equivalent to *Raphidium minutum*, Näg.—self-division occurred after the same mode as that described, and the aggregated families consisted of at most eight cells. This was rare, but two and four common; Nägeli referred this (?) plant to Raphidium, Kg. = Ankistrodesmus, Corda, on *à priori* evidence only, as he had not seen its self-division.*

It may, perhaps, seem somewhat premature to assume my plant as identical with *Closterium Griffithii*, Berk., and *Closterium subtile*, Bréb., seeing that the characteristics relied on by me as generic, in regard to the former, are unknown or unfurnished in regard to the two latter. It is true that in the former instance I found my assumption rather on *à priori* evidence, and I cannot, therefore, feel perfectly confident that I am right. My plant agrees with Mr. Berkeley's in very many ways—in form, in the central pale space, in the absence of moving granules, and in its occurring in long-kept samples of water. It nevertheless differs in size, my plant appearing to be smaller; and Mr. Berkeley's figures indicate a few larger granules in the endochrome, disposed in a longitudinal series. Taking it, however, for granted that I am right in supposing my plant and Mr. Berkeley's to be identical, and that I am also right in my appreciation of the generic characters, I should perhaps have used his specific name; but I *may* be wrong in assuming their identity, for I conceive it not improbable that two organisms might resemble very much in form, but differ in nature, as might be evidenced by their mode of development. Therefore I thought it better *not* to take his specific name. But any doubt as to my plant being identical with M. de Brébisson's is removed by my having forwarded, amongst others, specimens of my plant to him; and, in a list returned to me by him of the objects which he had met with on the slides, he includes "*C. subtile,*" alluding to the very specimens in question. I have not since had the opportunity of having the honour to lay my ideas as to the nature of this plant before him, and consequently cannot say whether he may coincide or not with what I have above laid down in regard to it. It may seem, therefore, that, if not Mr. Berkeley's, I ought to have adopted M. de Brébisson's specific name; but as there appears to me so strong a probability that Mr. Berkeley's plant *is* indeed the same thing, and his name being prior, I thought it, under the circumstances, better to adopt a specific name different from both.

Seeing that a true generative process (such as conjugation) is unknown in Ankistrodesmus, no propagation being known,

* Op. cit.

save mere self-division in the manner described, the position of the genus is, therefore, doubtful.

Probably, for the present, it is best to consider it as a doubtful or aberrant genus of Desmidiaceæ. Its oblique self-division, so far as it goes, is somewhat like that of Spirotænia, but there is no further resemblance. Nägeli* and Rabenhorst† place Raphidium (equivalent to Ankistrodesmus) amongst Palmellacæ; but the very elongate, acute cells are very unlike anything else in that family. De Bary‡ alludes to this genus as doubtfully Desmidian.

Assuming that I have proved my plant to be a true Ankistrodesmus, and not a Closterium, it may be well to compare it with the other admitted species of that genus. It agrees with *A. falcatus* in its very slender and acute cells, but it differs from it by its straight, not arcuate, cells, by its fusiform, more quickly attenuated, cells, by its more intensely acute extremities, and by the constituent cells of an old fasciculus being much fewer in number. It is, indeed, a very different plant. This form scarcely agrees at all, except generically (as I think), with *A. convolutus*, Corda, the cells differing, as they do, in their very slender (not, comparatively, stout) form, in their straight (not crescent-shaped) outline, and in their extremely acute extremities. With *A. contortus*, Thuret, this form agrees in the very acute cells, but it differs in their straight (not arcuate or sigmoid) form, and in the cells being not inflated at the middle.

I have in the foregoing remarks alluded to the distinctive characters of Closterium and Ankistrodesmus as regards the mode of self-division. I conceive it may be quite worth while, in connexion therewith, to draw attention to a remarkable state of *Closterium acutum*, Bréb., (it may be *C. subulatum*, Bréb., but I am disposed to think these are synonymous). This consists of a curious aggregation of fronds of that Closterium into chains and bundles in the manner I represent in the accompanying sketch of some of the most remarkable of these cases (figs. 58 to 60, × 200). The fronds were sometimes juxtaposed side by side, sometimes irregularly, at other times combined into a kind of chain, while multitudes of fronds, in the ordinary free condition, abounded in the gathering. This, whatever it portend, was no accidental juxtaposition; for they, not unfrequently, in order to accommodate themselves to one another in the combination, were of a sigmoid or otherwise curved and bent character, yet no

* Op. cit.

† 'Algen Sachs.'

‡ 'Untersuchungen über die Familie der Conjugaten,' p. 77.

gelatinous matrix was apparent, and I cannot say what may have held them together. Of the meaning of this very remarkable condition I cannot form any idea, except to guess the possibility of its being an approach for the purpose of conjugation, on a scale, indeed, wholesale. No alteration took place, either in their internal or external appearance, though kept for some time; and I then unfortunately lost the specimens. One thing, however, seems to me certain—the hanging together of the fronds in the manner shown did not indicate longitudinal self-fission after the mode in Ankistrodesmus, for in the same gathering dividing fronds occurred after the manner normal and generic in this and other species of Closterium (figs. 61, 62, × 200), and the combined fronds were all mature and fully grown, and were quite specifically characteristic.

On the Practical Application *of* Photography *to the* Microscope. By Professor O. N. Rood, Troy, N.Y.

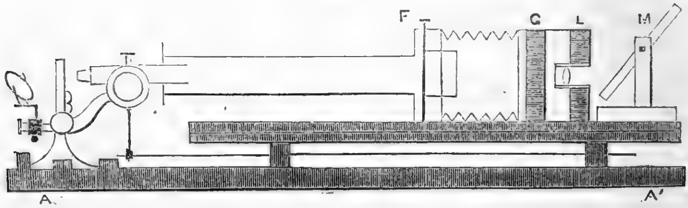
While the value of the photographic delineation of microscopic objects, as a means of accurately recording observations, seems to be generally acknowledged, yet, owing to the real or imaginary difficulties with which the process is beset, but very few working microscopists have adopted it.* After eight months of steady experimental work on the subject, this fact appears to me a matter of astonishment, for the difficulties, which are not inherent, mostly disappear when proper precautions are taken. I propose to mention briefly certain points in my experience, and to indicate the methods pursued.

Arrangement of the apparatus.—The microscope is brought into a horizontal position, and connected with a camera box

* In Vienna microscopic photographs have been produced under the direction of Auer. Pohl and Weselsky have also worked at this subject. ('Sitzungsbericht d. Kais. Akad., 1857, xxiii, vol. 1, page 317); at an earlier date Mayer, of Frankfort, obtained fine photographs of this kind. Bertsch presented similar results to the French Academy ('Comptes Rendus,' 1857, xliv.) Nachet also obtained good results. Hodgson ('Quart. Journ. of Micros. Science' 1853, ii, p. 147), Delves (3d No. of the same, p. 57), Shadbolt (ibid., p. 165), Huxley (ibid., p. 178, also No. 4, p. 305), Wenham (same journal, 1855, No. 10, p. 1), and Kingsley 'Phil. Mag.,' (1853, June, p. 461), have published accounts of their more or less successful results. Harting 'On the Microscope,' *Braunschweig*, 1859. To the above must be added the great work now being issued in numbers in Munich, entitled 'Atlas der allgeminen theirischen Gewebelehre, herausgegeben von Th. v. Hessling und J. Kohmann, nach der Natur photographist von Jos. Albert.'

by a blacked pasteboard tube. Much vexation will be avoided by constructing at the outset the arrangement seen in the woodcut, Fig. 1. Blocks are fitted around the foot of the

Fig. 1.



microscope, that it may be firmly held in position, and the camera box slides between parallel strips of board, so that its distance from the microscope can be varied. The length of A A′ is seven feet; the frame holding the ground glass slides in at G; behind it, at L, is a door on hinges, carrying an achromatic lens of two inches focal length, for the purpose of magnifying the image on the ground glass while focusing. The glass plate should be finely ground. A tube, lined with black velvet, is to be inserted in the compound body, as recommended by Shadbolt, if the eye-piece is not employed. Precautions must, of course, be taken that light does not enter at unguarded points. At F is a rod connected with a flap of blackened sheet brass in the interior of the box, with which the exposure of the sensitive plate is very conveniently effected. It is obvious that, while the operator is manipulating the mirror, or using the stage movements, on account of the length of the apparatus it is impossible for him to see the ground glass, or even to know when light has been thrown on it. A plane mirror, mounted as seen at M, reflects the image of the ground glass, enabling him not only to arrange the illumination with nicety, but to select the microscopic object, and to focus on it approximately. While the mirror is in use the door carrying the achromatic lens stands open; the mirror is afterwards removed, and the focal adjustment completed, with the help of the lens, by the rod and lever attached to the rack work of the microscope. If the rack work is moderately good, this arrangement is very delicate. When a high magnifying power is employed, it is essential that the microscope be provided with stage movements, to bring the object into its proper position. The lever stage is not to be recommended for this purpose.

Illumination of the object.—That direct sunlight is greatly to be preferred is admitted by those who have experimented on this point. With light from a white cloud I have obtained negatives in from one to three minutes, with 1-inch and $\frac{1}{3}$-inch objectives; though not highly magnified, they were inferior to those taken with sunlight. Shadbolt obtained negatives by concentrating the light of a small camphene lamp on the object with two lenses. Wenham, in repeating this experiment, met with no success. I concentrated the light of two flames of a "burning fluid" lamp, with a bull's-eye condenser, on the object, employing the 1-inch objective without an eye-piece, and obtained, with several samples of collodion from different manufactures, absolutely no image at all, after an exposure of five minutes. With samples prepared by myself tolerably intense negatives were obtained in four minutes. With the $\frac{1}{3}$-inch objective a faint image was obtained in the same time. For my own work direct sunlight is always employed.

It is well known that the proper display of microscopic objects requires that great attention should be given to their illumination, not only in degree, but in kind; much has been written on this subject, and an astonishing amount of labour bestowed on it. All this applies with double force to the illumination preparatory to the introduction of the sensitive plate; refined methods here find a most useful application. If the power employed be under 100 diameters, the plane or concave mirror will answer, if the stage be provided with a diaphragm-plate having apertures of different size. The mirror should be most carefully adjusted, so that the maximum of distinctness in the image on the ground glass is obtained. I was kindly furnished by Professor Charles A. Joy with a *silvered* mirror which Liebig presented to him some months ago while on a visit in Europe. It furnished brighter light than the ordinary amalgam mirror; the use of Liebig's mirrors for this purpose, as well as for ordinary microscopic work, is to be recommended. With powers from 100 to 2000 diameters, a condenser of some form is needed; for powers from 100 to 400 diameters, an achromatic condenser, adjustable by rack work, was used. Such a condenser must be provided with a series of diaphragms, having circular apertures differing in size; also with a set of central stops for annular oblique illumination.

Trial alone will settle which aperture gives the clearest image in any particular case. As the lenses of this condenser were not large, I constructed, for powers from 400 to 2000 diameters, a Wollaston doublet, with an angular aperture of 44°, the lenses being ·5 and ·6 of an inch in diameter. This condenser, when provided with a similar set of diaphragms, was found to answer very well, both as to the degree and quality of the light, negatives being obtained in fifteen seconds, enlarged 1500 diameters. As the chromatic aberration was not corrected, it was found easy to illuminate the object either with white or bluish-white light, use of the red or yellow rays being, of course, carefully avoided.

The proper distance of the condenser from the object is a point of much importance, and is best ascertained by carefully repeated trials. To obtain really good results, much nicety in arranging the illumination is required; this is a matter in which microscopists are well practised, but to secure the best results possible *under the circumstances*, as in photographing test-objects, the art and patience of the operator is taxed to the utmost, and several days are often consumed before a really satisfactory result is attained, even in the case of a single object.

Focal adjustment, &c.—Trouble will be saved by selecting the exact object which is to be photographed by the microscope in an upright position; the instrument is then inclined and connected with the camera. After the compound body is thus placed, if the objective is provided with a "screw collar" for correction, this adjustment must be *carefully made*. Even when this point has received attention, it by no means follows that the chemical focus coincides with the visual, and the exact correction necessitated by this difference must be ascertained by trial. This can be effected by the use of the fine adjustment (see Shadbolt's paper). Contrary to some other observers, I have found it necessary when using sunlight, with both high and low powers, with and without eyepieces, to make this correction carefully. The use of the rod and the lever and achromatic lens has already been mentioned. After the corrected image has been thrown on the ground glass, it will remain nearly unaltered from thirty seconds to ten minutes, according to the power and mode of illumination employed.

Collodion.—This article, when furnished by makers of repute, can, of course, be used, though it is better, for more than one reason, to be independent of the dealers, if possible. A considerable number of samples of pyroxyline were prepared according to different receipts, and sensitized variously. The very simple process described by Waldack, on page 266 of his 'Treatise on Photography,' was found, with slight modifications, to yield an excellent article.* The strength of the sulphuric acid was slightly greater than recommended by him, no water was added, the temperature also was slightly

* 'Treatise on Photography,' by Chas. Waldack, Cincinnati, 1860.

higher at the time of the immersion of the cotton; a more prolonged washing than that prescribed in this work is desirable. This collodion can be sensitized with advantage by the iodide and bromide of cadmium, in the proportion of four to one. A receipt published in 'Humphrey's Photographic Journal,' has lately been used by me with very good results.*

No. 1.	No. 2.
Plain collodion, 1 oz.	Plain collodion, 1 oz.
Iodide of ammonium, 5 grs.	Iodide of potassium, 5 grs.
Bromide of potassium, 3 grs.	Bromide of ammonium, 3 grs.

Dissolve the iodide of ammonium and bromide of ammonium in alcohol, the iodide of potassium and bromide of potassium in the least possible quantity of water, before adding them to the plain collodion. Mix Nos. 1 and 2 in equal parts for use.

This collodion, when used according to the wet process, though not very intense when first made, is quite sensitive, negatives of landscapes being obtained in a quarter of a second, indicating by their strength that a shorter time would suffice. It acquires intensity by keeping. The exposure is effected by the flap at F, and will last from a quarter of a second to four minutes, according to circumstances. The development is as usual, hyposulphite of soda being used as a fixing agent. The use of the bromide of arsenic, mentioned in the same journal, gave, with some samples of collodion, excellent results, so far as intensity was concerned.

The negatives thus obtained are examined by a lens of 1-inch focal length, to test their degree of sharpness. This quality will not only vary with the manipulation, but with the nature of the object; the sharpest negatives obtained by me, when examined by a power of forty diameters, appear as well defined as finely executed lithographs seen by the naked eye, while other classes of objects (dots in pine wood, &c.), with all care, yield negatives which present the same appearance under a much lower magnifying power.

Positive prints.—In order to preserve the fine details, the prints should be taken on glass, not on paper; mica answers when a print is to be transmitted by mail. Great care should be used that little or none of the fine markings on the negative are lost in this process; a bright light (sunlight thrown on the negative backed by ground glass), a small diaphragm before the copying lens, and careful allowance for the chemical focus, are the essentials. To produce enlarged positive prints on glass, the negative is placed on the stage of the micro-

* 'Humphrey's Journal,' Joseph H. Ladd, New York.

scope and treated like a microscopic object, the magnifying power varying from five to twenty diameters. If the prints are to be on *paper*, it will be found that a more liberal use of nitrate of silver and chloride of gold than is generally recommended makes success easy.

Magnifying powers employed.—To produce enlarged images, the objectives, as is well known, may be used alone or in connection with an eye-piece. In the former case, with proper illumination, sharp images are produced when the distance between the object (on the stage) and the ground glass is as great as five feet. With this distance the

1-inch	enlarges	65	diameters.
$\frac{1}{3}$	"	190	"
$\frac{1}{7}$	"	460	"

In using the objectives in this way the screw collar is set *after* the microscope is connected with the camera.

For more highly enlarged images, it is best to add the long eye-piece, as has been practised by some experimenters. The adjustment of the screw collar can then be very nearly completed before the microscope is connected with the camera, which is a great saving of time; it will, of course, fall nearer the mark "uncovered" than in the first case. However perfectly this operation may be performed in either instance, allowance must still be made for the actinic focus. By varying the distance between the eye-piece and the ground glass, different degrees of enlargement are obtained. When the long or 2-inch eye-piece is used, the distance from the object-slide to the eye-*lens* being twelve inches, from the latter to the ground glass thirty-four inches, then

1-inch	enlarges	160	diameters.
$\frac{1}{3}$	"	550	"
$\frac{1}{7}$	"	1300	"

Powers obtained in this way with the two latter objectives have been used by me with advantage.

Thus with the $\frac{1}{7}$th, 113° aperture, the Wollaston doublet of 44° aperture, having a central stop, being used as a condenser, I obtained sharp negatives of *P. angulatum* magnified 1300 diameters, with well-defined hexagonal markings similar to those obtained by Wenham with a $\frac{1}{12}$th of 130° aperture. Portions of the negative bore a photographic enlargement of ten diameters. Mr. Wenham announces* that he has discovered, by the use of a $\frac{1}{50}$th of large aperture, made by himself, that the markings on this object and on some others are really due to spherical particles of quartz, which can be

* 'Quart. Journal of Mic. Science,' No. xxxi, p. 145.

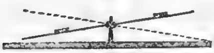
made by illumination to appear hexagonal. With a power too low, I obtained photographs of the *P. Balticum* with *hexagonal* markings; with a higher power and larger angle of aperture the tendency was to the spherical form.

Photographs by polarized light.—A Nicol's prism is placed under the stage, one also directly behind the objective; sunlight is reflected from the mirror, and one of the prisms revolved till the field is dark; with the low powers, by this simple arrangement, photographs of objects may be obtained which exhibit the structure revealed by the polarized light. For higher powers it is necessary to use the polarizing arrangement described by Von Mohl, 'Pogg.,' vol. cviii, p. 178, and recommended by Carpenter; that is, the light from a large Nicol's prism is concentrated on the object by an achromatic condenser. The perfection with which this apparatus operates may be inferred when I state that photographs of the cross and rings in starch-granules as well as of the *P. angulatum* in a dark field, were obtained by me without difficulty. Von Mohl remarks that, with inferior apparatus, some very distinguished observers have been unable even *to see* these appearances. The selenite stage can, of course, be used when it is found desirable.

By arranging the apparatus according to the plan adopted by Professor v. Kobell in his micro-stauroscope (Silliman's Journal, [2] vol. xix, p. 425), the peculiar effects which microscopic crystals produce on the cross and rings of calc spar, can be photographed. By removing the condenser and objective, as well as the slide containing the crystals, beautiful photographs can be obtained of the normal cross and rings; the systems of rings in other crystals can be photographed by substituting them in place of the calc spar, as well as the changes which they undergo by combination with plates of doubly refracting substances (circular analysis, &c.), it being merely necessary to introduce the plates or films at the proper positions. I was shown by Professor Dove some years ago, while in Berlin, photographs of the normal cross and rings around the axis of the calc spar, but, so far as I know, this is the first attempt to photograph the changes which the cross and rings undergo by the action of microscopic crystals.

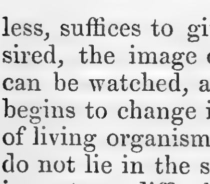
Stereoscopic photographs of microscopic objects can be obtained with the monocular microscope, by covering, first, the right half of the objective, then the left, by a suitable brass cap, and taking two successive pictures. When using this method it becomes necessary to move the mirror towards the right or left hand with each successive exposure, which is not only inconvenient, but often produces a slight distortion, that prevents the proper stereoscopic union of the two photographs. On this account I have generally adopted a different plan :—the object is placed on an extra stage, which can be inclined from 5° to 10°, as seen in profile in the woodcut, Fig. 2. It is photographed first at one angle, then at the other. In practice the manipulation is easy, and no particular difficulty is experienced from the fact that the extreme right and left hand portions of the field are thrown slightly out of focus. High and low powers can be used equally well. The second negative should be taken immediately after the first, before the illumination has altered. I do not know that stereographs of microscopic objects have actually been taken by other experimenters, though this may easily be the case.

Fig. 2.



Living organisms offer the photographer some difficulties, by their constant motion about the field and in and out of the focus. It becomes necessary to adopt a plan by which the image can be thrown on the sensitive plate the very instant after the animalcule has been brought into focus. The following method has been used by me with success, to obviate this particular difficulty :—a plate of glass, with parallel sides, is introduced at an angle of 45° into the tube outside of the camera; it reflects an image of the object to the ground glass at G, Fig. 3, which is placed so that an equally sharp image of the same object is formed at G′. The sensitive plate is introduced at G′, the flap at F being closed; with one hand the operator, by the aid of the image at G, focuses on the animalcule; just as this is effected, the plate is exposed by the other hand turning the flap. If the collodion is sensitive, a second, or less, suffices to give an image; if a longer exposure be desired, the image of the animalcule on the ground glass at G can be watched, and the exposure prolonged till the creature begins to change its position. The real difficulty, in the case of living organisms, is found in the fact that all parts of them do not lie in the same focus; this, in fact, is one of the most important difficulties connected with the whole subject of microscopic photography. But the introduction of a slight modification in the ordinary compressorium removes it in many cases; the plate of glass on which the objects rest, instead of being plane, is made slightly *convex*, by the use of a spectacle-lens of rather long focus. Objects to be examined are placed near the point of contact, and pressure applied as usual when they are brought nearly into the same plane.

Fig. 3.



Photographs of opaque objects were obtained by concentrating sunlight on the object, either with the concave mirror, properly mounted, or with the plane mirror and bull's-eye condenser. The $1\frac{1}{2}$-, 1-, and $\frac{1}{3}$-inch objectives were employed. The colour of microscopic injections for this purpose should be blue or white, though, with a long exposure, photographs were obtained of yellow injections.

I am indebted to Dr. Wolcott Gibbs and G. T. Strong, Esq., for valuable suggestions relating to the subject of this article.

As some interest has lately been manifested with regard to eye-pieces, it may be proper to state that, in the course of this investigation, three eye-pieces were constructed—No. 1 on the general Huyghenian plan, the eye-lens being an under-corrected *achromatic;** the distance between the eye- and field-lens could be varied at pleasure, as advised by Amici. As a single microscope, its power was eight diameters. The general performance of this eye-piece seemed to me somewhat better than that of the plain Huyghenian eye-pieces with which it was compared.

No. 2 was a Kellner eye-piece; the distance between the lenses could be varied; alone, it enlarged twelve diameters. The performance was good. No. 3 consisted of two under-corrected achromatic lenses combined, in the Huyghenian manner; alone, it magnified twenty-five diameters. When used as the eye-piece of a telescope, it gave a pretty good image; as a microscopic eye-piece, it was inferior to No. 2, in spite of its superior magnifying power, except, perhaps, when used with well-corrected objectives of large, angular aperture. With all three eye-pieces the correction of the objectives remained unaltered in kind.†

TROY, NEW YORK;
July 1st, 1861.

* The orthoscopic eye-piece of Grunow consists of an eye lens partially achromatized in combination with a field lens differing in form from the ordinary Huyghenian.—O. N. R.

† After this article was in print, I received from a friend a paper of Amasa M. Eaton, Esq. 'Proceedings B. S. N. H.,' vol. viii, p. 105. Mr. Eaton has devoted himself with success to the production of *ambrotypes* of microscopic objects.—O. N R., Troy, N. Y., July 23rd, 1861.

TRANSLATIONS.

On the Transmigration *of the* Entozoa.

The following is a summary of M. V. Beneden's remarks upon the communication of MM. Pouchet and Ferrier, given in our last number.

MM. Pouchet and Verrier state that, according to M. V. Beneden, the *Cœnurus cerebralis* is the larva or scolex of *Tænia serrata.* But in order to show that that is not his opinion, the latter remarks that, in his 'Mémoire sur les Vers intestinaux,' as well as in the 'Zoologie Médicale,' the tapeworm derived from that cystic form figures as a distinct species, under the name of *Tænia cœnurus,* whilst that which is derived from *Cysticercus pisiformis* is denominated *T. serrata.*

In M. Van Beneden's opinion it is owing to the circumstance of their not having distinguished these two species that MM. Pouchet and Verrier were unsuccessful in their principal experiment, induced by the results of which, mainly, they have ventured to express doubts with respect to the doctrine of the metamorphoses of the Entozoa, and their peregrinations through the organism.

Whence do these doubts arise?

1. In one of their first experiments they administered 600 heads of the *Cœnurus,* and obtained 36 *Tænias.* On another occasion, from 60 heads of the same Entozoa they had 51 *Tænias.* In a third experiment, 60 heads produced 78 *Tænias;* and in a fourth instance, having given 100 heads to a sucking puppy, which was isolated, they found 237 *Tænias.*

How was it that in the latter two cases the number of tapeworms was greater than that of the heads which they thought they had given? "I cannot explain it," says M. V. Beneden, "but have no doubt whatever that, if they continue their inquiry, with the same precautions to ensure precision in their experiments, these gentlemen will, before they have done, themselves discover the explanation of this apparent excess."

"2. MM. Pouchet and Verrier administered to two lambs some perfectly matured ova of *Tænia serrata,* and, notwithstanding their having proceeded with every requisite precaution, these lambs, contrary to the results obtained by other experimenters, never presented any of the symptoms of 'staggers,' nor did their brains at the end of four months contain a single vestige of a *Cœnurus*.

"Not to mention the perfectly successful experiments performed at Munich, at Zittau, and at Toulouse, those which were made about the same time at Louvain, at Giessen, and at Copenhagen, with *ova*, afforded by one and the same dog fed with *Cœnuri*, all produced exactly the same results, and pretty nearly after a similar lapse of time. In all three places the lambs were attacked with 'staggers' about the fifteenth day, with this difference only, that at Copenhagen only two out of three sheep were affected.

"What is the reason that the experiments of MM. Pouchet and Verrier have afforded such different results? This arises, without doubt, from the circumstance that those observers administered to their lambs, not the *ova* of *Tænia cœnurus*, but those of *T. serrata*. If they wish to succeed in the experiment, let them administer ova really derived from *Tænia cœnurus*, and, like others, they will find all the symptoms of staggers manifested.

"But even should they be equally unsuccessful a second or even a third time, is it wise to conclude from this negative result, as they have done, that the *Cœnurus* is developed spontaneously in the sheep's brain? Clearly not. What would be said of any one who, having sown for the first time some flower seeds, and not finding them to grow, should assert that his neighbour's flowers sprang up spontaneously in his garden?"

M. Van Beneden goes on to relate an interesting experiment just concluded with perfect success by Professor R. Leuckart.

"It is some years since a second species of *Tænia* has been known to infest the human subject—*Tænia medio-canellata*. It has already been noticed in several countries. If this Entozoon be really distinct from *Tænia solium*, by what means is it introduced, what are the characters of its *Cysticercus scolex*, and whence is the latter derived?

"Having considered all the facts relating to the history of this parasite, the skilful and learned professor of Giessen was induced to administer the ova of *T. medio-canellata* to some calves, and in a short time he found that such numbers of Cysticerci were developed in the muscles of all parts of the body, that they appeared, as it were, to be 'larded' with them. And, besides this, he noted another circumstance which gives the experiment a great value, namely, that this Cysticercus, even whilst still within the cyst in the calf, presents all the distinctive characters of the adult *Tænia*.

"Thus, a tapeworm follows the use of both veal and beef, but of a species which has always been hitherto erroneously confounded with *T. solium*.

"In the actual state of science it may be affirmed as a fact that *T. solium* is introduced into the human system by the pig, *T. medio-canellata* by the calf or ox, and *Bothriocephalus latus* or *Tænia lata* of the older writers (in Switzerland, Poland, and Russia, &c.) by water. Man, therefore, owing to his mixed diet, is obnoxious to true tapeworms with a crown of hooks, like the Carnivora; and to Bothriocephali or tapeworms without that armature, like the herbivora [and, it might be added, like the fish]. The two former enter with the flesh which he devours, the other by the water which he drinks."

MIGRATION *of* ENTOZOA. REPLY *to* M. V. BENEDEN'S NOTE. *By* MM. POUCHET *and* VERRIER.

OUR doubts respecting the migrations of the Entozoa are justified to some extent by those which have been expressed by the two most celebrated French helminthologists themselves. Nevertheless we have not ventured to bring them forward without long and laborious critical study and experiment.

Von Siebold regards *Cœnurus cerebralis* as the larva of *Tænia serrata*. Our experiments have been based upon the data afforded by that zoologist, undoubtedly the best informed and the most illustrious amongst all who have occupied themselves in the study of these transmigrations. Consequently we cannot plead guilty to the charge of error brought against us by M. V. Beneden.

Tænia Cœnurus has never been a species distinct from *Tænia serrata*, nor even has it been so regarded by several of the zoologists or physiologists who have written or experimented since the learned Belgian professor. Some of them, amongst whom may, in particular, be cited Von Siebold, even regard this same *Tænia* of the dog and that of man as belonging absolutely to the same species.

In the works of experimenters a lamentable confusion exists with respect to the determination of the species, some of which have in fact been admitted simply with a theoretic view.*

Nevertheless, M. V. Beneden may be assured that if his *Tænia Cœnurus* be really a distinct species—a fact of which we have much doubt—*that* is the species employed in our experiments. We have strictly administered the same species as that which we have found in our dogs after we had given them *cœnuri*. Moreover, if this is not the *Tænia Cœnurus,* M. Von Beneden himself reverses his own theory, for in that case all our experiments have been absolutely negative. In fact, if the *Tænias* met with by us cannot be referred to the embryos swallowed, the metamorphosis of the *Cœnurus cerebralis* into *Tænia Cœnurus* is wholly erroneous as a fact. There is not escape from this proposition. Our experiments, continued on a large scale, will before long be laid before the world, and will determine positively whether the transmission of the entozoon of the sheep to the dog, and *vice versâ,* is or is not an actual fact.

We take this opportunity of informing the Academy that two new experiments recently performed appear to us calculated still more to justify the doubts we have expressed. Two dogs, each of which had swallowed a hundred heads of *Cœnurus* taken from the same segment, were killed at the end of two months. In one of these dogs the intestine contained two specimens of *Tænia cucumerina,* crammed with ova, and about fifty centimeters in length, whilst that of the other afforded two of *Tænia serrata,* one 12 millimetres and the other 120 millimetres long. It is not possible that one and the same *Cœnurus* should give origin to two distinct species. At the same time the extreme inequality of length of the two specimens of *Tænia serrata* indicates that they could not be derived from the same parent; besides which even the larger of them is far too small for it to have been the result of the experiment.

It has been seen that we have been alarmed only by our success. We gathered many more *Tænias* than we had sown of *cœnurus* heads. This is a cardinal fact. M. Von Beneden himself does not explain this mysterious result. The *scolices* of the *Cœnurus* only survive the animal infested by it a few

* That we should not be suspected of partiality, we borrow from a work composed with the greatest care what is said respecting *Tænia serrata.* It is derived from—1. *Cysticercus pisiformis,* according to Küchenmeister, V. Beneden, V. Siebold, Baillet; 2. *C. tenuicollis,* according to V. Siebold; 3. *C. cellulosæ,* according to V. Siebold; 4. *Cœnurus cerebralis,* according to Haubner? V. Siebold, V. Beneden, Eschricht, and Leuckart. (DAVAINE. Entozoaires, Synopsis, p. 34.)

hours—a fact of which experience has assured us. M. Valenciennes makes the same remark with respect to the *Cysticerci* of the pig. It is consequently very difficult to admit *à priori* that the *Cænuri* of the sheep can reach the intestine of the dog in the living state. And besides this, the circumstance that the head of the encephalic entozoon of the sheep differs enormously in size from that of the intestinal parasite of the dog, renders it extremely doubtful that the one can possibly proceed from the other.

In the absence of further proofs we can scarcely believe that a microscopic embryo of a *Tænia,* hatched in the intestine of a sheep, should be able to bore its way as far as the brain of a ruminant, and there become transformed into a vesicle capable of developing numerous *scolices,* to make use of an expression of M. V. Beneden's, whilst all the embryos of the other *Tæniæ* are capable merely of being developed temporarily as individuals in any situation where their inexplicable peregrination may be arrested.

We have shown to several members of the Academy portions of sheep's intestine absolutely obstructed by the multitude of Tænias. This has been repeatedly observed by one of us. These ruminants, however, never feed upon pork, nor upon rabbits, nor upon any flesh infested with *Cysticerci.* If these tapeworms are so well contented with the intestine, why on earth should some among them set off, amidst so many difficulties, in search of the brain, in order there to undergo a metamorphosis, to which the rest are not subjected? How does it happen also that in dogs kept isolated we should meet with more than double the number of Tænias than we have administered of *Cænurus-heads?*

On the EXISTENCE *of* URTICATING FILAMENTS *in the* MOLLUSCA. (Om Forekomsten af Neldefiim, &c. Vidensk. Meddel. fra den nat. Foren for Aaret, 1860. Andet Parti II, p. 309. Copenhagen, 1861.) By DR. BERGH.

THE prehensile threads, now generally termed "urticating organs," were discovered in 1835, in the Hydra, by Corda and by Ehrenberg. About the same time they were found by R. Wagner in the Actiniæ, who at first regarded them as zoosperms. Subsequently, however, he recognised their identity with the similar organs in the medusæ, and gave them all the name of urticating organs.

Since then numerous observations have shown that these organs exist in the entire class of polypes, and in that of the Hydra medusæ, as well in the *Synaptæ*, many Turbellariæ, some annelids, and lastly, among the mollusca, in some of the Eolidæ.

Max. Schultze has divided these organs into two categories: one including those of a rod-like form or the bacillar, which are found pretty generally in the Turbellariæ; and the other containing the urticating capsules armed with a long filament. The researches of Johannes Müller, and of Leydig, Max. Müller, and Busch, have shown, however, that this distinction is unimportant, and that all these organs of whatever kind may be embraced under the common term of urticating filaments, as has been done more particularly by Max. Müller. Dr. Bergh adopts the same view.

M. Bergh has devoted much attention to the urticating filaments or *cnida* of the mollusca which are far less well known than those of the cælenterata. Even Linneus and O. F. Müller had recognised, at the extremity of the papillæ of several Eolidans a minute sac, readily distinguishable from its white colour. A similar sac communicating with the exterior was noticed, but wrongly interpreted in *Tergipes* by Forskäl, Cuvier, and Oken, and M. de Quatrefages thought that he could recognise in the whitish contents of this sac the structure of bony corpuscles. But MM. Hancock and Embleton soon rectified this error by showing that the sac contained filiferous capsules. Though at first inclined to deny the correctness of this statement, M. de Quatrefages was obliged to confess his error, and he fell into the, since then, general opinion that the organs in question resembled the urticating filaments of other, lower animals.

The existence of sacs filled with *cnida*, that is to say, the existence of true urticating batteries, is then at the present day a well established fact as regards the typical forms of the Eolidæ, that is to say, in the genera *Eolidia, Montagua,* and *Facelina.* The profound researches of Dr. Bergh in this remarkable group of Nudibranchiata, have besides revealed the presence of these organs in other genera, as *Galvina, Coryphella, Phidiana,* and *Glaucus.* Their existence, therefore, may almost be regarded as a family character.

Dr. Bergh's memoir passes in review a great many species of the Eolidæ, and contains detailed descriptions of the *cnida* peculiar to each. In every case the urticating batteries are planted at the extremities of the papillæ above the hepatic lobe. The sac opens to the exterior by a minute pore situated at the summit. Its walls are muscular, a circular layer of fibres being the most considerable element. The interior is filled with urticating cells, together with cysts full of closely packed filaments and free filaments. Besides these are found cellæform bodies which represent probably the first stages of development of the urticating filaments. The course of this development, however, is at present it must be confessed but imperfectly known. But it may not perhaps be incorrect to regard the battery as a follicle whose secreting cells develope urticating filaments in their interior.

The genus *Pleurophyllidium*, according to Dr. Bergh's observation, is the only mollusc besides the Eolidæ in which *cnida* are met with, and it is to be remarked that in their anatomical conformation these animals appear to approach very closely to the Eolidæ. The minute organs described in them by Dr. Bergh present, it is true, an appearance widely different from that of the ordinary urticating filaments, but it is by no means improbable, nevertheless, that they may be morphologically homologous with them. They are minute, riband-shaped bodies, with irregularly sinuated borders, larger at one end than at the other, and probably possessing a contractile faculty. These little bodies are enclosed in sacs, within which they are disposed sometimes in a regular radiating mass, sometimes confusedly heaped together. The sacs communicate with the exterior by a minute pore.

The use of these *cnida* is still problematic. Their presence in the Eolidæ and in *Pleurophyllidium*, and their absence in the Dorididæ, Tritoniadæ, and Phyllidiæ, in all of which the integument is much hardened by calcareous salts, might lead to the suspicion that they may be defensive organs, which are not required by the Gasteropods with tougher hides. But one cannot conceive that fishes and crustacea would be arrested by such organs when attempting to make the molluscs their prey. Dr. Bergh regards it as far more probable that they serve to paralyse the minute animals upon which Eolids* live—a function that is possible but not yet demonstrated.

Mr. Lewes has adduced reasons of great weight in opposition to the notion that the precisely similar organs in the *Actiniæ* ever have this property. It is certain that the *urticating* function implied in the name by which these

* It should be remembered also that most species of *Eolis* live not upon minute animals, but upon Actiniæ, and perhaps other soft creatures of considerable size.

organs are generally known, is a highly improbable one. In fact, although cnida exist in certain medusæ and in the actiniæ, animals undoubtedly endowed with a stinging power, as well as in the Zoantharia, to which a similar power is generally attributed, though erroneously according to Mr. Lewes, they are found on the other hand in the Turbellariæ and in the Eolidæ, among which no species is known to possess any urticating property. Mr. Lewes, by conclusive observations, has further shown that the *cnida* do not paralyse the motions of minute animals (crustacea) which have been seized by an *Actinia.* (It is true observations to the contrary might be cited, with respect to the cnida of the hydra and the trichocysts of certain Infusoria.) Lastly, the great extent to which the cnida are developed in the internal organs, denominated " mesenteric filaments " in the Actiniæ, renders, as Mr. Lewes rightly remarks, the urticating function of these organs extremely doubtful.

On the EMBRYOLOGICAL BASIS *of the* CELL-THEORY. By Professor ROB. REMAK.

(Reichert and Du Bois. Reymond. 'Archiv,' 1862, No. ii, p. 230.)

SINCE the conclusion of my " Researches on the Development of the Vertebrata " (1851-55), and the devotion of my attention to other subjects, I have not ceased to take interest in the progress of histological literature; and although I have frequently remarked that my labours on that subject have been either entirely overlooked or insufficiently acknowledged, I have not on every occasion thought it requisite to enter into a polemical discussion. I am compelled, however, to make an exception to this course, in the case of an Essay by Professor Max Schultze, of Bonn, which appeared in this 'Journal' in the beginning of last year, entitled " On Muscle-Corpuscles, and what should be termed a 'cell,' " because the paper in question sets out openly with the claim to upset all the foundations of the prevailing cell-theory, part of which had been laid by my labours; and also because I think that, offering these anti-critical remarks, I may be able to protect the science to which I have formerly devoted so much time against some misunderstanding and error.

Schultze proposes himself to put an end to the contention respecting the so-termed " muscle-corpuscles," their existence, and their cell-nature; but instead of stating what a muscle-corpuscle is, or is said to be, how it originates, and how it may be demonstrated, Schultze at once starts with the attempt to trace the history of the development of the muscular fibre, in order to make us understand the nature of the so-termed muscle-corpuscles, from genetic considerations, and afterwards to demonstrate their cell-nature.

Although it is by no means my object or intention to subvert the belief in the existence of special muscle-corpuscles, I will nevertheless not leave the reader in doubt that, in my opinion, the so-termed "muscle-corpuscles" are the result of various kinds of imperfect observations. In transverse sections of hardened muscular fibres, as, for instance, of the frog, stellate anastomosing figures may occasionally be seen, resembling the well-known connective tissue "corpuscles." The appearance in question, however, has manifestly nothing whatever to do with any cell or nuclear formation, but arises simply from the circumstance that the contractile muscle-cylinder breaks up into fibrils, around which, in consequence of some kind of chemical or physical cadaveric differentiation, portions of a substance possessing a different refractive power, are deposited with a certain regularity, and thus constitute, as it were, a system of connected septa or tunics around the transparent fibrils. Again, rows of minute granules may occasionally be seen proceeding from the extremities of the well-known nuclei which lie between the sarcolemma and its contents, and which thence assumes the aspect of a fusiform cell. And, lastly, nuclei are said occasionally actually to occur in the axis of the muscular cylinder, from which stellate figures proceed. With respect to this, however, all I can satisfy myself of is the fact, that in the Purkinjean muscular fibres of the endocardium of the ventricles in the sheep and goat, bodies are presented which should be referred to the same category, and which have probably been the means of adding to the confusion in which the subject is involved. The Purkinjean fibres, like the rest of the muscular tissue of the heart, are striated and anastomose with each other; but the nuclei lie, not between the sarcous cylinder and the sarcolemma on the surface, but in the interior of gelatinous globules of considerable size, by which the continuity of the sarcous cylinder is interrupted from point to point, and which are otherwise in contact or more intimately connected with the sarcolemma. (This disposition is obviously intended to interfere with the contraction of the muscular fibres, of the very firm and elastic endocardium, so far as may be necessary to prevent a complete emptying of the ventricles, which, at any rate, in the animals above mentioned, does appear to take place, from what may be observed in the closure of the ventricles in a transverse section of the heart after death.)

So far, the distinction of muscle-corpuscle would appear to have no foundation, had not professor Weber, of Bonn, put forth the observation (not since followed up) that in certain diseases of the muscles, the granular masses surrounding the nucleus, not only simply multiply themselves, but also produce from their interior cellæform bodies, like pus-corpuscles, exhibiting, in short, phenomenon hitherto deemed to belong to cells alone.

However interesting it might be to discuss the correctness of these statements of Weber's, it will nevertheless at once be seen, that we have in this case to do only with the development of pathological elements, with respect to which I have already shown in a paper on the endogenous origin of pus- and mucus-cells,* that so far as *cell-formation* is concerned, bodies of this kind present peculiar deviations from the laws which are known to obtain in normal cell-formation in tissues. At best, the instance cited by Weber would only be an example of "cell-formation around portions of contents," of which other instances have already been adduced by Bahl and myself.

Let us now return to Schultze's statements with respect to the development of muscular fibre. It is true that what I first made known in 1845, and illustrated with figures in my Embryological Researches in 1851-55, respecting the origin of transversely striated muscular fibres from the elongation of simple cells, whose nuclei undergo continual division, is here confirmed, but with additions, against which I must protest. It is asserted, for instance, that in the *protoplasm* of cells, "already endowed with contractility, the disdiaclasts and their groups, the '*sarcous elements*,' become differentiated in the form of strongly and doubly refracting corpuscles, and group themselves in a longitudinal direction into rod-shaped fibrils," which "continue attached to each other by the remains of the unchanged protoplasm, which are demonstrable even in the adult." In the first place, I deny that the protoplasm, previously to the first movement of the animal, as for instance of the tadpole, exhibits the slightest trace of contractility. The notion that it is contractile can only arise from the confounding with contractility of the endosmotic phenomena exhibited in the muscle-cells. Furthermore, at first there is no trace of fibrils, and still less is there *between* them any remnant of protoplasm; but the

* Virchow's 'Archiv,' Bd. xx, 1860.

truth is, as I have elsewhere shown, that together with and at the cost of the granular protoplasm, a homogeneous, continuous soft substance arises, which acquires on the surface a system of fine transverse furrows, *in consequence of* the first movement of the animal.* In the vertebrata, after the formation of the sarcous cylinders within the sarcolemma, no vestige is left of the granules of the protoplasm. The series of fatty granules, which may be observed in mature animals between the so-termed fibrillæ, and which are very abundant in the muscles of fatted carp and pigs, are of a later and pathological origin, and represent the first indication of the pathological condition, which in man has been termed "fatty degeneration." These granular deposits are seen mostly in the neighbourhood of the nuclei, and particularly at their extremities, and thence they come to present a fusiform appearance, to which, without any necessity, the name of *muscle-corpuscle* has been given. In place of recognising this truth, and describing the phenomenon in question as unessential and unimportant as it really is, Schultze raises the question whether the so-termed muscle-corpuscles might not lay claim to the title of "cells."

With a view of solving this query, Schultze proceeds to consider the primordial type of cells, viz., the embryonic cells, and finds that they consist of a viscous protoplasm, crowded with granules and a nucleus. The internal layer, it is said, is often formed merely of the homogeneous matrix, "but these cells are never furnished with a membrane chemically distinct from the protoplasm." He then declares that "*I had given myself great trouble to demonstrate the presence of a membrane in the segmentation cells of the frog.*" I have also succeeded, by means of hardening agents, in raising from the segmentation-globules a transparent layer, which I have regarded as a membrane chemically distinct from the protoplasm. Even Schultze himself has thought that "*he was able to raise a similar membranous layer in Petromyzon,* but more recent research has made him seriously doubt the value of the proof afforded by this method." Were a "chemically distinct" membrane really present, it would necessarily be capable of demonstration by other means. The cause of the deception depends upon the condition of the protoplasm; in the hyaline substance, "the granules are absent in the outermost layer," and when this layer is distended, it presents the appearance of a membrane. However certain it may be that the external layer of protoplasm may "at any time be transformed into an ex-

* "Ueber den Bau und die Zusammenziehung der Muskelfasern.' 'Monætsb. d. d. Wiener Akademie.'

external chemically differentiated membrane, *so much the more certain does it appear to him* that at the period when the cells, still as a whole, are multiplying by division, *no such chemically differentiated membrane exists.* A cell, therefore, according to him would, be "*a mass of protoplasm containing a nucleus in its interior.*" A muscle-corpuscle, therefore, although in the normal condition it has no vestige of a wall, nor even any definite outline might in this sense not only exist, but might also properly be regarded as a cell.

With respect to all this, I can only say that I am unable to find a shadow of either reason or fact which can cast doubt upon what I have formerly stated on this subject, and which has not, in my work been submitted to the strictest examination. To fully establish this, I should be compelled to cite the entire chapter in my book; but for the benefit of those who may not have it at hand, I will quote only a single passage to show the cautious reserve with which I accepted the results of my own observation. After describing the formation of the egg-cell-membrane on the surface of the zooplasm (protoplasm of the egg cell) after impregnation, as well as its progressive action in the formation of the segments as they were multiplied by division, I proceed to say (pp. 173, 174): "we have seen (p. 136) that the cell membrane, distended with water, *is raised up sometimes in a vesicular form, and sometimes in that of a solid spongy substance.* These phenomena may be explained by supposing that the membrane of the inner cells just as little as the egg-cell-membrane itself is interiorly independent of the protoplasm, but that it is inseparable from it, being attached by the lax connective medium by which the germ corpuscles are held together, and possessing similar chemical properties to those of the membrane itself. To this circumstance may be referred the doubts of those who deny in general the existence of a membrane in the segment cells, and recognise in them merely a "sarcode-like" connective medium derived from the protoplasm. To all these notions is opposed the circumstance that, every kind of chemical reagent having an immediate and energetic action during life, corrosive sublimate, solution of nitrate of silver, vitriol, sulphuric acid, chromic acid, alcohol), harden the thin smooth envelope of all the cells in the form of a separable membrane, and that many phenomena (p. 135, section 15) even indicate the presence of a special envelope or agglutination of the protoplasm, which thence derives a definite border, even when the distended cell membrane cannot afford it. The question may, nevertheless, arise, whether, in any one case and to what extent in animal cells, such a well-marked distinction is set up between the membrane and contents as is met with in the vegetable kingdom, or whether this separation be not, rather, confined to those cases in which, as in plants, it is intended to afford the cell a firmer protection, or to regulate the entrance of nutritive materials through a solid partition. By no means, therefore, can it be asserted that the foregoing observations afford grounds for a general decision with respect to all kinds of animal cell membranes. The more closely we examine the elements of the data already obtained, the more essential does it become that we should be able to determine the real conditions of the membranes in those classes of cells of which the tissues themselves are formed. So long as in the membranes of the embryonic cells we possess *only chemical means of exhibiting it, and no other means of distinguishing* its existence at all comparable in clearness and certainty with those afforded us in the vegetable cell-membrane, this difficult problem can hardly be approached with any hope of success, and we shall be confined, in the distinguishing between cell-membranes, thickening layers, and intercellular substance, to the deceptive and unsatisfactory appearances arising from the varying states of aggregation of these parts.

But if there actually be, as is said, no chemical difference at all between membrane and protoplasm (a proposition, however, which still remains open to proof or to contradiction) what comes of Schultze's assertion that a cell is nothing at all but a "mass of protoplasm with a nucleus?"

In the next place, we must look at the history of the cell theory. According to Schwann, the embryonic cells are said to arise in the germ after the manner of crystals, and in fact that the nucleus is first formed, around which the protoplasm is stated to be afterwards deposited; and in the same way new cells arise, sometimes without and sometimes within cells, in the latter case becoming free, it is said, by escaping, like a nest of pill boxes, one from within another.

After I had, as early as in 1841, observed the division of the blood-cells, and in 1845 the longitudinal division of the muscular fibre-cells, I satisfied myself in 1852, that the majority of all known cells might be referred to the progressive division of the original segmentation cells.

But now arises the question, as to how this division is effected. Is it owing to the protoplasm becoming soft and breaking up at any given spot? or, as in the vegetable cell, is it owing to the constriction of the cells from without inwards, and the formation of septa, which are to be regarded as continuations of the cell membranes?

It was not till 1854 that I obtained proof in the frog by the use of hardening agents, that the latter is the mode; that is to say, that in the process of segmentation, the firm cell-membrane becomes constricted, and sends equally solid dissepiments inwards into the protoplasm. In this way the division is completed, and consequently the new cells are at once formed, fully furnished with a firm membrane.

The cell membranes, therefore, even in the cases where they remain inseparably united to the protoplasm, or are, as it is said, chemically identical with it, possess more than a mere historical interest (inasmuch as they first afforded the cell theory a certain and intelligible basis); but they would in any case so far have to be reckoned among the essential attributes of the embryonic cells, that they establish the fact that all the surfaces of cells represent continuations of that of the ovum. In other words, we must comprehend in the definition of an embryonic cell from which tissues are produced, so far as our present knowledge extends, its origination, in accordance with the laws above stated, from a process of *division*. and not regard any accidental mass of protoplasm furnished with a nucleus as a *cell*.

The next question is, whether every kind of cellæform structures in the animal body arise in the manner stated. As regards the normal tissues, no certain exception is as yet known. But, under pathological conditions, the organization of cells within cells in an endogenous way, has been placed beyond doubt by the observations of Hiss, Buhl, Weber, and myself.

Now, since this endogenous cell formation in which the nucleus of the parent cell has no part, does take place, it is quite conceivable also that in the course of fibrous tissues, which are known to be the production and prolongations of cells, cellæform structures may also occasionally arise. It would be even possible to ascertain—and this remains to be done—whether the same thing may not also take place in many normal tissues. I would remark that in my papers on "cell formation" (in Müller's Archiv, 1852,) I have pointed out, as striking instances, the secondary prolongations of the vessels in the cutis in the frog, as structures in which I had been unsuccessful in referring the nuclei which made their appearance to a division of the embryonal nuclei, any more than ithas hitherto been possible to trace any connection between the stellate cells (Virchow's "connective tissue-corpuscles") in fully formed connective tissues and the embryonal cells.

It would be one of the most interesting discoveries, if we could show that not only in pathological conditions which result in a destruction of the normal tissues, but also in the normal course of development, or in the restoration of destroyed tissues, together with cell division, a process of endogenous cell and nuclear formation within cells, or in the equivalents of cells, also takes place. This subject presents a promising field for zealous efforts.

REVIEWS.

On True Sexual Reproduction in the Infusoria.—Recherches sur les phénomènes sexuels des Infusoires. Par le Docteur BALBIANI, 1861.

(*Concluded from page* 196.)

TEN or twelve hours after the commencement of copulation, yolk-granules begin to be deposited on the outer surface of the germ-vesicle, around which they speedily increase in number and form a homogeneous layer, which does not, however, succeed in reaching the vitelline membrane; albeit that the latter becomes more and more encroached upon from without. Its distinctness may, at any time, be demonstrated by the addition of water or acetic acid; as may also that of the germ-vesicle, even when wholly concealed by its fully formed investment of yolk-substance.

As to the germinal spot, it does not appear until a late period, when a few isolated granules arise within the vesicle, and coalesce to form a brilliant, rounded dot. These pre-Wagnerian granules must not be confounded with the scattered molecules above referred to, which are sometimes seen inside the rudimentary germ-vesicle, but in time wholly disappear.

At the end of four or five days the development of the eggs is complete, and each, with the aid of reagents, displays in a very distinct manner its characteristic elements, namely, vitelline membrane, vitellus, germ-vesicle and germ-spot.

By the shortening of the delicate tubular membrane, within which they are confined, the ripe eggs make their way into the excretory duct, and, in their passage towards the surface of the body, probably undergo fertilization. At the same time the other ovarian contents unite into a single mass, so that, when the reproductive period has elapsed, the nucleus once more returns to its original form.

A like development of the ova has been observed in

Frontonia leucas (*Bursaria leucas,* Ehrb.) and in *Ophryoglena flava* (*B. flava,* Ehrb.), and takes place, perhaps, in many other Infusoria.

We see, therefore, that while in some Infusoria a nucleus appears, *de novo,* after each reproductive act, to replace the old ovary which has left no trace of its presence, in others, it is formed anew from those parts of the same organ which have not been concerned in the production of generative elements. "This re-construction of the sexual apparatus seems then to show that oviparous propagation does not assign a term of limit to the propagation of these beings, as occurs in the case of a large number of other animals, but that they continue to live, still preserving the power of producing fresh generations." It is, indeed, true, that in captivity, individuals which have already reproduced, are more prone to perish than their fellows, but this, M. Balbiani conjectures, may arise from the want of proper food, or some other untoward condition of the environment.

Evolution of the Testis.

When first the nucleolus appears by the side of the female organ, it "presents itself under the form of a minute spherical vesicle, composed, like it, of a membranous wall, and of granular contents." Its early development closely corresponds to that of the nucleus. "There is usually an exact accordance as to the mode in which each of these comports itself in the same species. When the egg attains the term of its maturity, without previously multiplying by transverse fission, the male element equally shares every phase of its evolution from the undivided condition; and, in like manner, when the former has given origin, before this period, to a greater or less number of other similar elements, the latter also divides into the same number of secondary parts, each of which corresponds to one of the elements of the first organ. But the multiplication of the two first formed reproductive elements is not always effected simultaneously, and it often happens that the sub-division of the one precedes by a greater or less interval that of the other. As to the male element in particular, its multiplication is sometimes completely finished, just when the animal enters on adult age, while that of the eggs is still effected only in part. More frequently, however, it is the male element which is less advanced, and which persists sometimes in its rudimentary form up to the time of propagation, then to divide itself into as many pieces as there are eggs destined for maturity. Hence, to estimate aright the correlation which has just been indicated, it is only at the reproductive period that one can properly examine the number of elements to which each primitive sexual organ has given birth."

In *Stylonychia mytilus,* an Infusorium which, at the reproductive period, possesses several male elements already formed, the further development of their contents is as follows:—First, each undergoes "a sort of distension during which its membranous envelope separates a little from the contents to which it was before closely applied. At the same time these contents, which were at first remarkable for their homogeneous consistence, and refractive aspect, become paler, more transparent, and better enable one to recognise the fine molecular granules of which they are made up. Each spermatic globule is then transformed into a minute round vesicle, enclosing within it a free granular mass or "nucleus." Out of this granular mass the evolution of spermatozoa takes place. One may note, in fact, at a somewhat later period, that the vesicle has increased in size, and the nucleus assumed a slightly flattened, hemispheric or discoidal, form. At the same time it has drawn nearer to one point of the limiting membrane. On that side which looks to the interior of the vesicle, this nucleus gives origin to a conical bundle of exceedingly delicate filaments agglutinated together, especially towards the apex of the cone, which presents a brilliant homogeneous aspect, which is heightened by treatment with acetic acid. This apex at length nearly touches the wall of the vesicle, at a point opposite to that near which is situated the granular mass from which the spermatozoa have been evolved. Those filaments which occupy the peripheric portion of the bundle soon become detached from the common mass and arrange themselves around the granular nucleus. The filaments at its centre, hasten, in like manner, to separate one from the other, and assume the same arrangement as their predecessors. When at this period of its development the spermatic cell is placed with its granular mass uppermost, the latter appears to occupy the centre of the cell, and from its margin may be seen radiating a circlet of slightly curved filaments, extending as far as the cell-wall. By degrees the cell acquires an elongated oval form, the granules of the nucleus become more and more rare, and the spermatic filaments, abandoning their radiate disposition, arrange themselves in two bundles with their bases opposed, and their free extremities directed towards the two poles of the cell.

A more or less narrow granular zone, the last trace of the nuclear plasma, still, for some time, continues to separate these bundles, but afterwards wholly disappears. Sometimes, before vanishing, the granulations of this zone fuse together, enlarge, assume an elongate, ovoid form, and range themselves in a regular series, placed transversely about the middle of the cell. Each spermatic filament then appears to terminate in a slightly swollen extremity, which represents the head. This form, however, does not agree with the fully matured condition of these elements, for by degrees, the head-like swelling diminishes as it becomes more slender, and finally altogether disappears."

"When the male element has attained complete maturity its form is that of an ovoid vesicle or capsule, extremely delicate, transparent, and pale. Its size is nearly the same as that of the egg arrived at the term of its development. Observed in the living animal, with the aid of gentle compression, it appears as a simple clear spot in the interior of the body, and one recognises but very imperfectly the bundle of filaments enclosed in its interior, which only become perceptible after treatment with acetic acid, iodine, or other appropriate reagents. Under these conditions, a magnifying power of from 200 to 300 times enables one to perceive the fasciculate appearance of the capsule's contents; but, in order to make out the more delicate filaments of the spermatic tuft, it is necessary to have recourse to more powerful magnifying powers, assisted by a favourable day, and an oblique illumination obtained by means of a suitable inclination of the mirror. These filaments then appear under the form of a straight bundle, stretched from one end of the capsule to the other. Here and there they are grouped in secondary tufts of greater or less size, and parallel to one another. It is not impossible that this fasciculate arrangement of the principal tuft may be an effect of retraction due to the action of the reagent made use of. Whether this be so or not, the form of these tufts allows us to gain a clearer idea of that of the isolated spermatozoa, these last being often difficult to recognise by reason of their extreme delicacy and transparency. They are minute hair-like bodies, straight, somewhat rigid, of extreme tenuity, very slightly swollen towards the middle, and terminated at each end by an attenuated point, which cannot be traced through its entire extent. Consequently they do not offer a distinct head and tail, as in many other animals; and it is with the spermatic filaments of the *Turbellaria* and several *Mollusca*, that they have the greatest resemblance."

These spermatozoa, at all periods of their evolution, were quite motionless.

Water and most other reagents exert a rapidly destructive influence on the spermatic capsules.

While the development of these capsules is in progress they undergo considerable changes of position, gradually withdrawing from the ovarian segments to which they were, at first, so closely approximated. As to the arrangement which they eventually assume, no two individuals precisely resemble one another in this respect. M. Balbiani, however, infers that they still, as before, remain protected by a common envelope.

After each sexual act the capsules become much smaller, and more or less altered; their contents, by degrees, becoming wholly absorbed. At length they disappear *in toto,* while, as yet the fertilized eggs remain within the body of the parent.

Among other Infusoria, the development of the male organ takes place in a manner more or less similar to that of the case just cited. Usually the number of male and female elements corresponds. "Thus, *Chilodon* produces but one egg and one spermatic capsule. In *Stylonychia Mytilus, Urostyla Weissei,* &c., the sexual elements are four in number, respectively. One of the most remarkable cases in this regard with which we are acquainted is that of *Spirostomum ambiguum,* in which each of the forty fragments which, at the time of reproduction, make up the long chaplet of eggs in this species, bears, attached to its surface, a minute corpuscle, which only becomes visible at this period, and which represents the corresponding male element."

Occasionally, however, the number of male and female elements is not equal. "The case which most frequently occurs is that which is expressed by the ratio 4 : 2, the first term representing the female, the second, the male elements. This ratio affords a mathematical demonstration of the mode in which each order of elements is produced, by means of the binary division of an element primitively simple (*Oxytricha, Stylonychia pustulata, Kerona polyporum*).* But greater numerical differences may occur. Thus, one species of *Paramecium* has at least twenty eggs, and but two or four spermatic capsules. And in two other forms of the same genus (*P. aurelia* and *P. bursaria*) the contents of these capsules are developed in a curiously exceptional manner, the details of

* "It is not uncommon to see the male element subdivide itself twice, like the female element, the numerical equality of their determinate products being thus again restored."

which could not be rightly interpreted without the aid of M. Balbiani's figures.

The testis, like the ovary, may remain undivided up to the commencement of the reproductive epoch, or, at an earlier period, begin to exhibit its peculiar modifications. Such changes are, in some cases, at first very similar to those which precede the occurrence of fission, but subsequently become very different, for, in the latter case, no evolution of spermatozoa follows the previous elongation and division of the male organ. In the general account already given of its structure, reference has been made to the remarkable striated appearance which, about this time, the testis presents.

With regard to the final exclusion of the spermatic particles, this, according to M. Balbiani, is probably effected by the contractions of the outer membrane common to the whole testis, which, eventually becoming shorter, tends to drive its contents into the neighbourhood of the external orifice. As the eggs do not "usually acquire their full development before the separation of the two individuals at the close of the sexual act," it would seem that they are not actually brought into contact with the spermatozoa until after copulation has ceased. "After their fecundation they are successively evacuated outwards," in all probability by the aperture above described. But the exact moment of their exit M. Balbiani was not able to seize. "In certain species, as those of *Oxytrichina* and *Stentor*, this emission is entirely effected by the third or fourth day subsequent to sexual union. In other Infusoria, as *Paremecium*, eggs have been seen within the parent more than eight days after copulation. It is highly improbable that they ever escape into the interior of the body." Among some specimens of *Stylonychia mytilus* observed by him in copulation, M. Balbiani, at the end of three or four days, found a number of minute brilliant rounded corpuscles, deposited at the bottom of the vessels, which bore a striking resemblance to the eggs still enclosed within the animal's body. Similar results were obtained in the case of *Stentor cœruleus*.

So much, then, for M. Balbiani's researches on the phenomena of reproduction among the Infusoria. Throughout the course of the preceding résumé, we have ventured to make little or no comment on the large amount of new matter which he has brought forward, lest in any wise we might mar the high interest which must attend the simple narration of the facts themselves. Such interest seems to us to be of (at least) a four-fold character; that is, *histological,* in its connection with the subject of egg-formation in general; *zoötomical,* so far as it suggests data for comparison with the organs of reproduction in other animal tribes; *practical,* as showing how much may be effected in a certain class of investigations, by patience combined with the right use of reagents; and *physiological,* from its bearing on the important question of fertilization in bisexual organisms.

The past season has seen the production of Mr. Darwin's new work on the 'Fertilisation of Orchids,' in which he has set forth, with much skill and interesting detail, the various and often highly complicated contrivances by which, among this extensive group of hermaphrodite plants, self-fertilisation, save in a very few exceptional instances, is rendered absolutely impossible. For the ovary of one Orchid is fertilised by the male element of another, and to affect the junction of these the intervention of insect agency is necessary. The case of the Infusoria is, in some respects, comparable, even though with them such foreign intervention be wanting. Like Orchids, they are hermaphrodite, but not self-fertilising, their fecundation being effected by constantly dissimilar elements produced in different individuals. And in both cases, this contact cannot take place without the previous occurrence of a process more or less complex, the details of which are curiously varied in their several tribes. Theoretically, nothing seems easier than for an Infusorium (or Orchid) to fertilise itself. There are indeed some Infusoria in which, so far as we at present know, the act of sexual union appears impossible. May it not be that these are capable of self-fecundation, just as, in this very respect, a few Orchids differ from the great majority of their order. Here, as elsewhere, the exception proves the rule; and such exceptions, while they forbid the systematist to dogmatise, and warn him never to neglect the final process of verification, are full of meaning for the philosophic student of biology. By these nature, so to speak, points out to us the simpler method, while in practice she adopts another, attended with much delay and apparent difficulty. But not without a purpose. And, perhaps, in this particular case the lesson which she seeks to convey is that which has been so well expressed for us by Mr. Darwin: "It is an astonishing fact [among Infusoria as well as in Orchids] that self-fertilisation should not have been an habitual occurrence. It apparently demonstrates to us that there must be something injurious in the process. Nature thus tells us, in the most emphatic manner, that she abhors perpetual self-fertilisation

. . . that some unknown great good is derived from the union of individuals which have been kept distinct for many generations."—J. R. G.

The reader is requested to correct the following errata:—page 176, line 2, for *germination* read *gemmation;* page 182, line 4 (of table), for *being* read *rarely;* line 13 from bottom, for *Holophrya* read *Holophyra;* page 183, line 2, after *a* read *single;* line 9 from bottom, for *Cothurina* read *Cothurnia;* page 184, line 27, for *radiating* read *running;* page 185, line 3, for *Rhonchylostoma* read *Kondylostoma;* line 17, for *The* read *Thus;* page 186, line 26, for *Spirostonum* read *Spirostomum;* page 187, last paragraph, and page 188, the first complete paragraph, to be marked with quotations; page 189, line 5, for *on* read *of;* line 16 from bottom, for *construction* read *contraction;* line 6, ditto, for *continued* read *continue;* page 190, line 3 from bottom, for *complete* read *complex;* page 191, line 17 from bottom, for *great* read *granular.*

Beiträge zur neuern Mikroskopie. By Von FRIED. REINICKE.

We welcome the appearance of another part—the third—of Professor Reinicke's useful contributions to microscopy, and the more warmly because the present part contains some observations of greater interest, perhaps, to English microscopists than were those embraced in the former parts. Judicious as were the previous notices, and useful, no doubt, as they would be to many, they were, for the most part, of too elementary a nature to be of much interest to the majority of English microscopists, who, furnished so abundantly by our microscope makers with every variety of contrivance and adjunct to the instrument, would not require to be told much of the very simple matters which have formed, for the most part, the subject of M. Reinicke's former lucubrations.

In the present part, however, we observe several things which will be found as interesting and useful to many in this country, as in Germany; and of the substance of these observations we shall proceed to give a brief summary. The subjects treated of, are—

1. A cheap Polarizing Apparatus.
2. Observations on Nobert's Test and Modern Objectives.
3. On Atmospheric Micrography.
4. On a New Method of making Preparations.
5. Miscellaneous Notices.

1. The polarizing apparatus described and recommended

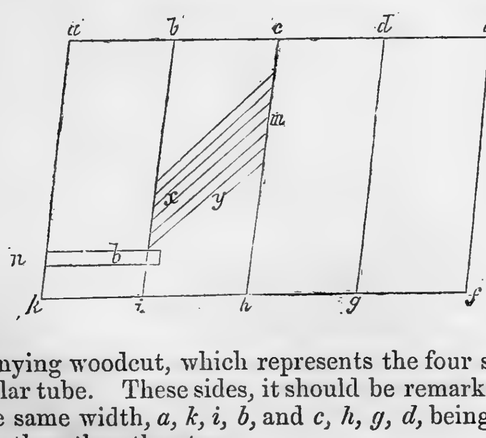
for general use by M. Reinicke is constructed on the principle of one constructed on a larger scale by Mr. Andwith, and with which most persons are, doubtless, familiar.

Polarization of the light in this form of apparatus is effected by its repeated reflection at an angle of 36° from the surfaces of numerous super-imposed pieces of glass, or by its transmission through similar pieces placed in the proper angle. As is well known, many pleasing experiments in polarized light may be thus performed at a very trifling cost.

Taking advantage of the same principle, M. Reinicke has contrived a polarizing apparatus, which can be adjusted to almost any microscope, made by any one gifted with the least ingenuity, and at a very trifling cost, and which yet, according to what he says, is capable of performing nearly as well as Nichol's prisms, and better than polariscopes made of the still more expensive tourmaline. The polarizing medium is constructed of super-imposed pieces of thin covering glass, contained in a square tube of card board; and the following directions are given for its construction:—

1. Procure from fifty to sixty pieces of thin covering glass, of uniform size, and a little more than half as long again as they are wide. A convenient size, he states, is 18+12mm. These are to be carefully selected as free from veins or specks, and they should, of course, be as flat as it is possible to procure them. The case or tube, in which they are fixed at an angle to the axis of the tube of 35° 25″, is conveniently made of cardboard.

On a piece of this material draw the figure shown in the



accompanying woodcut, which represents the four sides of the rectangular tube. These sides, it should be remarked, are not all of the same width, *a, k, i, b,* and *c, h, g, d,* being somewhat narrower than the other two.

The distance between *a b*, or *c d*, corresponds to the breadth of the glass plates, or = 12mm., whilst the width of the other two sides is equal to the length of the glass plates when placed at the proper angle, as indicated in the line *l, m*. The breadth *b c*, that is to say, the distance between the sides *b i*, and *c b*, must, in other words, be such that when a glass plate 18mm. long, is placed between them, it should form, with the axis of the tube, the angle of 35° 25″, or very nearly so. This distance can, of course, be readily found by raising a line *l m*, from the point *x*, at an angle of 35° 25″ with *b i*, measuring off on *l m*, the length of the glass plate, slip, and drawing at that point another line *c h*, parallel with *b i*. Thus is obtained the width of *b c*, with which *d e* is made to correspond.

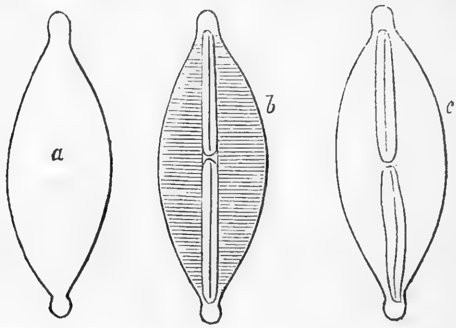
The cardboard is now to be cut nearly through, in the direction of the lines *b i*, *c h*, and *d g*, so that the four portions can be readily bent upon each other. The inner side of the paper should be painted black, or pasted over with black paper, and when all is dry the four sides are brought round, and the edges *a k*, and *e f*, joined with a little gum. But before the sides are joined, a narrow slip of the same, or of thinner cardboard, should be gummed across either *a, b, i, k*, or *c, d, g, b*, a short distance from one end, as at *l, n*. The tube being thus constructed, one of the glass slips is dropped in it, so that one end of the slip rests upon the little ledge *l n*, the other, of course, abutting upon the opposite side of the tube, at the proper angle. All that now remains is to drop in the requisite number of glass slips, one upon another, and to see that they come into close and parallel contact with each other. When the last glass slip has been placed, a second slip of cardboard, similar to *l n*, should be glued to the wall of the tube, immediately above the upper edge of the slip. The whole set will thus be secured from displacement.

The number of glass slips to be employed, varies according to circumstances. The greater the number, the more completely is the light polarized, but at the same time, its quantity is diminished, especially when the glass is not absolutely colorless. Five plates afford scarcely any polarization, but with ten a considerable effect is obvious in the change between the light and dark fields. Fifteen plates show indications of the cross in potato-starch, which is rendered very distinct by twenty, and is perfectly sharp and well defined by twenty-five slips; whilst at the same time the field, when two polarizers are at right angles, is almost perfectly dark. Here it is generally advisable to stop. But with perfectly colourless glass as many as thirty slips may be inserted, but beyond this no apparent advantage is gained by an increase in their number.

With respect to the mode in which polarizers, constructed as above, can be adapted for use to the microscope, M. Reinicke enters into long details, in which however it is hardly necessary to follow him, as the mode must be left to be determined pretty much by the construction of the microscope. All that appears requisite to remark is, that the square tubes above described can very easily be inserted and fixed in cylindrical ones of any size, made of thick paper, coiled up and properly secured, and that these cylinders, which are quite as serviceable as those made of brass, can be fitted for use in any way that the ordinary ones containing Nichol's prisms are. Owing however to the necessarily greater length of the glass column, it is better to insert one of the polarizers in the microscope tube between the ocular and objective, than to place it in front of the former, by which the field would of course be too much diminished for most purposes.

2. The article on Nobert's Test-Plate, and on Object-Glasses of recent construction, consists chiefly of a translation of the paper by Messrs. Sullivant and Wormley, which first appeared in the 'American Journal of Science and Art' for January, 1861, and was given in the April number of this Journal for the same year. M. Reinicke retains the opinion expressed in the second part of his "Contributions," that the new objectives of Hartnack, so constructed as to require the immersion of the lower lens in water, are the best he is acquainted with, or are only equalled by a combination by Hasert. These, he says, are the only glasses with which he has been able to show the cross lines in a new test-object, *Frustulia Saxonica*. As this is an object with which we are unacquainted, we are unable to express any opinion as to its value as a test, but from what M. Reinicke states, it would appear to be one of the most difficult of the class to which it belongs. In order to obviate some misapprehensions regarding its structure, which appear to have been entertained by many to whom he had sent specimens, he communicates a few remarks concerning it. The *Frustulia* is a diatom, in form not unlike a *Navicula*. Like all other diatoms, it is composed of two siliceous valves, joined together into a double plate by an interposed delicate frame. In all the specimens of this object furnished by him, the valves are more or less separated from each other according to the method proposed by Gerstenberger. The valves and frame are accordingly found in various degrees of disjunction, whence are produced, besides broken fragments, three kinds of figures. 1. (*a*) A simple outline

as it were of the diatom, without any markings at all—this is the interposed frame. 2. A similar form with sharply



defined outline, but with a well-marked longitudinal line, and having the entire surface covered with fine transverse lines. These lines however he has hitherto been unable to count, not having any objective capable of bringing them out clearly enough; and he would be much obliged, he says, to any one who may be more successful, and who would communicate his results to him. 3. The third form (*c*) presents a much thicker outline, and a very strongly defined longitudinal costa. This is the complete diatom, consisting of the two valves, on which it is usually more difficult to bring out the fine lines, and it consequently should not be taken as the proper test-object.

3. The third article also, or that on atmospheric micrography, is merely a translation of M. Pouchet's observations on this subject, which have already appeared in our pages.*

The fourth article consists of a new method of preparing algæ and other very delicate and soft objects, especially parts of plants, &c., by C. A. Hantzsch. The method, however, does not appear to be very new in this country, however advantageous it may doubtless prove. It depends upon the principle that, in order to prevent the shrinking of soft tissues when they are immersed in a dense, non-drying fluid, such as glycerine, or a solution of chloride of calcium, it is necessary to add those media very gradually. The way this is effected by M. Hantzsch is as follows:

The mixture he employs consists of—

3	Parts	Alcohol (90°)
2	,,	Water
1	,,	Glycerine.

* 'Quart. Journ. Mic. Sc.,' No. XXII.

The spirit being lighter and more limpid than water, compensates for the greater density of the glycerine. The preparation then being placed on the glass slide in a drop of water, another drop of the above mixture is added to it. The slide is then placed in a dry place, protected from dust, and the spirit and water are allowed to evaporate, until almost the whole of the fluid is gone. A second drop of the mixture is then added, and this allowed to evaporate as before, and so on, until a sufficient quantity of the non-drying ingredient (glycerine) is left to cover the object. The slide should then be allowed to remain a day or two before the cover is put on, in order to be sure that no evaporable part of the fluid remains. In this way M. Hantszch states that he has succeeded in preserving a great variety of delicate objects such as filamentous Algæ (*Spirogyra, Vaucheria, Œdogonium,* &c.), Desmidiæ, Infusoria, *Hydatina, senta Carchesium, Euglena viridis, E. sanguinea* (*Amœba, &c.*), delicate fungi and other vegetable tissues, animalcules, &c., all retaining their natural appearance in *form, colour,* and *structure.* Although in many cases it is true that the contents of the cells are somewhat contracted, they nevertheless retain their original structure; and in every case the retention of the external form may be ensured. Objects taken in the act of fission, conjunction, &c. remain in precisely the condition they were found in, and with a little care therefore, objects may be obtained, in most cases, quite as useful as the living subjects.

Introduction to the Study of the Foraminifera. By W. B. Carpenter, M.D., F.R.S., &c., assisted by W. R. Parker and T. Rupert Jones. London: Printed for the Ray Society, and published by R. Hardwicke, 192, Piccadilly.

After the lapse of five years Dr. Carpenter follows with his promised introduction to Professor Williamson's recent 'Foraminifera.' The subscribers to the Ray Society, like other unreasonable people, have undoubtedly complained of the delay. But no one, we think, who understands the nature of scientific research will feel that the subscribers to the Ray Society have lost anything. To be sure, five years makes a large vacancy in any man's existence, but then, when it has been industriously used, what may not be the advantage? That the five years have been employed to the advantage of the members of the Ray Society and the readers, we leave Dr. Carpenter himself to set forth:

"When, some years since, I undertook to prepare for the Ray Society an outline view of the structure, physiology, and systematic arrangement of the Foraminifera generally, I had no idea of contributing anything else than an introduction to my friend Prof. W. C. Williamson's 'Recent Foraminifera of Great Britain.' With the progress of my own researches, however, I came more and more strongly to feel how unsatisfactory are the results of the method pursued by M. D'Orbigny and by those who have followed his lead, both as regards the multiplication of *species*, the distinction of *genera*, and the grouping of these genera into *families* and *orders*. I found, moreover, that notwithstanding the dissimilarity between the lines of inquiry pursued by myself on the one hand and by my friends Messrs. Parker and Rupert Jones on the other, they led to conclusions most singularly accordant. My own studies had been restricted to a limited range of types (for the most part collected by Mr. Jukes, on the Australian coast and by Mr. Cuming in the Philippine Seas), which included, however, all the most complex and highly developed forms of recent Foraminifera; and I had specially devoted myself to the elucidation of their structure and physiology, and to the careful comparison of their numerous varietal forms. Theirs, on the other hand, had involved the comparison of the zoological characters of vast numbers of representatives of nearly all the generic types of the group, fossil as well as recent, brought together from various parts of the world, from various depths of the ocean, and from various geological formations; but had not been prosecuted with the same minuteness in regard to the details of internal structure or to physiological relations. Yet we had all been alike brought to recognise—(1) the extreme latitude of the *range of variation* in this group, which breaks down in almost every instance the boundaries which it has been attempted to erect between *species;* (2) the necessity of a like abolition of the divisions between many reputed *genera* which have been erected on an equally insecure basis; (3) the completely unnatural character of any system which makes a fundamental division between the monothalamous and the polythalamous types, and which adopts plan of growth (that is, the geometrical arrangement of aggregations of successive segments) as the basis of the subdivision of the *Polythalamia* into *orders;* and (4) the fundamental importance, in the determination of the true affinities of the several generic types, of all that relates to the physiological condition of the animal, especially the texture of the shell, and the peculiarities of conformation which characterise the individual segments."

The consequence has been that Messrs. Parker and Rupert Jones have assisted Dr. Carpenter in the present work, and the volume appears as the result of their joint labours. The work however in its present form is not merely an introduction to the study of the general structure and functions of the Foraminifera, but is an analysis of all that is at present known on the subject. Dr. Carpenter commences with an historical summary of the subject, in which he not only goes over the ground trodden by Professor Williamson, but greatly extends and simplifies this part of the whole subject. He divides our knowledge of the history of the Foraminifera into four periods. First, the period from the time they first attracted attention to the appearance of D'Orbigny's classification of them. Secondly, from the appearance of D'Orbigny's arrangement of them as mollusca to the announcement by Dujardin of their essentially rhizopod structure. Thirdly, the period which terminated with Ehrenberg's great discovery of their abundant presence in the chalk. The fourth period commenced with the researches of Professor Williamson, of Manchester, on *Lagena* and *Polystomella,* the latter series of which were first published in the 'Transactions of the Microscopical Society of London.'

In the second chapter, the structure, organization, and physiology of the whole group of rhizopods are treated of, and concludes with some remarks on the reproduction of rhizopods. In this department of inquiry there is yet a field for the labours of the young physiologist.

The third chapter is devoted to the chief types of structure and Mode of growth of the Foraminifera. It is in this chapter that the general reader and microscopic observer will find most to interest him. The subjects taken up in order are the texture of the shell, its mode of increase, the intermediate skeleton, the canal system, the separation of segments, the plan of growth, the septal aperture, the form of septal plane, and the nature of the surface marks.

These subjects are, however, all treated in relation to the principles of classification. Dr. Carpenter, as is evident from his preface, is deeply impressed with the fact that there are no definite limits within which the so-called species can be confined, and he loses no opportunity of impressing this on the mind of his reader.

The following are the propositions which the author considers his researches warrant him in laying down :

"1. The range of variation is so great among *Foraminifera,* as to include not merely the differential characters which systematists proceeding upon the ordinary methods have accounted *specific,* but also those upon which the greater part of the *genera* of this group have been founded, and even in some instances those of its *orders.*

"2. The ordinary notion of *species,* as assemblages of individuals marked out from each other by definite characters that have been genetically transmitted from original prototypes similarly distinguished, is quite inapplicable to this group; since even if the limits of such assemblages were extended so as to include what would elsewhere be accounted genera, they would still be found so intimately connected by gradational links, that definite lines of demarcation could not be drawn between them.

"3. The only natural classification of the vast aggregate of diversified forms which this group contains, will be one which ranges them according to their direction and their degree of divergence from a small number of principal family types; and any subordinate groupings of genera and species which may be adopted for the convenience of description and nomenclature, must be regarded merely as assemblages of forms characterised by the nature and degree of the modifications of the original type, which they may have respectively acquired in the course of genetic descent from a common ancestry.

"4. Even in regard to these family-types, it may fairly be questioned whether analogical evidence does not rather favour the idea of their derivation from a common original, than that of their primitive distinctness.

"5. The evidence in regard to the genetic continuity between the *Foraminifera* of successive geological periods, and between those of the later of these periods and the existing inhabitants of our seas, is as complete as the nature of the case admits.

"6. There is no evidence of any fundamental modification or advance in the foraminiferous type from the Palæozoic period to the present time. The most marked transition appears to have taken place between the Cretaceous period, whose foraminiferous fauna seems to have been chiefly composed of the smaller and simpler types, and the commencement of the Tertiary series, of which one of the earliest members was the Nummulitic Limestone, which forms a stratum of enormous thickness that ranges over wide areas in Europe, Asia, and America, and is chiefly composed of the largest and most specialised forms of the entire group. But these were not unrepresented in previous epochs; and their extraordinary development may have been simply due to the prevalence of conditions that specially favoured it. The Foraminiferous fauna of our own seas probably represents a greater range of variety than existed at any preceding period; but there is no indication of any tendency to elevation towards a higher type.

"The general principles thus educed from the study of the Foraminifera should be followed in the investigation of the systematic affinities of each of those great types of Animal and Vegetable form, which is marked out by its physiological distinctness from the rest. In every one of these there is ample evidence of variability; and the limits of that variability have to be determined by a far more extended comparison than has been usually thought necessary, before the real relations of their different forms can be approximately determined.

"As it is the aim of the physical philosopher to determine 'what are the fewest and simplest assumptions, which being granted, the whole existing order of nature would result,' so the aim of the philosophic naturalist should be to determine how small a number of primitive types may be reasonably supposed to have given origin by the ordinary course of 'descent with modification' to the vast multitude of diversified forms that have peopled the globe during the long succession of geological ages, and constitute its present Fauna and Flora."

Dr. Carpenter divides the Foraminifera into two great groups or sub-orders, the IMPERFORATA and the PERFORATA. The imperforate Foraminifera include the families Gromida, Miliolida, and Lituolida. The perforate forms include the Lagenida, the Globigerinida, and the Numulinida. These families are divided into genera, and each generic form, recent and fossil, with its recognised specific types and varieties, are treated in great detail in the remaining chapters of the work. It is impossible to give too much praise to this part of the volume before us, as it presents an amount of detailed labour unrivalled for its extent and minuteness in the family to which it is devoted. However much Dr. Carpenter's views on the nature and limits of species may be open to criticism—and our pages are not the place for this purpose—no one can complain of any deficiency of illustration. The work is illustrated with twenty-two plates, containing upwards of three hundred figures, and the text contains upwards of forty woodcuts. We need not say that such a work has especial claims on the microscopic observer, for although the forms of the Foraminifera are most of them visible to the naked eye, it is only as microscopic organisms that they possess interest in the eye of the naturalist. Just as the microscope has been improved in its structure, and its uses understood, has this family been studied, and its importance recognised in the scale of created beings. In fact, through the researches of Williamson and Carpenter, and their coadjutors, this family of Foraminifera invite attention, as affording a means of studying those great laws of morphology and the origin of species, which at the present moment are attracting so much attention alike from the philosophic naturalist and the patient student of specific forms.

NOTES AND CORRESPONDENCE.

Simulated Helminthiasis.—Under this head is a short communication in the 'Archiv für Anat. and Phys. 1862,' p. 275, from Dr. A. Schneider, relating to the so-termed *Spiroptera Hominis* of Rudolphi, an entozoon, which, from its apparently extreme rarity, has been a puzzle to helminthologists for more than fifty years. The case in question occurred in London, and will be found described in detail by Mr. Lawrence in the 'Medico-Chirurgical Transactions.' It was that of a woman in St. Sepulchre's Workhouse, and the worms were said to be passed from the urethra, and they were occasionally even drawn off through the catheter, so that no doubts with respect to deception appear to have been entertained at the time.*

Specimens, having been forwarded by Mr. Barnett to Rudolphi, are still preserved in his collection now in the Zoological Museum at Berlin, and it is these specimens which have formed the subject of Dr. Schneider's observa-tions.

They are contained, as described by Rudolphi, in three bottles. When Dr. Schneider first looked at those contained in one of the bottles, they appeared to be well-known forms, and nothing more, in fact, than the very common *Filaria piscium*, Auct. (*Agamonema piscium*, Dies.), a name under which several species of asexual nematoid have been described, which are found in the abdominal cavity and among the muscles of several marine fishes. The specimens in this bottle were the commonest species of all, as was proved by a number of the most distinctive characters. The mouth is surrounded by three indistinct labial lobes, one of which supports a tooth. The vascular system is very peculiar, and presents a disposition met with in but few nematoid worms, the œsophagus having posteriorly a cæcal prolongation. Not in this point only, however, but also in the histological details to which the comparison was extended, did *Filaria piscium* agree with the supposed *Spiroptera hominis*.

But the worm is said to have come directly from the urethra, that is to say from the bladder—how did it get there? It is impossible that a nematoid worm, whose proper habitat is the body of a fish, should, even in an exceptional case, inhabit the urinary bladder of a warm-blooded animal. Such a supposition is contrary to all that we know of the

* See Art. "Entozoa," 'Cyc. Anat. and Phys.,' vol. ii, p. 127.

developmental history of the Entozoa. It is far more probable to suspect that the person had herself introduced the worms into that situation. Instances of a similar kind, with various articles, are common enough. The *Filaria piscium* could be readily procured in London, and would be well known to any one in the custom of eating fish. How well known and abundant they are may be gathered from the circumstance, that in Copenhagen the haddock is not eaten in summer, owing to its containing too many of these parasites. There is no reason, therefore, for surprise at the circumstance that the patient in question, in the course of two years, passed 1,000 of these worms, and that the deception was carried on for so long a time.

A second bottle contains several slender shreds of matter, about an inch in length, which have also been noticed by Rudolphi, who describes them as "*concrementa lymphatica.*" Their structure and origin Dr. Schneider could not determine with any certainty, but considers it not improbable that they are portions of intestine cut fine.

But if any doubt could be entertained as to a deception in this case, none whatever can attach to the contents of the third bottle. This contains round, tolerably firm, vesicular bodies, which passed through the catheter when introduced into the bladder. Mr. Barnett regarded these bodies as the ova of the worm, and Rudolphi as "*concrementa lymphatica.*" But it is clear beyond all dispute that they are the ova of a fish, of which they exhibit every distinctive character—the facetted outer membrane covering the cells of the *membrana granulosa*, beneath which is the shagreen-like coat, and lastly, the vitellus, with its large oil-globules.

Notes from Madras.—In an article* that appeared in the 'Bibliothèque Universelle de Genève,' written by Professor Thury, a rule is given for finding the equivalent focal length of a compound object-glass, which rule being freely translated may stand thus:

To find the equivalent focal length of the compound objective, replace the ordinary negative eye-piece with a positive eye-piece micrometer, the scale of which has a known value, and place in the focus of the objective to be measured a stage micrometer of the same value.

Let N be the number of divisions of the eye-piece micro-

* *Notice sur les Microscopes.*—'Remarques sur un article du 'Journal de Sillimann' relatif aux Microscopes de Spencer et à la structure des pores du bois dans les Conifères, et considérations sur les Microscopes en général.' Par M. le Professeur Thury, No. xxxii, Août, 1860.

meter which measures one division in the stage micrometer, and let D be the distance between the two micrometers.

Then F, the equivalent focal length, is equal to $\frac{D}{N+1}$

This rule was new to me, and may be so to other readers of the Journal. I have, therefore, sent you the results obtained by applying it to my instrument, adding, for the sake of comparison, and to show the correctness of the rule, the power of each glass with the A eye-pieces, as obtained with the camera lucida a long time ago.

If there were no cause of error, the right hand column, divided by that next to it should give, in every case, the same quotient, viz., the power of the eye-piece. But the slight discrepancies that will be found are readily accounted for by the impossibility of obtaining *exact* measurements with a micrometer eye-piece of this description, particularly when the lines on the stage micrometer are magnified with high powers. Besides which the draw-tube was sometimes pulled out a little, which would obviously make a difference, *i.e.*, make the powers obtained in this way differ from those obtained by the camera lucida, when the draw-tube was not moved.

Focal length, &c., of a set of objectives obtained by the rule, $F = \frac{D}{N+1}$

				Power with the A eye-piece by camera lucida.
2-inch	$\frac{D\ \ 10{\cdot}85}{N+1\ \ 6{\cdot}6}$	Focus 1·664	Power 6·08	26
1 „	$\frac{D\ \ 10{\cdot}2}{N+1\ \ 10{\cdot}6}$	„ ·952	„ 10·05	44
$\frac{1}{2}$ „	$\frac{D\ \ 10{\cdot}65}{N+1\ \ 33{\cdot}}$	„ ·323	„ 30·96	140
$\frac{1}{4}$ „	$\frac{D\ \ 10{\cdot}3}{N+1\ \ 63{\cdot}5}$	„ ·162	„ 61·7	269
$\frac{1}{6}$ „	$\frac{D\ \ 10{\cdot}75}{N+1\ \ 71{\cdot}}$	„ ·151	„ 66·2	286
$\frac{1}{8}$ „	$\frac{D\ \ 10{\cdot}5}{N+1\ \ 71{\cdot}}$	„ ·148	„ 67·56	302
$\frac{1}{12}$ „	$\frac{D\ \ 9{\cdot}95}{N+1\ \ 131{\cdot}}$	„ ·076	„ 131·58	570

The 1-12th is Powell and Leland's, the remainder were made by A. Ross.

It will be observed that with the exception of the 1-8th, which ought to be about ·125, every objective has less than its *nominal focus*, notwithstanding which all have not their *nominal power;* for by Mr. Ross's catalogue the 1-6th should give 320, and the 1-12th 600 diameters. He calls the power of the 2-inch 20, which gives a power of 4 to the eye-piece; but if we apply this number (4) to the 1-6th we find that 320 is the proper power of the 1-8th, and that the so-called 1-8th, with a power of 420 assigned to it, is something less than a 1-10th.

This to me appears very unsatisfactory, and although M. Thury observes in a foot-note that "Les opticiens Anglais semblent ne se faire aucun scruple de ces petites surprises, par la raison que les objectifs coutent d'autant plus qu'ils ont une distance plus courte et qu'ainsi le constructeur donne plus qu'il ne promêt; entre deux excès, celui la est assurément le meilleur. . . . C'est celui dont nous avons le moins le droit de nous plaindre," it seems to me it would be best to call a spade a spade. As to the gain to the customer, if I want a glass of a certain power, what satisfaction is it to be told that, although I have not been supplied with what I asked for, I have got more for my money than I had any right to. An argument of that kind would be simply impertinent, and such as no man with the reputation of our best makers would, I think, use. But the fact remains, that they do make "les petites surprises," as my 1-4th, 1-6th, and 1-8th are perpetually reminding me.

But these little "surprises" may do the makers themselves injury in a way they little expect. It may happen that a good honest glass is compared with another of the same nominal power but of less pretension, and may fail to show the same objects, the consequence of which is that the work would be said to be "falling off." I say this is possible because it has happened to me. If I had an opportunity of getting at the true focal length of the "new and improved" 1-4th,* I should probably find why it is not better than the old one, but I have not had that opportunity.

It must not be supposed from the foregoing that I am finding fault with the *workmanship* of my microscope. On the contrary, I feel bound to say that I consider the finish of everything that I have seen from Featherstone Buildings as second to none, and I believe that everything about my microscope is (like the stand) A 1. Nevertheless, I should

* Bought by a friend on my recommendation.

like a 1-4th to *be a 1-4th, and a 1-8th a 1-8th,* or else to be told what they really are.

Wenham's Adjustment for Covering Glass.—Some time near the end of 1858 I resolved to treat myself to a 1-12th. I had read in the Journal Mr. Shadbolt's remarks upon Mr. Wenham's method of effecting this adjustment, and I determined my 1-12th should have it. Mr. Wenham, to whom I am an utter stranger, was kind enough not only to explain to Messrs. Powell and Leland his method of applying it, but also to examine the objective when finished. This adjustment is such a luxury compared with the old method, that it will perhaps justify the inquiry, why has it not been adopted by our makers? It is just as easy to make, I think easier, and I do not think any one who has used it for a week could by any possibility be satisfied with the old method; I may therefore ask again, why has it not been adopted?

Micrometry.—A good deal was written some time ago about the best form of micrometer. I do not wish to provoke a fresh discussion of this subject, and will therefore only say that no man who has conscientiously endeavoured to meke exact measurements of minute objects can by possibility be satisfied with anything less refined than the cabinet micrometer. With a fixed scale like the glass micrometer there never can be anything but guess-work. Who, for instance, would undertake to measure the blood-corpuscles with such imperfect means? No one, I am certain, who was qualified for the task.

But in using a cabinet micrometer with high powers and the ordinary stage movements, it is very difficult to make exact contact with the fixed filament; and although it may be done in time, it is an exceedingly great trial of patience when it has to be repeated, and, what is worse, a great loss of time.

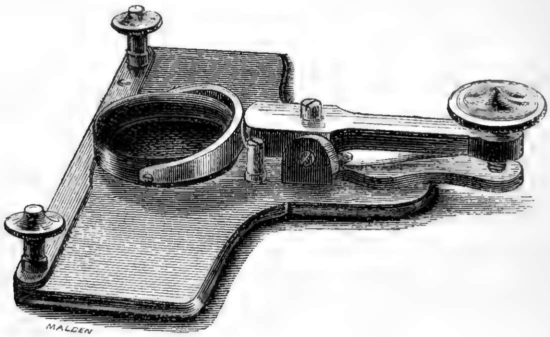
To remedy this inconvenience I suggested to Mr. Thomas Ross an alteration of the object-plate, upon which, as a matter of course, with his better mechanical knowledge, that gentleman improved, and I have found it so exceedingly convenient that I feel bound to recommend it to those microscopists who desire to make accurate measurements withthe least expenditure of time. It would not probably cost much to alter a stage or to apply it to a new instrument, but in consequence of my absence from England I was obliged to have a new object-plate made.

There are people who say that stage movements of any kind are a superfluity, or something worse. Of course those nimble-fingered and clever manipulators will not require Mr. Ross's help, but the clumsy fellows who, like me, still wish to be accurate, perhaps will. I have ascertained that when using the 1-12th I can without difficulty move an object on the stage 1-130,000th of an inch. I beg to introduce to Mr. Ross all who desire this convenience and *not* superfluity.—J. MITCHELL, Captain European Veterans, Madras Museum; June 20th, 1862.

Polycistina off the Orkneys.—I beg to mention the fact that I have found some Polycistina in sand dredged by Messrs. Waller, Gwyn Jeffreys, and Norman, off the Orkneys, in July, 1861, Lat. 60° 30′ N., long. 0° to 1° E. They are very rare, only nine specimens occurring in fifty slides examined with great care. Still, as I have never mounted any Polycistina, their presence cannot be attributed to any other source, and I am forced to conclude that they come from the locality which I have mentioned, although it is north of their previous supposed habitat. — T. G. STOKES; August 21st, 1862.

Highley's New Compressorium.—All the forms of compressorium I am acquainted with seem to have been designed by the philosophical instrument maker, rather than the anatomist conversant with the practical requirements of microscopical manipulation, for the space placed at the disposal of the operator is far too limited. If the object subjected to compression be *only* microscopic, such instruments may serve their purpose. The compressorium, however, is generally used by the anatomist to assist in tracing out parts in objects of some magnitude. If, for instance, we wished to follow the anatomy of an annelid placed on a glass slide, three inches by one inch or longer, we should have some difficulty in bringing *all* the parts under the compressor; for to do so, we should have to reverse the ends of the slide; and in all the instruments I have handled, the centre of the slide cannot be placed conveniently in position. To obviate this imperfection in the instruments at present in use, I have arranged a compressorium which meets every requirement, whether for microscopic or larger specimens, animal, vegetable, or pathological.

The arrangement will be readily understood by aid of the the annexed illustration. A base-plate for the support of an ordinary 3 inch by 1 inch glass slide is placed at right angles to a projecting portion that carries the arm and mechanism of "the compressor;" in front of the base-plate, a ledge is placed, against which the glass slide can firmly rest, as suggested by my friend, Dr. Lionel Beale (see illustrations to 'How to Work with the Microscope,' xviii, fig. 80). In the centre of the base-plate is an aperture with a sunk ledge, into which a disc of thin glass can be dropped when required for examining both sides of an object. The compressing ring, fitted with a disc of thin glass, is gimbled on to an arm that rotates upon a centre pin, which arm is acted on by a mill-



head-screw to secure compression by leverage in the ordinary way. If both the upper and under side of an object are to be examined, two pins are to be screwed into the ends of the base plate, and these, with the pin that stops the arm, (to secure the compression, being central with the aperture in the base-plate), form a tripod stand, so as to allow of the instrument being turned over, and either side being placed on the stage of the microscope at pleasure. By this arrangement it will be seen that any portion of a 3 by 1 glass slide can, by traversing, be brought under the compression, and that every movement and requirement is provided for. One of these instruments will be found in my collection, in Class XIII, at the International Exhibition.—SAMUEL HIGHLEY, 70, Dean Street, Soho Square, W.

Supplementary Note on the Reproduction, of Thaumantias.—Since my note on the reproduction of Thaumantias was written, each of the secondary polyps of the zoophytes in the small vessel which were supposed to be dead have been reproduced. The new polyps are seated on ringed stalks, which rise up from within the original cells, and have each only fourteen tentacles and their cells seven teeth; a most delicate membrane unites the polyps to the mouths of their cells.

In some of the young zoophytes in the larger vessel the polyp stalk was ringed throughout, and in others the ringing at the foot was preceded by a slight dilatation. The Clytea vicophora* of Agassiz is figured with a polyp-stalk having a like variety in its annulations, and his Clytea posterior with cells rising up within each other.—T. STRETHILL WRIGHT.

* 'Contributions to the Natural History of the United States,' vol. iv, pl. 29.

PROCEEDINGS OF SOCIETIES.

Literary and Philosophical Society, Manchester.

Microscopical Section.

Annual Meeting, 19th May, 1862.

E. W. Binney, Esq., F.R.S., F.G.S., in the Chair.

Mr. David Joy, and Mr. John Leigh, M.R.C.S., were elected members of the Section.

The Secretary then read the

Annual Report, 1862.

The Council of your Section in this, the fourth Annual Report, have to congratulate its members upon its steady progress during the past session; ten new members have been elected, but two have retired. The loss of Mr. W. C. Unwin, who has ceased to reside in this city, is to be regretted, as he gave promise of active co-operation in the business of the Section. Your Council have also to congratulate the members upon the work done since the last yearly meeting, the most important and arduous of which was, undoubtedly, the Microscopical Soirée, given to the members of the British Association at their last year's meeting in this city. The management was entrusted to a sub-committee formed of members of this Section, and it has been considered, even in London, to have been the best exhibition of microscopes and microscopical objects hitherto attempted. With every meed of praise to those to whom the management was committed, the great success of the exhibition is due to the liberality with which the owners of the microscopes placed their apparatus and objects at the disposal of the sub-committee; and it is gratifying to state that the damage was most insignificant, only two object slides having been broken; not a single piece of apparatus belonging to 150 first and second class microscopes was known to be lost or injured.

The Section has held, during the Session, eight ordinary meetings, at which several excellent papers and valuable communications have been read; the most important of which were—

A paper by Mr. John Watson, "On certain Scales of some Diurnal Lepidoptera," illustrated by drawings by Mr. Joseph Sidebotham.

A paper by Dr. Thomas Alcock, "On the Tongues of the Mollusca," illustrated by four drawings, in which the author proves that the lingual dentition and internal organization of these animals are more important, as characteristic of species, than their external forms or shells; and he points out several errors into which some eminent naturalists have fallen, in consequence of their different methods of classification.

The before-mentioned papers were considered worthy of recommendation to be printed, with their illustrations, in the Society's Memoirs, and the recommendations have been adopted by the Council of the Society.

Amongst other communications may be named

A paper by Mr. Thos. G. Rylands, of Warrington, "On the classification of the Diatomaceæ," in which the author enlarges upon the necessity of a reconstruction of the system of nomenclature, &c.

A paper by Mr. Thomas Davies, of Warrington, upon "Crystallization," in which he describes his method of obtaining flower-like forms in fused films of certain salts, by graduated reabsorption of moisture from the atmosphere.

And a paper by Mr. Petschler, of this city, "On the Vegetable Forms produced by Crystals of Bichromate of Potash in Gelatine with Collodion," &c., discovered by him in the preparation of photographical plates; these take the shape of microscopical ferns, mosses, &c., and some of them, mixed with nitrate of silver, are very beautiful.

There can be no question that if these discoveries in crystallization be properly followed up, and experiments made with a variety of salts, and media of various densities, not only may new forms of crystals be obtained for the polariscope, but light may be thrown upon the causes which induce certain compound molecules of matter to assume determinate and characteristic forms. It was observed by one of the eminent chemists of the day, that the revelations of the microscope with regard to certain crystals will necessitate an entirely new course of study to learn their molecular arrangement.

Abstracts from the foregoing papers have appeared in the printed proceedings of the Society, and in the London 'Quarterly Journal of Microscopical Science.'

Since the last Annual Meeting, one hundred and twenty specimens of soundings and dredgings have been received from captains of vessels, from various parts of the world; they have been arriving lately from distant stations, and it is supposed that many more are on the way. The thanks of the Section are particularly due to Mr. Dale, for his assistance in separating the material from the tallow in which the soundings are mostly imbedded, and for the use of his laboratory and materials.

The previous selection of a subject for discussion upon the evenings when no paper is read, is found to be productive of interest; that "On the Cause of the Metallic Lustre on the Wings of the Lepidoptera," brought written communications from Mr. Latham, Mr. Dancer, and Mr. Unwin, all containing valuable information and suggestions; it led also to the rediscovery of an important paper on the Lepidoptera in a French periodical, published twenty-seven years ago, a portion of which Mr. Latham kindly translated and printed for distribution.

The Section may be congratulated upon the additions to the cabinet during the past session; it is now comparatively well supplied with objects, to which Mr. Hurst's donation of his private collection of microscopical objects has mainly contributed.

A subscription was open amongst your members for the benefit of the widow and children of the late Professor Quekett, but it was found that there were two committees in London with different objects in view, as claimants for the fund; and also that the Royal College of Surgeons had provided liberally for the family; your subscription list was therefore cancelled. A local memorial was suggested, and three new lists were opened. For Dr. Beale's committee the sum of £11 10*s.* was collected and remitted. Several sums were given for the MANCHESTER QUEKETT MEMORIAL, and that list is yet open. When the amount subscribed was sufficiently large to warrant the expenditure, it was resolved that a microscope should be purchased, to remain in the Society's room for the use of the subscribers. The microscope is now before you, and it bears the following inscription:—"Purchased by members of the Microscopical Section of the Literary and Philosophical Society, Manchester, in remembrance of the late Professor QUEKETT, April, 1862."

The Treasurer reports that the expenditure of the Section has somewhat exceeded the income. The Session commenced with a balance in his hands of £3 11*s.* 10*d.*; the receipts have been £18 5*s.*, and the payments £20 18*s.* 11*d.*, so that the balance in favour of the Section is reduced to £1 7*s.* 11*d.*

In conclusion, your Council can only recommend the continued persevering attention of your members to carry out the objects for which the Section was formed; and it cannot fail to render essential aid to scientific discovery, not only amongst its members, but by presenting facilities whereby other discoverers may make known their researches to the world.

A ballot then took place for the election of officers, when the following gentlemen were duly elected for the session of 1862-3:—President, William C. Williamson, Professor Natural History, Owen's College, F.R.S. Vice Presidents, Edward W. Binney, F.R.S., F.G.S.; Joseph Sidebotham; Arthur G. Latham. Secretary, George Mosley. Treasurer, James G. Lynde, M. Inst. C.E., F.G.S.

Of the Council:—Thomas Alcock, M.D., Joseph Baxendell, F.R.A.S., John Dale, F.C.S., John W. Maclure, F.R.G.S., Thomas H. Nevill, John Parry, William Roberts, M.D., John Watson.

Hull Micro-Philosophical Society.

The annual meeting of this Society was held at the rooms of the Royal Institution, on the 5th of November, previous to the commencement of the Sessional Course for 1862-63, constituting the fifth year of its formation, when George Norman, Esq., the president, and other officers, were re-elected. A numerical increase of members appears over that of last year, and the Society, in its various resources, is evidently in a prosperous and progressing condition.

The unpropitious state of the weather during the appointed excursion days tended to some degree of disappointment in making the usual amount and quality of gatherings. The subjects approved as papers to be delivered in bi-monthly course, during the forthcoming Session, are as follow, and promise to be a useful and interesting selection:

Friday.	*Subjects for Discussion.*	*By whom.*
1862.		
Sept. 19.	On Diatomaceous Deposits ...	George Norman, Esq., President.
Oct. 3.	The History and Philosophy of a Grain of Barley	H. Prescott, Esq.
,, 17.	The Polarization of Sugars ...	W. Hendry, Esq.
,, 31.	General Exhibition and Discussion.	
Nov. 14.	The Structure of Hairs	E. Hunter, Esq.
,, 28.	The Bee	Thos. Stathes, Esq.
Dec. 12.	On Histology (the Eye)	Wm. Hendry, Esq.
,, 26.	On Ovipositors	Wm. Hanwell, Esq.
1863.		
Jan. 9.	On Spermatozoa	Dr. A. M'Millen.
,, 23.	On Nervous Tissue	Dr. K. King.
Feb. 6.	On Histology (Connective Tissues)	Wm. Hendry, Esq.
,, 20.	On the Structure of certain Seeds	H. Prescott, Esq.
March 6.	On the Anatomy of the Snail ...	Thomas Ball, Esq.
,, 20.	On Vegetable Fibre	J. R. Mayfield, Esq.

W. Hendry, *Hon. Sec.*,
Hull.

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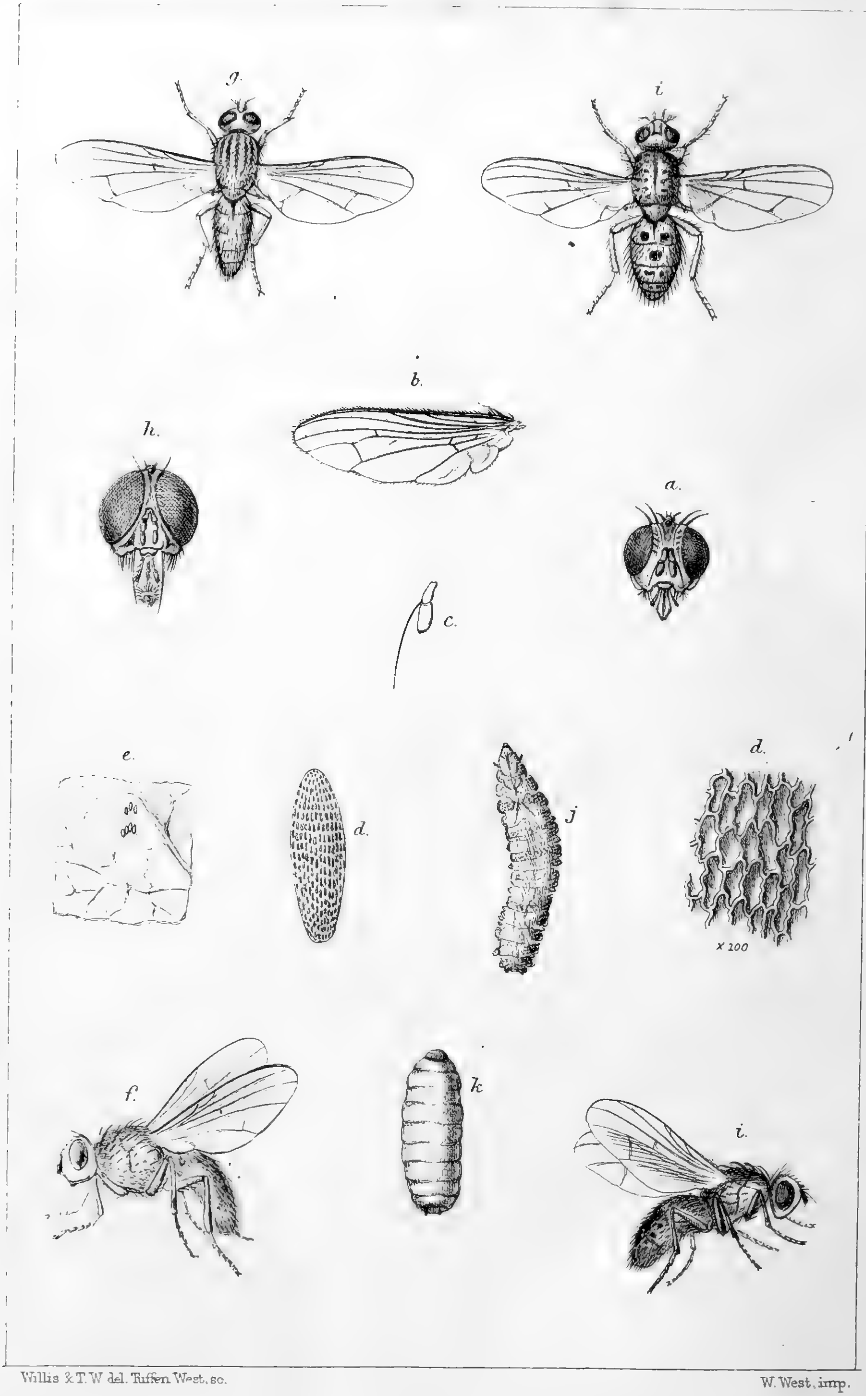

Willis & T. W del. Tuffen West, sc.

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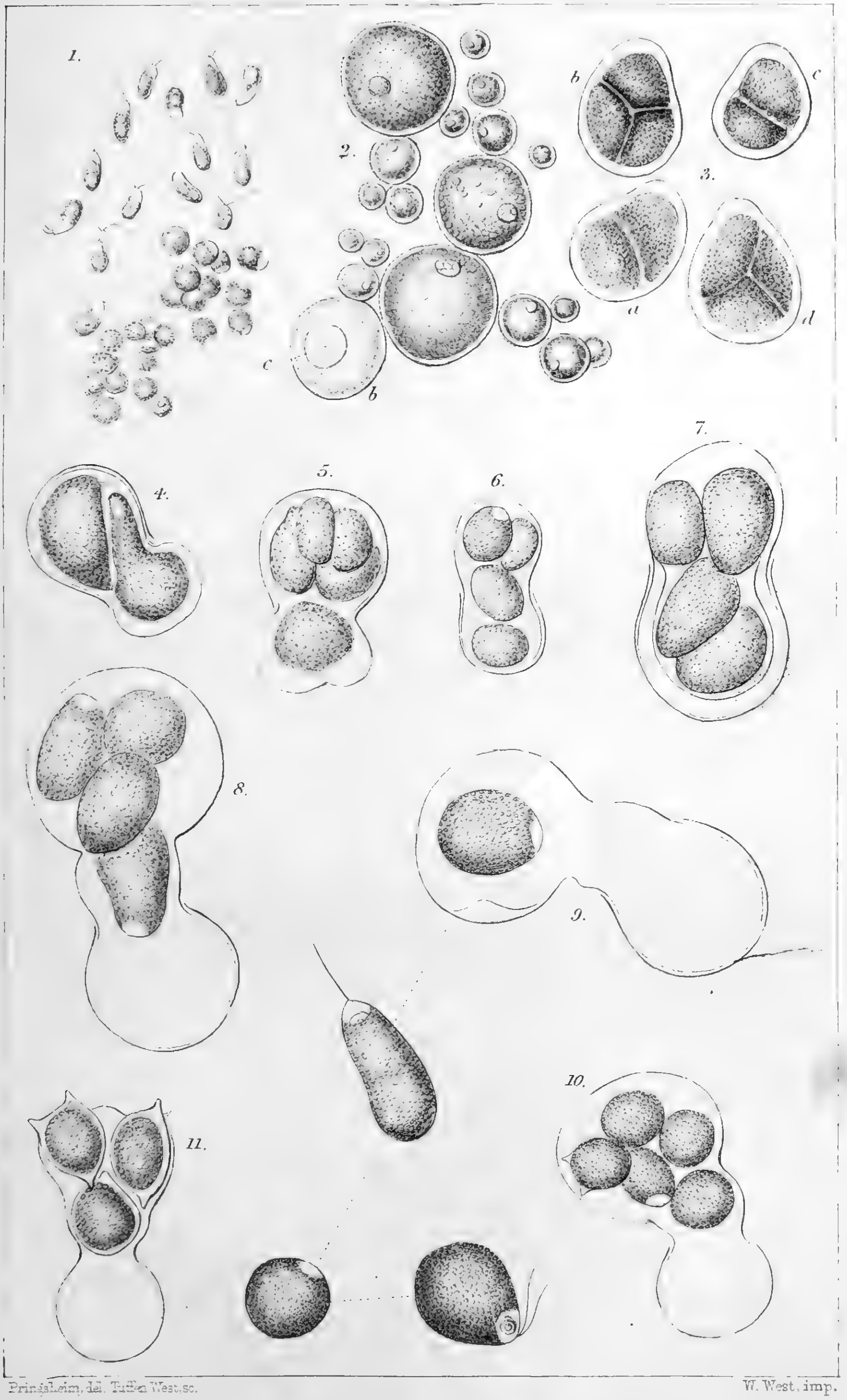
DESCRIPTION OF PLATE I,

Illustrating the Rev. W. Houghton's paper on Observations on the Fly affecting the Mangold Wurzel Crops in the year 1861.

Fig.

a.—Head of *Anthomyia Betæ* (fem.).
b.—Wings of do.
c.—Antennæ.
d.—Ova (magnified).
e.— ,, natural size.
f.—Female fly.
g.—Male fly.
h.—Head of male.
i.—Female, with dusky patches.
j.—Larva.
k.—Pupa.



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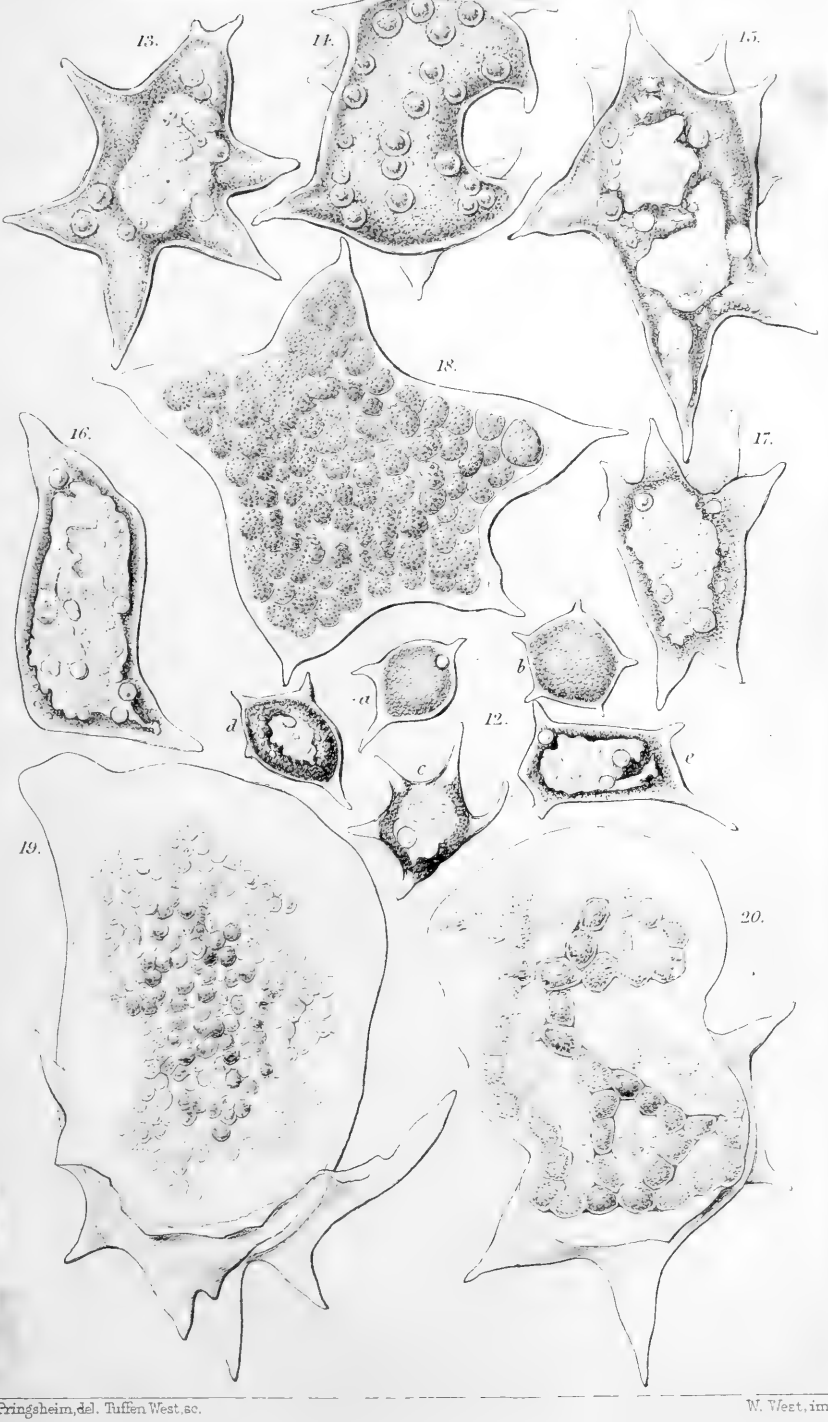

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DESCRIPTION OF PLATES II AND III.

Illustrating M. N. Pringsheim's Translation, on the Chronispores or Chronizoospores of Hydrodictyon, and on some Analogous Reproductive Bodies.

NOTE.—All the figures represent objects equally magnified, that is to say, about 582 diameters.

Fig.

1.—Chronizoospores of *Hydrodictyon*. Some (*a*) are seen immediately after their escape from the parent-cells (which are utricles from an old *Hydrodictyon*), and during their motility; the others (*b* and *c*) after they become motionless.

2.—Chronizoospores resuscitated, and already grown in various ways. Having been kept dry for eight minutes, they were then placed in water, and were not figured until they had been immersed for four minutes. One of these bodies, *b*, is already empty, and its cavity can be seen through the superior opening *c*, which has given passage to the herniary sac spoken of above.

3.—Other chronispores, seen at different moments during the progress of division of their plastic contents.

4—9.—Chronizoospores further enlarged, and all opening to allow the internal dilated sac to escape. In one of them (fig. 8) the four parts of the plasma can be perfectly recognised as so many new zoospores. In another (fig. 9) the herniary sac is ruptured, and three zoospores have already escaped.

10 and 11.—Chronizoospores which have grown and burst; the zoospores that they have engendered are still in one of them (fig. 10), all enclosed, to the number of five, within the internal utricle; in the other three only remain. These secondary zoospores have already returned to a state of repose, and begin to assume a polyhedral form.

12.—Young polyhedrons, derived from the ulterior development of zoospores issuing from chronizoospores.

13—17.—Adult polyhedrons.

18.—A Polyhedron, the plastic contents of which, adhering to the internal wall, are already transformed into large zoospores.

19 and 20.—polyhedrons, whose internal tunics are throwing off the external membrane, which is detached like a cuticle. One of these bodies (fig. 19) is seen a few minutes after the rupture of its envelope; the other (fig. 20) from forty-eight to sixty hours after the same phenomenon. In the last, large zoospores are formed; microzoospores are, on the contrary, produced in the other.

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DESCRIPTION OF PLATE IV,

To illustrate Dr. J. Braxton Hicks' paper on Vegetable Amœboid Bodies.

Fig.

1.—Amœboid state of ordinary zoospore.

2.— " " in first stage of gemule growth.

3.—Changes during segmentation.

4.—Ciliated bodies in Volvox.

5.—Gonidium of moss-roots.

6.— " " becoming red.

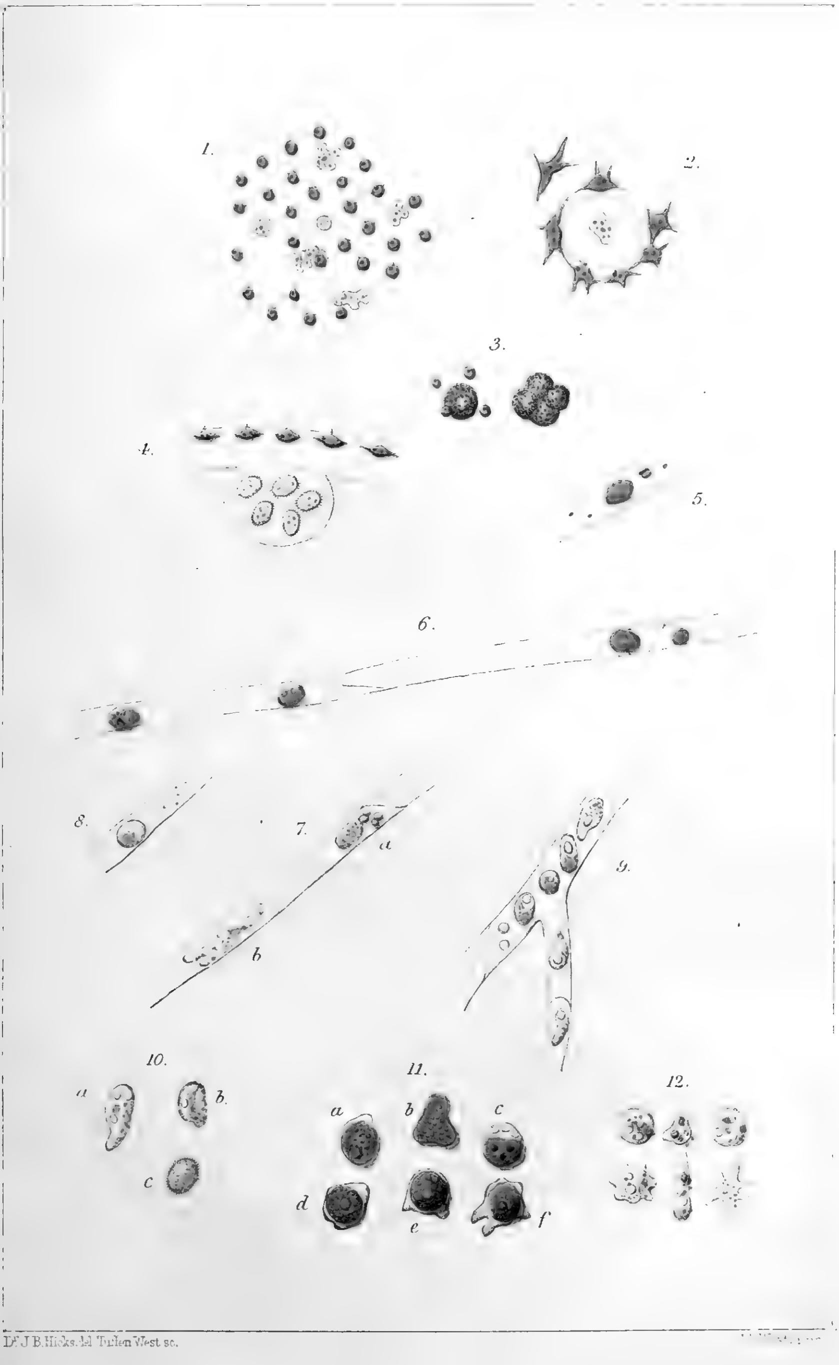
7.— " " changing into Amœbæ within the cells.

8 and 9.—Amœboid bodies completely formed.

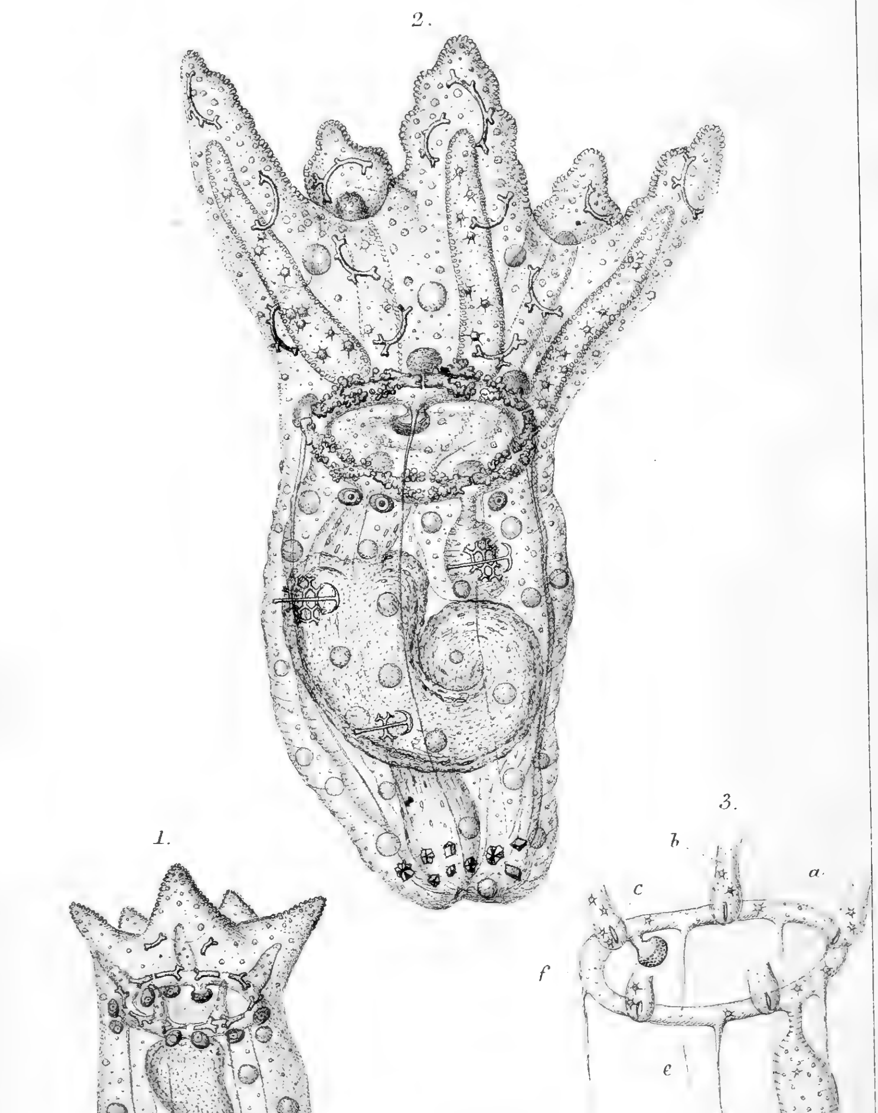
10.— " becoming ciliated.

11.—Changes towards amœboid form in free gonidia of mosses.

12.—Same, more or less completed.



Dr J.B.Hicks del. Tuffen West sc.



Wyville Thomson, del. Tuffen West, sc.

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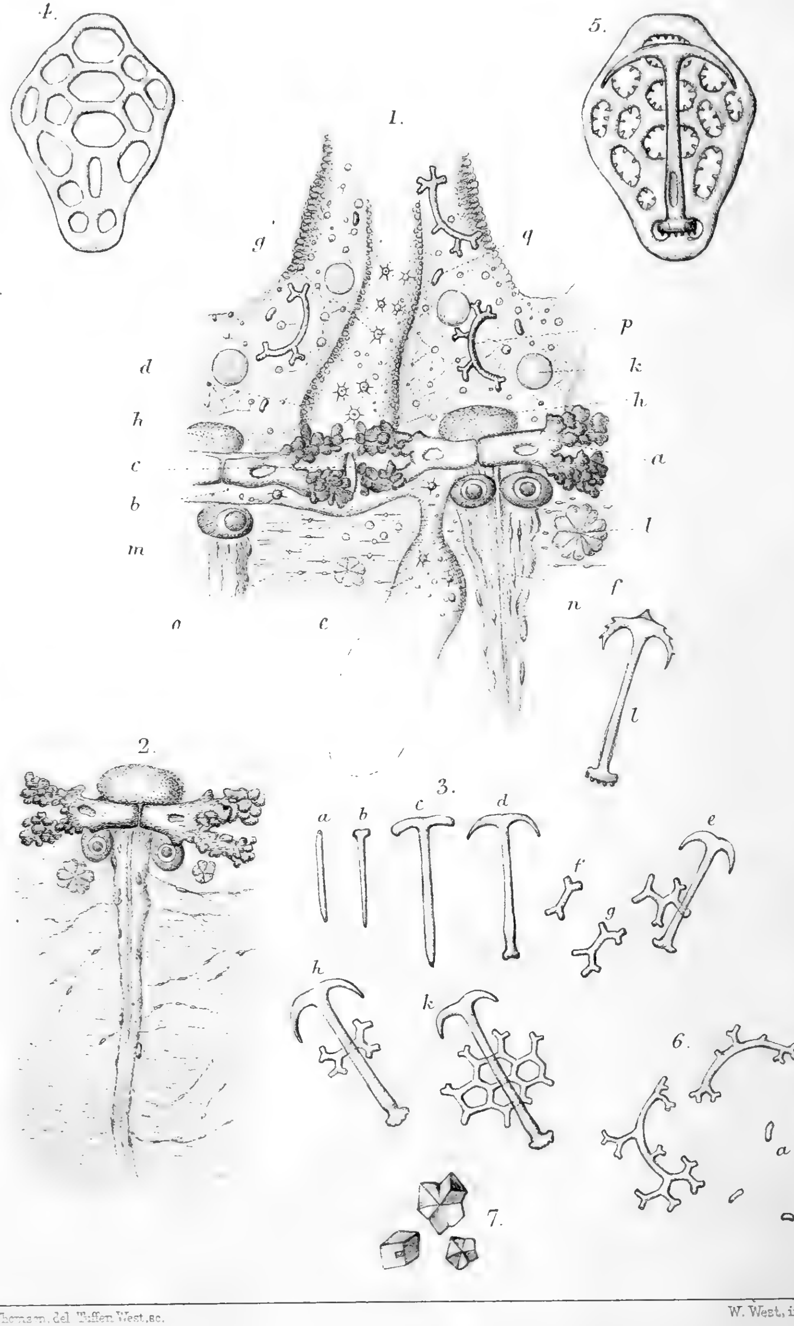

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DESCRIPTION OF PLATES V AND VI,

Illustrating Prof. Wyville Thomson's paper on Synapta.

PLATE V.—*Synapta inhærens* (O. F. Müller, sp.)

Fig.

1.—Young when first observed, June 15th, 1861.

2.—Young about a month later.

3.—Diagram of the centre of the ambulacral vascular system of the young in the second stage; *a*, œsophageal vascular ring; *b*, base of cæcal process of the ambulacral vessel forming the cavity of one of the tentacles; *c*, slit-like valve between the cavity of the tentacle and the annular vessel; *d*, Polian vesicle; *e*, ambulacral vessel accompanying one of the longitudinal muscular bands; *f*, madreporic tubercle and canal.

PLATE VI.

1.—Base of one of the tentacles, showing the relation of parts; *a*, one of the calcareous plates of the œsophageal calcareous ring; *b*, central ring of the ambulacral vascular system; *c*, valve between the vascular ring and the cavity of the tentacle, *d*; *e*, Polian vesicle; *f*, ambulacral vessel accompanying the longitudinal muscular band, *n*; *g*, peculiar cirrated bodies circulating in the ambulacral vessels; *h*, nervous ganglion; *k*, large lenticular cells, imbedded in the external sarcode layer; *l*, contractile rosettes connected with the layer of transverse muscular fibres, *o*; *m*, oval vesicles, probably rudimentary organs of special sense; *p*, calcareous "fibulæ" imbedded in the sarcode of the tentacular fringe; *q*, miliary granules.

2.—Upper portion of one of the longitudinal muscular bundles, showing the relation of parts.

3.—*a*—*l*, development of the "anchor" and "anchor-plate."

4.—Network of anchor-plate just completed, before the deposition of the external thickening layers

5.—Perfect anchor and anchor-plate.

6.—Irregular calcareous spiculæ of the tentacles; *a*, miliary granules.

7.—Calcareous granules and rosettes at the anal extremity of the body.

DESCRIPTION OF PLATE VII,

Illustrating Mr. Houghton's observations on the parasitic nature of the Fry of *Anadonta cygnea.*

Fig.

1.—Glochidium-larvæ attached to the tail of the Stickleback.

2.—Front view of a *Glochidium.*

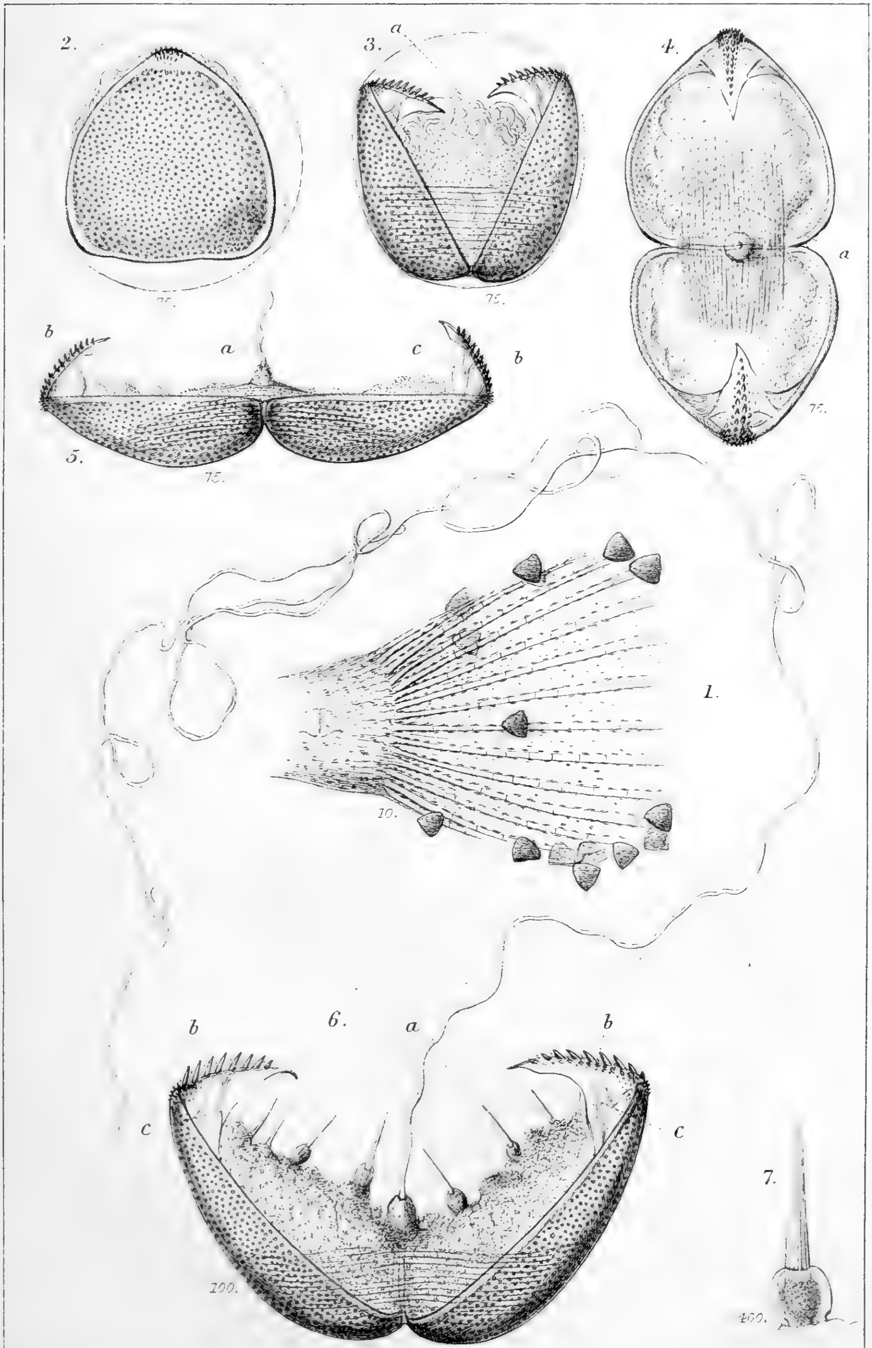
3.—Side view; valves partially open. Both of these, though still enclosed in the egg-membrane, show the byssus-filament (*a*) distinctly.

4.—*Glochidium*, with the valves fully open, showing the adductor muscle (*a*).

5.—Side view of the same, showing the mode of origin of the byssus-filament (*a*)

6.—A more magnified figure in the same position, showing the three pairs of tentacular organs noticed by Carus (*a*)

7.—One of the latter, × 400, to show its resemblance to a wetted camel's-hair pencil.

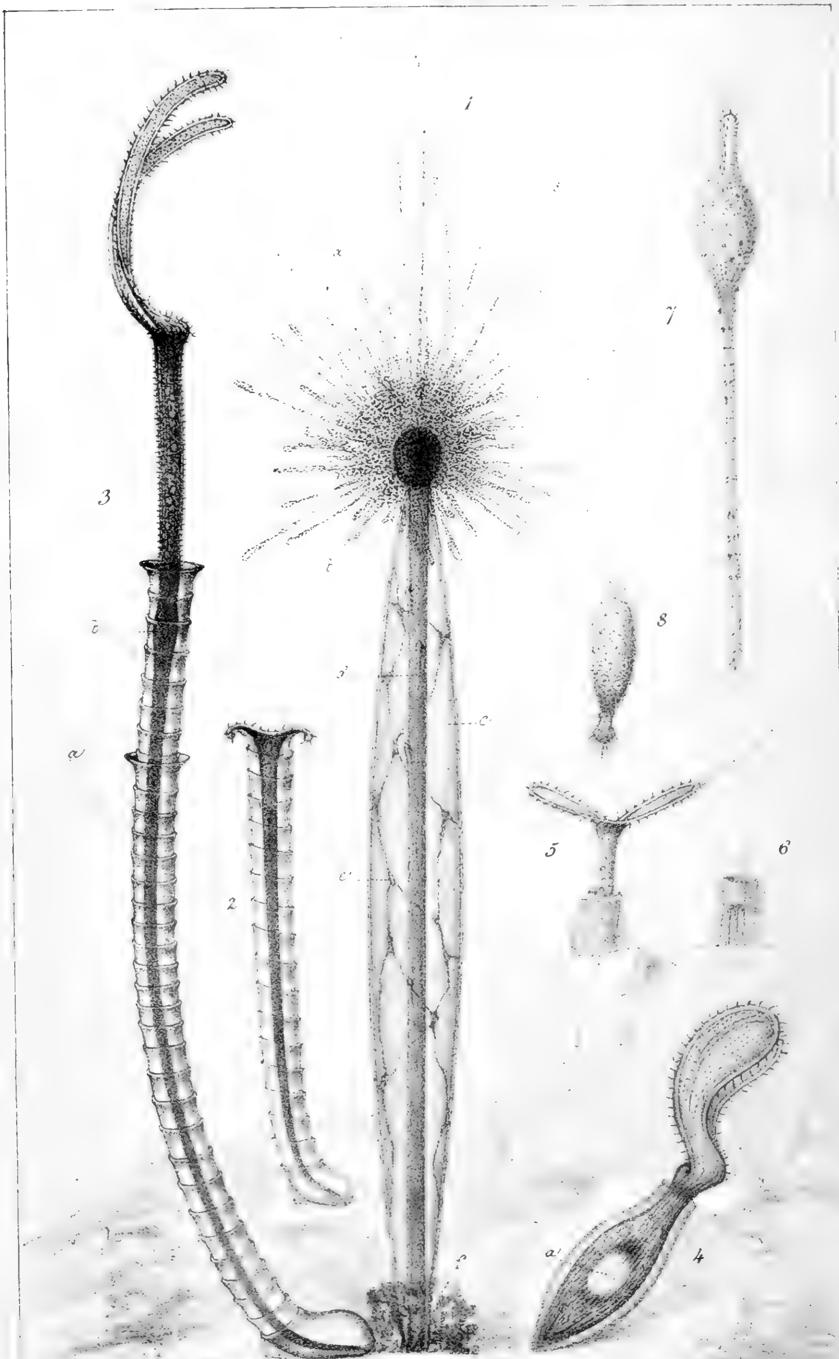


Tuffen West, ad nat del. et sc.

W. West, imp.


a
b
c

[illegible]



T. Strethill Wright, delt.

W. H. McFarlane, Lith. Edin.

DESCRIPTION OF PLATES VIII AND IX,

Illustrating Dr. Strethill Wright's paper on British Protozoa.

PLATE VIII.

Zooteirea religata, seen by "black-ground" illumination, and focused for the centre of the endosarc—*a*; with palpocils extended and curved by an upward current of water; *b*, emerging from its cell; *c*, retracted within its cell.

PLATE IX.

Fig.

1.—*Zooteirea religata*, with palpocils partially extended, and tubular contractile pedicle distended with water; *a*, ectosarc; *b*, endosarc; *c*, tube; *d*, muscular band; *e*, areolar fibres; *f*, gelatinous cell.

2.—Young *Freya producta* building its tube.

3.—*Freya producta*, with lengthened tube; *a*, old mouth of tube; *b*, thickened part of body from which the tube is secreted.

4.—*Freya obstetrica*; *a*, nucleus.

5.—*Freya stylifer*, extended.

6.— „ „ in its cell.

7.—*Oxytricha longi-caudata*, with tail extended.

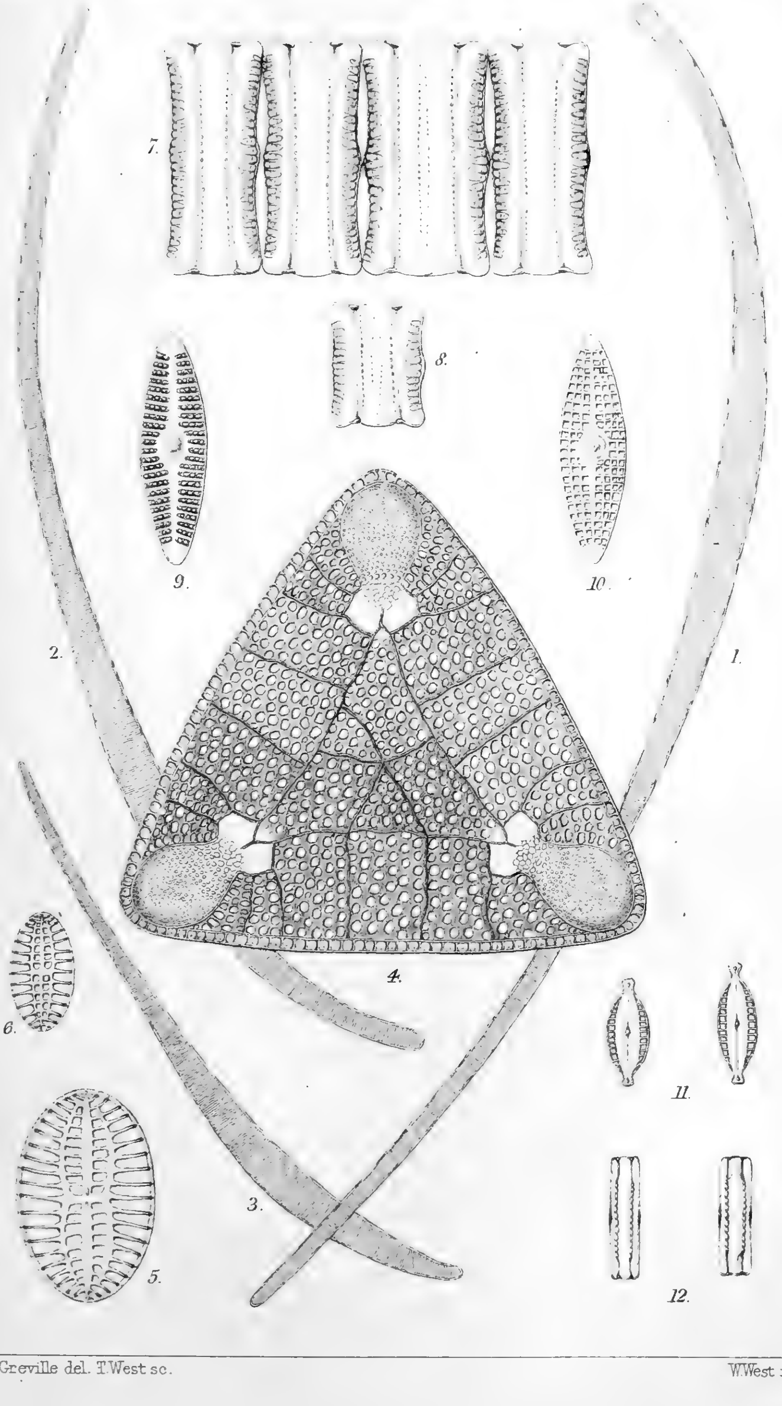
8.— „ „ with tail contracted.

DESCRIPTION OF PLATE X,

Illustrating Dr. Greville's paper on New Diatoms.
Series VII.

Fig.
1, 2.—*Synedra Normaniana.*
3.— ,, ,, dwarf variety.
4.—*Triceratium Davyanum.*
5, 6.—*Cocconeis cœlata,* × 600.
7.—*Glyphodesmis eximia,* front view.
8.— ,, ,, small frustule.
9.— ,, ,, lateral view of valve, showing moniliform striæ.
10.— ,, ,, the same, focused to show the clathrate structure.
11.—*Mastogloia capitata,* lateral view.
12. ,, ,, front view.

All the figures except 5 and 6 are × 400.



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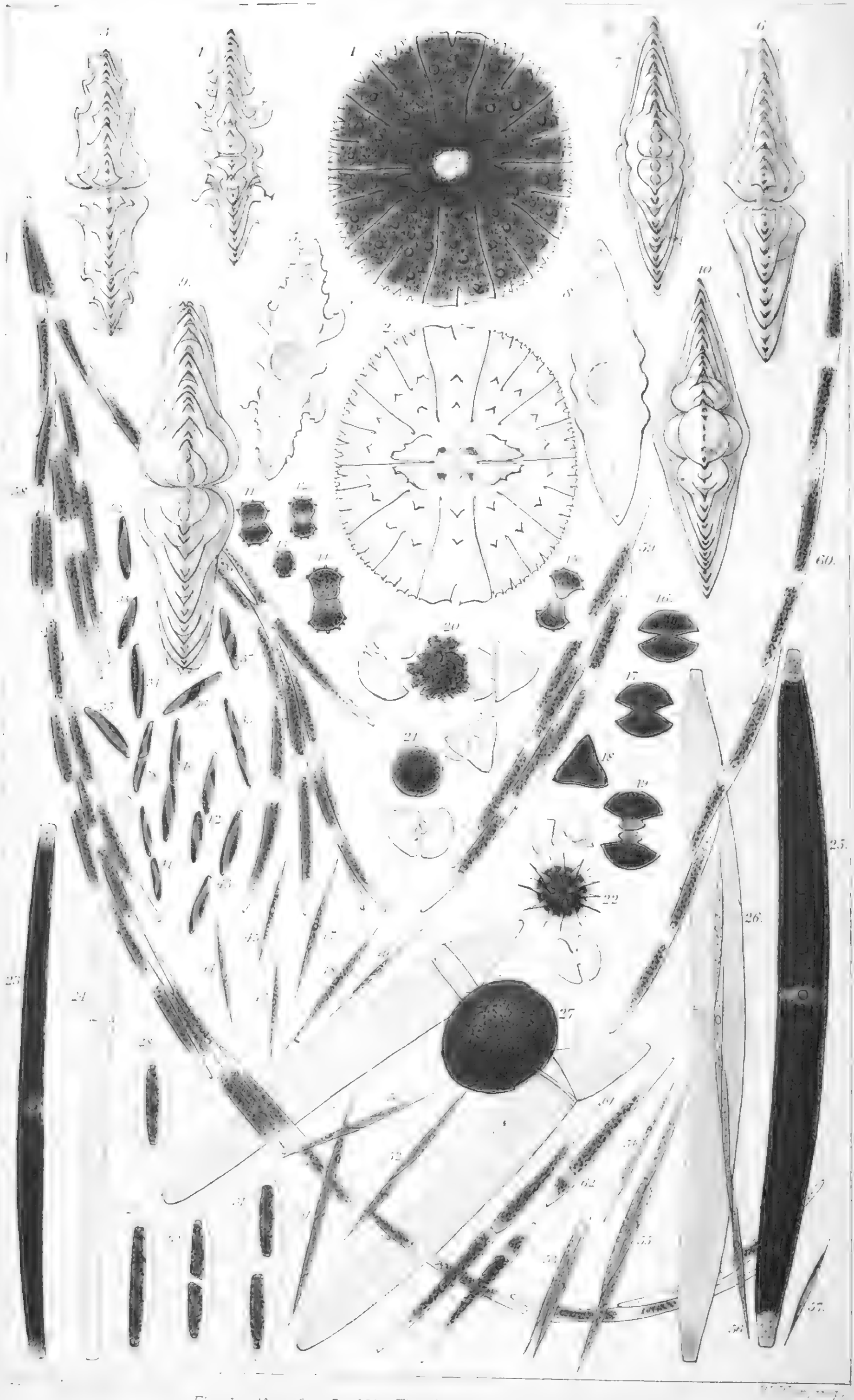

Figs: 1 to 10 & 25 to 27, × 200 — Figs: 44, 45, 57, × 250. — The rest × 400, except 58 to 62 × 200.

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DESCRIPTION OF PLATE XII,

To illustrate Mr. Archer's papers.

Figs.

1—10.—Different views of *Micrasterias Thomasiana.*

11—15.—Views of *Cosmarium tuberculatum.*

16—22.—Views of *Staurastrum lanceolatum.*

23 & 24.—Views of *Closterium directum.*

25—27.—Views of *Closterium Pritchardianum.*

28—31.—Views of *Spirotænia truncata.*

32—43.—Views of *Spirotænia parvula.*

44—62.—Views of *Ankistrodesmus acutissimus.*