THE MONTHLY MICROSCOPICAL JOURNAL:

TRANSACTIONS

OF THE

ROYAL MICROSCOPICAL SOCIETY,

AND

RECORD OF HISTOLOGICAL RESEARCH

AT HOME AND ABROAD.

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MONTHLY MICROSCOPICAL JOURNAL.

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I.—*Thermo-dynamic Origin of the Brownian Motions.*

By the Rev. Joseph Delsaulx, S.J.

(*Read before the* Royal Microscopical Society, *June* 6, 1877).

The Brownian, or molecular motions, have been hardly known more than fifty years. Robert Brown announced, in 1829, that when extremely minute solid particles, either organic or inorganic, are found suspended in pure water, or in an aqueous fluid, they display certain motions whose cause he was unable to discover, and which, by their irregularity and apparent independence, resembled to a remarkable degree the less rapid motions of the simplest infusoriæ. The smallest of these particles he called *active molecules.** The motions discovered by Robert Brown in minute particles, and for that reason called Brownian motions, have since been observed by all naturalists. In fact, there is not one amongst them but must have been struck by the strangeness, the persistence, and the frequent apparition of these molecular motions in the field of the microscope; not one, I fancy, who has not tried to raise up, were it only by a corner, the veil which nature has cast upon the secret of their origin. Hitherto, it must be confessed, all their efforts have been fruitless: the sphinx has kept his enigma.

A friend of mine has, I think, approached the nearest to the truth in investigating this matter. His opinion, the fundamental idea of which has been put in print,† may be expressed in these terms: "Every free particle, the molecules of which remain associated by their mutual actions as in the liquids and the solids, or by an external pressure as in the gas-bubbles in the mass of a liquid, must oscillate incessantly, if it is sufficiently small. These oscillations are a necessary result of the molecular vibrations which constitute heat; because each molecule, in vibrating, tends to displace the centre of gravity of the body to which it belongs. If this displacement is not commonly produced in the bodies we observe, it is because the effect of one, owing to the immense number of molecules, is always neutralized by that of another." ‡ The theoretical de-

* Ch. Robin, 'Traité du Microscope,' p. 526.
† 'Bulletin de l'Académie Royal de Belgique,' t. xli. p. 410.
‡ Ibid. t. xli. p. 410.

velopments into which I shall enter shortly, will show how much we ought to ascribe to this really ingenious, but much too incomplete idea.

The Brownian motion of minute particles in suspension in liquids, is a movement of oscillation and of vibration, *in situ*, that is quick, irregular, and continuous. We do not remark there either translation or locomotion properly so called. The orientation of the oscillatory motion passes briskly, and without following any law, from one direction to another. In the cellules of the epidermis, the pigmentary granulations having less than five or six thousandths of a millimeter in diameter, are animated with this motion of vibration ; the grains of chlorophyll in the green cellules, and probably all the cellular granulations whose surrounding liquid is not solidified, likewise manifest this movement. It is observed also in gold particles, in little grains of iridium, platinum, coal, lime, &c., &c., in milk globules, and more generally in all viscous globules immersed in water or in liquids that have little resistance.

The phenomenon occurs also in the little gas-bubbles imprisoned in a liquid; for example, in the air-bubbles which are so easily formed by agitating soap and water. The Brownian motion is more active in heated liquids than in those of a low temperature. Supposing equal diameters, the oscillatory displacement is more rapid and more extended in fatty granulations than in metallic granulations whose density is very great. The duration of the phenomenon may be said to be without limit: M. Robin possesses aqueous preparations of charcoal dust, made more than twenty years ago, in which the Brownian motion still continues to manifest itself.

In this respect, quartz rocks are yet more remarkable: the Brownian motion has been going on in them for millions of years. In fact, it is not a rare thing to find, in the quartz of geological strata, liquid cavities containing a gas-bubble in a state of perpetual agitation. It is a little bubble of vapour produced by the withdrawal of the liquid, and which the Brownian motion carries hither and thither into all the recesses of its transparent prison. Of all the physical phenomena that the microscopic study of rocks, so fruitful of surprising results, has revealed to us, this fact, first observed by Mr. Sorby, is certainly one of the most beautiful.

My intention in this note is to show, that all the Brownian motions of small masses of gas and of vapour in suspension in liquids, as well as the motions with which viscous granulations and solid particles are animated in the same circumstances, proceed necessarily from the molecular heat motions, universally admitted, in gases and liquids, by the best authorized promoters of the mechanical theory of heat. I have been led to consider the phenomenon from this point of view, from the study I have made of the movements of Mr. Crookes' radiometer. I will begin by explaining according to this theory the Brownian motion of gas-bubbles.

In estimating the pressure exerted by a gas on the walls of the containing vessel, Clausius attributes to all the molecules a medium velocity, in such a manner, however, as not to alter the total vital force of the gas. Thus determined, the pressure is found to be the same at each point of the walls of the vessel.

In order to hold good, this hypothesis of Clausius evidently requires that the dimensions of the vessel be incomparably greater than the mean length of path of a molecule between two consecutive collisions. Besides, we cannot use this hypothesis, when, by the rarefaction of the gas or by the contraction of the envelope, the dimensions of the vessel and the mean length of path of the molecules become quantities of the same order. Then, and this is precisely what takes place in the little bubbles of gas immersed in a liquid, the pressure exerted by the gas upon the different points of the envelope, and which are no longer subject to the law of the total communication of pressure, varies with the time for the same point, and are very different at the same instant at different points. The investigations of M. Finkener upon the radiometer fully justify this assertion.*

In fact, in the atmosphere the mean length of path of the molecules is about $\frac{1}{10000}$ of a millimeter for the ordinary pressure, while, according to the most recent observations, all air-bubbles whose diameter does not exceed $\frac{1}{500}$ of a millimeter, are, when imprisoned in a liquid, in a permanent state of molecular agitation. In this case, as is evident, the ratio of the dimensions of the envelope to the mean length of path of the molecules is represented at its maximum value by the number twenty. Now, it results from the numerical tables of M. Finkener, in regard to the movements observed in the radiometer, that the total communication of pressure produced by variations of velocity in any part of the gas, ceases in the air, at least partially, when the ratio of the dimensions of the vase to the mean length of path of the molecules is less than 3000. We can easily see this, by applying to the numerical data with which we are concerned, the following theorem of Clausius: the mean length of path of a molecule is to the radius of its sphere of action as the total space occupied by the gas is to the part of this space, which is really filled by the spheres of action of the molecules.† It follows that in the radiometer the mean length spoken of is inversely proportional to the number of the molecules, and consequently also inversely proportional to the density and to the pressure of the gas. In M. Finkener's experiments on the radiometer, the value of the ratio between the dimen-

* 'Annales de Poggendorf,' 1876, No. 8.

† 'Théorie Mécanique de la Chaleur,' 2e partie, p. 230.

sions of the vase and the mean length of path of the molecules, descends below $\frac{1}{5}$, and the maximum effect of the pressure of the gas upon the disks takes place when this ratio becomes equal to twenty. Admitting the preceding data as established, which accord very well with results obtained by Mr. Crookes, we are therefore justified in attributing the oscillatory motion of little gas-bubbles imprisoned in a liquid, to the velocity of translation of the molecules, varying in intensity and direction from one to another, and giving rise at the same instant, by default of the total communication of pressure, to unequal propulsions upon the different points of the envelope. The tension of the gas, the mass of the molecules, and the coefficient of resistance of the surrounding liquid, will determine, in each particular case, the conditions of volume for which the Brownian motion ceases or is produced.

The bubbles of the liquid cavities in quartz are very probably bubbles of vapour, produced when the strata were formed by evaporation, on the cooling and the retreating of the liquid. The Brownian motion of these vapour bubbles, and the molecular motions of the little gas-bubbles, are due to the same cause. It is true, however, that, according to the mechanical theory of heat, the state of equilibrium of a mass of vapour "is not a state of repose, in which the vaporation has ceased; but a state in which there is a continual evaporation, and a condensation equally strong, which counteract one another." * When a molecule of vapour strikes the liquid, the latter "does not generally repel it, but retains it, and assimilates it by the attraction which the other molecules immediately exert upon that which approaches." † This phenomenon does not take place in gases. But at the same time as the condensation of which we have just spoken is produced, an equivalent evaporation is developed at the same place. This simultaneous evaporation makes up for the losses which the liquefaction causes in the vapour, and thus maintains the tension and density of this latter in an invariable state.

Moreover, the pressures determined by the collision of the molecules of vapour, and the evaporation accompanying it on the different points of the surrounding liquid, are evidently equal to those that an elastic gas would produce in the same conditions of volume, density, tension, and temperature. From this I conclude, that the cause producing the Brownian motions in small gaseous bubbles, is also that which produces these motions in the vapour bubbles of liquid cavities. This conclusion is by no means weakened, in the case of bubbles in quartz, from the consideration of the ratio between the dimensions of the surrounding liquid, and the mean path of the molecules. For, in the assimilation of steam with the atmospheric

* 'Théorie Mécanique de la Chaleur,' 2e partie, p. 195.
† Ibid. p. 194.

air, we find by Clausius' theorem, mentioned above, that at the pressure of 15 millimeters, the probable pressure of vapour in cavities, the mean path of the molecules is $\frac{1}{200}$ of a millimeter. On the other hand, the most authorized measures assign to bubbles, dimensions inferior to $\frac{1}{500}$ of a millimeter. The value, therefore, of the ratio between the dimensions of the surrounding liquid and the mean path is in this case inferior to $\frac{2}{5}$. This is more than the theory requires for the manifestation of the Brownian motions. The smallness of the value found in this case for the ratio between the dimensions of the surrounding mass and the mean path of the molecules, is probably the result of the great resistance opposed by the liquid of the cavity to the Brownian motions. We know, in fact, that these liquids are ordinarily very concentrated saline solutions.

After having explained, in conformity with the principles of thermo-dynamics, the movement of the Brownian gaseous bubbles, and the little masses of vapour in quartz, I shall endeavour in the same way to account for the movements observed in viscous globules, and solid granulations in liquids. According to me, all these movements result from the interior dynamic state that the mechanical theory of heat attributes to liquids, and are a remarkable confirmation of it. The following are, with regard to the question now occupying us, the points of doctrine admitted by science.

In the molecular heat motions of solid bodies, "the molecules oscillate around certain positions of equilibrium, which they never leave, as long as no extraneous forces act on those molecules. This movement, which may be considered as a vibratory movement, is of a very complicated nature. In the first place, a molecule's constituent parts can vibrate among themselves; in the second place, the molecules themselves can vibrate. And these latter vibrations may consist either in an oscillatory motion of the centre of gravity, or in an oscillatory motion round this centre."

In liquids, "the molecules have not a determined position of equilibrium. They may oscillate in the body, and turn entirely round their centre of gravity, which can completely change its position. . . . In a liquid, therefore, there is a movement of oscillation of rotation, and of *translation* of the molecules; but this movement is such that it does not separate the molecules from one another. They maintain themselves even without any exterior pressure within the limits of a certain volume."*

That which distinguishes the heat motion of liquids from the thermal motion of solid bodies, is, among other things, the movement of translation with which the liquid molecules are animated. It is from having neglected to take into account this movement of translation in liquids and gases, that the author of the thermodynamic theory of the Brownian motions, mentioned in the begin-

* Clausius, 'Théorie Mécanique de la Chaleur,' 2e partie, pp. 192 et 193.

ning of this article, has only given an incomplete and wholly insufficient explanation of the phenomenon.

If the molecules in the mass of liquids are only subject to single vibratory motions, the displacing of the centre of gravity of the Brownian particles, consisting of thousands of molecules, would always remain imperceptible. The influence of the motion of translation of the liquid molecules acting on the surface of the particles, permits us to explain easily all displacements hitherto observed.

In fact, just as on the surface of a liquid * "it is possible that a molecule, by a favourable concourse of motions of translation, of oscillation, and of rotation, be separated with such violence from the rest of the neighbouring molecules, that before all its velocity is destroyed by the attractive force of the last-mentioned molecules, it is beyond their active sphere, and continues to move in the surrounding space lying beyond the reach of the liquid," thus producing the phenomenon of vaporation; so also in the mass of the liquid, it is not only possible, but even necessary, that a favourable concourse of the motion of translation, of oscillation, and of rotation produce on the different parts of the surface of the Brownian particles a pressure endowed with an exceptional intensity.

The maxima of pressure, sufficiently great on the particles of large dimensions to produce equilibrium, are not so on the Brownian particles, at least, I may be allowed to suppose it. This supposition is quite legitimate, since we only treat of isolated points belonging to the surface of the particle, and not to the entire volume or to the exterior surface.

The particles are then drawn with all the energy and irregularity of movement which the resultant of forces, remarkably variable both in intensity and direction, inevitably produces. As to the pressure which is not the result of the favourable reunion of circumstances of which there is question here, they possess the same equilibrium on the Brownian particles as on globules and granulations of much larger dimensions.

Mr. Sorby's Observations on M. Delsaulx' Paper.

I have read the paper on moving particles with very great interest, since it appears to me that the author has suggested the best explanation yet propounded. When my attention was first directed to the movement of the bubbles in fluid cavities, I could not help thinking that it was in some way or other connected with those movements which are supposed to be constant in the ultimate particles of matter. The chief difficulty was to imagine how they could in any case be slow enough and large enough to be

* Clausius, p. 194.

visible. My studies of this question were long before the experiments of Mr. Crookes, and none of the data now available were known. It would require a good deal of consideration before saying positively that the author has completely explained the whole phenomenon; but at all events I am not able to mention any fact which is not to be reconciled with his theory.

Whilst thus writing on the subject, I may as well mention that I have very recently observed a curious fact in connection with it. I have found that very minute granules of kaolin, massed together so that the particles cannot move to and fro, do yet show that there is a real movement. When examined under polarized light, they twinkle in such a way as to prove that their axis of double refraction alters its position; they rotate, although they do not visibly move.

II.—*An Explanation of the "Brownian" Movement.*

By W. N. Hartley, F.R.S.E., King's College, London.

(*Read before the* Royal Microscopical Society, *June* 6, 1877.)

If the view be correct that the attraction of bubbles by heat and the constant vibration of minute bubbles, described in my two papers presented by Professor Stokes and lately read before the Royal Society, are due to the alteration in surface tension of the liquid on one side of the bubble consequent on an alteration in temperature, it follows that light solid particles beneath the surface of water should be attracted by a source of heat. In order to determine this point, I made the following experiments:

Gamboge was rubbed up in water, and observed under the microscope to be in irregular motion.

Application of a hot wire caused the particles to be attracted and to become stationary.

Water contained in four shallow glass dishes was dusted over with gamboge, carmine, and plumbago.

The liquid was stirred up to prevent the particles floating.

When a heated wire was plunged below the surface of the water, the immersed particles of those substances were energetically attracted.

When a particle immersed in water is attracted by heat it is because the surface of liquid surrounding and in contact with the solid has its tension diminished on that side to which the warm wire is presented, hence the tension of the liquid on the opposite side urges it forward. When the "Brownian" movement occurs in a simple liquid like water, and not in a mixture of two liquids, and when the motion is a constant and steady vibration or irregular shuffling of very minute particles, I find that, as in all other cases, the movements cease, and attraction is caused by the approach of a source of heat. I conclude that, as in the case of minute bubbles in constant motion, the cause is the continual passage of heat through the liquid rendering alternate sides of the particles the warmer, and consequently diminishing the tension of the opposite liquid-surface in contact with the particle.

Very energetic movements are noticed in water when alcohol is mixed with it. Solid particles seem to be swept along in currents, and are hurried hither and thither. A number of causes are at work in such a case. The alcohol and water are not liquids of the same density, nor having the same surface tension; moreover, their mingling causes an evolution of heat, hence currents may be easily set up. And again, evaporation from the surface of the liquid or from the edges of the thin covering glass may cause movements similar to those which cause the tears of wine which Professor

James Thomson showed to be due to alterations in surface tension consequent on evaporation of the spirit.

By shaking arsenious acid with water, bubbles of air become incrusted with the powder and sink in the liquid. These are attracted* by a warm wire, and as they are of considerable size, no microscope is required to see them, as is the case with the bubbles in mineral cavities.

* Since the approach of a bubble to a warm body is caused by the tension of the liquid behind it, the attraction is more apparent than real.

III.—*An Essay on the Classification of the Diatomaceæ.*

By Paul Petit. Translated by F. Kitton, Hon. F.R.M.S.*

(*Taken as read before the* Royal Microscopical Society, *June* 6, 1877.)

M. P. Petit has favoured me with a copy of his papers (published in the 'Bulletin de la Société Botanique de France,' vols. xxiii. and xxiv.) on the classification of the Diatomaceæ according to a natural system, and has kindly given me permission to introduce the following translation to English microscopists.

He commences by observing that "when one wishes to classify the Diatomaceæ they are met by a great difficulty. Every author has his system of classification, but none have constructed a natural method.

"It would take too long to analyze here the systems of MM. Agarah, Ehrenberg, Kützing, W. Smith, Meneghini, Grunow, Heiberg, Pritchard [the arrangement in Pritchard's 'Infusoria' is really that of Mr. Ralfs, Rabenhorst, and Pfitzer. To this list should be added that of Professor H. L. Smith, of New York, and published in the 'Lens.'—F. K.].

"It suffices to say that most of the systems of the authors I have cited are constituted on the exterior form of the valves and frustules, on the presence or absence of nodules on the surface of the valves, or on the mode of growth of the diatoms, i. e. whether free or attached to a stipes or imbedded in a gelatinous mass having the form of a tube or frond.

"We must, however, recognize the fact that M. Grunow † has apprehended the affinities of certain genera, and his classification, although imperfect, contains many groups that are very natural, and which I have adopted.

"Long ago the author of the now classic 'Synopsis,' the Rev. W. Smith,‡ had called the attention of observers to the constancy of the characters furnished by the endochrome or plasma, colouring the frustules: it presents itself under two conditions, sometimes as a layer attached to the inner surface of the cell, sometimes consisting of granules irregularly disposed or radiating from a central point. At the commencement of each of the two volumes of the 'Synopsis' he gives coloured figures of a great many species filled with endochrome. The figures of W. Smith are much more exact than those of Ehrenberg in his great work on the Infusoria.§ The remarks

* This paper was sent by Mr. Kitton to the Royal Microscopical Society, but the rules of the Society forbid the reading of translations of foreign memoirs.

† 'Verhandlungen der K. K. zool. bot. Gesellschaft.' Wien, 1860, 1862, and 1863.

‡ W. Smith, 'Synopsis British Diatomaceæ,' vol. ii. p. xxv.

§ 'Die Infusionsthierchen.'

of W. Smith are also very just. Dr. Pfitzer has likewise studied the plasma of the Diatomaceæ very profoundly, and has published the result of his researches in that remarkable work, 'Bau und Entwicklung der Diatomaceen' (Bacillariaceen).*

"As the result of his researches, he introduced a new system, but it cannot be considered a natural one. In fact, all the groups are not connected naturally with each other, though the species composing the groups have a certain affinity.

"I must nevertheless admit Dr. Pfitzer's system approaches the nearest to a natural one, and that combined with M. Grunow's it has served as the basis of the method I now propose.

"It is in verifying the observations of Dr. Pfitzer, and in completing them by the study of marine and fresh-water species, which he had not at his disposal, that I have been enabled to recognize the relation of the groups to each other.

"Some details are, however, necessary for the better understanding the bases on which my method is founded.

"If we examine a large number of living diatoms, and note exactly the disposition of the endochrome as well as the form of the frustule, we shall not fail to detect the two distinct states of the endochrome as indicated by the Rev. W. Smith, and the constancy of its disposition in all individuals of the same species. We shall see at the same time that the connection of the endochrome with the frustule is common to all the species of the same genus, and sometimes to many genera which have an analogous development of the siliceous envelope. We can therefore lay down the two following laws:

"1. The internal disposition of the endochrome is alike in all individuals of the same species.

"2. The mode of connection of the endochrome with the frustule is common to all species of the same genus, and frequently to many genera, having an analogous structural development of their siliceous envelope.

"These principles will be of great service in the classification of fossil species, when identification by means of their plasma is impossible. It seems certain to me that the connection between the siliceous envelope and the endochrome does not exist at the time of reproduction, but as observations have only been made on about sixty species belong to twenty-five genera,† it is impossible to notice this character, which, however, appears to be constant in the few instances with which we are acquainted.

"I follow Dr. Pfitzer in dividing the family of the Diatomaceæ into two sub-families.

* 'Botanische Abhandl.,' von Dr. I. Hanstein, Heft ii. Bonn, 1871.
† Pfitzer, *loc. cit*., p. 163.

KEY TO THE SYSTEM.

DIATOMACEÆ

- Endochrome laminate, PLACOCHROMATICEÆ, 1st sub-family.
  - Endochrome only covering the interior of one valve .. .. — I. Achnantheæ.
  - One or two layers of endochrome resting on the middle of the zone .. ..
    - Endochrome never showing a central elliptical opening .. ..
      - A single layer of endochrome ..
        - Valves cuneiform — II. Gomphonemeæ.
        - Valves cymbiform or arched .. — III. Cymbelleæ.
      - Two layers of endochrome ..
        - Valves non-carinate .. .. .. — IV. Naviculeæ.
        - Valves carinate .. — V. Amphiproreæ.
    - A central elliptical opening in the endochrome which is sometimes completely interrupted .. .. — VI. Nitzschieæ.
  - Two layers of endochrome resting on the middle of the valve.. ..
    - Valves alate .. .. — VII. Surirelleæ.
    - Valves non-alate
      - Endochrome dentate on the margin, or divided into strings (*lanières*) .. — VIII. Synedreæ.
      - Endochrome divided above the zone by a deep sulcus .. .. — IX. Eunotieæ.
- Endochrome granular, COCCOCHROMATICEÆ, 2nd sub-family.
  - Frustules never elliptical, and never forming cylindrical filaments .. ..
    - Endochrome dispersed on the internal surface of the frustules
      - Frustules without diaphragms
        - Valves never cuneiform .. .. — X. Fragilarieæ.
        - Valves cuneiform — XI. Meridieæ.
      - Frustules with diaphragms ..
        - Valves cuneiform — XII. Licmophoreæ.
        - Valves never cuneiform .. .. — XIII. Tabellarieæ in part.
    - Endochrome radiating from a central point ..
      - Frustules with a number of diaphragms .. .. — XIII. Tabellarieæ in part.
      - Frustules without diaphragms
        - Valves regular or irregular, but not discoid .. — XIV. Biddulphieæ.
        - Valves discoid .. — XV. Coscinodisceæ.
  - Frustules elliptical or united in cylindrical filaments more or less elongated .. — XVI. Melosireæ.

(Tribes.)

"First sub-family—Endochrome lamillate: Placochromaticeæ.

"Second sub-family—Endochrome granulate: Coccochromaticeæ.

"In spite of the labour bestowed by Dr. Pfitzer on the study of the endochrome, he has allowed himself to be led away by previous German classifications. I have, however, followed him in the subdivision into symmetrical and non-symmetrical forms, and valves with or without a central nodule. This method of division has the grave inconvenience of separating groups between which there is an affinity, as, for example, the Meridieæ and the Licmophoreæ, and of placing the Tabellarieæ before the Licmophoreæ, whilst, as we shall see farther on, that the latter forms the connecting link between the Fragilarieæ and Tabellarieæ (tandis que comme on le verra plus loin ce sont ces dernières qui établissent le passage des Fragilariées aux Tabellariées).

"I am far from admitting all the groups of Dr. Pfitzer; above all, those that he has established sometimes for a single genus, and even for a single species, for example, Amphitropideæ.* It is the same with the new genera created for those species that are found at the extremity of a genus, and presenting only slight variations from the type form in their plasma. These species, on the contrary, by the modifications of their endochrome, establish the passage of the groups into each other.

"The Diatomaceæ form a very natural family, having on the one hand a connection with the Monads through the genus Cocconeis, and on the other with the Confervaceæ through the genus Melosira.

"It is, in fact, the genus Cocconeis that offers physiologically the simplest organization; a layer of endochrome rests on one valve only, leaving the other completely independent. On the other hand, the genus Melosira, includes those species which have cylindrical frustules connected under the form of filaments, and containing an endochrome the granules of which indicate a great affinity with those of the Chlorophyllaceæ as well in their form as disposition. We know that the Melosira becomes green when desiccated.†

"Much remains to be done to firmly establish the groups. It is only with time and patient research that we can arrive at this result. There still remain a great many genera in which the disposition of the plasma has to be studied, but one is able to foresee that according to the immutable laws of nature all of them can be placed in the proposed groups. Some additions will possibly be necessary for future discoverers, but I dare to hope that these alterations will not affect the bases of my method. The number of genera is too large to allow me to indicate all of them. I therefore

* Pfitzer, *loc. cit.*, pp. 94, 95.

† Kützing's 'Bacillarien,' 1844, p. 23.

confine myself to the two extreme genera in each tribe, and one or two intermediate ones. It will be easy for observers familiar with the study of diatoms to intercalate those genera he wishes to classify, by taking notice of the modifications of the endochrome which cause the difference of genera."

(*To be continued.*)

IV.—*The Histology of the Island of Reil.* By Herbert C. Major, M.D., Medical Director West Riding Asylum.

Plates CLXXXV. and CLXXXVI.

The present article is intended to form the first of a series having for its object the investigation of the minute structure of the Island of Reil as found in the human brain under varying conditions and in the ape.

Little need here be said with the view of advocating the claims of the Island of Reil, Insula, or Central lobe of the brain, as being worthy of the closest and most careful study on the part of the anatomist; not that it is more important than any other part of the cerebrum, but because, in some respects, it has special features of interest. It is that part of the brain which appears earliest both in the human fœtus and in the animal series. It appears to be peculiar to man and the higher apes; with the exception of the Makis, no indication of its presence being observed in other animals.* Situate also as the lobe is, deeply in the cerebral mass, and concealed between the frontal, parietal, and temporo-sphenoidal lobes, it is, in those of the lower animals in which it occurs, peculiarly difficult of access to the experimental investigator. And finally, there would seem to be good grounds for believing that this region of the cortex is connected in an especial manner with the exercise of the faculty of language.

The above facts have for the most part long been known; but

EXPLANATION OF PLATES CLXXXV. AND CLXXXVI.

Plate CLXXXV.—Section through a gyrus of the Island of Reil, showing the cortex of the *summit* of the gyrus (healthy).

Plate CLXXXVI.—Section through the cortex of the Island of Reil at the *bottom of a sulcus* (morbid).

In both:—1, 2, 3, 4, 5, 6, indicate the cortical layers magnified 50 diameters. *m m*, Medulla. 1′, 2′, 3′, 4′, 5′, 6′, cells of the various layers magnified 350 diameters. *m′ m′*, Medulla. In the medulla the corpuscles of Deiter (cellules araignées, Gratiolet) are seen.

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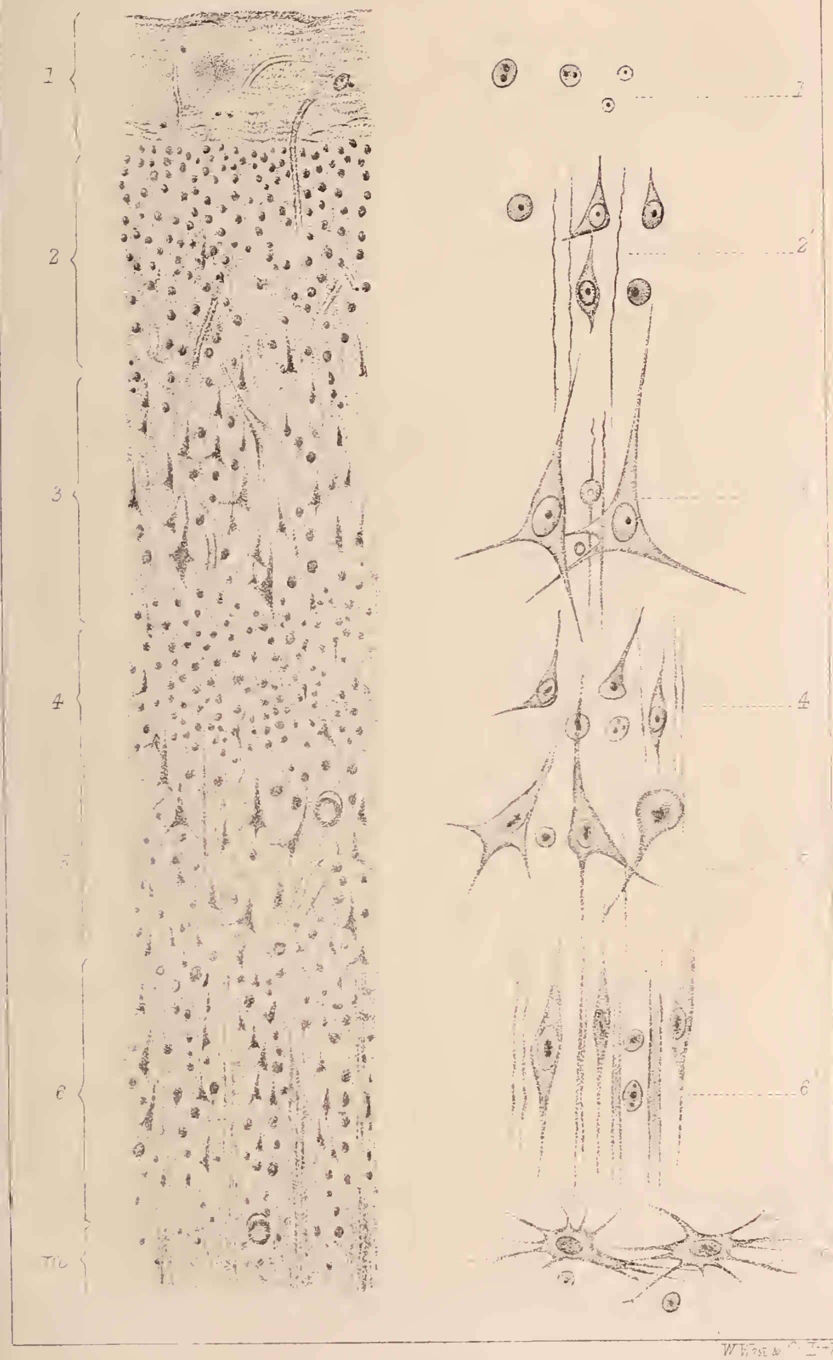
* Gratiolet et Leuret, 'Anat. Comp. du Syst. Nerveux,' p. 111.



W.West & Co. lith.

the directions in which they point with irresistible force, as those in which research should be conducted, have, as I believe, been greatly overlooked, so that facts which ought ere this to have been elicited, and questions which ought to have been set at rest, have still to be worked out and brought to light.

Since the time when Fr. Gennari inaugurated the study of the cerebral cortex (1782), or even when Baillarger published his admirable memoir,* which ought to serve in all time as a model of accurate investigation and clear exposition, great additions have doubtless been made to our knowledge of the minute anatomy of the brain. But much remains to be done in many directions, and one of these, as before stated, is, I believe, the Island of Reil.

The ordinary descriptive anatomy of the Insula, the manifold courses taken by the fibres which bring the lobe into relation with other parts of the cerebrum, have been carefully studied and described by Meynert, Luys, L. Clarke, Broadbent,† and others. With regard, however, to the minute anatomy of the cortex of the Insula, while it may be that unwittingly I do injustice to some whose labours have escaped my observation, I am not aware that the part has attracted heretofore special study, with the view of ascertaining its exact structure.

The comparative anatomy of the lobe, again, is touched upon, in the briefest manner, by Gratiolet, who bestows merely a few vague sentences on its characters in the Orang and Chimpanzee ;‡ and I am not aware that any other author has extended our knowledge in this direction.

And thus it is also with regard to the relative structure of the Insula in the fœtus and young child as compared with the adult; our knowledge is vague, uncertain, incomplete. And lastly, in the consideration of those atrophic changes which, under certain circumstances, induce wasting and destruction of the nervous structure, the condition of the Insula, and the extent to which it is involved, are, I have reason to know, very generally passed over, and often, I cannot doubt, to the loss of important data. Now all these questions are well deserving of careful consideration, and it is to them I desire in this and subsequent papers to direct attention. And it seems natural and advisable that the opening paper should be devoted to a consideration of the histology of the Insula in the healthy human adult, an accurate knowledge of which is essential to a right judgment on the other points of the inquiry to which I have alluded.

The questions, then, now proposed, and the answers to which

* Baillarger, 'Structure de la Couche Corticale.' Paris, 1840.

† See more especially Broadbent, 'The Structure of the Cerebral Hemisphere.'

‡ Gratiolet, 'Mémoire sur les Plis Cérébraux de l'Homme et des Primates.'

it will be my endeavour to supply in the present article, resolve themselves into the following:

I. Can any structural peculiarity be detected in the arrangement of the cortical layers of the human Insula, or in the nervous or other elements composing them?

II. Do the gyri which collectively form the Insula, agree with each other in minute structure?

III. Does any structural difference exist, under ordinary conditions, between the right and left Insula?

IV. Does the white matter of the Insula maintain the same plan of union with the cortex, as regards the course of the fibres, as in other convolutions generally?

I. It is not strange that at the time when Fr. Gennari, Vic d'Azyr, Meckel, Cazauveilh, and even Baillarger wrote, considerable differences of opinion should have existed with regard to the layers of the cortex of the brain, and that, consequently, the descriptions given by these authors should have varied. For them, the chief method of investigation consisted in pressing a small portion of brain substance between two pieces of glass, and examining it with the unaided eye, or, at most, very imperfectly magnified. But it is strange that more recent investigators, with all the means for accurate observation at their disposal, should, on a simple matter of observation, fail generally to arrive at a common conclusion. And yet such is the case. Kolliker * distinguishes four cortical layers as constituting the general plan of arrangement. L. Clarke † gives the number as eight; Th. Meynert,‡ five; Charcot,§ five. Doubtless there are many sources of difficulty and fallacy. Frequently it happens that at one spot the cortical layers appear so mingled and thrown into confusion as to render a candid and truthful enumeration of them almost a matter of impossibility; while in another section, taken only a line from the first, the layers of cells manifest themselves with unmistakable accuracy and precision. But then, such accidental sources of fallacy should disappear before systematic and extended observation, and should not long occasion doubt. And in truth, much of the uncertainty and confusion on the subject, and which are only now beginning to pass away, thanks to the labours of Bets and others, would have been avoided if authors had more frequently delineated the objects which they desired to describe. In so complex a study as that of the structure of the brain, long descriptions, unaided by actual demonstration or by plates, are in reality of little value.

Since, then, there exists this diversity of opinion with regard to the elementary points of cortical structure as usually presented to us, it is necessary that I should in the first place state what, in

* 'Histologie Humaine.' † 'Proceed. Roy. Soc.,' September 1863.
‡ 'Stricker's Handbook,' vol. ii. § 'Progres Medecal,' 1875.

my opinion, is the general plan and arrangement of the layers in the convolutions of the vertex, so as to be in a position to draw comparisons between such arrangement and that found in the Insula in man and in the apes.

The method of preparation of the brain tissue adopted in making these investigations, as well as the source from which sections of the normal Insula were obtained, should first be stated. With regard to the former point, it will be sufficient for me to say that Clarke's method has been followed. The fresh method of preparation which my colleague, Mr. Bevan Lewis,* has done so much to improve and extend, is here, I regret to say, not available, or only to a very slight extent. The disadvantage of the fresh method is that by it the operator does not know *exactly* what he is investigating—cannot, for instance, pick out the fourth cortical layer and examine it, excluding the admixture of other layers. Doubtless this is a difficulty which patience and ingenuity will in time surmount, but at present it is fatal to such an investigation as the comparative structure of the cortical layers.

The preparations which have served as my standards of comparison for the healthy structure of the Insula were provided by the brain of a young man æt. 21, who was accidentally killed when, so far as could be ascertained, in a condition of full health.

In a Thesis presented to the University of Edinburgh (1875), on the 'Histology of the Brain in Apes,' I described six cortical layers as being the usual arrangement in the human brain. In the 'Journal of Mental Science' for January 1876, in a paper on the brain of the Chacma Baboon, I again showed that in the human subject the six-layer type of the cortex was the usual one. Now this is not the number as given by the majority of histologists, and it is necessary, therefore, that I should explain where it is that we diverge.

An examination of the drawings I have given (Plates CLXXXV. and CLXXXVI.), and their comparison with that given by Meynert,† will make the point of divergence clear. It will be at once observed that with regard to the first, second, third, and fourth layers we are at one, but beneath the fourth layer Meynert figures *one* layer, while I give *two*; and hence Meynert describes five layers, while I, following Baillarger, describe and figure *six*. Doubtless, modifications in the general appearance of the layers are frequent. To illustrate this it is only necessary to pass successively in the field of the microscope, under a low power, the cortex of the summit of a gyrus and that in a sulcus, as figured in Plates CLXXXV. and CLXXXVI. Yet here is no alteration in the six-layer type, but merely a modification of it.

* 'Monthly Micro. Journal,' September 1876.
† 'Stricker's Handbook,' vol. ii. p. 234.

Now the first point I desire to establish is this—that the *plan of arrangement* of the cortical layers in the Island of Reil differs in no respect from that I have already alluded to as being the ordinary one throughout the cortex. If the layers delineated in Plate CLXXXV. be compared with those figured by Meynert, it will be seen that, with exception of that which I term the fifth layer, and which Meynert does not notice as distinct from the deepest, the resemblance is nearly complete. The cells may not have the same relative or absolute size—that is a point which will be considered shortly—but their general aspect as seen with a low power of the microscope, and their relative numbers in the several layers, correspond very closely.

With regard to the intimate constitution and appearance which the nerve-cells of the Insula present, as seen under a power of 350 *diameters*, I can observe nothing unusual,—nothing that would seem to imply (as in the case of the so-called giant-cells of the vertex) any special and peculiar functions. Even with the highest magnifying power at my command (*one-tenth* objective, Hartnack), I can detect no departure from those characters which are so well recognized.

The size of the nerve-cells of the Insula, as of all other parts of the cerebrum, deserves special attention. I gather from the account of Dr. Lockhart Clarke,* that, while he considers the nerve-cells of the Insula to be generally larger than in some other parts, yet that they are not as large as those commonly found in the convolutions of the vertex.† I am quite sure of the general accuracy of the above remark, but would wish to extend the observation and render it more precise by an appeal to actual measurement of the cells of the various layers as taken with the micrometer.

1st layer. The small and for the most part nucleus-like bodies which occur in this layer, I find measure ·008 *millimeter*, the occasional nucleated corpuscles being about ·012 *millimeter* (Plates CLXXXV., CLXXXVI., 1 1′).

2nd layer. The small pyramidal bodies of the second layer (CLXXXV., CLXXXVI., 2 2′), average ·012 *millimeter*, occasionally reaching ·016 *millimeter*.

3rd layer. The cells of the third layer vary between ·016 at the superficial portion of the stratum, to ·024 or even ·028 *millimeter* (occasionally only) at the deepest part. It will be observed that in this layer, as the cells increase in size, they diminish in number (CLXXXV., CLXXXVI., 3 3′).

4th layer. The small oval or pyriform bodies of this layer, which impart to the stratum so distinctive an appearance, owing to

* Maudsley's 'Physiology and Pathology of Mind,' 3rd ed. p. 115.

† This is, I believe, Dr. Clarke's meaning.

their small size and especially to their great uniformity, measure, with few exceptions, ·012 *millimeter.* Occasionally, as in other parts, a large cell measuring ·02 or even ·024 *millimeter* is seen, but this is rare. The sudden diminution in the size of these bodies as compared with those of the previous layers is very striking, coinciding, as the fact does, with the result of simple observation.

5th layer. In this layer, I believe, more than in any other, the cells vary in size, and it is the more difficult to give an approximate average. I think, however, that the dimensions ·02 to ·224 *millimeter* will include most of the corpuscles. Many, however, are very much smaller, while, on the other hand, some occasionally occur measuring ·032 *millimeter* in length (CLXXXV., CLXXXVI., 5 5′).

6th layer. The corpuscles of this, the deepest cortical layer, are for the most part spindle-shaped, more especially in that part of the cortex forming the summit of a gyrus, and hence their length is very disproportionate to their breadth. Average length, ·02 to ·024 *millimeter;* breadth, ·008 *millimeter* (CLXXXV., CLXXXVI., 6 6′).

The above results are those afforded by the healthy brain to which I have before alluded, but they have been supplemented and confirmed by measurements taken in twelve other cases, which, although morbid, afford valuable *confirmatory* evidence. It is hardly necessary to point out the impossibility of giving in any instance the exact dimensions of all the corpuscles, a fair average derived from a large number of observations being the most that can be afforded.

Taking now a section from a convolution of the vertex (frontal region), it will be seen that the estimated dimensions of the cells show a close resemblance as regards absolute as well as relative size, thus (as before, in fractions of a *millimeter*):

1st layer	.. ..	·008	to	·012	millimeter.
2nd layer	.. ..	·012	„	·02 (rarely)	millimeter.
3rd layer	.. ..	·02	„	·028	„
4th layer	.. ..	·012	„	·02 (rarely)	„
5th layer	.. ..	·02	„	·024	„
6th layer	.. ..	·016	„	·02	„

Now a comparison of the above figures with those before given as representing the size of the cells in the Insula, might hardly seem to warrant the statement formerly put forward that in the latter situation the cells are smaller than at the vertex. The truth, however, and its explanation, appear to be this: The *third layer* is that in which the contrast occurs. In the Insula cells are found quite equal in size to those in the corresponding layer at the vertex (I exclude, of course, from consideration the so-called giant-cells); but the *majority* are smaller; and hence it is that while in a section taken from the vertex the band of cells forming the third layer stands out from all the others, in the Insula it is much less conspicuous.

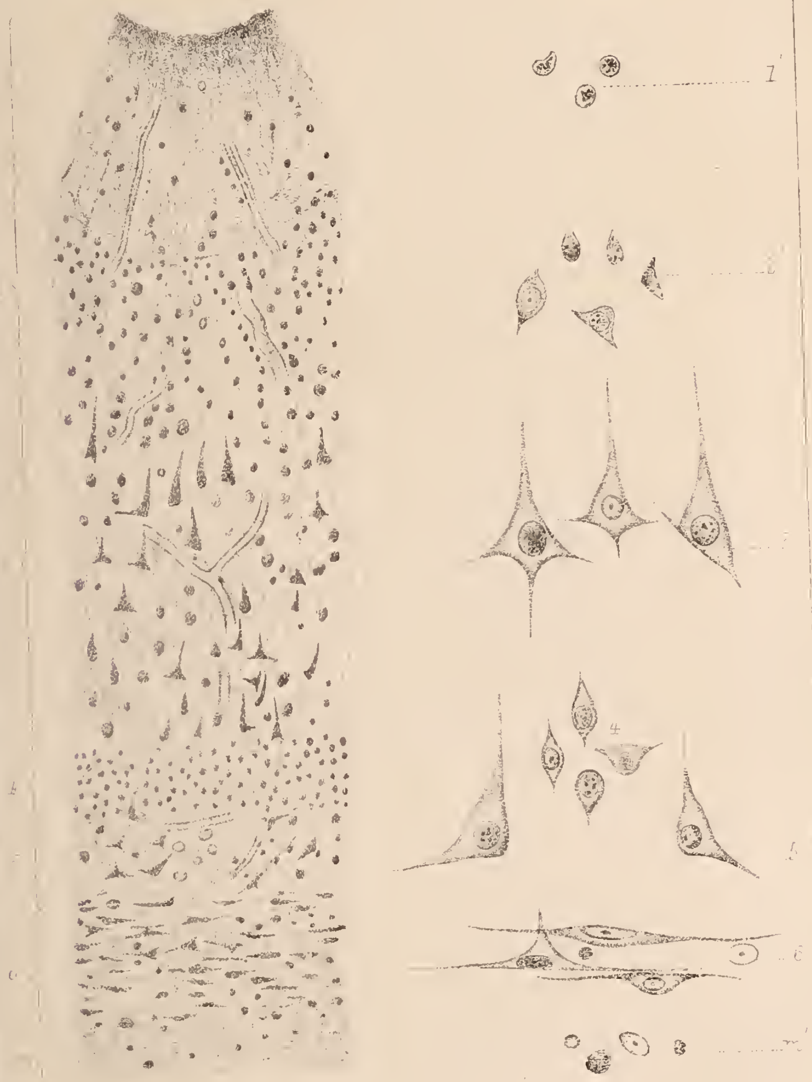
The above, then, I apprehend to be the chief feature of distinction; and while at present I would not venture to suggest an inference, there can, I think, be no doubt that the point is an important one. For it must be remembered that it is in the cells of the *third layer* that degenerative changes described by myself and others are most frequently apparent.

II. The next point for consideration is as to whether any structural differences can be detected between the several gyri which collectively form the Insula. To ascertain this, sections were made through the entire Insula at different levels, so that in each section the gyri were viewed side by side, and structure could be compared under exactly similar conditions. The result, however, has been negative; no structural variation being discoverable in the various gyri, even under the severe comparison above indicated. This result is probably in accordance with what would have been anticipated, but nevertheless it is, I consider, important.

III. In like manner I have failed to establish, after a careful and prolonged search, any structural difference between the right and the left Insula. Doubtless the point is a difficult one to determine with absolute certainty, but at present I am decidedly of opinion that the structure on both sides is identical; and if the opinion is expressed with some confidence, it is only because I know that peculiarity of structure does not readily escape detection when the eye (to put it so) has become perfectly familiar with the intimate structure of the cerebral tissue.

IV. The course of the fibres issuing from the Island of Reil has been studied and described more especially by Clarke, Meynert, Gratiolet, and Broadbent, who have dealt very fully with the subject. The only point I desire to refer to has reference to the course of the fibres as they pass into the cortex of the Insula. It was shown by Baillarger,* and again by Broadbent,† that all parts of the cortex do not receive fibres coming directly from the central stem of white matter, and the portions which do not so receive fibres are those at the bottom of the sulci between the convolutions. Baillarger states, with perfect accuracy, that long and numerous fibrils run from the central white stem to the *summits* of the convolutions; that such fibrils become rarer and shorter as the sulcus is approached, and become transverse at the sulcus, where the white matter is almost, as it were, *applied* to the cortex, instead of being fused with it as it is at the summit of the gyrus. Hence it is that, as also remarked by Baillarger, a section of brain (in some of the lower animals more especially) will often show the cortex, owing to a little pressure, actually separating from the white matter at the

* *Loc. cit.* † *Loc. cit.*



W. West . lith.

bottom of a sulcus. Now in the human Insula the same arrangement holds good, the fibres for the most part curving round the cortex at the bottom of the sulci, instead of passing upwards into the grey matter.

With regard to the blood-vessels and neuroglia of the Insula, I have been able to observe no peculiarity calling for special description or remark.

Such, then, are the conclusions to which I have arrived, and with their brief recapitulation will close this the first part of the present inquiry.

In reply to the four questions proposed at the outset of this article, I would answer as follows:

1. The cortical layers of the Insula agree in number, order, and general arrangement with those of the vertex, but the cells of the *third* layer are in the Insula generally smaller than at the vertex. The vessel and neuroglia present no peculiarity.

2. The various gyri forming the Insula present similar structure.

3. No difference of structure can be detected in the right as compared with the left Insula.

4. The method of union of the white matter with the cortex is in the Insula similar to that observed in other lobes.—*The West Riding Lunatic Asylum Medical Reports,* vol. vi.

V.—*The Microscopes at the American Exhibition.*

By J. Gibbons Hunt, M.D., of Philadelphia, Pa.

[The following observations are remarkable from the bluntness, or rather sharpness, with which they are expressed. Still, if the reader will make the necessary allowances, they will not be found devoid of interest.—Ed. 'M. M. J.']

After a great Exhibition, like the one recently held in our city, it may not be unprofitable to note some facts which have a bearing on that branch of human skill and science which is supposed to be cultivated in this section of the Academy, viz. microscopy.

Conscious incompetency would deter me from attempting a description of all the microscopical exhibit offered at our Centennial. I will ask you, therefore, to consider with me some subjects in which you and all workers with microscopes are interested, but which did not and could not find fitting expression in the reports of the eminent judges on that occasion. I take it for granted that we are at liberty to speak of the results of work, without embracing with admiration or neglecting with total indifference the workman, and this I propose to do from my own stand-point of observation, which is that of an interested observer of the field, rather than an active labourer therein.

Common courtesy leads me to speak first of the well-known foreign instruments which were displayed doubtless for the especial purpose of being looked at by all observers. Ornate show-cases have no essential connection with microscopy; they belong, in my opinion, to a distinct branch of mechanics. I shall not, therefore, entertain you with their description. Neither does needlessly massive brasswork necessarily give stability nor perfect motions to microscopes; therefore such specimens of brazen elephantiasis I will not further diagnose at this time.

The improved form of the Ross instrument in which the fine adjustment is removed from the upper and placed beneath the lower end of the body, is a great improvement over the old pattern. Greater accuracy of motion is secured along with improved appearance. The wart is placed under the nose instead of on it, that is all. Like most other English microscopes, *the distance between the focal point and eye-piece is changed every time the fine adjustment is touched*, and therefore the magnifying power is constantly altering, and is perceptible under highest powers. The new form is stronger and more steady than the old one, and less massive. The binocular prism is a fixture in the body, and does not change position while focussing. The Ross stage is still too thick, necessitating special and expensive apparatus for obliquest light. The finish of these instruments is good, but not the best, and the motions are smooth; but, I have reason to believe, had the hypercritical judgments of American microscopists been earlier known, that eminent firm would have displayed superior work to that we have seen.

Beck's large stand has more grace of form than any other foreign microscope; and, in excellence of finish, was superior to any other foreign instrument on exhibition. In my opinion the stage is mechanically defective. It has no adjustment for eccentric concentric rotation, and therefore seldom turns *in* the optical axis. Its mechanical arrangements for motion do not remain in order without frequent adjustment, and this results not from neglect of workmanship, but from defective design. Better abandon racks altogether in stage motions than spend time in adjusting bad ones. It is common experience, in this country, that foreign-made racks are not equal in smoothness of motion to those made at home.

The stands exhibited by Mr. Crouch displayed great excellence of workmanship, and this maker's aim has been to cheapen production without sacrificing commercial good work, and I think he has succeeded. His motions are made with more than ordinary foreign care, and his instruments therefore wear well. Crouch's best stands are supplied with the concentric adjustable stage, thus adopting Zentmayer's idea, introduced sixteen years ago. It is to be regretted that Mr. Crouch allowed his name to be connected with the introduction of the adjustable rotating stage, for it is exclusively an American invention.

The stands of Nachet are not elegant in design, neither is it the experience of workers here that they are conveniently adapted to all kinds of scientific work, nor do they continue in perfect condition after much use. I can remember the time when the American market was largely supplied with indifferent French microscopes, but, happily, that day is past.

Hartnack's instruments were not on exhibition, but previous experience has taught me they compare unfavourably with other reputed first-class instruments in workmanship and finish. After experience with American and English microscopes they are unsatisfactory in the extreme. Some German microscopists, and their imitators elsewhere, indulge the sickly sentimentality of lauding Hartnack's instruments as though *they only* were competent to do best work. In every respect, when compared with American and English first-class work, they are inferior. Clever working instruments in a restricted way they are, but they are not the best.

From Germany I have never seen first-class microscopical brasswork, and much of it has come under my notice. German microscopes are creations of deformity, and, speaking comparatively, are not instruments of precision at all. In the great struggle for the survival of the fittest, they will rapidly perish from sight, as rapidly as workers become instructed in such things.

American microscopes were in the minority at our Exhibition, if we estimate numbers alone. Not so if we consider beauty of design, workmanship, and originality of construction. Among such work, claiming to be first-class, Zentmayer's is pre-eminent. It has no superior anywhere. The stands he placed on exhibition were the best microscopical work there. In all his best stands the adjustable rotating concentric stage is used, and has been for sixteen years, long before any foreign maker conceived the idea.

The "American Centennial" stand, for the first time exhibited on that occasion, is worthy of special notice. It combines specialties of construction not found in any other instrument, and its mechanical finish is more perfect and displays superior workmanship to all others in the Exhibition or elsewhere. It is the only microscope stand constructed on accurate scientific principles. All its optical and mechanical parts are built around one primary centre, which is the focal point of the instrument. When placed horizontally, in the position for drawing, the entire microscope revolves around a centre which lies perpendicularly under the optical focus. A graduated base gives facility for approximative measurement of the angular aperture of objectives. The top of the stage is elevated accurately to a level with this centre of rotation, and revolves concentrically around the focal point. The stage is accurately graduated, and is adjusted by screws which are turned only by screw-drivers, and when once centred is not easily disarranged by careless trifling with inviting milled-head screws. All the illuminating apparatus, including the mirror, turns around the same centre, remaining always in focus, and all degrees of oblique light from 1° to 90°, are read off at sight on a graduated index level with the stage. This obtaining and registering of obliquity was perfected two years ago, and similar facility is not found in any other microscope. Its scientific value is apparent.* By turning a large milled-head screw a stage of extreme thinness, which likewise rotates concentrically, may be substituted for the longer one, and now your achromatic condenser and mirror may rise above the stage for illumination of opaque objects, and still the degrees are registered. The fine adjustment has been removed from the end of the body, the wart has been operated upon, not by Esmark's, but by Zentmayer's process, and not a drop of blood was spilled. It has disappeared entirely. Still a peculiarly shaped, large milled-head graduated screw, which gives a comparatively rapid or extremely slow motion, moves a slide independent from the rack-motion, and focusses the entire optical body, thus always preserving the same relationship between the objective and eye-piece, an arrangement not found in any first-class English microscope. The binocular prism is ground with equal skill and adjusted with more care than in most other instruments that have ever come under my examination; hence, both fields appear coincident, and do not resemble the longitudinal section of a cylinder, one side up, quarter way round depressed.† Here, then, we have a microscope of home production, but of surpassing precision, and which has taught the skilled English makers a useful lesson. If they propose to compete for the American market they must send hither better work. Thus far I have spoken chiefly of first-class microscopes, and only of those which have come under my notice.

The so-called student's stands are of equal importance, though less elaborate. All makers, foreign and domestic, furnish enough of these. Some are fit instruments for scientific work, very well adapted to the coarser observations in biology; but most of this

* It is stated in the 'American Naturalist' for December, that a firm from Rochester, New York, "hinged the sub-stage bar at the level of the object," but the small stands exhibited by said firm at the *opening* of the Exhibition were not so made, neither had they any facility for registering obliquity. The firm in question did not grasp Zentmayer's idea at all, and hence can justly claim no priority of invention.

† The sub-stage is cut entirely through transversely, which gives unusual facilities for accessory illuminating apparatus.

class are not instruments of precision. It is a mistake to place in the hands of beginners bad tools to work with. Wherever a microscope is cheapened in cost by inferior workmanship, it is unfit for the student. It had better be in the hands of the expert who will eliminate its errors by his previous experience. Drop all mechanical luxuries in order to reduce expense, but give the best workmanship to the beginner. Much of this class of work sent here from abroad is so inferior that time would be wasted in speaking of it further.

In the construction of objectives great advances are to be noticed. On this subject my remarks will not be confined to lenses only which were on exhibition.

The patent system of Mr. Wenham, by which corrections are obtained by a single flint lens, was exhibited very fully before the judges. From the $\frac{1}{5}$th to the $\frac{1}{15}$th were on trial. They gave evidence of undeveloped microscopical potentialities of an advanced order, but their mounting and the mode of testing, justice compels me to say, were unsatisfactory. I therefore forbear judgment until I shall see more careful work.

Mr. Crouch's lenses were of the first grade. Those on exhibition and those seen since, without revealing any extraordinary optical qualities, are exceedingly fine in field and definition for their cost. Their corrections for achromatism resemble strikingly the Wenham lenses.

Beck's objectives form a series with which I am familiar, and they retain their character for many excellent optical properties. Without aiming at maximum angle, they are as nearly achromatic as lenses can be made. Their $\frac{4}{10}$th is not inferior in performance to any other of equal power made, and, in use, is the most satisfactory lens of the series. But I must say these objectives—the adjustable ones—are not accurately mounted. The screw-collar jolts around from degree to degree in a way that forbids hope for the finest performance. The old plan of adjustment is retained, viz. of traversing the front combination, which must be comparatively defective. Lister's plan of adjustment and correction did well enough for twenty-five years ago, but modern microscopy demands a higher grade of work than that.

Fortunately, that demand is satisfied. The new $\frac{1}{8}$th, so called by Powell and Lealand, brought into this non-achromatic world by what process of microscopical parturition we are not informed, ranks highest of all foreign objectives I have yet examined. Its corrections reveal a bluish-green light, and its definition marks an entire new era in English microscopy. It is difficult indeed to judge of this grade of lens because of our former defective experience. I cannot call its definition brilliant, but it is sharp and very accurate. On the margin of the field a good image is formed, which is generally not the case in lenses of extremest angle. The mechanical mounting and splendid finish of this truly grand objective should be a stimulus and admonition to other foreign makers to do likewise. It is useless to spend the time in such patient optical work as this lens demands if the mounting is defective. It is superbly mounted. Genius never clothes an angel of light in a beggar's garment. The American plan of traversing the back combination is adopted, and every expert knows its value.

From Germany I have seen nothing respectable. Several of Zeiss' objectives have come under notice recently. His lower powers which I have seen are unfit for use. His $\frac{1}{25}$th fails in revealing details which our lower powers show better. The brass-work is specially inferior. Amplification is not definition. Power "is necessary to transport mountains; definition and precision we demand in studying atoms." I do not see in Zeiss' objectives too much of Professor Abbe's mathematics, but I do see an absence of finger-skill which stamps them with a national characteristic. Mathematics never made an objective. Like theology, it says, this is the way, walk in it. It is the manner of walking in that way, in each case, which is the business. Yet these and similar grades use the lenses continually recommended to students. This is a serious mistake, and is the explanation of much misinterpretation in biological work. But these foreign lenses are cheap! For a dollar an optician will mount an uncorrected lens which will do as good work. Recall the results obtained by Swammerdam, who worked successfully at the anatomy of insects, and who discovered the values of the lymphatics in 1664. Of Leuwenhoek, who, with microscopes of his own make, better than some of which I am now speaking, and cheaper. discovered the organic muscular fibre cell, now attributed to Kölliker, and who described accurately the fibres of the crystalline lens of the eye. Of Malpighi and Grew, who first used the microscope in anatomy, and who made many discoveries in the structure of plants. Of Dr. Hook, and Baker, and Adams, and the earlier work of Ehrenberg. They observed with cheaper lenses and did better work than can be done with the glasses of which I am now speaking. Is anything cheap which misinterprets nature? Do you give the student in astronomical science, or in spectroscopy, or in surveying, or the chemist, or in any other branch of mechanics, bad tools to work with? Why should the biological student be specially degraded? Give him the *best* objectives. Cheapen their production as much as possible, but never at expense of their optical performance, because his function is to interpret, not only the genesis and structure of present organization; but equally, the vast and sacred mysteries of extinguished ages. True microscopy is the fertile branch of the great tree of æsthetics. Its revelations are the minute and beautiful things in nature, and when these are shown without optical distortion, we realize that splendour and grace are the common garments of all.

American objectives are not behind the best from abroad. I shall speak chiefly of those made by Mr. Tolles, because others of home product which I have seen have been disappointing. It is more difficult to judge of Mr. Tolles' work than of that of any other optician, because no two of his lenses that I have seen are alike; and that dissimilarity is evidently designed, and not accidental. Most surely his guide is not Lister, nor Amici, nor Abbe; but his genius is more comprehensive than all these combined. The true optician is he who can vary his formula at will to obtain other or finer results. To work by rule is mechanical, and may be taught an apprentice; it is never marked by progressive excellence. The power to direct your steps at will, while threading the labyrinth of optical construction, marks the master. That Mr. Tolles can do. In him are greater optical possibilities in the construction of lenses for the microscope than in any other maker, and my judgment is based solely on work. Still I have seen many lenses of his make which disappointed me greatly, because to gain some *special* point other qualities which I happened to value most were sacrificed. But when I detected, by larger experience, that all this was designed, and not accidental, my appreciation increased.

It is more amusing than instructive to hear learned professors define the limit of microscopical vision and the angle of aperture of objectives. They gravely tell us moreover that penetration and resolution are incompatible qualities in lenses. Possibly, in a degree, they may be so, but that degree is not yet a matter of professional experience. I can indicate objectives of Mr. Tolles' make of extreme angle, yet their penetration is so extraordinary, that they form the best lenses I know for best histological work by central light, showing details with a brilliancy which I never saw otherwise. A recent $\frac{1}{10}$th which came into the world not by oblique presentation exclusively, is the highest standard to which I can refer. It is high commendation to compare any lens with Powell and Lealand's new $\frac{1}{8}$th, but Mr. Tolles' last $\frac{1}{10}$th is superior in most respects. Alike in power, the English lens has a remnant of London fog in its construction; the Boston one is brilliant and clear as crystal. Moreover, the Boston glass shows clearly structural details beyond the penetration of the English lens, without change of focus. Both are used wet or dry. The $\frac{1}{8}$th has a separate front, the $\frac{1}{10}$th is set for dry work by adjusting the screw-collar; this plan is more convenient than the separate front. A recent $\frac{1}{5}$th, bearing the name of Spencer, from whom we naturally expect much, gave results not elsewhere obtained in lenses of that grade and cost—student's objective at \$20·00—but it was triumphantly under-corrected, and all ablaze with orange light.

I see cause to fear that micro-photography may, for a time, retard the best construction of lenses for histological work; especially that oblique micro-photography, whose best results are often only diffraction spectra, which leave it doubtful whether the lens or illumination was the chief factor in obtaining the result. Photography, at its best, gives only approximate representations of delicate structural details; and it is not yet proven that objectives so afflicted with strabismus are best for biological work.

Our best modern high-angle lenses have in them optical capacities not adequately developed by our present defective plans of illumination. Universal absence of *absolute* central light marks most microscopes, and accurate means of obtaining it, modified or concentrated at will, is a greater need at the present time, than further improvement in lenses. If we observe critically, all minutest details, as shown under most microscopes, are fringed with diffraction phenomena which can be removed often by simply improving the light. Even for coarser microscopical work attention to the light is universally neglected. Most instruments have no adequate provision whatever for accuracy of observation, hence misinterpretation is so common under the higher powers. The American microscopist has lenses, in common use, which will easily define Bacteria if our means of illumination shall be improved.

The results of microscopical work have interested our members on many occasions. Processes of demonstration, of comparatively recent origin, have given preparations of higher character than were attainable before. Our market is still too liberally supplied with foreign refuse material of this kind. Best work, in this department, is always kept at home. We import that which is unsaleable abroad. To this statement there are a few exceptions. In animal histology no one now hopes to see any foreign work worth having. In pathology, always more difficult of demonstration than normal tissues, we expect neither appreciation nor help from beyond the sea; yet it is not from talking members of pathological societies that we obtain best work. The Army Medical Museum, at Washington, has produced the finest pathological work, that is, work retaining most structural details, if not most neatly mounted that I have seen from other sources. In our Centennial there was nothing respectable from abroad in this department. Some of this imported stuff from Germany is abominable.

In demonstrating and mounting botanical subjects, this country is immeasurably in advance of all others. Some workers here offer preparations which are models of technological skill and of surpassing neatness. Every cell is revealed without dissection, and differentiated by double staining in most beautiful manner. But in this kind of work *all* structural details are not preserved. The cells are empty. None but the botanist will ever do best botanical microscopical work. If he knows not by previous study of the fresh tissues, what nature puts in them, he will not be successful in revealing them best in mounted preparations.

Biological science is not to be studied from microscopical slides, no more than from stuffed animals or dead shells in our museums. Botanists do not get best education by poring over mounted specimens, however beautiful they may be, no more than they do by daily browsing on the desiccated vegetation in herbaria or haystacks. We must go to the living for the best use of our instruments, and a knowledge thus obtained of structural detail is essential before any attempt should be made to preserve such details in mounted preparations. Some post-centennial work in botany, aiming at that result, has been exhibited before the Section, in which every cell showed the cell anatomy; the nucleolus, nucleus, protoplasmic contents, and cell-wall were all apparent at one view. Demonstration which falls short of this is unsatisfactory, because important morphological details are not brought out, and such work, like fossils in the rocks, belongs to a past era in microscopical technology.—*The Cincinnati Medical News*, March.

VI.—*Opaque Objects with High Powers.* By G. W. Moorehouse.

A few words, giving experience in the use of opaque illumination with the highest powers of the microscope, may not prove entirely without interest. Some of the powers now successfully used in this way have even been thought extraordinary when used with transmitted light, and this may have led some persons to doubt the practicability of this method, and so prevented their giving it a trial. There are no natural tests yet known to have been well defined by the best microscopes that may not be seen with a power of 500 diameters. Of course it is often necessary, in order to understand the structure—say to distinguish circular markings from hexagonal—to resort to an amplification of 2000 to 4000. Can such powers be profitably used with illumination from above the object?

Many errors of interpretation arising from the use of transmitted light might be avoided if we could view all microscopic objects by light reflected from them, as we do almost everything we see with the naked eye. Yet with careful and practised use of transmitted light the same results may be obtained on suitable objects.

Place a thin leaf of honeycomb between your eye and a lamp, and mark the varying appearances and shadows as you increase the distance between the object and the eye, and as the position of the lamp is changed from central to oblique. Something of an idea of the difficulties of interpretation accompanying ordinary methods of illumination may thus be obtained, both as produced by changes in focal adjustment and in position of mirror.

Attempts have been made to use high powers on opaque objects by making pointed-nosed objectives, and also by constructing conical front lenses, and these methods have met with some degree of success with objectives as high as dry $\frac{1}{4}$ths; but as the finest views of the smaller objects and minute structural peculiarities can only be got with immersion objectives of wide angle of aperture, that necessarily have short working distances, other plans had to be invented. One proposition was to throw the light down one tube of a binocular instrument and view the object in the other tube, thus making the instrument its own illuminator. Previously, Professor Smith had devised a plan by which the objective itself was made the illuminator, light being reflected downward into it by means of a small silver speculum. The light was admitted to the speculum through an aperture in the tube, or an adapter above the objective. As all are aware, several opticians have made more or less important modifications of this device. The one I have used is described in Carpenter, fifth edition, page 153, under the name of Beck's Vertical Illuminator. It is simple, cheap, easily removed and cleaned, and admirably suited to the purpose for which it was made. It consists of a disk of thin glass attached to a milled head, and placed in an adapter fitted with the Society screw, and placed between the objective and the body of the instrument. The light entering the aperture is reflected by the glass disk downward into the objective, and by it concentrated upon the object.

In using the instrument, as a general thing, the lamp should be placed about eight inches from the aperture, and opposite it, but, on some objects, it is desirable to change both distance and position. The German student's lamp is poorly adapted for this work, and I have found the ordinary flat wick or sun-burner to serve a much better purpose. The lamp should be placed with the flame edgeways toward the aperture, and the narrowest possible image of the flame brought to the centre of the field of view. The image of the flame as seen in the instrument should be so perfect that any flickering of the blaze may be distinctly seen. A small bright image of the flame may be seen on the under surface of the slide with a pocket magnifier. The mirror under the stage may be used with advantage to find and centre the object, and at times illumination, both from above and below, may be used advantageously in determining the character of the study.

Dr. Carpenter speaks of the vertical illuminator being "specially applicable to diatoms, Polycystina, minute foraminifera, and the scales of insects, viewed under objectives of from $\frac{4}{10}$ths to $\frac{1}{5}$th of an inch." Evidently this means dry-working objectives. A few gentlemen have used it with immersion objectives. When an immersion lens is used, the whole aperture of the objective is available, both as a condenser and an objective, for the light passes through the glass cover to the object without reflexion from the upper surface of the cover, as would be the case with all rays striking the cover at an angle of total reflexion, if a dry front was used.

I have used this illuminator with excellent results with $\frac{1}{10}$th and $\frac{1}{50}$th immersion objectives, with lamp as described above. Improved effects may sometimes be produced by introducing the hand or a diaphragm between the lamp and reflector, cutting off a portion of the light, and such tests as *Pleurosigma Spencerii* and *Navicula rhomboides* may be well resolved.

The object should be mounted dry, and in close contact with the covering glass, so that the extreme oblique rays will pass to it, and not be reflected from the lower surface of the cover. The usual care must be taken in correcting the objective for thickness of cover.

I append selected memoranda of observations to show the utility of this mode of using the microscope, and venture to presume that no one will deny the general trustworthiness of illumination by reflected light, or the fact that errors of interpretation are less likely to creep in with it than with ordinary transmitted light. Objects are seen in their natural colours, and the views obtained of such specimens as the scales of insects are indeed beautiful. This is also true of numerous other objects.

The scales of *Macrotoma major*, *Lepisma saccharina*, *Deegeria domestica*, and *Lepidocyrtus curvicollis*, I have been able to see better, and the true character of the markings more satisfactorily indicated, than by any other method of illumination. It may not be out of place to state the fact that no semblance of the so-called beading is to be seen on any of them. The Macrotoma and Lepisma, like the scales of the gnat, show only the longitudinal, or, as the case may be, radiating ribs, with the transverse and often irregular and waved corrugations or wrinkles. The smaller scales of any of the insects named show almost as easily and distinctly as the larger, the resolution is so much superior to that ordinarily employed. With the Tolles immersion, $\frac{1}{50}$th powers of x2500 and x4000 were employed; and with Tolles' four-system $\frac{1}{10}$th, x500, x1000, x2000, and x4000, the last two by using $\frac{1}{2}$-inch and $\frac{1}{4}$-inch solid eye-pieces. The objects were well defined, with enough light, even with the highest powers used.

The Deegeria scales are covered with short or interrupted ribs, or long spines, adhering to the surface of the scale; a structure intermediate between the true ribs of the Macrotoma and the short spines of the Podura scale. It must be remembered that these three insects are very closely allied. That Podura scales are really armed with projecting spines I consider as proven by the experiments of Dr. Arnold, of New York, a few years ago; but if any further proof was needed, the *demonstration* is complete by this method of illumination. Both on the scales of the American Podura and the British Lepidocyrtus Podura, the spines are seen distinctly projecting anywhere on the surface of the scale, and also over beyond the end of the scale farthest from the body of the insect. The inference would appear to be that the scales are undeveloped hairs, and the spines secondary hairs, and that the latter are in some species modified, or imperfectly developed, so as to form ribs.

Of the many diatoms examined I only mention one, the *Pleurosigma angulatum.* Some of the specimens of this test were mounted by Möller, and others by Wheeler. All are seen in hexagons, and with great distinctness; not, however, surpassing results obtained by other illumination. I send with this communication a slide of broken specimens of a coarsely marked variety of this diatom, found in Nottingham earth. I think it will readily be seen that the line of fracture runs through the hexagonal areolæ, often leaving the points of the network projecting. The vertical illuminator confirms this idea of the structure. It will be noticed that some of the fragments of Angulatum on this slide are split into two layers or plates; the two plates are quite distinct, and the line of fracture of each may be easily traced in some of the pieces. With the $\frac{1}{10}$, and a $\frac{1}{2}$-inch eye-piece, with either the opaque illuminator or an objective used as an achromatic condenser, the edges of the fractured specimens are clearly defined. Although the Angulatum is made up of two plates like Coscinodiscus, the two plates are much nearer alike than they are in Coscinodiscus.

The coarsely marked diatoms are displayed with great beauty under this reflected light, and one can have but little doubt in regard to their true structure; and this in a still greater degree is true of insect scales. On the whole, then, opaque illumination, with high powers, cannot be said to be a failure, but, on the contrary, almost or quite keeps pace with the easier problem (as far as construction of accessories is concerned) of illumination by transmitted light, and proves itself a valuable aid, even when the most difficult and strongly controverted questions are attacked.—*A paper read before the Dunkirk (U.S.A.) Microscopical Society.*

VII.—*A Simple Form of Mechanical Finger for the Microscope.* By G. Hanks.

I wish to call the attention of the San Francisco Society to a device for picking up and selecting minute objects under the microscope; in other words, to an improvised mechanical finger, which may be easily arranged by any person who possesses a first-class stand.

Feeling the want of such an apparatus to pick out and arrange the interesting and beautiful crystals which occur in the washings from the hydraulic gold mines of California, and in the black, gold-bearing sands of the sea-coast, I was led to give the subject much careful study.

The elegant mechanical finger described in the 'American Journal,' second series, vol. xlix., folio 304, is not only expensive, but must be detached from the microscope and laid away when not in use, being for this reason inconvenient. Considering these defects, I thought on a number of ways to simplify the arrangement, and finally hit on a plan to do away with all extra apparatus, and still accomplish all that could be desired. The plan is so simple that I am almost ashamed to make it public. For aught I know, it may be in use by a host of microscopists in different parts of the world, but I have never heard it mentioned, nor have I seen it described in any of the published works.

As I am sure that the idea is new to our Society, I will describe it as briefly as possible. Let the microscope be placed in a vertical position and a suitable object-glass screwed on. Fix the parabola in its place in the sub-stage. Let it be pushed as far in as possible, so that when elevated by the milled heads, it will rise through the opening in the stage, with its upper edge above the surface. As it will not be immediately required it may be depressed, using the milled heads for that purpose. A glass slide, upon which the rough matter is laid, from which it is desired to select an individual crystal or other object, may now be placed on the stage. The sliding pieces of the stage must then be separated as widely as possible, and the stage forceps fixed in the usual position. If the objects to be picked out are small, such as diatoms, &c., a human hair must be placed in the jaws of the forceps, and so arranged that it will appear in the field and near the surface of the slide. The objects to be selected should be as near the centre of the slide as possible. By turning the milled heads of the mechanical movements of the stage, the desired object may be centred, after which the hair must be readjusted without moving the stage. By elevating the sub-stage slightly, the slide will be lifted from the stage, the position of which can be changed by the mechanical movement, while the slide remains stationary.

When the end of the hair is exactly over the object, which is dimly seen out of focus, a turn of the milled head of the sub-stage lifts the slide until the object touches the hair and remains attached to it. When the sub-stage is lowered, the object remains suspended to the end of the hair. The slide may then be removed and another substituted, to which the object may be transferred by simply elevating the sub-stage, the slide rising to meet the suspended object. If the slide has been gently breathed upon, the object leaves the hair and attaches itself to the glass. This applies only to minute objects. When the object is larger and too heavy to be lifted by a hair, it will be necessary to substitute a bristle, and to wet the end of it; when the second slide is placed under it, a few minutes will suffice to evaporate the moisture, and the object will fall into the desired position.

The hair may be used to push away worthless matter which may surround the object desired. It is perfectly easy to push any portion quite out of the field, simply by using the stage movements while the slide rests on the parabola.

If a piece of fine aluminium wire, the end of which has been flattened by a pair of steel rollers, be substituted for the hair, and a low power used, a crystal may be lifted with as much ease as a lump of coal on a shovel. To prevent the object from being pushed before the chisel edge of the wire, a small piece of glass may be placed in the direction of the movement, against which the object is held, while the edge of the flattened wire passes under it.

It will be found difficult to place a hair firmly in the jaws of the stage forceps. This difficulty may be overcome by cementing the hair or bristle between two small pieces of thick paper, which the forceps will hold rigidly.

Nothing can be more simple than this device, and I question if any mechanical finger can be more effective. A few minutes will suffice to make it perfectly understood.—*A paper read before the San Francisco Microscopical Society*, May.

NEW BOOKS, WITH SHORT NOTICES.

Journal de Micrographie. Revue mensuelle des Travaux Français et Étrangers, publiée sous la direction du Dr. J. Pelletan. No. 1. May 15, 1877. G. Masson: 10, Rue Hautefeuille, Paris.—This is the opening number of a new venture. It is really the first attempt of the French to establish a journal devoted exclusively to microscopic matters. In Germany they have what used to be Max Schultze's 'Archiv'; in England we have two journals devoted to microscopic pursuits. In America there is also a monthly 'Journal of Microscopy.' But France was till now without any representative periodical of the field of microscopy. Now, however, it is no longer so. The first number of M. le Dr. Pelletan's journal has appeared, and it bids fair to supply a decided want; while, if its future numbers equal that which has already been published, we shall welcome most heartily its entrance into the field. We shall now give a brief sketch of the plan which the editor has laid down for himself to follow. He promises to keep his readers *au courant* of the principal facts, discoveries, publications, and public courses of lectures relative to micrography. He also tells them that he will keep them informed as to the various novelties in the microscope itself, and the numerous accessory instruments that belong to it. Questions of optics, too, which have relation to the microscope will find a place in his journal. Finally, he states that he will have a certain space devoted to the correspondence of his readers, and that he will, when necessary, have a series of illustrations, both in the form of woodcuts and engraved plates.

It will thus be seen that the editor's address promises well for the new periodical. We shall now see how he has at first attempted to carry out this programme. The opening portion of the volume, that headed *Revue*, appears to be the editorial part, and it contains some valuable abstracts, and some titles of papers which will be reviewed in future numbers. A portion of this department has to do with continental work, but a good deal of it consists in abstracts of the essays, &c., which have appeared in the pages of the 'Monthly Microscopical Journal.' Indeed, it would be impolite on our part if we did not here express our thanks to Dr. Pelletan for his extremely courteous notice of the contents of this magazine. One of the most valuable parts of this portion of the *review* is his notice of Dr. Wallich's researches on the Diatomaceæ. Other papers are also abstracted; as, for example, Dr. Stahl on the reproduction of Mosses; M. Magnus on the same subject; Dr. Brandt on the ova of Ascaris; Mr. P. H. Carpenter on the anatomy of Crinoids; and Dr. Abbe's paper on the employment and application of the microscope. The original memoirs in the present number of the journal are not original, inasmuch as one of them is on "The Electric Organ of the Torpedo," a series of lectures delivered before the College of France; and the other a paper by M. Abbe, with which our readers are already familiar, on "The Theory of the Microscope." The reviewing department contains a good notice of MM. Bornet and

Thuret's "Notes Algologiques," and one or two short summaries, which we shall give in translation in our next issue.

Altogether, we have every reason to be satisfied with these first labours of M. Pelletan as editor of a microscopical journal. We hope for even better things in future from one who is himself so distinguished in the world of micrographic science.

PROGRESS OF MICROSCOPICAL SCIENCE.

Microscopic Nature of the Blood in Tropical Fevers.—Dr. H. Vandyke Carter, writing from Bombay to the 'Lancet' (June 9), states that in the blood of individuals who are attacked with fever at the present time in Bombay, there may often be found numerous and active spirilla. Commonly, but not quite invariably, the presence of these minute organisms is limited to the periods of high temperature, and in his experience hitherto the spirillum may always be found in those fevers which present a clear tendency to relapse, after an interval longer than any yet recognized amongst intermittents so-called. From a number of instances, however, which have come before him, and of which he has full notes, it is already evident that also in types of fever which ordinarily would be termed "remittent," or possibly "intermittent" (for intermediate grades are many), the blood may sometimes be found to contain the spirillar filaments. The latter here closely resemble those alluded to by Dr. B. Sanderson in his summary on European relapsing fever, printed in the Health Reports of the Privy Council.* Further inquiries are now in hand regarding the import of this new observation.

Structure and Development of Vascular Dentine.—Mr. C. S. Tomes, who has for some time been engaged in the study of the structure of the teeth, and who is a worthy follower of Mr. J. Tomes, F.R.S., has communicated a valuable paper on the above subject to the Royal Society. The nomenclature and classification of the varieties of dentine have hitherto been based solely upon the appearances discoverable in dried teeth; in the present communication the author seeks to amend and place upon a more satisfactory basis the grouping of these several kinds of dentine, by bringing to bear upon their arrangement observations upon the nature of the contents of those large tubes which give to the tissues their name of "vascular" dentine, and, more especially, observations upon the methods by which they are developed.

Vaso-dentine is the term generally used to designate a variety of dentine exceedingly common in the class of Fish, in which the substance of the tooth is permeated by a number of anastomosing tubes, of considerable size, which have been called "medullary" canals, as they have been supposed to contain pulp-tissue; whilst osteo-dentine

* New Series, No. iii., London, 1874.

is used to designate that variety of vaso-dentine in which the matrix is arranged in concentric layers round the canals, like the laminæ of an Haversian system in bone, and in which spaces like the lacunæ of bone occur. The author would not propose to introduce any new terms, but to render more precise and definite the meaning attached to the terms vaso-dentine and osteo-dentine, premising that the application of the two words will be greatly altered by so doing. The author defines vaso-dentine as a modification of dentine which is permeated by a system of canals far larger than ordinary dentinal tubes, which anastomose freely with one another, and contain capillary blood-vessels and nothing else. That is to say, each several canal contains a capillary of the same calibre as itself, and no cellular or other pulp-tissue, for which, in fact, there is no room; the canals were formed by the enclosure of capillaries of the pulp in a calcified matrix. True dentinal tubes may co-exist with the large capillary canals; but if they do, they radiate from the central pulp-chamber and not from the canals: in the most typical vaso-dentine, such as that of the hake, the matrix is solid and there are no true dentinal tubes. Vaso-dentine is developed from a sharply defined "membrana eboris," or layer of odontoblast cells. Osteo-dentine, on the other hand, is also permeated by a system of large channels, but these do not (except as an accident) contain capillary blood-vessels, nor were they developed around capillaries. True "dentinal tubes" can perhaps hardly be said to exist; but the tubes of small calibre which do exist radiate, not from a common pulp-chamber, but from the several canals. Its greatest distinction from vaso-dentine lies in the manner of its development. It is not (if we except a thin outer layer of hard dentine with which it is often clothed) developed from a specialized layer of odontoblast cells; but calcifying trabeculæ shoot rapidly from the interior of the first-formed dentine cap through the whole substance of the formative pulp, and the canal-system ultimately formed is due to the partial coalescence of these ossifying trabeculæ leaving interspaces between them. The canals have therefore nothing whatever to do with the blood-vessels of the pulp, and therefore do not correspond very closely with those of vaso-dentine. Osteo-dentine is thus not derived from the calcification of a "membrana eboris," or special layer of odontoblast cells, but by ossification (of cells like osteoblasts) shooting through its whole mass. Thus the tooth-pulp can be bodily withdrawn from a tooth consisting of vaso-dentine by tearing across the capillaries only, and the interior of the dentine cap will be left smooth; but the pulp can by no possibility be withdrawn from a tooth which is advancing in calcification into osteo-dentine, because it is permeated through and through by a network of calcifying trabeculæ. It is possible by careful observation to distinguish in sections of dried teeth true vaso-dentine from osteo-dentine; the majority of teeth consisting of the latter tissue ordinarily pass as consisting of the former (e. g. the teeth of the pike, of many Plagiostomi, which really consist of osteo-dentine, but are always described as vaso-dentine). The teeth of the hake are selected as an illustration of vaso-dentine; they have large pulps, richly vascular, and red blood circulates abundantly through the capillary channels of the dentine, so that the tooth, when the fish is alive, is brilliantly red. The matrix of the dentine is dense and solid; i. e. it is not permeated by dentinal tubes. The transition between typical and vaso-dentine, such as that of the Gadidæ, and hard unvascular dentine, such as that of most mammalian teeth, is gradual. Thus most of the Pleuronectidæ have teeth which at their basal halves consist of typical vaso-dentine without dentinal tubes, just like that of the Gadidæ; but above the middle, dentinal tubes radiating out from the central pulp-chamber begin to appear, at first sparsely, and the capillary canals to become fewer, till the apex of the tooth consists of ordinary fine-tubed dentine, in which few, if any, capillary channels exist. And in *Serrasalmo* there are teeth which are throughout composed of a dentine permeated by dentinal tubes, but in the basal half of the tooth a few capillary channels are present. From such a form of dentine to ordinary hard unvascular dentine is but a short step. The development of osteo-dentine is illustrated by a description of the teeth of a pike; the outer layer is developed, like dentine, from a layer of cells analogous to, though less specialized than, odontoblasts; and so soon as this has been calcified the interior of the tooth is formed by a rapid ossification, just as the subjacent bone is formed. Vaso-dentine therefore differs much less from true or unvascular dentine than osteo-dentine does, the relation between the three tissues being well seen in the teeth of Sparidæ. In *Sargus ovis* the incisor-like front teeth appear to be implanted by long roots; these are formed by the dentinal formative pulps, just as are the roots of ordinary rooted teeth. But there is this peculiarity in the nature of the process: the dentinal pulp, so long as the "crown" (or portion which will be above the bone) is being developed, is converted into fine-tubed *unvascular dentine;* but so soon as the root or implanted portion commences to be formed, this same dentinal pulp, the apex of which is even yet forming unvascular dentine, calcifies into *vaso-dentine.* Without there being any exact break or breach of continuity, the change from true dentine to vaso-dentine is sudden, and the tooth is easily broken off at this point. When the greater part of the length of the root has been formed, the manner of calcification again changes, this time not so abruptly, till near to the end of the root the dentinal pulp becomes converted into *osteo-dentine*, which is quite indistinguishable from and blends insensibly with the surrounding coarse bone by which the tooth is fastened into the socket; there is, in fact, no reason for calling it anything else than coarse bone, except the fact that it is the product of calcification of a dentinal pulp. In this case a single dentinal pulp forms first hard dentine, secondly vaso-dentine, and at last osteo-dentine. Another variety of complex dentine is brought about by foldings and subdivisions of the formative pulp: both vaso-dentine and osteo-dentine are formed by the calcification of simple pulps; but in many instances the odontoblast-bearing surface of the pulp is itself complicated in form, and a dentine arranged as it were round many pulp-chambers is the result. For this no better name than plici-dentine (also a term already in use) suggests itself: it is to be seen in its simpler form at the base of the teeth of *Lepi-*

dosteus, in greater complexity at the base of the teeth of *Varanus*, and in exceeding complexity in the teeth of Labyrinthodonts.

The author would distinguish, therefore:

(i) *Hard unvascular dentine*, the characters of which are sufficiently known.

(ii) *Vaso-dentine*, which is developed from odontoblasts after the manner of dentine, but contains an anastomosing network of canals modelled around and containing capillaries.

(iii) *Plici-dentine*, developed from odontoblasts, but from a complicated pulp, so that it is more or less divided up into distinct systems of dentinal tubes.

(iv) *Osteo-dentine*, developed from osteoblasts, like bone, and quite unlike dentine; permeated by a system of large canals, which do not contain, or have any special relation to, blood-vessels.

The author lays no stress on the characters formerly given as distinctive of osteo-dentine (i. e. a laminated arrangement of the matrix and the presence of lacunæ), because (i) lamination of the matrix is not unknown in vaso-dentine, (ii) lacunæ are very frequently absent from bone in fishes, and very frequently from osteo-dentine, so that these characters, as those who have tried to apply them have found, are not useful in practice. The attachment of the teeth of the hake is so peculiar as to merit a word of notice: the inner and longer of the two rows of teeth are set upon elastic hinges, which allow of their being bent inwards towards the throat, but cause them at once to spring back into the upright position when pressure is taken off them. This arrangement, shared by the angler, was hardly to be expected in one of the Gadidæ; but the author has found in others of the family steps toward this highly specialized arrangement, the benefit of which to a voracious predatory fish like the hake is obvious.*

The Microscopic Study of Human Blood.—The 'Medical Examiner' (May 31) says that the Medical and Surgical Society of Bordeaux offer a prize of 1000 francs, to be adjudged at the end of the year 1879, for the best essay on the following subject:—The microscopic study of human blood, recent and dry, of the fœtus and adult, compared with that of the blood of other mammals, from a medico-legal point of view. The essays must be very legibly written in French or Latin, and addressed, post-paid, to M. Donaud, Secrétaire Général de la Société, Allée de Tourny, 10. The last day for the essays to be received will be the 31st of August, 1879. Each essay must bear a motto, and be accompanied by a sealed envelope containing the name and address of the author, or of his agent.

Fungi in Excrement.—Dr. Trimen states, in the 'Journal of Botany' (June 1877), that these have lately been investigated by M. E. C. Hansen. A memoir has been written by this author which comprehends an account of the fungi found in Denmark growing on excrement, and is chiefly devoted to their classification, literature, and geographical distribution, but there are also various morphological

* See 'Proc. Roy. Soc.,' No. 179.

and physiological observations. The previous literature of the subject appears to have been exhaustively worked up. Commencing with *Pilobolus*, the various genera containing fimicolous species are passed in review; those in countries other than Denmark are also enumerated. There are twelve species of *Agaricus*, and the same number of *Coprinus*. *Coprinus niveus* is treated in detail, and the development and structure of its sclerotia described. The latter are exceedingly variable in size, form, and colour; they possess a fine grey membrane on the outside which appears under the microscope as a granular mass composed of broken-down cells; beneath this is a black cortical portion in continuation with the former, and composed of many irregular rows of small thick-walled cells. This tissue passes gradually into the central portion made up of a pseudo-parenchyma with fine meshes, the intervals filled with air. The cells of this tissue are very irregular, and become gradually larger towards the centre; if the sclerotium be boiled with potash they are seen to form irregular cylinders branched and provided with numerous partitions; these interlace and form a firm, very close tissue. A dimorphism is noted in this species: in one form the pileus is covered with a felt-like, white, floccose down, and in the other with a snow-white, floury stratum; the first form develops solely from the sclerotium, the second never.

Microscopic Characters of a New Order of Algæ.—Mr. S. Moore gives an abstract of a work by V. B. Wittrock, of Upsala, on this subject (1877) in the 'Journal of Botany' for June. One of the principal characters of this order, represented by the single genus *Pithophora*, is a branched thallus, the branches taking origin from the upper part of the mother-cell at a short distance below its top. On examining an individual, one sees that it consists of two regions, a unicellular usually unbranched basal portion (the "rhizoid" part), and a multicellular usually branched "cauloid" part. Ramification of this cauloid part is often various in degree in the same species. In *P. Sumatrana* the branches are of the first degree only; in five other species (*P. Kewensis*, *æqualis*, *polymorpha*, *Cleveana*, *Zelleri*) either of the first or second degree (and sometimes opposite in the last two); while in *P. Roettleri* a third degree of ramification is met with, the branches of the first degree being placed three (sometimes four) in a whorl, but those of the second and third either singly or in pairs. The cells which bear these branches are either ordinary cells or spores, rarely "subsporal" cells (to be spoken of presently). The lateral branches, which are most usually single, have a tendency to grow on one side, but occasionally other ("accessorial") branches are found taking origin, not from a point near the top, but from some other part, often near the base, of the mother-cell. The rhizoid part consists, as has already been mentioned, in most cases of a single unbranched cell, though sometimes several-celled rhizoid parts are met with, and in two of the species these can occasionally produce spores. On the other hand, the rhizoid part is sometimes not even composed of a whole cell, and only appears in the form of a basal protuberance from the mother-spores; while in *P. Cleveana* it is occasionally not developed at all. The anatomical elements consist of vegetative cells and spore-cells. The former are either intercalated ("enclosed") or terminal, usually cylindrical in shape and thin-walled without layers; within is a parietal layer of protoplasm and a large central vacuole. Their breadth varies from 40–190 mm., and the length is generally 5–20 times the breadth. On further examining the contents, it is seen that some of the cells have a layer of chlorophyll granules, the continuity of which is usually interrupted in certain parts, and sometimes to such a degree as to produce the appearance of a network; other cells, however, are almost deprived of chlorophyll, and have a much thinner parietal layer of protoplasm. In specimens which produce no spores, the green cells exist alone; but in spore-bearing individuals both coloured and colourless cells are found, the latter being the "subsporal" cells spoken of above. The terminal cells are either like the ordinary coloured cells (only longer), or else they are twisted and usually branched above, forming what the author calls "helicoid" cells. These helicoid cells are common only in *P. Cleveana*, but they are of occasional occurrence on all the other species, with the exception of *P. Sumatrana* and *P. æqualis.* As they are filled with chlorophyll, they must have an assimilating function; but their form and a modification of their membrane evinced by its capacity to adhere to foreign substances, show that they are also organs of attachment. Reproduction takes place in two ways: by formation of spores, and, as the author quaintly expresses it, "by the bringing forth of prolific cells." The cell (only occasionally a terminal one) destined to spore-production, first widens at its upper part, then the protoplasm in this part is increased by apposition from within at the cost of the protoplasm in the lower portion, and this transference is participated in by the chlorophyll, which penetrates into the widened portion and fills up the great central vacuole in it. After all (or rather nearly all) the chlorophyll has become collected in the upper part of the cell, it is shut off from the colourless, almost empty subsporal cell by the formation of a transverse partition. Finally, the spore is prepared for its season of rest by the thickening of its wall, and the transformation of a part or all of its starch-grains (formed in the chlorophyll) into a brownish oil. Several deviations from this normal method are described: thus, the upper part of a cell destined to become a spore may not enlarge; or a considerable part of the chlorophyll may remain in the subsporal cell, which, under these circumstances, either branches or else produces twin (sometimes triple) spores; again, the spore may be formed in the lower part of the mother-cell. Moreover, sometimes in specimens of *P. Cleveana* where no rhizoid part is developed, a spore may occupy the same place as the mother-spore, and possess the same membrane as its parent except at its upper part. The "prolific" cells are borne in most cases by sterile individuals; they are nothing more than ordinary cells packed with starch-grains, and being only provided with a thin membrane, are not adapted to undergoing a period of rest. They become disunited from the decayed elements in connection with which they were formed, but their isolation is not so complete as to prevent two prolific cells remaining united and germinating in company, which latter process consists in the production of ordinary lateral branches, or occasionally, in addition to this, of a terminal spore-forming cell. Quite different is the germination of the spores, where an apical cell—the mother-cell of the cauloid part—is formed, and also the basal rhizoid cell, which is shut off by a transverse partition. The cauloid part grows by repeated division of the terminal cell, the intercalated cells not dividing (except very occasionally) but reproducing by branching or spore-formation, while the terminal cell rarely develops branches or spores.

Peculiar appearances of the Blood.—The 'Medical Record,' in a recent issue, states that at the meeting of the Medical Society of Berlin, Dr. M. Litten described the appearances found in the blood of an anæmic emaciated man, aged twenty, who had suffered from enlarged masses of abdominal glands, reaching on each side of the spine from the diaphragm to below the promontory of the sacrum. Microscopic examination detected a diminution of the red corpuscles, which did not form rouleaux. The white corpuscles were large, and had a hyaline outline, which sent processes into the interior; they contained granules and nuclei. These appearances remained constant for a long time. The abdominal and pulmonary symptoms increased, and a considerable excretion of indican took place, as a result of irritation of the peritoneum. Five days before death œdema of the lung set in, rendering venesection necessary. On examining with the microscope the last drops of blood which flowed, a remarkable appearance was found. Very small red molecules were seen, which exhibited active movements; no appearance of processes could be detected. Among these were found red corpuscles of ordinary form and size, and some large disks. On examining the blood an hour later it was found to be normal; and it remained so until death. There was nothing remarkable in the marrow of the bones; but the femur contained a reddish-brown gelatinous mass, such as is often seen in anæmic conditions; there was red atrophy of the liver. Dr. Litten first thought that the appearance of the blood was due to *ante mortem* destruction. But against this there was the fact that the blood regained its normal appearance six days before death. Max Schultze has described a breaking up of the corpuscles at a temperature of 52 cent. (125·6 Fahr.); but this temperature is not reached in the human body. Similar appearances are observed in pernicious anæmia; and microcytes are found in diseases attended with subcutaneous extravasation, such as scurvy. Hayem has found them in chronic anæmia, but not in such a marked form as in the present case.

Origin of Lymphatics in Muscular Tissue.—We believe the first memoir on human histology that has been ever presented by a lady to the Royal Society is that by Mrs. F. E. Hoggan, M.D., in the 'Proceedings,' No. 178. It is really Mrs. and Dr. Hoggan's paper, and is entitled "Lymphatics and their Origin in Muscular Tissues." The authors announce that they have discovered the long-looked-for lymphatics of striated muscle, and describe them as radicles, valveless reservoirs, and valved efferent vessels. While describing their structure and relations, they point out that the reservoirs are found on one plane or side of a muscle; the valved efferents are found on the other side, as, for example, in the case of the diaphragm, transversalis abdominis, and triangularis sterni muscles. In connection with this, they have discovered a dense plexus of valved vessels on the anterior surface of the abdominal wall, corresponding to that on the pleural surface of the diaphragm. Upon the lymphatics of muscle they find the peculiar serous cells first described by Ludwig and Schweigger-Seidel, whose views they fully confirm, in opposition to those expressed by Ranvier. They deny the existence of stomata in the Mammalia, but admit it in the case of frogs; and as the peritoneum of the latter is lined by crenated lymphatic endothelium, they admit its connection with the lymphatic system; but, on account of the absence of the latter endothelium as well as stomata from the serous cavities of mammals, they deny any connection between these and the lymphatics. While describing the structure of basement membrane, they discuss the facts adduced by Klein and Debove as bearing on the question of absorption, and give their own views on this question. They hold that the lower surface of the diaphragm is an exuding one, and only an absorbent one when all the natural conditions are reversed. They describe the minute anatomy of the lymphatics of the intestine, and show that it is the glandular structures, and not the muscles of the wall, that regulate the amount of these vessels. They also trace complete identity between these and the lymphatics of striated muscle. In either case they figure the connective-tissue cavities as forming the radicles of the lymphatics, but hold that these are not the only lymphatic afferents, nor that that is their only function. To prove this, they discuss the nature of these cavities, as they have discovered them in tendon and other gelatinous structures in different classes of animals to be of the same structure as in the cornea. Unlike man, the small mammals have no special vascular or lymphatic vessels in the peritoneal tissue, being dependent on the muscles below for those structures. The authors finish by entering upon a minute description of the apparatus employed by them, and offer a series of about sixty camera-lucida drawings of preparations in their possession in illustration of their researches.

How are Giant-cells developed.—Dr. Giovanni Weiss * says that giant-cells are formed by the melting together of many smaller cells; these smaller cells are granulation cells. Giant-cells form also in connective tissue, and around blood-vessels; but, even though under the most favourable conditions for existence, they invariably undergo fatty degenerative metamorphosis.

Is there a difference between the Ova of Man and higher Mammalia?—In a critique of a somewhat bitter kind, of Haeckel's work in the 'American Naturalist' (June 1877), the writer says: "Professor Bischoff † directly contradicts Haeckel's assertion that we cannot discover, even with the aid of the best microscope with the highest

* Virchow's 'Archiv,' Oct. 1876.

† 'Sitztun. math. phys. Classe der k. b. Akad. der Wiss.' München. 1876. Heft i. p. 1.

power, any essential difference between the egg of man and those of most of the higher mammals, and states that the pictures showing the identity of mammalian embryos in plate v. of Haeckel's Anthropogenie differ essentially from the reality, and, finally, that the figures of apes' faces given by Haeckel on his title-page show a great agreement existing between the features of apes and of the lower human races, but that this resemblance does not appear in photographs."

On the Porosity of Wood.—Professor Sachs has published a preliminary communication in regard to the porosity of wood, which contains notes of many interesting experiments. One of these is the following, which is of interest. The best grade of artist's vermilion was treated with a large quantity of distilled water and repeatedly filtered through filter paper. The pigment was now left in so fine a state that it exhibited the well-known Brownian movement. Fresh cylinders of wood three to four cm. long, cut from a living stem of a conifer, were fastened to the lower end of a glass tube which at the upper part communicated with a broad vessel; tube and vessel were filled with the pigment emulsion so that the wood was under a constant hydrostatic pressure of 160 cm. Even at the end of three days the water which filtered through was perfectly clear and contained no trace of the vermilion. The upper transverse sections of the cylinders showed that all the layers of the spring-wood were bright red, the autumn layers were not red at all, or at most only in radial stripes, the heart-wood was wholly uncoloured. On splitting the cylinder of wood, the vermilion was seen to have penetrated nowhere deeper than two to three millimeters, corresponding to the length of the cells in the wood employed; the rest of the wood was colourless. The microscope shows that the majority of the spring-wood cells are wholly filled with vermilion even to their lower tips; also that the bordered pits of these cells are thickly filled with vermilion, and sometimes this did not pass through into the neighbouring cells which seemed to be in communication with them; there was obviously an obstruction in the bordered pits themselves. This is interpreted as showing that there still remains in the discoid markings a thin membrane as claimed by Hartig. The autumn-wood cells appeared to take up very little vermilion, and the medullary rays none.

Microscopical Preparations of Fungi.—A recent number of 'Grevillea' contains the following notice, which may be of interest to some of our readers. "For many years the want has been widely felt of some one with a practical knowledge of fungi, and withal expert in their manipulation, who could prepare for those who were unable to do it for themselves, mycological slides. We have often been applied to during the past to indicate such a person, if he could be found, and the application has been fruitless. This, however, is no longer the case, for we have had the opportunity of examining some of the microscopical preparations of fungi which have been produced by the Rev. J. E. Vize, of Forden Vicarage, Welshpool, and do not hesitate to recommend them to any of our readers who may be in search of such aids to study. It may be observed that no small advantage results from the manipulator being himself a mycologist, consequently the preparations are scientifically and accurately named, to say nothing of the neat and business-like manner in which the mechanical work of manipulation is performed. Here, then, is an excellent opportunity for anyone to possess themselves of illustrations of the principal genera of microscopical fungi, any such a series being manufactured to order. We are also further informed that anyone who is desirous of doing so may have their own material mounted, so that nothing more remains to be desired, except it be a reasonable and economical scale of charges, which, in this instance also, will be found entirely to their satisfaction. We can only hope that such invaluable aids to the study of fungi will not be neglected, and that Mr. Vize's unique and artistic preparations will find a place in every microscopical cabinet, whether specially devoted to mycological subjects or not."

The Spongilla fluviatilis.—Although the development of this species has been worked out before, Mr. Fullagar's researches are not without interest. 'Science-Gossip' for June says that, at a recent meeting of the East Kent Natural History Society, Mr. Fullagar (who has been successful in getting it to live and grow in confinement) again exhibited the fresh-water sponge (*Spongia fluviatilis*), illustrated by diagrams, showing (since the last meeting, December 6) the production by growth of the pellucid, semi-transparent, gelatinoid substance termed sarcode, which had extended to some distance on the glass cell in which it was placed; in the new sarcode the pores through which the current of water enters the sponge were observable, forming the in-current, bearing with it the nutriment on which the sponge feeds. In the newly formed sarcode was to be seen a number of new spicules; they were pointed at each end, and their middle or centre was bulged out, from which the growth extended to both terminal points; the mature spicules are a little bent or curved, and pointed at both ends, but not bulged out in the middle. Some good specimens of the mature spicules have been cleaned and mounted by Mr. Hammond. They are composed of the pure silex, as transparent as glass. The peculiar spicules of the ovaria were beautifully shown under the microscope. In a specimen Mr. Fullagar had successfully mounted in dammar, by first drying the ovaria, and then in a drop of dammar with a thin glass cover gently pressed down, the granular contents of the ovaria were pressed out, and the beautiful stellated form of the spicule was seen standing out in form of so many miniature palm-trees: the real form of them is stellated at the two ends, connected together by a shaft, similar to two wheels on an axle. This form of spicule in the ovaria performs the double office of tension and defence.

NOTES AND MEMORANDA.

Dr. O. W. Holmes on the Microscope.—Dr. Holmes is more a literary than a medical man, as those who have read the 'Autocrat at the Breakfast Table' may perhaps be aware. We were therefore surprised when we saw that he had been selected by the Boston Microscopical Society to deliver an annual address to that body. In point of literary style his remarks leave nothing to be desired; they sparkle with wit and sarcasm. However, we think that had Dr. Holmes any knowledge of the labours of Schleiden, Von Bär, Ehrenberg, Schwann, or Johannes Müller, he would hardly have committed himself to the following statement: "When he studied medicine the medical books treated the microscope with disgust or contempt, and from 1833–1835 he studied in the best schools of Paris, without hearing a word of the use of the microscope; but about that time a Frenchman published an organic chemistry which brought some of its revelations to notice."

Fossil Diatoms from South Australia.—The 'American Naturalist' (June) says that Mr. Galloway C. Morris, of East Tulpehocken Street, Germantown, Philadelphia, obtained from the commissioner in charge of the South Australian exhibit at the Centennial Exhibition, a small supply of a most interesting diatomaceous mineral called coorongite, from the Coorong District, in South Australia, where it is found. It is a mineral of a dark-grey or ash colour, a light specific gravity, and a fine spongy texture, occurring in great quantities, and consisting of about 20 per cent. of a hydrocarbon which can be separated by distillation for economical purposes as an illuminating and lubricating oil, and a residue consisting mainly of fresh-water diatoms. It burns when heated on platinum foil, is permanent in the air, and is unaffected by moisture. It is not disintegrated in ether or chloroform, though most of the oily hydrocarbon is removed. Mr. Morris has succeeded best in preparing it for the microscope by boiling it in sulphuric acid with the addition of a small quantity of bichromate of potash to make chromic acid and give off the hydrocarbon as carbonic acid gas. He has a few slides to spare, which he is willing to exchange for other mounted specimens.

Use of Eosine in the examination of Tendon.—In a late number of the 'Comptes Rendus' M. Renaut stated that he had found that eosine soluble in water fixed itself on protoplasmic expansions and coloured them strongly. Having employed this substance for the examination of tendinous cells, he had been able to determine the following fact: the network of stellate figures underlying the epithelioid layer of the tendon is not formed by cells of ordinary connective tissue, but by protoplasmic expansions of the tendon-cells near the surface, which are abundant at this point and anastomose together.

Professor Tyndall's Researches on Bacteria.—Dr. Tyndall recently presented an important paper to the Royal Society on the difficulty of destroying Bacteria in solutions. The memoir, although appearing only in abstract, is too long for insertion here. However, the following portion is of especial interest. After dealing with various processes of destroying germs in solution, he says:—"Another mode of sterilization, equally certain and perhaps still more remarkable, was forced upon me, so to speak, in the following way: In a multitude of cases a thick and folded layer of fatty scum, made up of matted Bacteria, gathered upon the surfaces of the infusions, the liquid underneath becoming sometimes cloudy throughout, but frequently maintaining a transparency equal to that of distilled water. The living scum-layer, as Pasteur has shown in other cases, appeared to possess the power of completely intercepting the atmospheric oxygen, appropriating the gas and depriving the germs in the liquid underneath of an element necessary to their development. Above the scum, moreover, the interior surfaces of the bulbs used in my experiments were commonly moistened by the water of condensation. Into it the Bacteria sometimes rose, forming a kind of gauzy film to a height of an inch or more above the liquid. In fact, wherever air was to be found, the Bacteria followed it. It seemed a necessity of their existence. Hence the question, What will occur when the infusions are deprived of air?

"I was by no means entitled to rest satisfied with an inference as an answer to this question; for Pasteur, in his masterly researches, has abundantly demonstrated that the process of alcoholic fermentation depends on the continuance of life without air—other organisms than Torula being also shown competent to live without oxygen. Experiment alone could determine the effect of exhaustion upon the particular organisms here under review. Air-pump vacua were first employed, and with a considerable measure of success. Life was demonstrably enfeebled in such vacua.

"Sprengel pumps were afterwards used to remove more effectually both the air dissolved in the infusions and that diffused in the spaces above them. The periods of exhaustion varied from one to eight hours, and the results of the experiments may be thus summed up:—Could the air be completely removed from the infusions, there is every reason to believe that sterilization *without boiling* would in most, if not in all cases, be the result. But, passing from probabilities to certainties, it is a proved fact, that in numerous cases unboiled infusions deprived of air by five or six hours' action of the Sprengel pump are reduced to permanent barrenness. In a great number of cases, moreover, where the unboiled infusion would have become cloudy, exposure to the boiling temperature for a single minute sufficed completely to destroy the life already on the point of being extinguished through defect of air. With a single exception, I am not sure that any infusion escaped sterilization by five minutes' boiling after it had been deprived of air by the Sprengel pump. These five minutes accomplished what five hours often failed to accomplish in the presence of air.

"The inertness of the germs in liquids deprived of air is not due to a mere *suspension* of their powers. They are *killed* by being deprived of oxygen. For when the air which has been removed by the Sprengel pump is, after some time, carefully restored to the infusion, unaccompanied by germs from without, there is no revival of life. By removing the air we stifle the life which the returning air is incompetent to restore."

High-angled or Low-angled Glasses in Microscopy, which are best?—This would not appear to be decided yet. Professor E. Smith, of New York, has lately gone in for the view that with high angles the depth of focus is increased. The following letter is from the 'American Journal of Microscopy' (May), and is by Mr. R. Hitchcock. After some preliminary observations, he says:—"In the first place, it is very questionable in my mind if the resolutions which the Professor exhibited, point to conclusions in any way opposed to those generally received by working microscopists. Certainly the resolutions were difficult tests for the glasses employed, and no one would expect to make them with low-angled glasses. Is it not admitted by all microscopists that the resolution of diatoms and Nobert lines require high-angled objectives? I believe it is Carpenter who says that low or moderate angles are to be preferred for almost every kind of work except resolution of diatoms. The mere fact that Professor Smith has succeeded in resolving the objects mentioned with glasses of high angles, does not support his view that high angles are universally preferable, but only confirms the general testimony in this regard. Unfortunately the abstract in this journal gives us no information as to how Professor Smith has been led to form his opinions so contrary to those generally accepted. It seems to the writer that it is time for the long-fought battle between high and low angled glasses to stop. His own experience teaches him that for ordinary work, penetration is a requisite; but he does not deny the necessity of high angles for certain work. There should be no disagreement in regard to matters which any man of experience can test for himself, and the universal testimony of our best authorities, i. e. of men who have spent their lives in microscopical work, is against Professor Smith. As already stated, I do not wish to criticise what Professor Smith has said in his paper, but I would like to ask him why he thinks that 'most of the work in histology and pathology done with the so-called 'working lenses' of narrow angle, would require further attention, and with wide-angled objectives?' (I quote from the report in the journal.) If Professor Smith really means what this passage intimates, viz. that the errors of interpretation are greater with low angles than with high, then it certainly is a novel idea, to me at any rate, and it is well worth the careful consideration of microscopists."

Microscopy at the Geneva Congress.—An international medical congress will be held at Geneva from September 9 to 15 next. The only really microscopic paper will be that on the "Histology of the Ovum, and the Function of the Zoosperms in Fecundation:" reporter, Dr. Fol (Geneva).

False Light Excluder.—We learn from the 'American Naturalist' that E. Gundlach, of Rochester, New York, mounts his new 2-inch lenses with a brass tube $\frac{5}{8}$ inch long projecting below the front surface of the objective, and having a perforated diaphragm at its lower end. This cuts off much of the stray light that would otherwise enter, and still leaves $1\frac{1}{8}$ inch of working focus.

CORRESPONDENCE.

The late Professor Ch. G. Ehrenberg's Researches on the Recent and Fossil Foraminifera.

(*Continued from page* 311, vol. xvii.)

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—Recognizing Ehrenberg's careful research, indefatigable industry, and just appreciation of the important bearings and applications of the facts he brought to light, Professor W. K. Parker and myself * set ourselves to compare and identify, as far as possible, all the *Foraminifera* he had illustrated in his successive publications down to 1872; and we stated with the highest respect for the veteran microscopist, that, though we found it impossible to accept most of his specific, and even generic, determinations, yet we felt certain that the better Ehrenberg's work is elucidated and understood, the more will his beautiful and lasting illustrations, and his painstaking synoptical registers, advance the progress of biology in its relation both to the present and the past. The removal of some obscurity from the highly valuable groups of *Foraminifera* of which he has treated must be of use to naturalists and geologists, enabling them to put several extensive faunæ and local groups into close critical relation with each other, and with such as have been observed by others.†

In 1872 the veteran and almost octogenarian naturalist of Berlin laid before the Academy a memoir, with numerous illustrations, as the results of his long-continued methodical researches on the microscopic life of the sea-bottom of all zones; and especially on its relationship to past life, and its bearings on geological formations. His chart of the world indicates the localities of 353 soundings in the North-Polar (45), North-Temperate (238), Equatorial (58), South-Temperate (15), and South-Polar (4) zones, the materials of which are described either in this or foregoing memoirs.

* In the 'Annals and Mag. Nat. Hist.,' Ser. 4, vol. ix. p. 216, &c.

† After careful comparison of all Ehrenberg's figures of fossil *Foraminifera*, Professors W. K. Parker and T. Rupert Jones have stated that, besides twenty undetermined forms, 138 species and noticeable varieties are shown in the 'Mikrogeologie,' most of which are living at the present day, and eighty-one of which had been named by other observers. 'Annals and Mag. Nat. Hist.,' March 1873.

An elaborate table (of 110 quarto pages) enumerates all the microscopic objects determined from these many gatherings, according to the above-named zones, and the respective depths, from 100 to 20,000 feet; materials from less than 100 feet are not included, being possibly of land or fresh-water origin, and therefore not indicative of real marine conditions.

These are—*Foraminifera* (*Polythalamia*) 605, *Diatomaceæ* (*Polygastrica*) 656, *Polycystina* 279, *Phytolitharia* (Pooliths and Spongoliths) 219, *Geolithia* 56, *Zoolitharia* 39, remains of Molluscs and other animals 70, soft Plant remains 21, inorganic particles, crystals, and Morpholites 35. References to the descriptions and figures in the author's various memoirs are also given. His latest corrections and arrangement of the minute oceanic organisms, (1.) independent *Protozoa* and *Diatomaceæ* (1540), with higher Invertebrates (70), and (2.) not independent organisms, but fragments and particles, named for convenience of recognition (314), are incorporated in the Table.

The nomenclature is that which Ehrenberg has adopted throughout his long-continued studies of the Microphytes and Microzoa, and may readily be correlated with that adopted in the critical treatment of his other works by modern naturalists, as in 'Annals Nat. Hist.,' Ser. 4, vols. ix. and x. The contents of one of the twelve beautiful plates of this memoir in the 'Abhandlungen kön. Akad. Wiss. Berlin' für 1872, namely, pl. i., with part of pl. ii., illustrating the *Foraminifera* of Davis Strait, from 6000 to 10,988 feet of depth, has been thus brought into relation with the modern nomenclature in the 'Manual and Instructions for the Arctic Expedition,' 1875, p. 194; and the figures of *Foraminifera* * from the East Coast of Greenland, published in 'Die zweite deutsche Nordpolarfahrt,' &c., vol. ii., 1874, Zool. 15, Polythal., pl. i., are similarly treated in this 'Arctic Manual,' at p. 571. The Arctic Rhizopods are thus shown to be comparable with those already described by others from the Arctic and North-Atlantic oceans, and their local differences of *facies* can be satisfactorily valued. In like manner, all deep-sea explorations will have to be studied with reference to what Ehrenberg has already done.

Another great work—on the fossil earths and rocks, marine and fresh-water, of all lands, and particularly the Polycystina-bed of Barbadoes—was brought out by the indefatigable Ehrenberg in 1875.

This volume † comprises, first, a *résumé* of the marine microscopic fossils treated of in the 'Monatsberichte' and 'Abhandlungen' of the Berlin Academy, and in the 'Mikrogeologie' (1854). This is an elaborate table (of 98 pages), arranged in geological order—thus, I. Primary; II. Jurassic: III. Chalk; IV. Tertiary; V. Quaternary and Recent; VI. Volcanic: also geographically for Asia, Africa,

* Drawn by Clara Ehrenberg with the truthful skill of the father's pencil.

† 'Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersicht der mikroskopischen Paläontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rücksicht auf den Polycystinen-Mergel von Barbados, von Christian Gottfried Ehrenberg.' Aus den Abhandlungen der Königl. Akad. der Wissen. zu Berlin, 1875. Mit xxx Tafeln. 4to, 1875, Berlin. Read before the Academy, December 17, 1874.

America, and Europe. Next follows (pp. 106–115) an account of the Polycystine formation of Barbadoes, describing 278 *Polycystina*, and about 20 "Polygastrica" and 70 other forms, including Phytoliths, Geoliths, a few *Foraminifera* (pl. 1, fig. 1, *Planorbulina;* fig. 2, *Discorbina? barbadensis*, Ehr. sp.), and some inorganic particles; and at pp. 116–120 the Polycystines and other small organisms (156 in all) of the Nicobar Islands. These are illustrated by thirty quarto plates, delicately drawn and tinted. Remarks on the Chalk marble of Antrim and white marl of Lubin (Poland) succeed; and notes follow on some of the statistics of the Table,—on the fresh-water and volcanic materials yielding *Diatomaceæ*,—on the economic use of microscopic organisms,—and on the systematic classification of *Polycystina*. An extensive synoptical Table (pp. 170–225) of the minute organisms found in fresh-water and volcanic materials in all parts of the world concludes this work. Chiefly "Polygastrica" are here enumerated, with some Phytoliths, Zeoliths, one Polycystine, twelve "Polythalamia," a small Mollusc, two Entomostraca (*Cypris Haguei* and *C. Mexicana*), and some miscellaneous particles.

To few is it given to gather together before death their gleanings of knowledge, industriously sought for during the midday of working life, and to harvest their sheaves in such noble volumes as the 'Infusionsthierchen' of 1830, the 'Mikrogeologie' of 1854, and the synoptical memoirs of 1873 and 1875. The strong constitution which withstood the sufferings and dangers of Eastern travel, to which his companion, Hemprich, succumbed, sustained Ehrenberg to a ripe old age; and the valuable recognition of his genius by A. von Humboldt and his sovereign, and the fortunate sympathy of an intellectual home and scientific society, fostered and encouraged his patient persistence in the gathering of facts from the minutest and most manifold of organisms both of sea and land. We can now see at a glance, in the beautifully exact plates he has set before us, group upon group of the myriad atoms, once endowed with life, and impressed distinctly with Nature's seal of rank and order, which range from almost nothing to the greater things,—and between far-past ages and the present. And thus he still helps others to fulfil their duty and reap their pleasure in the fields of Nature (as he himself has done),—interpreting her mysteries, and applying their hard-earned knowledge to the benefit of mankind.

I remain, Sir, yours, &c.,

T. Rupert Jones.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *June* 6, 1877.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society since the last meeting was read, and the thanks of the meeting were voted to the donors.

A paper "On the Thermo-dynamic Origin of the Brownian Motion," by the Rev. Joseph Delsaulx, of Louvain, was read by the Secretary. (The paper will be found printed at p. 1.)

A note from the President of the Society upon the subject of the paper, which had been submitted to him for perusal, was also read by the Secretary.

The Chairman proposed a vote of thanks to the author of the paper: carried unanimously.

Mr. W. N. Hartley said it would be remembered that on a former occasion he read a paper before the Society upon the fluid found in rock cavities, and since that time he had written a paper containing some further observations, and this paper had been read before the Royal Society by Professor Stokes. Before reading a short note which he had brought to the meeting, he wished just to refer to the contents of his paper to the Royal Society. In certain cavities of rock crystal he had found that the contained bubble was repelled when a hot wire was applied; but in other cavities, under apparently the same circumstances, the bubbles were attracted. He gave an explanation of this at the time, which had since been improved upon by Professor Stokes. When a capillary tube had a small quantity of liquid introduced, the liquid would form a kind of plug, and when heat was applied to one end it was found that this liquid plug was repelled by heat; and Professor Stokes informed him that this was caused by the diminution of the surface tension of the liquid. In the course of his observations on fluid contained in rock cavities, he had been led to the conclusion that the liquid in some of them was carbonic acid, and that at a temperature of 31° C. it existed there under a tension of 109 atmospheres, and in this case repulsion was caused by heat. Professor Stokes explained this by saying, that by heat a portion of the gas with which the liquid was saturated was driven off, and by this means the surface tension was increased, causing the bubble to move away. He made some further experiments, and found that an extremely slight increase of temperature caused a vibrating bubble to cleave to the heated side of the cavity, but, when the heat was equalized, the original movement continued. Vibrating bubbles of liquid carbonic acid he found could be of much larger size than those of water only. He also concluded that, as all bodies were always altering in temperature, it was impossible to maintain any body equally heated in every part; and if it were correct that the movements of bubbles were due to the alteration of the surface tension consequent upon the alteration of temperature, it followed that light particles below the surface of water should be attracted by heat and be subject to vibratory motion. Mr. Hartley then proceeded to read a paper in continuation of his former observations (see p. 8).

Mr. Slack asked if Mr. Hartley intended to use the word attraction to characterize the movement he had described, or would he not state it as a motion in the direction of least resistance.

Mr. Hartley said he should, of course, have said *apparent* attraction, because, though it appeared as if the bubble was attracted, it was really shot forward from behind, as from a catapult. When plumbago was floating upon the surface of the water it was repelled by a hot wire, the alteration in surface tension causing the liquid to shrink away and carry the wetted particles along with it; but when it had been left on the surface for some hours the shrinking away was less.

Mr. Slack inquired if Mr. Hartley had tried electricity? The old observers said that only heat affected the Brownian motion.

Mr. Hartley said he had tried electricity, but found that, with the current from six cells of Grove's, a heating effect was produced which rendered the result uncertain; he had also tried experiments by passing sparks, but could not do this very well because of the large amount of metal about the microscope. He could not say what might be the effect of a magnet.

The thanks of the meeting were then unanimously voted to Mr. Hartley for his paper.

The Chairman then intimated that the meeting would be adjourned to the first Wednesday in October. Notice was also given that in accordance with their usual custom the Society's rooms would be closed during the month of August. At the close of the meeting, Mr. Hartley exhibited an interesting experiment with white arsenic powder. Throwing a little upon water, it was found that some particles were in a film of air and floated in the liquid. On bringing a small mass of heated metal near these globules, they moved towards it. The explanation being, that the water acted upon by the heat opposed less resistance than the cooler water behind, and the bubble was thus propelled forward as if attracted by the metal.

Donations to the Library and Cabinet since May 2:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
Bulletin de la Société Botanique de France	*Ditto.*
American Journal of Microscopy. 3 parts	*Editor.*
Papers and Proceedings of the Royal Society of Tasmania, 1875	*Society.*
Considerations on Vegetable Nutrition. By Salvador Calderon. 1877	*Author.*
Five Photographs of *Physalia pelagica*	*Dr. Habirshaw, of New York.*
Six Slides of Double-stained Vegetables	*W. H. Walmsley, of Philadelphia.*

The following gentlemen were elected Fellows of the Society:—

Henry John Roper, Esq.; Charles Joseph Lambert, Esq.; Frederick Du-Cane Godman, Esq.; James Clifton Ward, Esq.; Albert Davidson Michael, Esq.; Francis John Kingsbury, Esq.; and M. L'Abbé Rénard was elected an Honorary Fellow.

WALTER W. REEVES,
Assist.-Secretary.

MEDICAL MICROSCOPICAL SOCIETY.

Friday, May 18, 1877.—Henry Power, Esq., President, in the chair.

Granular Kidney.— Dr. Goodhart made some observations, illustrated by specimens, upon this subject. He referred especially to the interstitial change, discussing whether or not this was entirely atrophic. He believed that in very many cases at least it was so, and that the course of events was the following. First, œdema outside the tubes; secondly, atrophy of the secreting cells; thirdly, fusion of various walls of tubes with the œdematous products to form hyaline masses that look more or less like ill-formed fibrous tissue. He did not believe this change to be the same as that seen in cirrhosis of the liver. The interstitial material there, was of the nature of new growth and resembled fibrous tissue; there was none of the hyaline material that is found in granular kidney, and which material it was well to notice was never an accompaniment of rapidly growing but rather of degenerating tissue.

Mr. Needham thought that the first change was interstitial cell growth which afterwards degenerated; and that the condition of arterio-capillary fibrosis was always one of interstitial growth rather than of atrophy. As to any analogy with the liver, he did not think it necessary to seek for it, since the changes in the liver were anything but uniform. Why, too, he asked, if the hyaline change were atrophic, was puckering of the organ found? That looked like contraction of fibrous tissue.

The President inquired whether the last or shrunken stage of a "large white kidney" could be told from a granular one by the microscope.

Mr. Golding-Bird favoured the view that the interstitial change was not degenerative; and appealed to the permanent change in the kidney of a pregnant woman that sometimes occurred, in support of his view.

In reply, Dr. Goodhart admitted that the subject was yet *sub judice;* and that what had been urged against his view, in regard to the puckering of the organ, was sound. He could distinguish microscopically the last stage of the "large white kidney" from the granular one, by the epithelium, which was fatty.

Hernia of the Ovary (?).—Mr. Golding-Bird showed specimens of a tumour that he had removed from the groin of a girl æt. 20. Clinically the symptoms were in every particular those of hernia of the ovary; but the microscope showed only a structure just resembling that of a fibroid of the uterus. He found no Graafian follicles.

After examining it, several members of the Society considered the tumour as affording no positive evidence of ovarian structure.

Adenoma of Lachrymal Gland.—The Secretary read a paper by Dr. Johnston, of Baltimore, illustrated by specimens, and a photograph. The patient was a woman æt. 22, who had had for ten years an orbital tumour that caused exophthalmos to the extent of 1½ inch, pushing the eye against the ala of the nose. The tumour was painless, and sprang from the lachrymal gland. On January 6, 1876, he excised it, and by degrees the eyeball somewhat receded into its normal position, and the sight was partially restored.

Microscopically the tumour was an adenoma, in which dacryoliths of carbonate of lime were seen, and which gave the black cross with polarized light.

The President thought growths of the lachrymal gland were more common than was usually stated; he had seen at least six cases himself.

Ecchymosis of Skin.—Mr. Golding-Bird showed a specimen stained with indigo-carmine and carmine. The epithelium as well as the connective tissue were variously coloured red, blue, purple, &c.; while the blood-cells that were extravasated everywhere between the fibres and fat-cells were of a vivid apple-green.

Spinal Cord in Hydrophobia.—Dr. Coupland exhibited specimens of the spinal cord in this disease, showing the exudation of leucocytes around the vessels lately described by Dr. Gowers.

San Francisco Microscopical Society.

A meeting was held by the San Francisco Microscopical Society on Thursday evening, February 15, in their new rooms, which were crowded.

Dr. S. M. Mouser exhibited a slide mounted by him with a portion of diphtheritic membrane, and made some extended remarks regarding the fungoid theory of its development; he assuming that such was not the cause of the disease. He said that the members would find in the specimen of diphtheritic membrane on the slide, epithelial cells in various stages of formation and disintegration, mucus and pus corpuscles; also spindle-shaped bodies, distributed with some regularity, indicating some sort of organization, though there are no indications of blood-vessels. Some authors suppose the membrane to be composed of hardened mucus. It seemed to the Doctor to be an exudation, and that the spindle-shaped bodies alluded to were fibre cells, or smooth muscular fibre. He had not been able to detect anything that he could say was certainly fungi, although they have been thought to cause the disease. In 1858, Dr. T. Laycock, of Edinburgh, conceived the idea of its being caused by a parasitic fungus, and the fact was noticed in Braithwait's 'Retrospect,' in July 1859, part 39. In Aitkin's 'Practice of Medicine,' vol. i. page 516, it is said: "Vegetable growths, as oidium, occur in the pellicle of diphtheria from time to time, and have been reported by some as a constant occurrence. It is, however, by no means so, and the accidental existence of such vegetable growths is no evidence that epiphytes have any essential connection with cases of diphtheria." In Beale's 'Microscope in Practical Medicus,' page 188, he says: "It is true that in many cases sporules of fungi are met with, but many circumstances prove satisfactorily that they merely grow in the false membrane as a nidus favourable to their development, and are not to be regarded as the cause of its production." On the page opposite this paragraph he has two figures, neither of which shows any fungi.

This fungus theory was revived in Germany a few years ago, and they made use of salicylic acid to destroy the fungi; they have abandoned this, however, and are now using, as a local application, warm water and steam. The Doctor concluded with the statement, that "the generally received opinion in the medical profession, at the present time, is that it is constitutional in its nature, and I think microscopic observation does not prove the contrary."

The remarks of Dr. Mouser being so essentially in opposition to those expressed by Dr. Edwards at a former meeting, the latter gentleman was requested by Dr. Woolsey, of Oakland, who seemed to favour the fungoid theory, to say a few words on his side of the question. Doing so, he alluded to the fact of the microscope being the only instrument able to decide the question, and then when used by careful illumination and manipulation, with powers of one thousand diameters and upward. He believed that diphtheria was local in the beginning, and spread by fungoid growth, and explained what he had seen, as well as others who had made the matter a study, in the way of watching the growth and development of the fungus. He used the black-board to explain the subject, and certainly convinced all present that his faith was firm regarding his theory, and that he believed the proper use of salicylic acid would destroy the fungus and cure the disease.

After an interchange of general conversation, the matter of illumination came up while examining the markings of some of the diatoms presented earlier in the evening; and as Dr. Edwards is not only an authority on diatoms, but has naturally made the study of the best method of bringing out their beautiful peculiarities very thorough, he was requested to state to all what he had to one or two privately regarding the blue ray in microscopy.

With a few remarks as a preface, he proceeded at length to explain and illustrate a matter which he stated he considered of great interest and extreme importance to every member as a working microscopist, namely, the character of the mode of illumination made use of in viewing more particularly the finer so-called "test-objects," the Diatomaceæ. His first experiments were made in the summer of 1863, when he was endeavouring to improve the modern achromatic objective. The results were made public at meetings of the American Microscopical Society, November 1865, and subsequently. He first found that, when using two objectives of the same power and angular aperture on the same object, with one he had to use a greater obliquity of the illuminating beam than the other to obtain the same result. If now a piece of blue glass were interposed in the course of the beam of light, details could be seen with the poorer lens as well as with the better one, with the same obliquity of illumination and with a less obliquity with the best lens. Also, if yellow glass were used, a greater obliquity was necessary with both lenses. Also details were better seen with sunlight than with kerosene light, better with kerosene than gas, better with gas than with a candle; all with the same obliquity of illumination. The blue colour most favourable for illumination he found to be that answering to the point in the spectrum where the maximum of chemical force or actinism resides. From this he framed a theory of vision, that it was due to the chemical action, and further experiment and experience tended to confirm this conclusion. The best way, he found, to get such monochromatic illumination was by means of a prism properly mounted. Evidently sunlight was the best to use in microscopic work, kerosene next. He begged to remind the members that colour blindness, or the inability to distinguish colours, was by no means uncommon, and that the eyes were not always to be trusted. He called their attention to the fact that a kind of light could be used to illuminate objects that would change their apparent character very materially, or even make them disappear entirely, and, in illustration, illuminated a coloured chart of the spectrum by means of gaslight, kerosene light, sodium light, and magnesium light. In the sodium light all the colours but yellow disappeared; whilst in the magnesium beam certain colours appeared that could not be seen in gaslight. He also showed how colours could be tested by means of the spectroscope, and said that this was one of, if not the best method of testing the correction for colours of microscope objectives. In this way he showed that this now much-talked-of "mazarine blue" glass was not blue at all, but more purple, as it transmitted a large amount of red light along with blue and other colours.

The regular meeting of the San Francisco Microscopical Society was held on Thursday evening, March 1, with President Ashburner in the chair.

Professor Ashburner donated a slide mounted by him with exfoliations from glass vases found in old Greek tombs, which showed some very curious features.

Mr. Kinne donated a slide mounted by him with the scale of salmon as a polarizing object, which was found to be of a character that would cause it to rank high among those beautiful and instructive objects. Mr. Kinne also presented two varieties of siliceous sponges from Oakland and Pescadero Beach, and a series of slides mounted by him with sections and fragments of the same, as well as the spicules cleaned from any extraneous matter to show their peculiar forms. Mr. Kinne stated that while they could not be called glass sponges in the strict sense of the term, from the fact that a certain amount of the framework or skeleton was composed of horny material, still the latter seemed to have only been used as a cement to hold the points of the acicular spicules together in one case, and as a very slight integumentary deposit about masses of spicules arranged in a filamentous form which anastomosed and spread in every direction, in the other. He called attention to the manner in which spicules in the Oakland specimen were placed at their point of juncture, under one and over another in a way that served to strengthen the whole fabric, and then exhibited a slide of the leathery or horny sponge of commerce in the way of comparison.

Mr. Hanks presented the Society with nine species of fossil corals, fossil crinoids and crinoid stems, from various localities.

Dr. A. Mead Edwards, who was present, exhibited a slide of *Volvox globator*, which he mounted in a saturated solution of salicylic acid some years ago, which had not changed a particle since it was first stained and immersed in the medium. Upon examination under a quarter and an eighth objective, the cilia were seen protruding from the membranous envelope, as well as the delicate radiating processes extending from the sides of the gonidia within the globe. Dr. Edwards also exhibited a section cutter, fitted with various-sized holders for the object, and a super-stage of his invention. He explained the advantages of a growing cell, which he had satisfactorily used for many years, formed of a square piece of glass, cemented to a thicker one, perforated with an aperture from one to two inches in diameter. Placing upon this receptacle for water a glass to cover the opening, in which two minute openings had been drilled, a common thin cover could be placed over the living desmid, diatom, or protococcus, and watched while it passed through its various stages of development.

The regular meeting of the Society was held on Thursday evening, March 15, with Vice-President Henry C. Hyde in the chair.

Mr. H. G. Hanks presented a sample of vegetable substance found on the beds of dried-up lakes in the deserts of Arizona and south-east California. He stated that some parties here had conceived the idea that paper could be made of the material, which was white and cottony in appearance. An examination with the microscope showed the filaments to be composed of cells loosely joined. The whole mass was but a collection of interwoven filaments of Confervæ, which had lived during some flood of water, and as the lakes became dry, were left to be blown about by the winds, and as they are often found apparently descending from the sky, have been named aërophytes, though formerly regarded as of meteoric origin. It would be but a waste of capital to endeavour to manufacture paper of a material which has no fibre, though perhaps a felt-like body might be obtained. A slide, with a portion of the filaments, was examined, and the subject of its being of no value for use as a paper material, being plainly evident from a microscopical examination of its structure, led Dr. Edwards to speak of the popular idea regarding the rice-paper common with us, and to the fact that it was not manufactured as paper is usually; in fact, not manufactured at all, but only shaved off in thin sheets from the pith of the *Aralia papyrifera*, a Chinese tree. Quekett first discovered that this paper was composed of natural parenchymatous tissue by the application of the microscope, and disproved the assertion of many who even went so far as to assert that they had seen the tissue manufactured as our common paper is made.

This reference to popular fallacies induced Mr. Kinne, later in the evening, to refer to a matter which thousands believe to be true, regarding the production of long, slender worms from horse-hairs. He did so from the fact that but recently an otherwise well-informed gentleman of this city not only asserted that horse-hairs, when placed in water, would undergo a peculiar transformation and become worms or snakes, but insisted that he had performed the miracle himself, and would do it again and bring them to him as an evidence of the truth of his theory. He has not yet done so; but as the general diffusion of knowledge should be constantly presented through the medium of the newspapers and scientific journals, we give some data that Mr. Kinne mentioned, as an item of general interest:

M. Villot, of France, some time since published a memoir, which entirely cleared up the life-history of these curious beings; and when we state that one of our common species (*Gordius varius*) lays about 600,000 eggs, it will be seen that there is no wonder we find them occasionally creeping through a faucet not supplied with a strainer of some sort. Strings of the ova are noticed in water in autumn, sometimes 50 feet or more in length, and being swallowed by insects are encysted therein, in turn to be snapped up with their host by some little fish, or carnivorous beetle, where they are set free and encysted again in the intestines. A transformation after some months causes them to be able to reach the water again, where great changes take place, and when about two inches long they turn brown aud begin to move. The *Gordius aquaticus*, our common hair-worm, grows to be about a foot in length, and is found in many animals. As it is a popular belief in certain parts of Europe that they live in man, and that they may be introduced into the system in drinking water from pools or brooks, or in eating fish not properly cooked, it behoves everyone to be on the safe side, order their fish well done, and strain their spring, valley, or other water before drinking.

Dr. Mouser exhibited one of the most beautiful forms of *Nostoc* known, in which the beaded filaments are arranged in a spiral form, and were found floating on the surface of the outlet of Lake Merced.

Mr. Langstroth exhibited a *Serpula*, brought down for the occasion from his marine aquarium.

Mr. Hyde brought up a subject of great interest to all, by exhibiting a number of branches of lupin destroyed by the larva of some iusect, which he had obtained from Mr. Pritchard, superintendent of Golden Gate Park. The ravages of this iusidious little foe are becoming apparent in a very alarming manner, some twenty acres of the lupin-covered sand-dunes of the park being destroyed. The blight was first noticed some six weeks ago, and rapidly spread from several well-defined patches. With the infected branches Mr. Hyde presented four vials, each containing forms of iusect life thought to be obnoxious.

The fly found most numerous on the healthy and diseased plants, and supposed by Mr. Pritchard to be iutimately connected with the trouble, was at once counted out, as well as the second insect noted. The third, on a casual examination, bore some of the finger-marks of that pest of the agriculturist, the *Curculionidæ*, of which there are some ten thousand known species; but, on further examination, Mr. H. Edwards decided it to be the active pupa of the second. He further made remarks on its tunnelling habits.

The regular meeting of this Society was held on Friday evening, April 19, with President William Ashburner in the chair.

Mr. Henry Mills, of Buffalo, New York, sent the Society a slide of *Stephanodiscus Niagaræ*, which he had mounted as an opaque object, without washing.

Dr. S. M. Mouser presented a slide mounted by him, with a section of the liver of man, showing cirrhosis.

There were many additions to the library.

Powell and Lealand's new accessory for oblique illumination was exhibited by Mr. Hyde, and Dr. Mouser handed around for examination a spatula which he had designed for the purpose of laying out and mounting sections of animal tissue, and which he had found to work finely.

There were no papers read.

The regular meeting of the San Francisco Microscopical Society was held on Thursday evening last,* President Ashburner in the chair.

Col. C. Mason Kinne presented some curious forms of insect life, which were obtained by Mr. Thomas F. Eyre from a tree, and rose-bush under the same, growing at Mazatlan, Mexico. They were mistaken by the casual observer for the thorns which are the proverbial necessary evils of the sweet-smelling rose, from the fact of the thorax being raised into a sharp-pointed crest, which had the appearance and feeling of a veritable rose-thorn. Mr. Kinne remarked that the tree-hoppers (*Membracididæ*) furnish many varieties of this peculiar form of raised thorax, but the variegated sharp crest curving upward and backward from the head of this, gives perhaps as beautiful and pointed an illustration as is often found of the genus. In the struggle for existence which has gone on for ages in the animal kingdom, the "mimicry of nature" plays an important part, and this little tree-hopper, from its appearance and known habits, is a good example of the theory.

Mr. C. W. Banks exhibited a fine specimen of the *Dionæa muscipula* or Venus' fly-trap, with some of the leaves expanded; others fulfilling their purpose in the way of holding a number of unwary flies which had been enticed within the trap-like jaws of the plant. Mr. Banks also exhibited a box of slides which he had just received from Mr. Charles Zentmayer, of Philadelphia, who has succeeded in doing good work in the way of the double staining of vegetable tissues, as the objects were found to preserve the peculiarities of the cell structure, and the colour was distributed excellently.

Mr. Hanks presented a slide mounted with crystals, to illustrate a paper by him, on a device to be used as a mechanical finger. This paper will be found printed at p. 33.

* As usual, the report is transmitted without any date.—Ed. 'M. M. J.'

THE

MONTHLY MICROSCOPICAL JOURNAL.

AUGUST 1, 1877.

I.—*A Simple Device for the Illumination of Balsam-mounted Objects for Examination with certain Immersion Objectives whose "Balsam Angle" is 90° or upwards.* By Surgeon J. J. Woodward, Brevet Lieut.-Col. U.S. Army.

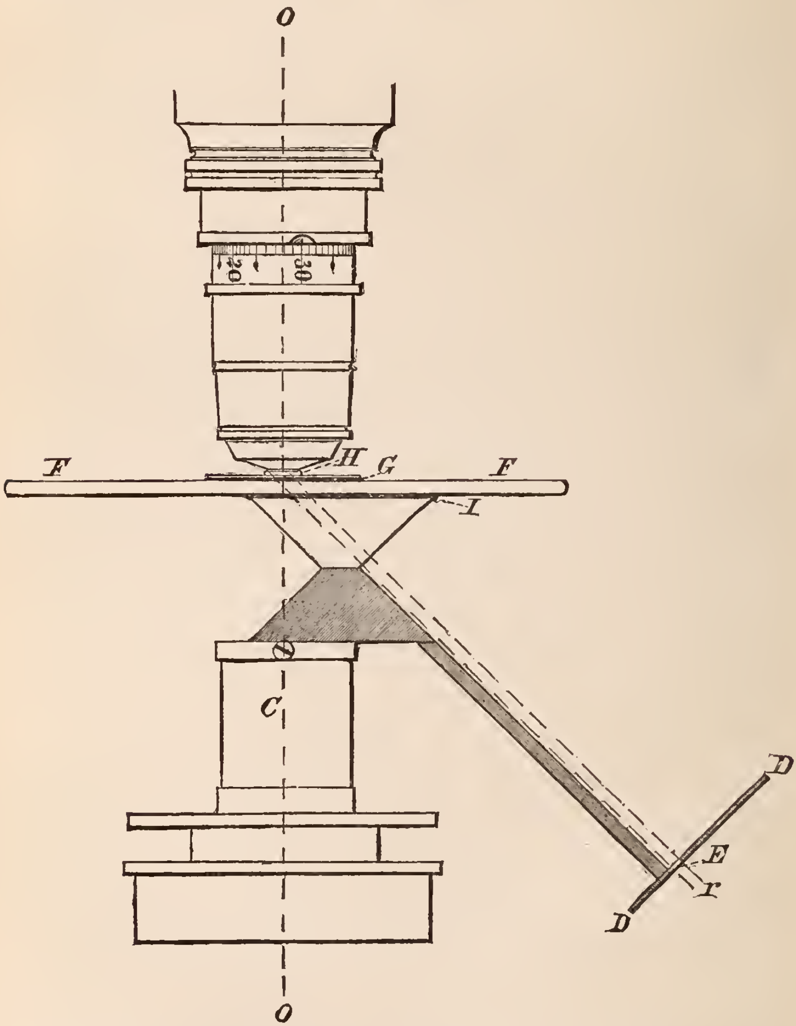
(*Taken as read before the* Royal Microscopical Society, *June* 6, 1877.)

Certain immersion objectives are so constructed that they are capable of admitting rays which enter the front lens at a greater angle with the optical axis than the limit for dry objectives. That this is not only theoretically possible, but that such objectives have been successfully constructed, was several years since demonstrated, in the 'Monthly Microscopical Journal,' both by Mr. Keith and myself,* notwithstanding which, the contrary has often since been energetically asserted by writers in the same Journal.

Meanwhile, immersion lenses possessed of the excessive angle in dispute, continue to be put into the market by more than one maker; and perhaps some of the purchasers will be interested in a simple device which I have used for some time with such objectives to illuminate test-objects mounted in balsam. This device consists merely of a right-angled prism of crown glass mounted beneath the stage in such a manner that its long side can be connected by oil of cloves, or some similar fluid, with the slide on which the object is mounted. The details of the plan will be understood from the diagram on next page, in which the glass prism is seen in section just beneath the object-slide F F. Just below it is another right-angled prism, of the same dimensions, made of brass; the section of this prism is indicated by dark shading in the diagram. The right angles of both prisms are truncated, and the facets are cemented together in such a manner that the long sides of the prisms are parallel. The brass prism slips transversely in a groove in the top of a holder, C, which is fitted into the sub-stage of the microscope. D D is a blackened brass screen held in position by two brass arms, one of which is shown in the figure. This screen is parallel to the adjacent face of the glass prism, and has in it a small circular aperture, E, about the size of a large pin-hole. The side of the glass prism next the screen is covered with black paper

* June 1873, p. 268; November 1873, p. 210; March 1874, p. 119; September 1874, p. 124.

in which is a corresponding pin-hole. The two pin-holes are so placed that a beam of parallel white sunlight (r) passing through both will be perpendicular to the side of the glass prism on which it impinges.



To use this apparatus it is adjusted in the sub-stage of the microscope, a drop of oil of cloves is placed on the upper face of the prism, the glass slide F F, on which the object is mounted in Canada balsam under the usual thin cover, G, is placed on the stage, and the sub-stage is racked up until the drop of oil of cloves is spread out into a thin layer, I.

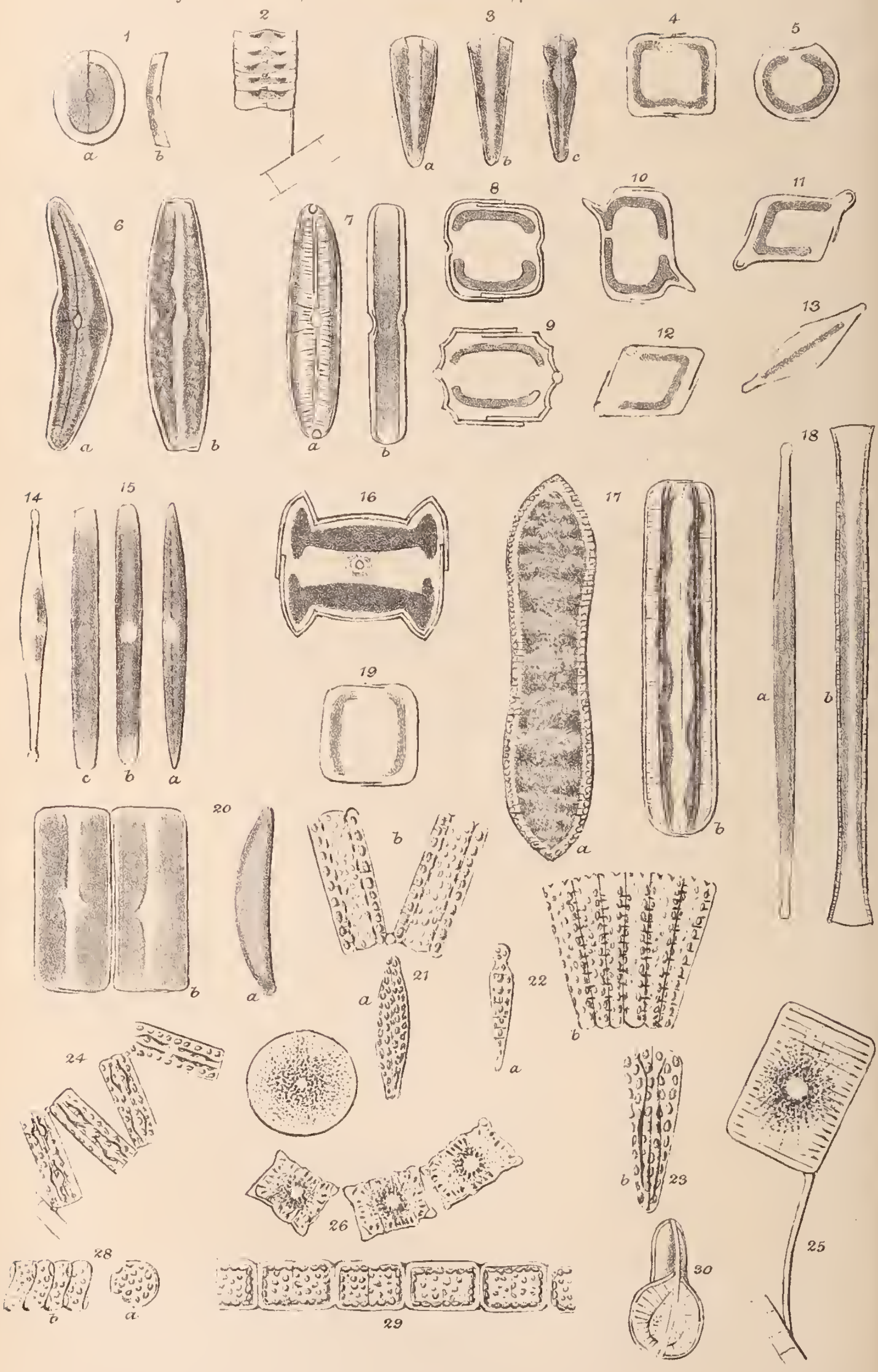
The object being thus arranged, it is evident that if a beam of parallel solar rays (white sunlight), reflected from a plane mirror, be thrown through the two apertures upon the face of the prism, being perpendicular to that face, it will enter and pass through without refraction until it reaches the upper surface of the thin glass cover G. The parallel rays impinge upon this surface, as is evident from the construction, at an angle of 45° with the optical axis O O. If, now, the medium next above the thin cover, G, be air, this obliquity will be greater than the critical angle, and total reflexion of the rays will take place. If, however, the medium next above the thin cover be water, the obliquity will *not* be greater than the critical angle. Refraction having taken place, the rays will enter the water, H; and if an immersion lens of sufficient angle of aperture be focussed upon the objects mounted beneath the cover G, these rays not merely enter the front of the objective, but will form a well-defined image of the object on a brightly illuminated field, which will be visible through the eye-piece of the instrument in the usual way. Of course it is evident from the diagram that with no dry objective, or any immersion objective of less than 90° balsam angle, can anything whatever of balsam-mounted objects * thus illuminated be seen.

Immersion objectives may be divided according to their behaviour with this apparatus, into three classes:—1st. Those with which, since they do not have sufficient angle of aperture to admit the illuminating pencil, nothing can be seen, precisely as in the case of dry objectives. 2nd. Those which have sufficient angle of aperture to admit rays of this obliquity, but are incapable of bringing them to an image-forming focus; with these the field appears well illuminated, but the objects are not well defined. 3rd. Those which not only admit rays of this obliquity, but form well-defined images with them. To this class belong not merely immersion objectives with the so-called duplex fronts, but others; and I may add, not merely objectives of American make, but some constructed by a well-known English house. As might be expected, the quality of the image formed by the direct rays of the sun thrown through a pin-hole at this excessive obliquity varies very greatly in different cases. I will state, however, that I have thus far found at least seven objectives, some of English, others of American make, which define sufficiently well under these circumstances to resolve *Amphipleura pellucida* mounted in Canada balsam. With the objectives which performed best, the field was of exceeding whiteness and brilliancy, but by no

* The apparatus can be used, of course, to secure black-ground illumination of suitable dry objects if they are mounted on the slide instead of the cover, as is usual.

means dazzling, the frustule undistorted, and the striæ clean and black on the white ground, very little colour-aberration being perceived. With other objectives there was more or less colour-aberration and distortion, both which faults were in one or two cases very conspicuous, although in the part of the frustule most sharply focussed upon the striæ were handsomely brought out. The objectives with which I thus succeeded, ranged all the way from a $\frac{1}{4}$th to $\frac{1}{16}$th immersion. I will add that the objectives which resolved *Amphipleura pellucida* under these trying circumstances, when used in the ordinary way with this or other test-objects, displayed an exquisite perfection of definition which it would be hopeless to expect to attain with objectives of less angular aperture.

As it is no part of my purpose in this communication to provoke ill-tempered discussion of the merits of individual makers, I will not append a list of the results obtained with the various immersion objectives I have tried in this way. The apparatus can be constructed for a few shillings, and those who take the trouble to use it will soon see to which of the three classes any particular objective they may test belongs.



W West & Co. lith.

II.—*An Essay on the Classification of the Diatomaceæ.*

By M. Paul Petit. Translated by F. Kitton, Hon. F.R.M.S.

(*Taken as read before the* Royal Microscopical Society, *June* 6, 1877.)

(*Continued from page* 14.)

Plates CLXXXVII. and CLXXXVIII.

Part II.

In the preceding part the author gave an explanation of his method of classification; he then proceeds to describe the typical forms of the sixteen tribes into which the two sub-families are divided.—F. K.

1st Sub-family, Placochromaticeæ. Frustules furnished with a lamellate endochrome.

1st Tribe, Achnantheæ.

This tribe is the same as Herr Grunow's (minus the genus Rhoicosphenia, which I again place with the Gomphonemeæ), and comprehends the genera Cocconeis and Achnanthes of Dr. Pfitzer. It contains the diatoms that have their frustules arched or geniculate and the two valves unsymmetrical, one of which is convex and the other concave, the latter only having a central nodule. The endochrome consists of a very thick single layer placed on the internal surface of one of the two valves, the other remaining independent.

I have been able to verify this disposition of the endochrome in *Achnanthes longipes* Ag. This species conforms to the common law, although Dr. Pfitzer * says that the endochrome is broken up into a great quantity of small fragments. This condition may be observed, but only when the Achnanthes have been some time out of the sea, the plasma altering very rapidly. [Dr. Pfitzer is not positive of this; he says, "Bei den wenigen Exemplaren von *A. longipes* Ag. welche mir vorkamen, waren die Endochromplatten in viele kleinere Theile zerschnitten *ich muss dahin gestellt sein lassen,* ob dies ein normaler Zustand war."—F. K.]

Genera, *Cocconeis, Achnanthidium, Achnanthes.*

2nd Tribe, Gomphonemeæ,

contains two genera only. This tribe is connected with the preceding by the genus *Rhoicosphenia* Grun.

This genus, like Achnanthes, has the valves non-symmetrical, bent or geniculate, and only one of them has a central nodule; but the frustule is cuneiform, like the other Gomphonemas, and the endochrome consists of a single layer resting on one of the scales

* *Loc. cit.*, p. 85.

of the zone, and covering the two valves and the other side of the zone, in the middle of which is found the line of separation. This disposition of the endochrome characterizes the Gomphonemeæ.

Genera, *Rhoicosphenia, Gomphonema.*

3rd Tribe, Cymbelleæ.

The Cymbelleæ comprises all the genera having the valves cymbiform or arched, and the endochrome disposed exactly the same as found in Gomphonemeæ. The layer sometimes rests on the convex and sometimes on the concave zone; this particularly serves to distinguish the difference between the genera. I follow the example of Dr. Pfitzer in connecting *Epithemia* with *Amphora;* but all of them require further study.

Genera, *Cocconema, Cymbella, Encyonema, Amphora, Epithemia, Brébissonia* Grun.

4th Tribe, Naviculeæ.

This tribe includes the genera having generally symmetrical valves and without keels, the endochrome of which is divided into two layers resting on each side of the zone with two lines of separation. The genera differ only by the slightest modifications which the endochrome undergoes.

The Cymbelleæ approach the Naviculeæ through the genus *Brébissonia* Grun. [This genus was constituted to receive the form named by Ehrenberg * *Cymbella Boeckii* = *Gomphonema lanceolatum* Ag. † = *Doryphora Boeckii* Smith. ‡ Professor H. L. Smith § refers it to Navicula.—F. K.] It has the symmetrical valves of the latter and the endochrome of the Cymbelleæ.

Navicula sphærophora (Kütz.) = *Anomœoneis sphærophora* Pfitzer, is the link on the side of the Naviculeæ. Dr. Pfitzer has created a new genus for the reception of this species, having remarked a blank space in the striation on one side of the central nodule, this want of symmetry establishing the relationship of this species with the Cymbelleæ. The characters furnished by the endochrome, according to Dr. Pfitzer, differ completely from those of *N. ambigua* Ehr., a species some authors are disposed to unite to *N. sphærophora* Ktz.‖ [*N. ambigua*, if the character of the striation is of any specific value, should be placed near to *N. cuspidata*, as its longitudinal striæ closely resemble those on that form.—F. K.] But Dr. Pfitzer does not say if the disposition of the endochrome is constant, but that the fault in the striation is found on individuals from various localities. For myself, I have not been able to verify the fact, neither on the specimens I have collected at

* 'Infusionsthierchen,' tafel 19, fig. 5.
† Agardh's 'Conspectus,' p. 34.
‡ 'Synopsis British Diatomaceæ,' i. p. 77.
§ 'Lens,' vol. i. pp. 77, 78.
‖ Rabenhorst, 'Fl. Europ. Algarum,' p. 192.

the end of the lac d'Enghien nor on the type specimen of Moller. The quincuncial disposition of the puncta as indicated by Herr Grunow * is the only thing I have been able to verify. [In my own gatherings of this species the blank space is not invariably present, and I have doubts whether the smooth space really exists. I frequently find that a slight change of focus renders the striæ visible, as in *N. lævissima* Ktz., and *N. crucicula* Donkin' = *Stauroneis crucicula* Sm. The one-sided blank space is constant on the valves of *N. bohemica* and *sculpta* Ehr. = *N. tumens* Sm., but the pseudo (?) blank space on *N. sphærophora* seems to be caused by a slight depression in the surface of the valves.—F. K.]

Genera, *Navicula* (*Schizonema*), *Pleurosigma*, *Scoliopleura*, *Stauroneis*.

5th Tribe, Amphiproreæ.

The tribe of Amphiproreæ only in some degree form a section of the Naviculeæ. The disposition of the endochrome is the same, the presence of keels on the surface of the valves constituting the difference. I unite in this tribe the Amphipleuræ, Plagiotropideæ, and the Amphitropideæ of Dr. Pfitzer,† the arrangement of the endochrome being the same in the three groups, and the sole difference consists in the number and position of the keels.

The connection with the tribe of Nitzschieæ is established through *Amphiprora paludosa* W. Sm., a species presenting a very curious organization, and for which Dr. Pfitzer has created a special group.

The f. v. of this species is in the form of a figure of 8, and is twisted in such a fashion that half of the lower half is at right angles with the upper, and the valves are so reflexed that only a small space exists between the two sides of the zone. One can comprehend that the two portions of the endochrome are united between them, and that the eye cannot detect a single layer. It is in consequence of this abnormal disposition that Dr. Pfitzer separates *A. paludosa* W. Sm., from the other species. Whilst I have only found a single modification of the endochrome forming a connecting link with a group of the Nitzschieæ in which the endochrome forms a single layer placed diagonally in the frustule (Fig. 13, Pl. CLXXXVII.).

Genera, *Amphipleura*, *Berkeleya*, *Amphiprora*.

[The following is Ehrenberg's description of *A. pellucida* in the 'Infusionsthierchen':

"*Navicula? pellucida*, gefurchtes Schiffchen, tafel xiii., fig. 3.

* Grunow, 'Verhandlung in Wien,' 1860, p. 540.

† Rabenhorst constructed what he supposed to be a new genus to receive *A. paludosa*, *A. alata*, *A. duplex*, and *A. gigantea*. This he called Amphicampa ('Flor. Europ.' p. 257), quite forgetting that he had at p. 75 described Ehrenberg's genus Amphicampa. He afterwards changed it to Amphitropis.

N. lævis testula lineari lanceolata aciculari utrinque sub-acuta longitudinaliter sulcata sulco singulo in quovis latere intercostas binis.

Ich kenn diese Form nur aus Exemplaren, die ich von Herrn Kützing trocken erhielt. Er hat in den verkäuflichen Decaden seiner Algen verbreitet. Sie liess sich schärfer beobachten, doch bin ich über die mittleren Öffnungen in Zweifel geblieben. Sie hat einen Kieselpanzer, kann daher kein *Closterium* sein. Vielleicht eigene Gattung. Sie fand sich zahlreich zwischen Oscillatorien und war beweglich."

I have examined specimens of this form from many localities and several exquisite photographs by Woodward, Janisch, and others, but have never been able to detect the keels; one of the photos., taken with a Tolles' immersion $\frac{1}{25}$ amplifying 2051 diameters, shows the striæ reaching from margin to margin, which would not be the case if the valve was not perfectly flat. Ehrenberg gives an ideal transverse section of the frustule, and this has apparently misled other observers who assumed the correctness of the sectional view. I have also examined the figures in Ehrenberg's 'Infusionsthierchen,' Kützing's 'Bacillarien,' Rabenhorst's 'Süsswasser Diatomaceen,' and 'Alg. Europ.' (the figure in the latter work is evidently copied from Wm. Smith's 'Synopsis'), Hassell's 'British Fresh-water Algæ,' pl. cii. fig. 8, Pritchard's 'Infusoria,' 3rd and 4th edition; the figures here are copied from Ehrenberg and Kützing, excepting fig. 30, pl. iv., 4th edit., which is from the 'Synopsis,' the last being the most unlike the form we call *A. pellucida;* indeed, were it not that West says * that it is identical with *Raphidoglœa micans*, Kütz. (by the way this is a marine species, and Kützing's figures of it, although like *A. pellucida*, do not resemble that in the 'Synopsis'), I should be disposed to believe that the *A. pellucida* of the 'Synopsis' is not the *A. pellucida* of other authors. *It is remarkable* that none of the engraved figures bear the slightest resemblance to the actual form, and that the curious median line, with its spatulate terminal expansions distinctly visible even with a single lens magnifying 60 diameters, should not only have been overlooked by the earlier observers, but also by the Rev. W. Smith, who sometimes used a Smith and Beck $\frac{1}{8}$th objective. The sub-marginal dots of course only existed in the draughtsman's imagination. Schumann's figure † is fairly like this species, but represents the striæ as composed of puncta arranged in squares about 15 or 16 in ·001"!!!

In a communication received (1864) from Professor W. Arnott, he says, "Not one species (of Amphipleura) has longitudinal ribs or costæ; even on the frustules what have been mistaken for them in *A. pellucida* are the median lines and two margins of each valve,

* Pritchard, 4th edit., p. 925.

† 'Die Diatomeen der Hohen Tatra,' taf. ii. fig. 19.

making two median lines and four margins, in all six lines, which, as the valves are very pellucid, are seen all at once in the frustule, but the valves show the real structure."

The descriptions are equally inaccurate and obscure. The Rev. W. Smith merely remarks that "The frustules (? valves) are linear lanceolate, length ·0033′ to ·0034′," a description that applies to scores of Naviculoid forms.

The species *A. paludosa* was considered by the late Professor Walker Arnott to be merely a delicate variety of *A. alata*. The form of the valves in both species is difficult to understand when examined with a monocular only, but with a binocular and a $\frac{1}{4}$-inch objective it is easily made out. The keel consists of a thin plate or ribbon of silex appearing when the frustule is seen in f. v. like a double arch, the central depression sometimes showing traces of a central nodule. In *A. paludosa* the four arches of the frustule are reflexed or bent over in opposite directions; in *A. alata* and *A. ornata* they are more nearly at right angles to the surface of the valve. The presence of a keel is in fact the principal distinction between Amphiprora and Scoliopleura Grunow. *Amphiprora latestriata* of de Brébisson is *Scoliopleura convexa* (*Navicula convexa* of Wm. Smith), and not *Nitzschia bilobata*, as supposed by the author of the 'Synopsis' and Mr. Ralfs. The nearest ally to Amphiprora is probably Donkinia.—F. K.]

6th Tribe, Nitzschieæ.

The Nitzschieæ offer the greatest variety in the form of the frustules; they all have a punctate keel and a single layer of endochrome with central elliptical opening. The relation of the endochrome to the valves offers three modifications. 1st. The parts of the zone are so compressed that there remains but little space for the layer of endochrome, which in consequence traverses the frustule diagonally (13) from one keel to the other. It is this group that forms the connection with the Amphiproreæ. 2nd. The layer is very small, and is completely divided by the central elliptical opening. 3rd, and lastly. The layer of endochrome rests on one of the sides of the zone, and covers the two adjacent valves (Figs. 11, 12, 13). Among the Tryblionella, a genus of which M. Pfitzer does not speak, the endochrome, so far as I have verified it in *T. constricta* Greg., and *T. Hantzschiana* Grun., presents the same disposition as in the third group of Nitzschieæ.

Genera, *Nitzschia, Ceratoneis, Tryblionella.*

[The first group belongs to my genus Perrya.* When I described the species *P. pulcherrima*, I had not seen the s. v., which is very narrow (·0005 to ·0007 of an inch in breadth), linear with acute apices. A line of large distant granules traverses the centre of the valve from apex to apex. The diagram,

* 'M. M. J.' vol. xi. p. 218.

Fig. 3, Pl. LXXXI., is consequently incorrect. M. Petit's Fig. 13 fairly represents a transverse section of a frustule of Perrya.

The genus Ceratoneis of Ehrenberg must be taken with some limitation, as it includes forms not belonging to the Nitzschieæ.—F. K.]

7th Tribe, Surirelleæ (Figs. 16, 17).

The siliceous envelope of the Tryblionella very much resembles in constitution certain species of the genus Surirella. I, however, have never had the good fortune to come across a transitional species, nevertheless one is able to comprehend the connection which exists between this tribe and the preceding; but in the meanwhile one is able to understand the unity that exists between them.

The endochrome in the third group invests only one side of the zone of the two valves; if we imagine this layer to become divided above the zone, that is to say, in the middle, and which occurs from the longitudinal extension of the central opening, the result will be two layers of endochrome covering each valve. This disposition of the endochrome is found in all the Surirelleæ (Figs. 16 and 17). To this disposition of the endochrome we have only to add the presence of alæ on the margins of the valves to have the distinctive character of this tribe.

[Dr. Pfitzer * says that this genus is very incorrectly called Surirella. The discoverer Turpin named it after a physician in Hávre, Dr. Suriray; it ought, therefore, to be called Suriraya. ("Mit Unrecht schreibt man den Namen dieser Gattung überall *Surirella.* Der Entdecker Turpin (*a a* O, S 362) benannte sie nach einem Arzte Suriray in Hávre und wir mussen daher wie von Bray *Braya*, von Berkeley *Berkeleya*, so auch hier von Suriray *Suriraya* ableiten.") I quite agree with Dr. Pfitzer that the name of this genus should be altered; but unfortunately the old spelling has become so fixed, that there is, I fear, but slight chance of the correct form being adopted.—F. K.]

8th Tribe, Synedreæ.

In the Synedreæ the endochrome, with some slight modifications, present the same aspect as that in the Surirelleæ and Eunotieæ. The alæ on the valves are absent, and this constitutes the differentiation of this tribe with the preceding.

Genera, *Staurosira, Synedra.*

9th Tribe, Eunotieæ (Fig. 20).

The arrangement of the endochrome is the same as that in the Surirelleæ and Synedreæ, but the layers cover the adjacent parts

* *Loc. cit.*, p. 107.

of the zone, and are divided towards the centre by a deep furrow spread out perpendicularly towards the valve. This character and the form of the valves are sufficient to distinguish the Synedras from the Eunotias.

Genera, *Eunotia, Himantidium.*

2nd Sub-family, Coccochromaticeæ. Frustules containing a granular endochrome.

10th Tribe, Fragilarieæ (Fig. 21).

This tribe contains the species very closely related to the Eunotieæ and Synedreæ through the form of the frustules. On the other hand, in the two last tribes (which strictly should form but one) we see that the endochrome shows a tendency to divide. In the Fragilarieæ we now meet with the endochrome divided into a great number of small layers, and we find it distinctly granular (Fig. 21).

The genera *Fragilaria* and *Odontidium*, through the study of their endochrome, must be again revised, as a great number of their species ought to be placed among the Placochromaticees. Ex.: *F. capucina* Desm., *O. mutabile* W. Sm., and *O. tabellaria* W. Sm.

As to the genus Diatoma, of which Dr. Pfitzer would even abolish the name, I believe it must be preserved, because it has given the name to the family, and, moreover, it offers some very decided characters. In spite of the very good reasons that he is able to give, it would be impossible to change the generally admitted name of Diatomaceæ to that of Bacillaria, which is only employed by a small number of German authors.

Genera, *Fragilaria, Diatoma,* and a number of marine genera.

11th Tribe, Meridieæ (Fig. 22).

The disposition of the granular endochrome on the internal surface of the valves is the same as that found in the preceding tribe, but in the Meridieæ the frustules are cuneiform—a particularity which is sensibly apparent in many varieties of the genus Diatoma. It is therefore through this genus that the passage of one tribe into the other takes place.

Genera, *Meridion, Eucampia.*

[Meridion is placed in the genus Diatoma by Professor H. L. Smith.* The cuneate form of the frustules is not constant. Professor Smith has sent me specimens in which the frustules form straight filaments like a Fragilaria. The species of this genus bear a strong resemblance to *Odontidium anomalum*, as noticed

* 'Lens,' vol. i. p. 83.

by the author of the 'Synopsis.'* The ordinary arrangement thus coinciding with the natural system.—F. K.]

12th Tribe, LICMOPHOREÆ (Fig. 13).

The endochrome in this tribe preserves the same disposition as in the two preceding; but the frustules are cuneiform as in the Meridieæ, presenting this peculiarity that between the two primary are developed a certain number of supernumerary valves to which we have given the name of diaphragms. This modification in the physical structure of the frustule leads to the tribe of the Tabellarieæ, in which we meet with the genera containing an illimitable number of diaphragms: ex., *Striatella.*

1st section, diaphragm rudimentary. *Podosphenia, Licmophora.*

2nd section, two diaphragms. *Climacosphenia.*

[The portions of the frustule here called diaphragms are the annuli and septæ of the 'Synopsis.'† The late Professor W. Arnott once suggested to me that these annuli were perhaps abortive valves. In this view I cannot concur.—F. K.]

13th Tribe, TABELLARIÉES (Fig. 24).

This tribe is composed of all the classes of Diatomaceæ of which the frustules are not cuneiform, and are furnished with internal diaphragms. The granular endochrome, which is scattered in most of the genera, here unites in the form of a star very similar to the genus *Striatella,* and forms thus the passage from the *Tabellarieæ* to the *Biddulphieæ.*

1st section, Frustules furnished with two diaphragms. *Diatomella, Grammatophora.*

2nd section, Frustules furnished with more than two diaphragms.

*Granular endochrome disposed without order. *Tabellaria, Tetracyclus, Rhabdonema.*

**Granular endochrome radiating from a central point. *Striatella* (Fig. 15).

14th Tribe, BIDDULPHIEÆ.

I unite in this tribe the Anguliferæ and the Biddulphieæ of authors, seeing that they have a common characteristic, the granular endochrome disposed in lines radiating from a central point. The development of the frustules is also the same in every species of these two groups, which thus form one very natural tribe. In most of the species the frustules are furnished with appendices; as to their form, it is most variable. Sometimes the frustules are very irregular, sometimes they affect a geometrical

* 'Synopsis,' vol. ii. p. 16. † Vol. ii. p. 32.

outline with regular angles; but we never meet with the discoid form. The regular polygonal form affected by certain species of Triceratium * reaches to the limit of the discoid form characteristic of the tribe of Coscinodisceæ.

Genera, *Isthmia, Biddulphia, Amphitetras, Triceratium.*

[Professor H. L. Smith unites the two last-named genera with *Biddulphia*, thus getting quit of the absurdity of calling a form with four or more horns a Triceratium. M. Petit's remark that we never meet with a discoid form in this tribe is incorrect. *Biddulphia radiata* (Roper) is truly circular, and in a gathering made by Captain Perry, of Liverpool, *Triceratium orbiculatum* occurred with a circular outline and sub-marginal processes, in fact so like an Auliscus that many specimens were distributed with the MS. name of *Auliscus formosus*; and it was only by the examination of a series of valves of *T. orbiculatum* from various localities that its true generic position was satisfactorily made out. On the other hand, one of the Coscinodisceæ, (a species of Stictodiscus,) is sometimes distinctly triangular.

There is one characteristic which appears to be very constant in the genus Biddulphia, viz. two or more spines placed at right angles to the processes. These spines or setæ may also be detected on several species of Triceratium, but usually placed at the base of the process. In this tribe, Professor H. L. Smith places *Eucampia.* —F. K.]

15th Tribe, Coscinodisceæ (Fig. 27).

In this tribe I comprehend all the genera having discoid valves and granular endochrome except *Cyclotella.* Meanwhile it is probable that further study of the endochrome will result in a division of the tribe. Many of the species are only met with in a fossil state, and those that are living are for the most part found in great depths, which render the study of this group very difficult. The only species I have been able to study whilst living is *Eupodiscus Argus*, and the figure of *Coscinodiscus centralis* Ehr. by M. Max Schultze,† which seem to confirm the hypothesis that all other discoid forms have radiating granules of endochrome. M. Borscow ‡ affirms that the Eupodisci have rudimentary appendages resembling the Biddulphias.

Genera, *Eupodiscus, Coscinodiscus, Actinoptychus, Asteromphalus,* &c.

[I am not satisfied that Diatomaceæ do live at great depths. I have had the opportunity of examining many deep-sea soundings, some of them from depths varying from 1189 to 3103 fathoms, and I have arrived at the conclusion that the forms occurring in them had

* Kitton, 'M. M. J.,' November 1874, p. 219.

† Max Schultze, 'Q. M. J.,' vol. vii., 1859, pl. ii. fig. 13.

‡ Borscow, 'Die Süsswasser Diatomaceen des Südwestlichen Russland.'

ceased to live long before they were deposited on the sea bottom. In some instances it seems probable that the dredge or sounding plummet had brought up a portion of some fossil deposit. One of the 'Challenger' soundings, made, I believe, somewhere in the neighbourhood of Kerguelen's Land (from a depth of 1950 fathoms),* I had an opportunity of examining before it had been acidized, and no traces of endochrome could be detected in the few frustules observed in it. Many of the valves had the abraded and water-worn appearance observable in the fossil Diatomaceæ.

In some soundings made during one of the United States exploring expeditions (from depths varying from 1189 to 3103 fathoms), fragments of *Coscinodiscus Rex* were not uncommon. This is undoubtedly a pelagic species, and was first found in the Indian Ocean by Dr. Wallich.† In one of the 'Challenger' dredgings (2900 fathoms) these remains occur in enormous quantities, and appear like thin plates of silex; they are very hyaline, and marked with small distant radiant puncta which become scattered as they approach the centre. Interspersed with these will be observed a few small nodules. Mixed with the remains of the discs are portions of the connecting zone; on these the punctæ are smaller, closer, and arranged in transverse parallel lines. I detected one of these zones nearly $\frac{1}{5}$ of an inch in length (and then not complete), and $\frac{1}{200}$ of an inch in breadth. The valve to which it belonged would not have been less than $\frac{1}{15}$ of an inch in diameter. In most of these dredgings various species of Asterolampra, Chætoceros, and Rhizosolenia occur, the latter never perfect. It is well known that the two last form a large proportion of oceanic surface gatherings, and are probably the food of Pteropods, &c., which again become the food of various species of whales, and, as their siliceous nature prevents their destruction, they are at last voided with other fæcal matter, and sink to the bottom of the ocean, the larger forms being of course much comminuted.—F. K.]

16th Tribe, Melosireæ (Figs. 28, 29).

The genus Cyclotella (Fig. 28) is composed of species with discoid frustules (? valves), and establishes the relationship of the Coscinodisceæ with the Melosireæ. In this last tribe the granular endochrome is scattered over the internal surface of the frustule; it is this circumstance that distinguishes it from the preceding tribe.

* This material contains many of the species figured by Ehrenberg in his 'Microgeologie.' His samples were collected by Sir James Clarke Ross during his Antarctic expedition in the year 1847. One was from "Pancake Ice," lat. 78° 10′ S., long. 162° W., and the other from the sea bottom (1620 feet), lat. 62° 40′ S., long. 55° W. Ehrenberg's 'Microgeologie,' tafel 35.

† I have had the pleasure of seeing a perfect and authentic specimen of this fine species; it measures $\frac{1}{17}$ of an inch in diameter. I do not think it has been published.

The frustules are discoid (? spherical), elliptical or cylindrical, and are united in pairs or in greater numbers, forming filaments more or less lengthened, thus giving them a pseudo-likeness to Algæ of the family of the Confervaceæ.

Genera, *Cyclotella, Melosira.*

These are the affinities of the tribes, as I understand them. I may add, in concluding the above arrangement of the Diatomaceæ, that it is only a very incomplete essay. However, I shall esteem myself happy if the criticisms of which the system I now propose may become the subject, should be the means of dissipating the obscurity which has so long enveloped the physiological knowledge of the Diatomaceæ.

[It affords me much pleasure in introducing the labours of my friend M. Petit to the readers of this Journal; and although, as he remarks, the essay is incomplete, it will have served a very useful purpose if it induces the diatomist to study the vital portion as well as the "dry bones" of the Diatomaceæ. One very important phase in the life-history of these organisms might perhaps be discovered by patient and continuous observation of the living frustule, viz. the formation of microspores. Their reproduction by means of auxospores and multiplication by self-division has long been known, but the existence of germs has not yet been detected. Their discovery would help to explain the rapid appearance of diatoms in recent rain puddles or amongst the confervoid growths invariably seen on walls and paths in the neighbourhood of leaky rain-water tanks and butts. It would be of the greatest interest to detect if the plasma in the frustule retains its vitality after the frustule becomes dry and itself an impalpable powder, and in this state carried hither and thither by the wind, and when deposited in a suitable nidus germinating.

Dr. Pfitzer quotes with approval Meneghini's observation, "That anatomy has to effect the same useful revolution in the natural classification of diatoms as has been produced in the system and nomenclature of the Conchylia." Unfortunately there is but little for the diatomist to anatomize in the organisms he studies, and that little is so rapidly altered by death, that it appears to me impossible to classify them in accordance with the disposition of the endochrome; we can in a vast number of instances only infer this disposition from the resemblance the dead frustules and valves bear to those which we have been able to study whilst living, thus constructing a system partly natural and partly artificial.

Professor H. L. Smith remarks,* "As for Dr. Pfitzer's classification, I only know it through abstracts published in the journals: that method I long ago tried and abandoned, as he will be obliged to do. With all the enthusiasm of a novice, I fancied here was the key to

* 'M. M. J.,' vol. ix. p. 221.

unlock the mysteries of the diatom world. Alas! the anomalies were so many and the difficulties so great, that I abandoned it in disgust."

Appended to the "System" is a list of Diatomaceæ found by the author in the environs of Paris: these gatherings were mostly made during the cold and wet seasons, viz. in winter and early spring. From this list I select those forms of which M. Petit has given figures and descriptions; a copy of his plate is also added. I may here remark that Fig. 1 *c* is not in the original plate, but has been reproduced from a sketch sent to me by M. Petit.—F. K.]

Cymbella turgida (Greg.) var. β *incisa* Petit. This little variety I have found in only one locality near Marly; it is distinguished from the typical form by slight indentations on the ventral margin (Fig. 2, *a*, *b*).

Navicula firma (Ktz.) var. δ *scoliopleuroides* Petit. This species is remarkable for the disposition of the striæ, which cut the median line obliquely as in the genus *Scoliopleura;* the zone is also obliquely striated, as in the latter genus. Length, 107 μ 8; breadth, 26 μ 4; striæ, 32 in 25 μ. Ermenonville. In a piece of water in the centre of l'île des Peupliers. Tomb of J. J. Rousseau. (Fig. 1.)

[Fig. 1 *c* represents a form of this species identical with Ehrenberg's *N. Iridis*, as found in the Monticello (N. York) subpeat deposit, and which likewise has a similar obliquity of striation. "Var. δ" must be deleted, as I have previously figured a var. δ of *N. firma.** Professor Pfitzer makes a new genus of the *N. firma* group, which he calls *Neidium:* according to him, it differs from the Naviculeæ; first, the endochrome layers are immovable, dividing whilst still on the zone; second, that fission does not take place obliquely, but parallel to the longitudinal axis of the cell.†—F. K.]

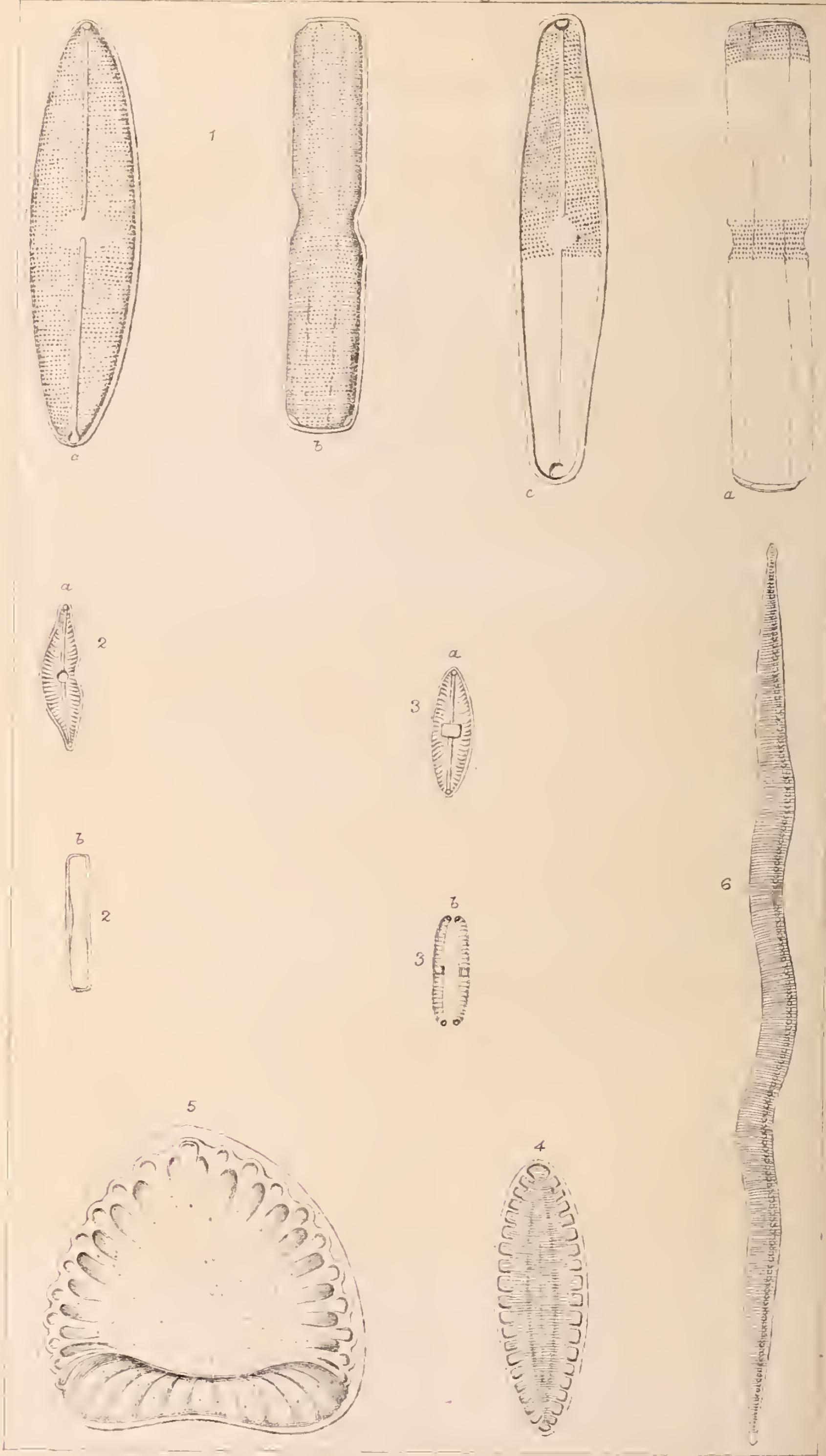
Stauroneis Cohnii Hilse (Fig. 3). [The figure does not agree with Schumann's;‡ his is elliptical lanceolate, apices obtuse and slightly produced, the striæ reaching the median line.—F. K.]

Surirella patella Ktz. Marsh at de Presles. (Fig. 4.) [Probably only a variety of *S. ovalis.*—F. K.]

Campylodiscus noricus (Ehr.) var. β *costatus* (? Grunow). (Fig. 5.)

Nitzschia sigmoidea (Nitz.) var. β *undulata*, n. s. This variety is very abundant in the Marais de Ver. It is distinguished by the undulation of the keel. Length, 22 μ 3; breadth, 8 μ 8; puncta, 14 in 25 μ. (Fig. 6.) [This form is not *var.* β of the 'Synopsis,' which is probably a distinct species and the same as *Synedra spectabilis* Ehr. (*N. spectabilis* Pritchard, p. 72, 4th edit.). The undulations are not confined to the keel, the opposite margin is also

* 'Science-Gossip,' 1867, p. 156. † Pfitzer, *loc. cit.*, p. 39.
‡ 'Die Diatomeen der Hohen Tatra,' pl. iv. fig. 61.



Diatoms found in the environs of Paris

undulate. It is rather an abnormal or distorted condition of *N. sigmoidea* than a true variety. I have seen *N. scalaris* and *N. spectabilis* Ehr. contorted in a precisely similar manner to the French form: the undulations are very irregular; in some specimens they appear on one-half of the valve only, on others they are central.—F. K.]

EXPLANATION OF PLATES CLXXXVII., CLXXXVIII.

Plate CLXXXVII.

Fig. 1.—*Cocconeis pediculus* Ehr. *a*, s. v.; *b*, f. v.
„ 2.—*Achnanthes exilis* Kg.
„ 3.—*Gomphonema constrictum* Ehr. *a*, *b*, f. v.; *c*, s. v.
„ 4.—Schematic section of a *Gomphonema* (after Borscow).
„ 5.— „ „ *Cymbella* (after Pfitzer).
„ 6.—*Cocconema cymbiforme* Ehr. *a*, s. v.; *b*, f. v.
„ 7.—*Navicula viridis* Rab. *a*, s. v.; *b*, s. v.
„ 8.—Schematic section of *Navicula*.
„ 9.— „ „ *Amphipleura pellucida* Kg. (after Borscow).
„ 10.— „ „ *Amphiprora Baltica* Pfitz. (after Pfitzer).
„ 11.— „ „ *Nitzschia palea* Kg. (after Borscow).
„ 12.— „ „ *N. amphioxys* Sm. (after Borscow).
„ 13.— „ „ *N. linearis* Sm.
„ 14.—*Nitzschia acicularis* Kg. (after de Brébisson MSS.).
„ 15.—*N. linearis* Wm. Sm. *a*, s. v.; *b*, f. v.
„ 16.—Schematic section of *Surirella ovalis* (de Brébisson MSS.).
„ 17.—*Cymatopleura solea* W. Sm. *a*, s. v.; *b*, f. v.
„ 18.—*Synedra splendens* Kg. *a*, s. v.; *b*, f. v.
„ 19.—Schematic section of a *Synedra*.
„ 20.—*Himantidium pectinale* Kg. *a*, s. v.; *b*, f. v. (after de Brébisson MSS.).
„ 21.—*Diatoma vulgare*. *a*, s. v.; *b*, f. v.
„ 22.—*Meridion circulare* Ralfs. *a*, s. v.; *b*, f. v.
„ 23.—*Podosphenia Lyngbyei* Kg. (after de Brébisson MSS.).
„ 24.—*Grammatophora marina* Kg. (after W. Smith).
„ 25.—*Striatella unipunctata* Lyrig.
„ 26.—*Amphitetras antediluviana* Ehr. (after W. Smith).
„ 27.—*Coscinodiscus centralis* Ehr. (after Schultze, 'Q. M. J.' vol. v. 1859).
„ 28.—*Cyclotella operculata* Kg. *a*, s. v.; *b*, f. v.
„ 29.—*Melosira varians* Ag.
„ 30.—*Amphiprora paludosa* W. Sm. (after W. Smith).

Plate CLXXXVIII.

Fig. 1.—*a*, *b*, *Navicula firma* Kg., var. *scoliopleuroides*, nov. var.; *c*, ditto.
„ 2.—*a*, *b*, *Cymbella turgida* Greg., var. *excisa*, nov. var.
„ 3.—*a*, *b*, *Stauroneis Cohnii* Hilse.
„ 4.—*Surirella patella* Kg.
„ 5.—*Campylodiscus noricus* Ehr., var. *β. costatus forma.*
„ 6.—*Nitzschia sigmoidea* Nitz., var. *undulata*, nov. var.

All the figures on this plate are enlarged 600 diameters.

Correction to previous paper.

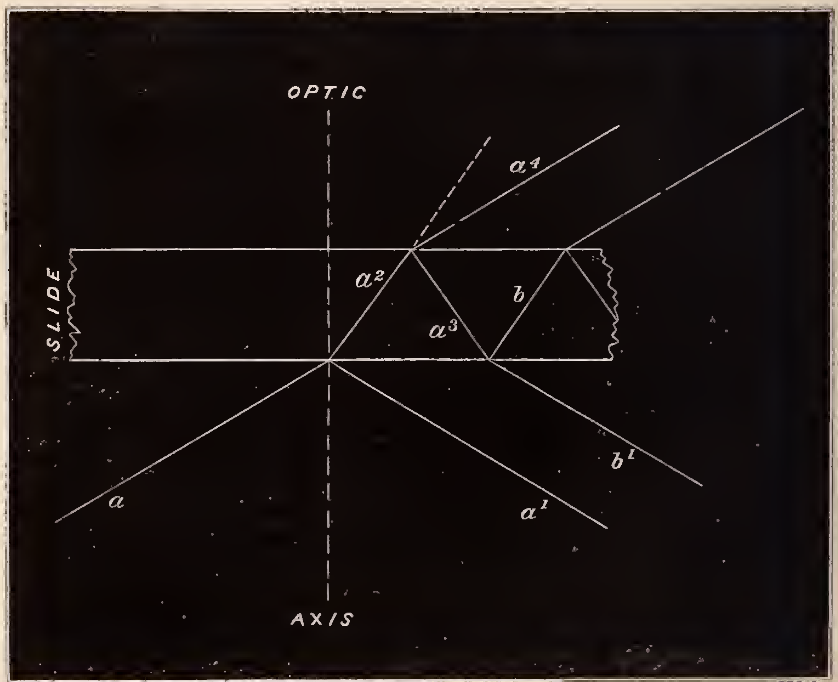
Page 10, line 13 from top, insert bracket after "Ralfs."

III.—*Note on a New Paraboloid Illuminator for use beneath the Microscope Stage. Also Note on the Resolution of Podura Scale by means of the New Paraboloid.*

By James Edmunds, M.D., M.R.C.P. Lond., &c.

(*Taken as read before the* Royal Microscopical Society.)

The glass paraboloid, known as Mr. Wenham's, is so useful an accessory that no microscope is complete without it; and, for dark-ground illumination, with dry-front objectives up to a considerable angle of aperture, the results are excellent. But with high powers of large angular aperture and with immersion fronts, the Wenham paraboloid introduces fog, while it fails to give a dark background. That these radical defects are inseparable, not merely from the Wenham paraboloid, but also from all our present contrivances for oblique sub-stage illumination, will be obvious to everyone on considering the following diagram.



Assuming that, by means of Wenham's paraboloid, a long focus objective, or other contrivance, a pencil of light be successfully thrown upon the under surface of the slide at an angle of 60°

from the optic axis, we get the following results. The ray a is in large part reflected from the under surface of the slide, as a 1, and the proportional magnitude of a 1 will increase in a great ratio as the obliquity of a itself augments. The reflected ray a 1 falls into the spherical hollow of the paraboloid, or upon sub-stage fittings, and in considerable part is reflected back into the slide at low angles. a 1, therefore, is not merely lost, it is detrimental by fogging the illumination. a 2, on entering the slide, undergoes refraction, and, assuming a low index for the slide (1·5), it will be seen by a simple geometrical construction or by reference to the table of sines that it reaches the upper surface of the slide with its obliquity reduced to about 35°. Its achromatism also will be damaged in proportion to the thickness of the slide. At the upper surface of the slide a 2 undergoes a second division into a 3 and a 4, a 3 being reflected back in the slide to its lower surface, where it splits into b and b 1. b 1 passes out below, falls upon the sub-stage fittings, and, in part, returns into the slide at low angles to add to the detrimental effects of a 1. b goes on repeating the results produced by a 2, and at each cycle in its course, throws a ghost image into the field.

Returning now to the remainder of the original pencil a 4, it will be seen that it passes out through the upper surface of the slide; and the ray, thus reduced in obliquity, weakened in power, and damaged in colour, enters any object which is optically continuous with the slide. Otherwise the ray undergoes a second refraction, and strikes the object or cover-glass at the original angle of 60°. Thus in any case the ray which enters the object is enormously weakened in power, and is more or less chromatized, while the illumination of the field is damaged with fog and with ghost images. And if the obliquity of the original pencil be made greater than 60°, the drawbacks all increase in a great ratio.

While working at difficult objects with high powers, it seemed to me that all these disadvantages might be got rid of, and our command of oblique sub-stage illumination made perfect by the new paraboloid of which I now submit a description, and which, having been constructed for me by Messrs. Powell and Lealand, has fully answered the expectations which were raised by optical and geometrical considerations.

A paraboloid lens of glass, free from veins and from colour, and of the lowest obtainable refractive index, is made. The apex of the lens is cut off at a point, one-twelfth of an inch below its *latus rectum* or internal focus. The whole surface is brought to an optical polish. The lens is set with its base left clear as far as possible, and with a flat shoulder projecting about one-fiftieth of an inch below its face, so that diaphragms may be adjusted to work against this shoulder, close beneath the base of the lens, without abrading its surface. By an arrangement which it would be difficult to make clear without diagrams, any combination from a set of central disks, peripheral zones, and revolving shutters can be so placed beneath the lens, as to admit light in any or every azimuth, and at any or every angle, and the light may come through a stage of any depth, from a simple plane mirror. In short, a splendid pencil of pure unrefracted light may be easily converged upon an object placed at the focus of the lens, if only the object be made optically continuous with it by means of a fluid or cement which is optically homogeneous with the lens.

If the lens be adjusted with a central disk stopping out from its base only such light as would pass directly through the upper plane surface, and sunlight be thrown up, the action of the lens is demonstrated with great splendour. The plane top throws back all the light by total reflection, and remains itself perfectly black, when viewed from above. But, if there be dust resting upon the plane, each particle becomes brilliantly luminous where the light from beneath impinges, and if, for the purpose of demonstration, the top be smeared with wax, or have tissue paper gummed on to it, there is seen a brilliant circle of light surrounding a sharply defined central black disk, about a fourth of an inch in diameter.

On placing upon the top of the lens a plate-glass slide one-sixteenth of an inch thick—fine tissue paper having been gummed on to the upper surface, and a drop of glycerine used below to cement the slide to the paraboloid—a central focus of intense white light is seen on the tissue paper. On lowering the paraboloid, but not sufficiently to separate the film of glycerine, this brilliant focus spreads into a small circle with a central black spot—the tissue paper having been raised above the focal point. If in place of the tissue paper there be cemented on to the slide a hemisphere of glass, and, by the stage movements, the centre of the plane surface of the hemisphere be located at the focus of the paraboloid, then all the light which reaches the focus diverges again and passes out through the hemispherical surface at a few degrees above the horizon without refraction. Here, while the eye in every azimuth at that angle receives a brilliant picture of the sun, no light whatever is received by the upper portion of the hemisphere. If the optical continuity between the slide and the paraboloid be broken by lowering the paraboloid until the film of glycerine be separated, the image of the sun instantly disappears, all the light being then thrown back out of the base of the paraboloid.

I find that the glycerine film makes the slide optically continuous with the top of the paraboloid, and at the same time acts as a perfect lubricant, allowing the slide to travel over its surface in any direction as if it were perfectly free, and without damaging its optical continuity with the lens. By lowering or raising the lens also the film of glycerine may be so far thickened or thinned out, as to give ample range of focal distance between the reflecting surface of the paraboloid and the object. Thus, by very simple management, an object under Powell and Lealand's twenty-fifth, sixteenth, or new immersion eighth of 140°, may be bathed in light until it glows with luminous radiance upon a perfectly black background. By slight alterations in focussing, or in centring the paraboloid, the light upon the object may be made converging or diverging, or it may be instantly extinguished. By extremely small inclinations of the plane mirror beneath, the paraboloid is made to act as a powerful prism, and the object may be bathed with a pure broad band of monochrome, from black-red through a brilliant luminous green, on to blue, and black-violet.

Amphipleura pellucida, in this pure white light, shows like a transparent three-edged file floating in black space and glowing with its own radiance. On slightly inclining the mirror, the diatom becomes black-red or disappears. On the tenderest possible further alteration of the mirror, the diatom stands out as luminous as before, but in splendid green with its cross-markings in black; as the inclination of the mirror is increased, the diatom becomes pure blue, then violet and hazy, and then again invisible. On slowly restoring the mirror to its original position, the diatom travels backwards through the same phases, but its cross-markings only come out well between the bright blue and the low green, and they are most distinct where the low blue merges into splendid green. Other objects such as *Navicula rhomboides*, which are in themselves prismatic, of course add their *quota* to the grand play of colours produced by the prismatic action of the parabolic lens. Such objects as give coloured images from illumination by pure white light may generally be viewed in red, green, or blue separately, by inclining the mirror or by focussing the objective. Taking the pure luminous green as the best image, the red comes out on shortening the focus of the objective, the blue on lengthening it. Moreover, these prismatic images, and the well-known diffraction bands, may be developed so splendidly by the paraboloid, that their images will probably become as useful for the measurement of extremely delicate objects in the field of the microscope, as Newton's rings have proved elsewhere for calculating magnitudes infinitely too small for mechanical measurement.

Bacterial fluids have been the despair of microscopists. Under the best modern immersion objectives, many important specimens give only a foggy, impenetrable field, in which dim spheroidal forms start into view only to fade out again and be lost in fog. If the new paraboloid, tipped with glycerine, be inserted into the substage, and gently racked up until its glycerine suffuses the under surface of the slide and spreads out so as to render the lens and the slide optically continuous, we get a new view of bacterial fluid. On looking into the microscope, the field is seen—clear as a glass tank in which thousands of minute fish are disporting themselves. Just as, in the heavens, a mass of nebula is resolved by the great reflector into a universe of stars, so, in the field of the microscope, an unweighable particle of foggy fluid is transformed by this paraboloid illuminator into a limpid pool tenanted by myriads of atomies. These atomies, if they have any theories of the future, must be thinking that a final conflagration of the universe has commenced. Observers may watch them as, on a summer evening, with soft white clouds behind and pure sky in front, boys look into a clear pool and see the life of the frogs and the minnows. Immeasurable in their minuteness, these atomies gyrate upon the field, and from point to point they urge their way with vast activity. Some of them appear like winged creatures, others are furnished with whorls of cilia, and some are seen as amœboid masses lazily digesting particles of solid matter.

Blood and saliva also may be seen as new objects. If fresh transparent blood-serum with a few corpuscles shaken out of the edge of the clot be viewed, the serum is seen filled with a nebulous haze of points, as is mote-laden air in a sunbeam or in the electric light. Isolated corpuscles appear as lenticular or flattened spheroidal masses of pale red amœboid matter. Other corpuscles have massed themselves into large rouleaux—not nummiform, but like rouleaux of dried figs—their exterior outlines showing as if their whole surface were self-luminous, the septa persisting and the corpuscles being easily separable. On pressure, the corpuscles fuse into large amœboid masses, and may be again broken up into corpuscles of various sizes, some small, some large, but not otherwise distinguishable from the original corpuscles. It may be that blood-corpuscles are formed mechanically by the capillaries through which the blood with its amœboid matter is continually being lashed, and that their continual re-coalescence is prevented by some modification of their exterior which is produced by the action of the serum. If this be so, the size of the corpuscles in various animals will prove to be a measure, in some simple ratio, of the calibre of their capillaries. I have just examined some blood taken from a gentleman dying of malignant pustule of the upper lip, and for whose treatment I have met Dr. Gomer Davies, of Bayswater, several days in consultation. The blood was drawn by myself twelve hours before death from a puncture in the cheek near the local disease, and was venous in colour. The tube was of Bohemian glass, heated to redness in a Bunsen burner, then drawn out and hermetically sealed. The points were broken off immediately before drawing the blood up into it, and were again at once hermetically sealed. Six hours afterwards I broke open the tube and examined the serum with some loose corpuscles. Upon this specimen I have based the description given above. I regret that, owing to the absence of sunlight at the critical time, and my own want of a heliostat, I could not get light enough to define the character of the nebulous points in the serum, or to determine the question as to their motility. Certainly, however, this serum contained no moving forms such as would ordinarily be recognized as Bacteria. The serum was quite free from that mere chylous milkiness often seen in blood drawn soon after a full meal.

Salivary corpuscles show up magnificently as spheroids of all sizes floating in a sky intrinsically dark, but lighted up by tracts of "milky way," and flecked with masses of heavy greyish-white cloud. The corpuscles, instead of being distorted by foreshortening into mere disks, appear as self-luminous spheroids, like moons, their nucleolar matter distinctly visible inside the sphere, and each one giving an image free from distortion by its own lenticular action on transmitted light. The "milky way" is like the opaline haze of the blood-serum, but not uniformly diffused through the field, and consisting of spheroidal particles rather than points, some of the spheruloids approaching in size and character to the corpuscles which alone are ordinarily seen. The heavy clouds are "epithelial scales," appearing, however, not as scales, but rather as irregular dodecahedral masses, and each one revealing from within a microcosm of its own.

In using a balsamed object with a very fine dry sixteenth by Powell and Lealand, no light whatever comes up through the cover except that which is seen in the microscope by the radiance of the object itself—the background remaining a soft black. With their new immersion eighth or sixteenth the appearance in the microscope is exactly the same, but the drop of water before the lens glows with horizontal radiance so as to become a sparkling and conspicuous object at many paces distance.

The first lens made for me by Messrs. Powell and Lealand was cut so perfectly as to answer exactly to the theory of its design. But this lens being calculated for a slide one-sixteenth of an inch in thickness, of course only gives light up to an angle of about 80°—a large belt of surface below the *latus rectum* having been cut away. These gentlemen are now making for me a second lens with the apex cut off at a point only one-fiftieth of an inch below its *latus rectum*, and, with such a lens, objects may be illuminated with light nearly up to their own horizon. But the mounting must be such that the object with its vehicle, slide, and subjacent film of glycerine, must come within the thickness of one-hundredth of an inch so as to allow a second hundredth of an inch in vertical sub-stage movements, for the purpose of altering the focus of the paraboloid when it requires to be exactly centred to the optic axis. If light beyond this angle be required, a third lens may be constructed with its apex cut off just below the *latus rectum*, and, upon the face of such a lens, a particular object may be set in glycerine or balsam, or may be merely attached to the surface. By stopping out light from the base with a central disk equal in size to the top plane, *plus* a peripheral zone, wide enough to stop out all rays which will not reach the focus at a sufficient angle, it is clear that an object may be drenched with unrefracted light converging upon it at practically 90°, and from as large an arc of its own horizon as may be determined by the use or disuse of the revolving shutters beneath. By cutting off the apex between the *latus rectum* and the *vertex*, then turning out through the top plane a lenticular cavity—its surface being a portion of a small sphere, and its centre of curvature located at the focus of the paraboloid—pure unrefracted light, considerably beyond the angle of 90° even, may be converged upon an object set near to the focus. The cavity may be occupied by gelatine, balsam, water, castor oil, or other medium in which it is desired to set the object, the refractive index of the medium being of no consequence in this construction; and a very high power might be brought to bear upon an object carefully set for a special investigation if covered with a small disk of thin glass. Or an object uncovered, or dry, might be supported near the focus of the paraboloid by a loose wad of curled hair or other material, the image of which would not blend with that of a delicate object. Possibly, by such a paraboloid, the illumination of an object may be made to reach the point where it could be taken up from above the stage by a fine parabolic Lieberkuhn or other reflecting appendage to the objective. Four such lenses would form an exhaustive series, and only one set of diaphragms and sub-stage tubing would be needed.

It is important that the glass of the lens be of very low refractive index, and that the optical media between its top plane and the object be as nearly as possible of the same refractive index as the lens—otherwise in using light at nearly 90° from the optic axis of the microscope slight differences in refractive power between the paraboloid, the cementing fluid, and the slide will come into play at the junction surfaces and deteriorate the illumination.

I fear lest in submitting this description I have occupied too much space. But I find, practically, that these new paraboloids go as far beyond the Wenham paraboloid as the Wenham paraboloid goes beyond the spot lens. In amount of light, in purity of colour, in freedom from fog and from ghost images, in range of azimuth and of angle, and in mechanical adaptability to every microscope, they are unexceptionable. They fill a gap in our illuminating appliances which, of late years, has been increasingly felt, and they lift the microscopic objective to a new level. They are, moreover, if well made, as manageable in practical work as they are perfect in optical principle. So far as I am aware, no previous appliance has ever converged upon an object unrefracted high-angled all-round light, so as to make it appear in the field of our best modern immersion-objectives as a brilliant shadowless picture floating in black space, like a star in the field of the reflecting telescope. In any case, those who have more time and ability than myself for microscopic manipulation will give to this appliance such welcome and development as it may deserve.

Note II. On the Resolution of Podura Scale by means of a New Paraboloid Illuminator.

By James Edmunds, M.D., M.R.C.P. Lond., &c.

(*Taken as read before the* Royal Microscopical Society.)

I have a large and finely marked Podura scale mounted upon an ordinary slide, and covered with ·003 glass. Placing this upon the new paraboloid, I find that by the aid of Powell and Lealand's twenty-fifth, sixteenth, and new immersion-eighth—working the scale up to about 2500 diameters under careful illumination from a white sunny cloud—the markings are, at various stages of the amplification, resolved into beautiful plumules or featherlets which appear to be exactly analogous to the scales upon the wing of a moth or butterfly. Each plumule stands out distinctly in fine definition, and is beautifully lighted up all round as if from above, while one looks down between the plumules on to a blue-black hyaline membrane from which the plumules spring—all the rest of the field being bistre-black. One can also see that the serrated margin of the scale is due to the overlapping of the ends of the plumules. This test-scale measures nearly the $\frac{1}{400}$ inch in extreme breadth, and fully the $\frac{1}{125}$ inch in length without the pedicle. The "test-scales" only differ from the other scales in that the featherlets are more finely developed, and I find that I can show the featherlets on almost all the scales irrespective of size. The rounded ones have their featherlets more like hairs, and they are often disposed in a vorticose manner, whereas the elongated test-scales have fully developed featherlets mostly disposed in a direction parallel to the long axis of the scale, and therefore not shadowing each other so much in the picture formed by transmitted light.

At one or two points where my scale has been blistered by the focus of the paraboloid, or has in some other way been damaged while under this work, the bare membrane of the scale can be seen, and on the black field some torn-off plumules may be distinguished. When I first observed the abraded portions of the scale, it appeared to me that there had been actual vesication, and that steam, formed in the scale, had raised a very delicate membrane, carrying up with it the plumules from the substance of the scale, much as a piece of blistered cuticle carries up fine hairs from the cutis off which it is raised. The "lined and beaded appearance" is produced by the running together of the images of the plumules when the glass is imperfectly focussed, or the light is badly thrown. The plumules only come out when they are softly illuminated all round and appear as if lighted from above, and when only a very slight glare is allowed to show at one part of the field, i. e. just beyond the free end of the scale. Under the same glasses, by ordinary central-light illumination with Powell and Lealand's new condenser, the substance of this scale is transparent, and the featherlets appear rounded out into fine "exclamation notes," as shown in Mr. Beck's well-known drawing and in Colonel Woodward's photograph.

Careful measurement of some large detached featherlets by means of Powell and Lealand's beautiful cobweb micrometer showed them to be about $\frac{1}{5000}$ inch in length and $\frac{1}{20000}$ inch in breadth.

IV.—*The Development of the Ovum.*

By W. H. Dallinger, V.P.R.M.S., and J. Drysdale, M.D.*

Few subjects can be more important in their bearing on biology than the more prominent of those considered in this volume. It now rests on a morphological basis which will never be shaken, that there has been a procession of the most complex animal forms from simpler and still simpler ones, until we reach eventually the ultimate of organized simplicity. There may be difficulties in the way, but they are as nothing to the overwhelming evidence which morphology provides in its support; doubt, indeed, is no longer possible; and every year diminishes the circumscribed area of difficulty. But our knowledge hitherto of the developmental processes which take place in the earlier states of the simplest elementary organisms is wholly incompetent. Much labour has been expended, and doubtless good work has been done; but as it at present stands, it is conflicting, crude, and essentially wanting in coincidence and correlation. The work † before us is the result of an attempt on

* This paper appeared as a review in 'Nature,' July 5 and 12. It seems worthy of a place in our pages as an original contribution to a certain extent.

† 'Bütschli on the Earliest Developmental Processes of the Ovum, and on the Conjugation of Infusoria.' ('Studien über die ersten Entwicklungsvorgänge der Eizelle, die Zelltheilung und die Conjugation der Infusorien.' Von O. Bütschli. Frankfurt, 1876.)

the part of its author to penetrate farther into the matter than his predecessors, and by completer knowledge to harmonize or explain away conflicting evidence and doubtful interpretation, and if possible to give a sequence to the morphological processes in the simplest ova, and in the least apparently organized of animal forms.

From the smallness of the space at our disposal all consideration of the second subject discussed in this volume must be passed over. It deals with cell and nucleus fission generally; but as it is chiefly theoretical, we may the more readily omit it, merely remarking that the author concludes that there is a fundamental harmony in the method of fission in the cells of both animals and plants; a conclusion which it may be fair generally to admit; but in the minute detail, only discoverable by prolonged research, there will be found palpable differences.

That which gives distinction, and to some extent importance to the book, is (1) its minute and practical investigation into the earliest changes effected by development in the ova of some of the more lowly organized animal forms; and (2) the abundance of data which it appears to provide for the support of a new theory of propagation amongst the Infusoria, which Bütschli propounds and advocates.

The embryological researches under the first head were conducted principally upon the ova of the Nematoid worms and the Rotifers. To a limited extent the living egg was studied; but the greater part of the results are derived from investigations of the ova treated with acetic acid. This is greatly to be regretted. The difficulties which present themselves in the minute examination of such ova in the living condition, are doubtless great, indeed complete results could scarcely be obtained from this alone. But undoubtedly the continuous examination of a set of living ova in process of development should be carried on simultaneously with every method of treatment which will reveal structure and change in ova of the same form in the dead condition. Only in this way can every possible mutation be traced, and its correlation and sequence be established.

It is extremely difficult to distinguish even striking discoveries in this direction from the manifold claims put forward by the many observers. We must state generally the facts as they at present appear, and seek to indicate the points specially claimed as new by Bütschli. It is now well known that the ovum is not suddenly formed, and then stimulated into new activity by fertilization. It evidently, in its very lowliest condition, goes through a process of internal growth and development; after which apparently it perishes unless fecundated. In 1864 Balbiani endeavoured to prove that besides the *germinal vesicle*, there existed one still more important, which he called the embryogenic cell or vesicle in the ovarian ovum; and it was held by leading embryologists that it was round this cell that the true embryo was constituted; but in what manner, each observer appears to have determined for himself. The disappearance of what was accepted as the germinal vesicle was generally agreed to; but whether before or after impregnation was never fully determined. That it merely retrograded to the centre and determined segmentation as the result of fecundation, was held by many; while the embryogenic vesicle was said to persist, and from it were derived the now celebrated "globules polaires," or "Richtungsbläschen," which had been variously called by different writers from Carus downwards "white vesicles," "round vesicles," "clear globules," and so forth, and which are now thought to enter directly into the genital organs of the future being; Balbiani considering them of much importance in the evolution, inasmuch as they are found just in the region of the ventral layer of the blastoderm where the genital organs appear.

We have only space for a consideration of one of the instances adduced by Bütschli of earliest ovum development; but that may suffice to indicate the distinctive nature of his work. We select the eggs of *Nephelis vulgaris*. In their youngest state, the yolk is retracted from the delicate membrane, and there is, resting on the yolk, a minute mound of spermatozoa. At a little distance from this spermatozoal eminence there is an eccentrically placed spindle-shaped body, composed of fine longitudinal fibres, which at the equator of the spindle are swollen to a thick shining granular zone. The yolk mass is depressed at one point, and the spindle has its long axis directed to that of the flattened yolk. At the ends of this body there are clear homogeneous spots, from which rays go forth in all directions through the yolk. This spindle-shaped body Bütschli affirms to be the true *germinal vesicle;* and it is this which is carried upward to the surface of the yolk, by the elevation of the upper set of rays proceeding from the homogeneous spot over its upper apex, until eventually this spindle is pushed out of the yolk in three segments. In the part first protruded fine granules appear, and these retain their connection with the fibres in the part still enclosed in the yolk, by fine filaments, which also terminate in a zone of granules. This protruded vesicle is the "Richtungsbläschen"; the real place and relation of which, in the subsequent development of the egg, is nowhere determined by these researches. In the stage of partial protrusion of this vesicle, at about a quadrant from the point of its exit, another clear space arises sending out its radial rays; this enlarges, moves to the centre, and the germinal vesicle—now the "Richtungsbläschen"—is at this time quite protruded. At a point in the yolk determined by the point of exit of the "Richtungsbläschen," two minute nuclei appear, one in the upper margin of the clear space, and the other between that and the point of exit of the said vesicle. They are at first entirely disconnected, and both, by treatment with acetic acid, prove to be true nuclei. But they soon unite in the clear spot or space, and, at its expense, rapidly grow. They become a perfect nucleus with a distinct envelope and fluid contents, and distributed within the latter are dark granules. While these processes have been taking place, two of the three segments of the "Richtungsbläschen" have again united, and at the same time the transformation of the nucleus begins. At two points on opposite sides of the nucleus, and in the direction of the long axis of the yolk, there arise clear spots and their accompanying rays. Between these, the nucleus differentiates itself into long fibres, and becomes a spindle-shaped body exactly like the germinal vesicle. An equatorial zone arises in it which is called a nuclear band (kernplatte), which now divides; and each half recedes to the opposite ends of the spindle-like body. These ends now lose their points and become rounded, and in the mean time occurs the furrowing or constriction of the yolk. Another equatorial band arises in the nucleus or spindle, and when the constriction of the yolk is half accomplished the formation of nuclei of the second generation takes place from the ends of the spindle, these being nuclei in the completest sense. These fuse together and grow at the expense of the clear space—the growth of the nuclei and the diminution of these homogeneous spaces being in all cases correlative. When these nuclei are developed, both hemispheres of the yolk collapse, and an almost spherical shape is again resumed.

What became of the fibres of the spindle was never discovered, but about this time the remaining segments of the "Richtungsbläschen" reunite, and in it a system of fibres appears. The following fission processes are but repetitions of this.

It becomes from the above apparent that Bütschli takes it for granted, first, that the eggs studied had been subject to no earlier developmental changes than those with which he starts. Next, that there can be no question as to the identity of his "spindle-formed body" and the germinal vesicle. He further at first claimed the extrusion of this germinal vesicle as the "Richtungsbläschen," as a sole result of the stimulus of impregnation; and ventures to consider that the process of nucleus formation described is widely diffused in the animal world, and that it is probably universal in impregnated eggs.

But (1) there is not the remotest evidence to show that processes of considerable import may not have preceded the condition with which these investigations started; complex processes are still known to occur in the unimpregnated ovum. We have only indeed to turn to the next example given by Bütschli himself to prove all this. In *Cuculanus elegans* the ovum leaves the ovarium without an envelope; and within the yolk is seen the "large *round* germinal vesicle and the germinal spot." The latter vanishes after impregnation, and the germinal vesicle becomes eccentric—and the next thing we are told is that "the germinal vesicle was no longer in the yolk, but *instead of it* there was a spindle-shaped something like that seen in Nephelis." How was the change effected? What were the steps? The transition is all-important, but how it happened is not worked out; and it would be, in so important a question, a matter of the greatest interest to know *how* the perfect spindle-formed body, with which these observations begin, arose. Nothing final can issue in this inquiry until, from first to last, every process and every step therein has been consecutively made out.

(2) The identity of this body with what is known as the germinal vesicle is certainly probable, but by no means certain, at present. It is certainly true that this supposition derives considerable support from the fact that Ratzel found that in the ripe ova of *Tubijex*, prior to laying, the spherical germinal vesicle lost its spherical shape, elongated, became spindle-shaped with a meridional striation, and so forth, closely resembling the nuclear spindle of *Nephelis*. But as the process is described by Bütschli this would involve the necessity that the *whole* of the germinal vesicle was extruded as the "Richtungsbläschen" in every case. Against this, however, there are irresistible facts; and in an appendix to the volume the author is bound in some sense to admit that there are cases where "a part of the germinal vesicle may remain." If this be so, evidently there is missing a link in the chain of observation. Difficulties of an equally complex character present themselves in the collation of these researches with those of other distinguished embryologists which it would be hopeless even to attempt to consider here.

(3) That the expulsion of the "Richtungsbläschen" is a result of impregnation must also be abandoned. In the text of this treatise the author earnestly contends for this point nevertheless; and endeavours to dispel the force of the very definite results of Œllacher, Bischoff, Flemming, and Beneden. But these are points that may be settled with comparative ease, and it certainly is true that the expulsion of the "Richtungsbläschen" may show itself as one of the earliest phenomena of development in the unfertilized egg. This is now admitted, and in the appendix is allowed by Bütschli.

(4) The universal application of the method of development seen in *Nephelis*, although strongly contended for, and carried by analogy into the interpretation of the theory advanced in the third part of the volume to account for the propagation of Infusoria, can only be admitted with the utmost caution. The evidence given by the author is by no means perfect. In *Cucullanus elegans*, for

example, he admits that the transition of the nucleus spindle into the "Richtungsbläschen" cannot be made out as in *Nephelis*, but contends that it *ought not to be doubted.* And precisely the same difficulty attaches to the transformations of the nucleus, of which "nothing could be certainly found;" yet the same doctrine is carried over, as though precisely the same phenomena had been witnessed as in *Nephelis.* So in relation to other Nematoids, it is rather inference than evidence that the protruded vesicle is the germinal vesicle, as in *Nephelis.* So in *Limnæus auricularis*, essential points in the original and subsequent evolution of the spindle and nuclei are presented, not as the result of observation, but of inference, and a leap across a chasm between two preparations of the ovum which show no continuity of evolution, is taken with an assurance that "doubtless," although the intermediate process was not made out, we might be guided by the analogy of *Nephelis.*

These facts are pointed out, not in the slightest degree to detract from the value of the author's observations, but simply to separate them, as such, from the inferences he draws from them. There can be little doubt that great value belongs to the discovery of the nucleus spindle and its behaviour in evolution; and there can also be little question that it is largely original research; but its relation to anterior and subsequent processes is not so definitely discovered. It is nevertheless a source of great interest to find that Balbiani has given such complete and recent confirmation to the main characteristics of the spindle nucleus.* It is true that he does not confirm the division of the equatorial band in the nucleus, and claims to have shown the existence of the clear spaces and rayings accompanying the nucleus transformations in the eggs of spiders four years before. But evidently a step is gained by these observations on the earliest development of the ovum; although, from the careful work of M. Fol, it is clear that not only the interpretation, but the detail, may be open to question.†

Coming now to the large and important question of the *Conjugation of Infusoria*, its nature and bearing upon the life-history of the forms, we are bound to state at once our conviction of the inefficiency of the observations recorded on account of their discontinuity. Nothing but a close and continuous observation of the same forms extending over an entire life cycle, repeated again and again, can lead to absolute results. Errors fatal to the interests of truth inevitably arise, when minute organic forms are studied, not by continuous watching, but from inferences made from the phe-

* "Sur les Phénomènes de la Division du Noyau Cellulaire," 'Comptes Rendus,' Oct. 30, 1876.

† "Sur les Phénomènes Intimes de la Division Cellulaire," 'Comptes Rendus,' Oct. 2, 1876.

nomena manifest at different periods, the intervals between which are blank. Further, whilst the use of reagents on the dead forms taken at various stages is of the utmost value, when they are examined side by side with continuous observation on the living form, these may be not only not instructive, but misleading when taken by themselves.

Bütschli's observations are numerous and interesting, but their value will be best estimated by understanding briefly the nature of the hypothesis they are declared by their author to indicate. Put in its shortest form, it is that conjugation amongst the Infusoria is simply a *rejuvenescence* of the creatures which undergo it, enabling them to become "the stem ancestors of a series of generations" which propagate by fission. As yet the process of rejuvenescence has had, in biology, a limited application, being noticed in the formation of the swarm-spores of Œdogonium and other of the lowliest plants; but its connection with sexual reproduction is not clear, as no union of different elements has been made out, and it is by no means certain that the whole process of reproduction is exhausted by it. When, however, it is combined with conjugation, as in the Bacillariaceæ, it becomes plainer; although, so far as is known at present, it by no means follows that the whole generative process in these forms is known; but it is to the *Auxospores* by which rejuvenescence is secured in these forms that Bütschli appeals for the support of his theory of infusorial conjugation. Pfitzer and Schmitz have made what are at present the most complete observations of the phenomena in question; from which we learn that the customary mode of reproduction is by fission, but at each repetition the individuals dwindle in size, until they can apparently go no farther,* then the conjugation of two individuals takes place, the formation of auxospores being the result, that is to say rejuvenated individuals; and from these a new departure of fissiparous generations takes place, well observed by Schmitz in the case of *Cocconema cistula.* There is no coalescence; the frustules simply lay themselves parallel to one another, they become surrounded by a common envelope of mucus; the protoplasm of the cells comes into contact, each frustule grows larger and becomes an auxospore. What the influence is which these frustules exert upon each other is wholly unknown; but that it

* It is impossible not to notice here the extremely interesting and certainly somewhat remarkable paper of Dr. Wallich in the February number of the 'Monthly Microscopical Journal' for 1877, "On the Relation between the Development, Reproduction, and Markings of the Diatomaceæ;" for in this paper what is apparently the *auxospore* of Pfitzer and Schmitz is called the *sporangial frustule.* But this, instead of having dwindled in size before conjugation, appears to have become enormous in proportion, and within this the "new parents of the race arise," and from the conjugation of *these* the new forms spring as daughter frustules.

has a real existence is shown in the result; each auxospore forming a stem ancestor of a new series.

This is what Bütschli extends to the Infusoria, and contrary to the interpretations of Balbiani, Stein, and others, maintains that the act of conjugation so well known amongst the Paramæcia, Vorticellæ, &c., is not a precursor of sexual products, but simply a means by which these forms, exhausted by continued fission, become more highly vitalized and rejuvenated, and again enter upon the process of fissiparous multiplication, which indeed becomes thus their only method of increase.

It should be noted that on the whole the facts adduced by Balbiani and Stein are admitted, but they are submitted to a wholly different interpretation; and it is specially insisted on that the forms that go into the conjugation state are of a minimum size; which fact Balbiani explains as the result of a special development for sexual purposes, but this is disallowed by Bütschli, who insists that it results from exhaustion of vitality at the terminus of a series of fissiparous multiplications. Indeed, these weakened and minimized forms unite in conjugation and are neither absorbed into each other nor produce embryos, but increase in size and vitality, separate, and commence again the fission by which alone increase is effected.

The truth of this is insisted on as deriving strong support from some of the very remarkable external changes which the author has seen certain of the Infusoria undergo. In *Euplotes* and *Oxytrichineæ* a great part of the *ciliary system* is said to perish towards the end of conjugation; and afterwards, when separation takes place, to be again renewed. In *Colpidium colpoda* the entire mouth was lost in conjugation, but was renewed again after separation. So in *Bursaria truncatella*, the conjugated animals, it is affirmed, lose entirely the complex apparatus of the peristoma, which by a new growth after conjugation is restored. So also there is declared to be a complete rejuvenescence of the more important internal parts. The "secondary nucleus" in *Stylonichia mytilus*, and in *Blepharisma laterita* and *Colpidium colpoda* the old nucleus is said to be eliminated and a new one formed. In others, part of the nucleus is thrown off, and part renewed; in others a new nucleus formed and coalesced with the old one. From these and similar observations it is inferred that the "essence of conjugation consists in the rejuvenescence of both the individuals;" and that this is chiefly centred in the "secondary nucleus" which is declared to be of the utmost importance in the life of the creature.

During the process of conjugation, also, the plasma contents of the individuals have been seen to interchange; this especially in *Oxytrichineæ*, but also in other Infusoria.

Against Balbiani's hypothesis—that the nucleus is the ovarium and the nucleolus the testis, containing spermatic elements—Bütschli affirms that in *P. aurelia* and *P. colpoda* the supposed spermatic capsule in some cases wholly disappeared without any following change in the nucleus that could be discovered, and that consequently it did not effect fertilization. In short, he believes that the observations he has made are quite competent to overturn the sexual hypothesis in these organisms, and to establish that of *rejuvenescence* in its place.

That there is extreme ingenuity in this hypothesis we readily admit; that there is also the utmost conflict of interpretation amongst the best observers of these organisms, we admit with equal readiness. But that the author's observations give *scientific* sanction to his theory on the one hand, or either explain away or harmonize the labours of his predecessors or *collaborateurs* on the other, we are fain to dispute. The exhaustive and continuous method of observation—following a single form through all the phases of its life—has never been thoroughly adopted; and conflict of interpretation inevitably arises. Bütschli has fallen into the same groove, and his results, although valuable and full of suggestion, have no irresistible meaning. They present points of new departure for hypothesis, and nothing more.

Nor can we be quite certain, from the evidence afforded, of the correctness of the larger and more important of the facts stated. We want, for example, more than a mere statement that the "ciliary apparatus" and the important organs of the *peristoma* were actually destroyed by conjugation. That they are suppressed—flattened—deranged by prolonged contact, we have observed again and again in several forms, especially *Stylonichia, Pustulata,* and *Mytilus;* but they rapidly regained their *normal condition*, and certainly did not *grow afresh* by "rejuvenescence" as in the cases stated by our author. And this is certainly of moment. In some important sense also this will apply to the nucleus and nucleolus themselves. Doubtless the investigations of Bütschli on the metamorphoses of these bodies, especially the latter, in such forms as *P. bursaria, aurelia, putrinum,* and others, have a large importance; and if they should be confirmed by *continuous observation* on the *living form*, controlled by the evidence of preparations, made at short intervals, under the influence of acetic and osmic acids, and other reagents, not only will Balbiani's hypothesis become modified, but a sequence will be given to the successive stages, often now wanting, in the observations of Bütschli himself. It is impossible not to be struck, for example, with the minuteness of his observations, made on the nucleolus changes in *P. bursaria;* but they are utterly incompetent to accomplish his own purpose and establish his own idea. He declares that both Balbiani and Stein utterly mistook the destiny of the nucleus and nucleolus; and quite repudiates the changes said to come upon the nucleus during conjugation. But to establish his own hypothesis the whole process of morphological change in the nucleus at least should have been followed, and not once but many times. Yet the very first complete change effected in this organ could not be explained; and after following it into fission as the result of conjugation, he observed four "nucleolus capsules" as the issue, in each paramæcium. Two of these became light and clear; the other two diminished in size, and became fibrous, but on the second day they lost their fibres and became homogeneous and dark; and on the third day—*vanished!* that is to say, by the method pursued by the observer, they were lost, and "no trace of them was to be found." From this Bütschli concludes that they were "cast out," and no further concern in relation to them is evinced! Yet it must be remembered that Balbiani describes a similar condition of the same forms, and considers the granules germs or ova. To deal thus lightly with the ejection of apparently organized bodies in a set of observations designed to *prove* that what have been considered ovarian, or at least sexual, products, was erroneous, is certainly remarkable. Clearly no result can be arrived at until the manner of the vanishing of these bodies be understood; and if they were ejected, until their future destiny became known. This is all the more imperative from the fact that *after* the ejection of the "bodies," the paramæcium resumes its normal condition in size and appearance, although the method by which this conclusion is reached is by saltative inferences, and not by continuous proofs.

Again, in *B. bursaria* and *aurelia*, two "light bodies"—definite products of the nucleolus—are repeatedly seen in successive stages after conjugation, but having been followed to a certain point we are told that "the further destiny of these two light bodies escaped me"! and yet it is assumed that the life-history of the creatures is known.

Again, in these same forms the *nucleus* broke up into a hundred spherules; and yet our author frankly declares, "I am not quite certain of the destiny of the . . . fragments of the old nucleus"! This is the more important since Schaafhausen affirms that he has seen *P. aurelia* lay or deposit ova; "the organisms crammed full of egg-spheres, surrounded with clear fluid, extrudes in an hour several times one such egg."

Again, in *Colpidium colpoda*, after conjugation, two small light spheres appear, these the author "thinks most probably" grow out of the nucleus capsules, while the *nucleus* itself is *cast out;* Bütschli followed it "for some time" and then it was lost, so he does not know its final destiny! Of what service can all the subsequent transformations of the organism itself be when this ejected organism is assumed to mean nothing? In *Blepharisma laterita* a number of "nucleolus-like bodies" were found by "squeezing and acetic acid," but their destiny was never found; while on the third day after conjugation "the *nucleus* which had been present up to this time was not to be found," and so the author meets the emergency by supposing that it was "cast out," and of course had no meaning in the history of the organism. So also in *Chilodon cuculus*, we are told that the "destiny of the original nucleus remains undetermined." In the conjugation phenomena of *Stylonichia mytilus* there is an equal or even more grave defect.

In precisely the same way in the attempt made by Bütschli to establish the position he occupies that the embryonal regions of Balbiani and others as existing in these lowly forms are to be entirely explained by the presence of swarm-spores of internal parasites, there is the same want of perfect sequence, and the unscientific "no doubt" which is made to supply the place of facts.

But our space is exhausted. We have not referred to the above defects with any attempt to depreciate a valuable book. It is because it is strong enough in important facts to be a help in the unravelling of biological difficulties that we have not hesitated to point out the difference between the *theories* and the *facts* which it contains. To have attempted exhaustive criticism of such a work would have involved four or five times the space occupied by this article; but after a careful perusal and reperusal of its contents, we are obliged to admit the ingenuity of the author both in the work he has done and the method he has employed for interpreting it. But it is to the former that we attach by far the most importance; for whilst there are many missing links in evidence which make conclusions from the whole unwise, there are facts given us which must help future observers and land us nearer to the desired truth.

It may be finally observed,—1. That if the theory of rejuvenescence, as put and insisted on by Bütschli, be established for any one form, conjugation should have no other meaning or place in any part of its history than rejuvenescence can explain. Now *Stylonichia pustulata* is amongst the forms the author has seen to conjugate, and as he believes, as a consequence, to become simply more vital and larger for renewed fissipartition. But Engelmann is undoubtedly right in his affirmation, that there is a conjugate state in which these organisms do *not* again separate, but the pair simply fuse together. One of the writers of this paper has observed it repeatedly under conditions which render error impossible; this is not the place to consider to what this fusion leads, but it is important as a fact, inasmuch as it throws doubt upon the *completeness* of the theory of rejuvenescence, even supposing the facts given us by Bütschli led without exception up to it. Bütschli even admits that this process of fusion may happen, but he simply dismisses it as a "very unusual one"—surely all the more important on this account, inasmuch as we know that in more highly organized creatures not only a long time, but generations may intervene between distinct acts of fertilization.

2. It does not follow that if rejuvenescence be rejected to the extent and with the meaning Bütschli gives it, that it must be rejected altogether. He gives us many remarkable facts that deserve further experiment and research; and it may result, that what he calls rejuvenescence, is one of the many modes by which rapidity of fissiparous multiplication is in some organisms aided, and the necessity for the true act of fertilization is made less frequent; and

3. It is clear that there are points in the theory of Balbiani which the facts given by Bütschli overturn; while there are others that certainly remain unshaken, if they be not strengthened. But it is needful to remember that if the facts given by Bütschli wholly invalidated the interpretations of Balbiani, the theory advanced by Bütschli by no means follows as a consequence. In the present state of this inquiry we must seek facts industriously, and with persistent honesty, and be assured that their accumulation will lead to important issues; but we shall do well to place theory, however fascinating, in an extremely subordinate place.

V.—*German Methods in Histology and Embryology.*

By Charles Sedgwick Minot.

The use of the microscope goes hand in hand with the work of zoologists in Germany, and it is there that we find the greatest number of means employed to render the objects suitable for examination. I have frequently heard American zoologists express a slight distrust of histological methods—well founded, perhaps; it ought not to lead to the rejection of the benefits to be obtained from using them, but merely to greater caution in employing them.

It is well known that animal tissues and organs consist of cells of various kinds, variously grouped together. The forms which these cells can assume lead to the most curious transformations, so that things as different from one another as muscular fibres, blood-corpuscles, and ganglion-cells can be traced as modifications of the same primitive form. The work of microscopic anatomists is to detect the changes which the simple cells of embryos undergo in the course of their transformations into the components of the tissues of the adult, and to investigate in detail the final results of these metamorphoses. It is much to be desired that America should assist more in this work, and it is with the hope of stimulating some persons to do so that this article is written.

In the tissues of the adult we find the cells arranged in a definite manner, and we have consequently to examine the shape and character of the single cells, and then their relation to one another. Simply placing a small piece of an organ underneath the microscope is not sufficient to enable us to do this, but we are obliged in every case to subject the preparation to a special treatment. The first thing to be done is to make the object transparent enough to let the light pass through it to the objective, which is usually done by mounting it in glycerine or in Canada balsam, both of which substances have a high index of refraction, and therefore when they penetrate the interstices of a tissue do away with the refraction inside of it, so to speak; for in every tissue the different parts refract the light so variously that a ray passing through frequently changes its path, thus confusing the final image which reaches the observer's eye. A layer of powdered glass lets the light pass through, but nothing distinct can be seen; if, however, the whole is immersed in Canada balsam, it immediately becomes beautifully transparent, because the balsam fills up the spaces between the bits of glass, and since balsam and glass refract light to about the same degree, the mass becomes optically nearly uniform, and a ray of light can pass through it without being deviated from its course or destroying the image. The action on the tissues is identical—and this should be carefully remembered, because balsam renders objects more transparent than does glycerine, so that in some cases one liquid is better than the other. It is a sign of inexperience to assert that balsam is better than glycerine, or *vice versâ*, for they are both useful, but for different purposes.

In order to observe the cells well it is necessary not to have too many superposed layers in the field of view, but to make the object as thin as possible. This is usually accomplished by making sections. So important and so useful are such very thin slices that probably nine-tenths of every histological collection consist of them. The first thing, therefore, is to acquire skill in making sections, and the perfection reached will mainly decide how far the progress of the student shall continue. The importance and benefits of making sections have led to the invention of a great many mechanical contrivances for cutting them. One form of cutter or microtome well adapted to its object was described in the April number of the 'American Naturalist' of this year. Numerous other forms have been suggested, but those with which I am acquainted all have some defects. Free-hand cutting still remains absolutely indispensable. It may be acquired by patient practice even by those who have no special manual skill, just as we are all able to write. There are many things which cannot be cut with a machine. The razor for cutting should be of the best quality, and when used always drawn towards the body, while the surface, which looks downward in cutting, must be flat. The edge must be perfect, the slightest notch being sufficient to tear a section to pieces, and so sharp that a human hair can be split with it. The sections themselves must be as thin as possible.

Since all parts of the body, with few exceptions, such as the skeleton, &c., are soft and permeated by water, besides possessing great elasticity, they cannot be cut in their natural condition; it becomes necessary, therefore, to harden the organs. Now protoplasm is the main constituent of cells, and itself consists chiefly of albumen. This substance can be coagulated by the action of various agents, some of which can be applied to the tissues without injuring them, to produce a coagulation of the albumen in its natural form within the cells.

Alcohol is one of the most valuable agents for this use. It produces its effect by its strong affinity for water, which it can withdraw from the tissue, thus causing the albumen, which requires an abundance of water to maintain its semi-fluid state, to solidify. It may be employed for the majority of tissues with perfect success. The volume of alcohol should be from twenty to thirty times that of the object to be hardened; weaker alcohol, say of 80 per cent., should be used first; after a sojourn of an hour or two, or even longer, if large, the object may be transferred to stronger (96 per cent.) spirit, and there left for twenty-four hours, more or less, according to the size of the piece. The great difficulty in the use of alcohol is to prevent the shrinkage which naturally follows upon the abstraction of the water from the tissues. This may be avoided by using first weak, and then strong, and finally very strong spirit. In some cases the action is not even then sufficient, and recourse must be had to absolute alcohol, which generally produces the desired result.

When even that does not succeed, the specimens may be put in picric acid (concentrated cold aqueous solution) for twenty-four hours, then in a syrupy solution of gum arabic for twenty-four hours, and finally in strong alcohol again for the same length of time. The picric acid removes the alcohol, and allows the gum to penetrate the object, within which it is finally coagulated by the last dose of spirit. The sections when made must be left in water for a day, to dissolve out the gum which they still contain, and which renders them quite opaque. A very few drops of strong carbolic acid may be added to the water to prevent the development of bacteria, &c., which would quickly ruin the preparations.

Coagulated gum renders the majority of organs of a pleasant consistency for cutting.

Instead of gum, paraffin may be made to permeate the tissues, in the way already described in detail in the article on the sledge microtome, in the April number of the 'American Naturalist.'

All acids produce in albumen chemical changes, which, without withdrawing the water, cause coagulation. There are some which are admirably suited for hardening agents. Foremost among these is chromic acid, first introduced by Hannover, in 1841, from motives of economy. It is employed in solutions of two-fifth parts for one thousand parts water. Very large quantities must be used—weak solutions at first, to be gradually replaced by stronger and stronger ones. If its action is kept up too long the objects become brittle and are then worthless, for every section crumbles to pieces as soon as made. Chromic acid is particularly useful in studying nervous tissues, organs of sense, and other unusually delicate tissues. Its action is very slow: thus the spinal cord of a large dog or a man requires at least six weeks or two months. Chromic acid is also admirable for preparing very young and frail embryos or eggs. There are many other agents which are sometimes used for hardening, but it is not deemed appropriate to enumerate here any but the two principal and most useful ones, alcohol and chromic acid.

After the proper degree of hardness has been produced, if the piece to be cut is large enough, it may be held in one hand and cut with the other without more ado. When, however, we have to deal with something too small and delicate to be held in the hand, it is necessary to have recourse to some method of imbedding. Paraffin will usually be found the most convenient substance for this purpose, especially when mixed with one-tenth of its weight of the best hogs' lard. The most satisfactory process of imbedding in paraffin we have elsewhere described.*

On some accounts transparent soap is to be highly recommended. The best quality, containing *no glycerine*, must be chosen, then shaved into small bits, and warmed with half its volume of alcohol (as compared with it before it was cut up) until it is entirely dissolved; the specimen to be imbedded is then suspended in the warm mass by a fine thread and left for twenty-four hours. The soap does not become hard until the alcohol evaporates from it; the less alcohol, therefore, put in originally, the better. The soap ought to remain perfectly clear, enabling one to see the imbedded specimen within, so that it can easily be observed exactly in what plane every section is made, which is not possible when paraffin or wax is used. The sections, when made, if cut in soap, must be put in alcohol, if from paraffin, in spirits of turpentine, to dissolve out the remains of the imbedding mass.

* 'American Naturalist,' April 1877, p. 208.

If now the sections, after being thus freed from the adherent foreign matter, be mounted directly, they make poor preparations; the single parts are indistinct, and the whole is very transparent. This can be avoided by colouring them. It may be safely asserted that the introduction of staining fluids, by Gerlach, in 1858, was the most important step in advance ever yet made in histological technic. Colouring matters, as regards their action on cells, belong to two classes: either they produce a diffuse colouring of the whole cell, or they stain the nucleus much more deeply than the protoplasm and the membrane of the cell. The principal are dyes of the latter class, carmine, hæmatoxiline, and aniline blue, which are esteemed in the order named. The two former are invaluable, for by marking out the nuclei so distinctly they enable us to recognize so many centres of cells, and to observe characters which have been made prominent by their colouration, and are very different in the various forms of cells. In fact, preparations for the microscope cannot be felt or dissected, but only seen; therefore the differential colouring produced by carmine, for example, is an assistance to the eye, comparable to the raised alphabets of the blind. In both cases, the conditions under which the special sense, whether sight or feeling, has to act are greatly exaggerated, so to speak, thus producing magnified or strengthened perceptions.

Carmine is by far the most generally useful. It is employed in various solutions, the recipes for which may be found in various handbooks, and need not, therefore, be quoted in this article. The first step in preparing it is to dissolve some of the fine-powdered carmine in a small quantity of ammonia, and it may be used at once in that form after allowing the superfluous ammonia almost entirely to evaporate. A very excellent solution may be prepared by simply adding an equal volume of rather strong acetic acid to the dissolved carmine; the exact proportion is not of very great import. Beale's carmine keeps a long time without alteration, and Ranvier's picro-carmine has certain advantages; but on the whole, I have found the above-mentioned mixture of acetic and ammoniacal carmine to be quite sufficient for most work.

Hæmatoxiline, on the other hand, has to be employed in a particular solution. Dissolve first thirty-five parts of hæmatoxiline crystals in one thousand parts of absolute alcohol, and mix it cold with a solution of ten parts alum in three thousand parts distilled water. The mixture is purple at first, but turns a deep blue in the course of a few weeks; but it may be used without waiting for the change of colour. For use it must always be filtered through porous paper to free it from sediment, and it may be advantageously diluted with 0·5 per cent. solution of alum. It acts much more quickly and produces a deeper and more exclusive staining of the nuclei than does carmine. It is therefore particularly applicable in those cases where it is desired to study the shape and transformations of nuclei, as, for example, in tracing the development of spermatozoa. The changes can be very well followed in sections of the testicle of *Epicrium glutinosum*, one of the Cœciliadæ or footless, worm-like amphibians. The testicle is divided up into numerous follicles, and the cells in each are all in one stage, while the various follicles present various degrees of development; thus in a single section all the principal alterations may be observed. The cells are round at first, with a very large granular nucleus. They then divide, becoming smaller and more numerous. The next change is a slightly irregular elongation of cell and its nucleus, slight at first, but gradually increasing. At this point in the metamorphosis the protoplasm is gathered at one end of the cell, and the long nucleus at the other, and it at once becomes evident that the nucleus is to make the head of the spermatozoon, the protoplasm the tail. At this stage the cells lay themselves in rows, the nuclear ends, or as we may now call them the heads of the young spermatozoa, all pointing the same way. Each cell continues to elongate until it grows into a fully developed spermatozoon, with a pointed front end, a long head which appears almost black when stained with hæmatoxiline, and a long, fine tail. The development of the spermatozoa seems to be very much the same in all vertebrates; that is to say, the primitive cells of the testicular follicles divide into smaller cells, and the nuclei of these make the heads, while their protoplasm changes into the tails of the spermatozoa. We have spoken of these changes here because it is proposed that the next paper shall be on the development and early stages of eggs, and there will be occasion to refer to the observations just quoted.

It is well known that cells create certain products which appear outside of the cells themselves; thus, wherever there is a layer of cells having a free surface, as, for example, the outside of the body of invertebrates, or the walls of tubes, such as ducts of glands, the digestive canal, &c., they tend to form a structureless membrane, which, stretching over them all, acts as a common protective covering. The hard crust of insects is such a membrane or *cuticula*, and a corresponding one lines the tracheæ and the stomach, &c., of insects and many other animals. Now the application of section-making to the study of *cuticular* growths reveals many interesting peculiarities; as this study is only just entered upon, it is hoped that a reference to some of the results may prove valuable.

M. Léon Dufour described curiously shaped teeth in the crop of certain crickets, especially well developed in the mole-crickets, very large also in the katydids. Herr Wilde, of Leipzig, has made a very thorough study of these teeth and their development; he kindly showed the author many of his preparations, and explained his results. He made numerous beautiful sections of the crops of several species, both young and adult. In one of his sections of the crop of *Gryllus cinereus*, the European field cricket, there are six teeth of very irregular shape, with many protuberances, but presenting, nevertheless, the general outline of a triangle, with the apex towards the middle. On each side of the projecting apex are two protruding points, at the base of which there is a bundle of stiff chitinous bristles. Between every two of these gigantic teeth there is a small ridge, which also has a hard cuticula. Further, the teeth are not attached along their whole base, but are partly drawn back, so that there is a space between the middle of the base and the muscular walls of the crop. The teeth form six regular, longitudinal rows, numbering each about twenty teeth. Their form varies according to the genera, and probably also according to the species. The walls of the crop are built up mainly of circular muscular fibres, which by their contraction drive the teeth towards the centre and so grind up the food of the cricket, thus performing a function which we are wont to think of as properly belonging to the mouth. The study of the development of the teeth enabled Herr Wilde to ascertain that they are formed by underlying cells through a series of transformations of the cuticula, which appears at first as a simple membrane and then develops the secondary projections, which give the teeth their ultimate form. All these interesting discoveries could hardly have been made except by means of sections.

The author has himself applied section-making to the study of the tracheæ of insects.* It was found that the current descriptions in works on comparative anatomy and entomology were incorrect in several important particulars. The outside of the trachea is covered by a layer of flat polygonal cells, or, as it is called, a pavement epithelium. Thus in a longitudinal section of the main tracheal stem of the common water-beetle, *Hydrophilus*, the thin cells may be easily recognized by their nuclei. The epithelium secretes the enormously thick and complicated cuticula, which makes up the rest of the tracheal wall. The well-known spiral threads or filaments are part of this cuticula, and not distinct structures as was generally supposed. These threads run around the tubes and serve as elastic supports to keep the thin walls distended; they are more or less spiral, but instead of there being but one single thread, as is usually stated, there are four or five which end, after making a few turns around the tracheæ, new ones arising to replace them. As the fibres run transversely, of course their cut ends only are seen in a longitudinal section. But these ends show that the filaments consist of a lighter outside, and a darker inside portion, which latter is round. The rest of the cuticula is divided into two layers, the inside one being slightly coloured by

* Minot, "Recherches histologiques sur les Trachées de l'Hydrophilus piceus," 'Arch. de Physiol. normale et pathologique,' sér. 2, tom. iii. p. 1.

carmine, while the outside layer is hardly stained at all. This affords another excellent illustration of the ease with which valuable discoveries may be made, when well-known histological methods are applied to the study of insects; indeed, insects offer a rich and easily accessible field of research, promising perhaps greater rewards in proportion to the necessary labour than almost any other department of zoological investigation.

It would be easy to add illustration after illustration to those already given, but it is not our purpose to review the progress of histology, but merely to give incentives to work in that field. We pass on, therefore, to a few additional considerations on the "technique" of preparing tissues for microscopical examination. Experience has shown that it is very difficult to distinguish the single cells in sections, in some case almost or quite impossible; or it is even impossible occasionally to make any sections at all. On these accounts various means are employed either to isolate a few cells or to mark the outlines of them. The methods hitherto employed for these purposes are few in number and limited in application, but they have already led to interesting observations.

Many cavities of the body, both of vertebrates and lower animals, are lined by a layer of flat cells that are separated by lines of intercellular substance; by treating such a surface suitably with certain silver salts the intercellular lines are coloured dark brown or black. A solution of one part of nitrate of silver in five hundred parts of distilled water (by weight) is very convenient. It gives beautiful preparations when applied to the mesentery of a rabbit, for example. The mesentery is the thin membrane by which the intestine is suspended from the back of the abdomen. Cut out a small piece from a freshly killed animal, a frog or rabbit, or any other vertebrate, and place it in a silver solution, where the direct rays of the sun can fall upon it, and move it about with a glass rod (metal would be corroded) so that all parts may be equally acted upon; next remove it for a moment into distilled water to wash off the silver, and then spread it out on a glass slide and let it dry almost completely, taking great pains to stretch it out by pulling it at various points so that it shall dry *fully* extended. Before it is quite dry put on a drop of glycerine and a thin glass cover in the usual way. If the impregnation has been successful, the lines will appear very sharply. If the impregnation was not sufficient the lines do not appear, but that is also the case if it has been too prolonged, for then the cells fall off altogether. The membrane may be coloured with hæmatoxiline or carmine, if so desired, after impregnation, and then the stained nuclei appear within the dark outlines, making exceedingly pretty preparations.

Maceration gives the means of isolating layers of cells. If the skin of an amphibian, a toad, for example, be pinned out on a bit of cork and then placed in a dish of water containing three or four drops of strong carbolic acid to prevent the development of germs, and then left for a day or two, the superficial layer of cells may be peeled off with a pair of pincers, and so on, successive layers from day to day until the whole skin has been removed. The bits thus peeled off usually contain but a single layer of cells, and if coloured with carmine they make very beautiful preparations.

But besides investigating cells in their relation to one another, the histologist endeavours to determine the form of single cells, and employs therefor means of isolation or dissociation. These may be either mechanical, such as shaking up a tissue in a fluid or teasing it out with fine needles, &c., or chemical. Usually a combination of the two is the most effectual.

In most tissues the cells are united by intercellular matter, just as above described in the epithelium of the mesentery. This substance acts as a cement binding the cells together. In some cases it reaches an extraordinary development, so that the cells come to be quite far apart, as in cartilage, for instance. But usually it is very thin, and may be dissolved, in some cases, without altering the appearance of the neighbouring cells. The cells that line the intestine and stomach are particularly adapted to illustrate this action of certain chemicals. Thus if a small bit of the wall of the digestive canal be left in alcohol of 30 per cent. for twenty-four hours, the lining cells all become loosened so that they are easily scraped off with a needle or scalpel, and if mounted in glycerine mixed with a little picrocarmine, they become stained in a week or so, and show the details of structure of the single cells very admirably.

Chromic acid has a similar action, and solutions of two parts in ten thousand of distilled water have a great value from their so affecting the brain that the ganglion-cells may be quite easily isolated. To effect this a very small piece of the brain—calf's brain is perhaps the best—is placed in fifty or sixty times its volume of the solution for twenty-four hours, and then carefully teased out under a good dissecting microscope.

Both weak chromic acid and alcohol may be used for isolating muscular fibres. Flies and beetles are perhaps the best for this purpose. The muscles of the wings (not those of the legs) should be torn out with fine forceps, and little bits, the smaller the better, placed in 30 per cent. spirit for twenty-four hours, and then dissociated or pulled apart on a glass slide, with fine needles. With sufficient care it is possible to separate the single fibrillæ of each fibre, and when stained with hæmatoxiline the alternating lines, dark and light, appear very sharply. These lines are those that make the muscles transversely striated. The cause of this striated appearance is not yet fully determined, but it is apparently connected with greater perfection of the muscular fibre than is found in the unstriated form. Different as is muscle in appearance from cells, yet it originates from them, and is in fact formed of metamorphosed cells, by a series of changes all as great as those which produce bone.

We have still to notice a very important class of procedures, namely, injections. In the higher animals we find two distinct sets of vessels ramifying through the whole body: one of these is the system of blood-vessels, the other the lymphatic system. As is well known to all, the blood-vessels branch out into very fine tubes that form a complicated network in every part of the body, so fine that it can only be followed when the tubes or capillaries have been artificially filled with a coloured matter. The same is true of the lymph-vessels, but to an even greater extent. Many of the structures of the body are permeated by connective tissue, and in this tissue there are numerous cavities filled with fluid; they are in communication with very delicate tubes, the lymphatic capillaries, which soon unite into larger canals, and these form branches which gradually join together and lead to the thoracic duct or main stem, which empties into the veins just before they open into the heart. The branches of this tubular system are provided with valves so arranged that the liquid contained in the tubes can only pass upward or towards the main stem. Now when any motion takes place, some of the liquid in the cavities of the connective tissue is pressed into the lymphatics and so slowly driven onwards into the heart. To counterbalance this loss of intercellular fluid, certain constituents of the blood exude through the walls of the capillaries and keep up the supply. There is, therefore, a double circulation: one within the blood-vessels, and another from the walls of the capillaries through the lymphatics. The liquid in both circulations is ultimately returned to the heart.

Different methods have to be employed for injecting the two systems. In the case of the blood-vessels a rather large syringe may be used, provided with a point small enough to pass into the artery of the part to be injected. The artery should be carefully laid bare and cut about half-way through; the point of the syringe, which must be previously filled with the injection mass, is pushed into the artery and firmly tied in place. In many cases it is quite sufficient to inject a cold saturated solution of Prussian blue in water, or when more perfect preparations are wanted, a little gelatine may be added; in this case, however, there arises the inconvenience that both the injection mass and the organ to be injected have to be kept warm while the operation is going on, otherwise the gelatine solidifies.

To prepare a "warm" injection mass, the following method is, perhaps, the best. A solution of Prussian blue is necessary; this the histologist must make for himself. To do this, take a concentrated solution of sulphate of protoxide of iron in distilled water, and pour it slowly into a concentrated solution of yellow prussiate of potassium; a precipitate of insoluble Prussian blue is formed. There should be a small excess of prussiate at the end of the operation, to test which take out a drop and add to it a little of the sulphate. If there is any free prussiate still present, a blue precipitate is thrown down. Filter through a felt strainer, below which a funnel with a paper filter has been placed. Pour water on to the strainer in small quantities at a time, and continue filtering; this operation must be kept up for several days, until the liquid below the second filter appears distinctly blue. The matter on the felt strainer is then removed and dissolved in distilled water. This solution is admirable for cold injections or for filling the lymph-vessels, as will be described presently. There should always remain an excess of blue in the vessel in order to be sure that the solution is saturated; as the solution is removed it may be replaced by distilled water, as long as there is any blue left. To make the "warm" injection mass, take twenty-five parts of the Prussian-blue solution and one part gelatine. The latter must be of the finest quality, as otherwise it produces a granular precipitate which renders it useless for histological purposes. Put the gelatine to soak for half an hour in distilled water, then remove and wash it; place it in a glass vessel and warm it in a water-bath, when it will melt in the water it has absorbed. The Prussian blue is put in another vessel in the same water-bath, so that the two liquids are at the same temperature. Pour the gelatine, little by little, into the blue, stirring constantly with a glass rod. Keep on warming and stirring until the granular precipitate formed at first disappears. Upon being filtered through a piece of clean flannel, the mass is ready for use.

It requires only to be slightly warmed to become liquid, and the organ to be injected does not need to be heated to so high a temperature as is necessary in using many other injection masses; there is therefore no danger of injuring the tissues by subjecting them to too high a temperature. The injection should be continued until a little while after the mass begins to come out through the veins, in order to allow all the capillaries time to fill themselves. When the injection is finished, the organ may be placed to advantage for twenty-four hours in a 2 to 1000 solution of bichromate of potassium in distilled water, and then be removed to alcohol; or it may be put at once in alcohol, and, when hardened, sections made of it. The sections should be pretty thick, and may or may not be stained as is desired. If too thin, they do not show the connections of the vessels.

As an example of the clearness with which the blood-vessels may be traced in a successful preparation, a section through an injected human lip may be taken. The skin proper is penetrated by papillæ sent up from the underlying connective tissue, known in anatomy as the cutis, and carrying the blood-vessels. There is a network of small arteries in the cutis, and from this there pass up from three to five fine branches into each papilla, and form by division and intercommunication a wide capillary network. One or several fine capillaries bend round, and form the veinlet which passes down the middle of the papilla, from top to bottom, in a nearly straight line, and sometimes taking up fine branches on the way until it finally connects with the venous network of the cutis.

This arrangement of the vessels is very characteristic; similar ones occur elsewhere, where there are well-developed papillæ, as, for instance, on the tongue or in the intestine. But each organ presents characteristic peculiarities in the distribution of its blood-vessels, and to an experienced histologist the veins, capillaries, and arteries of the liver and kidney, &c., are as distinctive of each organ as is its general shape and appearance.

As the presence of the valves does not permit us to inject the lymphatics from a large stem in the finer branches, as in the blood-vessels, a different method of forcing in the fluid has to be adopted. A small syringe with a very fine sharp point, such as is known among instrument makers as a hypodermic syringe, must be used. The point is made to penetrate in the connective tissue, and the coloured liquid—the best is a solution of Prussian blue—is forced out slowly and gently, and fills at first the cavities of the tissue and then the small lymphatics. These injections are difficult to make, and by no means always succeed well. Perhaps the best place to try first is the interdigital web of the hind foot of a frog, or the outer half, that is, the muscular part of the walls of the small intestine; but the easiest of all to fill are the lymphatics of the dog's testicles. When the injection has been once made in the way indicated, the tissue or organ may be hardened for cutting either in chromic acid or in alcohol.

Such, then, are some of the principal means employed to investigate the microscopical structure of animals. They all have this much in common, that they are endeavours to render certain characters more visible than they are naturally. This we do whether we stain the nucleus, or inject the blood-vessels, or isolate single cells. It may well be added that a good knowledge of optics is necessary to a good histologist.

The worker should also remember that American instruments are usually much less convenient and practical than the German and French microscopes, while the lenses are no better, though enormously more expensive. The writer personally likes Zeiss's instruments very much. As this optician manufactures his objectives upon mathematical principles, he is able to make them all nearly alike; but it must be understood that there are many others whose objectives are also of the best quality. At present there is no difficulty in getting the best lenses and instruments, providing an American or English microscope of large size and complicated structure is not chosen. It will be found that those only who use a microscope for amusement utterly condemn the simple instruments, while those who make investigations and gather wide experience often assert that the greater the simplicity the better. The European histologists I have met generally use a stand without rack and pinion for coarse adjustment, without movable stage and without movement round a horizontal axis.

As to books, Frey's 'Manual,' of which there has been a translation published in New York, is only pretty good. It came into general use because it was for a long time without rivals. There have lately appeared two little works on this subject, in England, one by Professor Rutherford, the other by Mr. Schaeffer, both of which are considered good. But by far the most important work is Ranvier's 'Traité Technique d'Histologie,' now being published in Paris, in numbers, three of which have already appeared. The moderate price of the book—only 25 francs for a volume of a thousand pages—the fulness of detail, and the superb illustrations alone are sufficient to recommend the work. M. Ranvier has written a treatise which will probably always be remembered as one of the most important and valuable manuals ever published, and which ought to be owned by everyone who attempts to investigate the elementary structure of animals.—*The American Naturalist,* July.

NEW BOOKS, WITH SHORT NOTICES.

The Microscopist: a Manual of Microscopy and Compendium of the Microscopic Sciences. Third Edition. By J. H. Withe, A.M., M.D., Professor of Microscopy and Biology in the Medical College of the Pacific, San Francisco. London: Churchill, 1877.—We had always imagined that when a man who wished to learn what was known regarding the microscope, consulted the works of Carpenter and Beale, he attained all the knowledge that was requisite. To be sure there are several other books, both French and German, to be consulted. But from what we have seen of both English and foreign works, we have learnt to prefer the former. It will then very naturally be inquired whether there are departments of science unnoticed by the two writers we have mentioned, that may possibly have been referred to by the author of the book now under notice, and which may possibly justify its existence.

And on examination of the volume which Dr. Withe has issued in its third edition, we are compelled to answer the question we have raised by a decided negative. It does not contain any material which is not amply referred to in the works to which we have alluded. Not only so, but the great mass of the illustrations—which we may add are most effectively reproduced—are simply copies of the various engravings, &c., which our English workers are by this time so familiar with. But this is not all. In point of fact, the book is decidedly inferior to both Carpenter's and Beale's treatises. And it is so from two very different aspects. It touches on a very large number of subjects, but deals at sufficient length we had almost said with none; some few, however, may be looked on as nearly complete. But it is in point of style that we see the distinction between the English treatises and their American or cousinly rival. The composition of the latter is by no means to be contrasted with that of our home productions. Indeed, this feature is most marked in the volume now before us.

It is then impossible to conceive why the American work was brought out at all, save that the books of this country may bear higher prices. This circumstance and likewise the fact that it has gone successfully through two earlier editions, can alone explain its issue in a new form by one of the first publishing firms in this country. However, we shall now point out a few of the imperfections to which we have alluded. In the first place, we find that micro-photography has been entirely omitted. This would have been an unjustifiable omission even if the writer were an Englishman. But in an American volume it is absolutely unpardonable. The United States can pride themselves on having excelled in this one branch of microscopy. Dr. Woodward has, without the smallest doubt, produced the most splendid micro-photographs the world has yet seen. But for all this, an American, in writing a book on the microscope, omits the subject of micro-photography completely. Again, the micro-spectroscope is badly explained. Indeed, when first it is mentioned it is little more than referred to, but farther on a series of spectroscopic images are given, without, however, any mention of the improvements which are due to the labours of Messrs. Sorby, Palmer, and Browning. Then the subject of immersion lenses, which is one of considerable importance at the present time, is dismissed in about ten lines, which are the sum-total of two separate paragraphs. The mode of defining "angular aperture," "penetration," and "definition" is a bad one, and it seems to us to be perfectly unintelligible, at least to an amateur. The author shows also an ignorance of the attempts that have been made, and successfully made, to define certain of Nobert's bands; for he states as a marvellous fact that "it is said that Hartnack's immersion system No. 10 and oblique light has resolved the lines on the 15th band." Is he unaware that Colonel Woodward, his fellow-countryman, has already clearly made out and photographed even the 19th band of Nobert? As to orthography, we notice many errors, more especially in regard to names, some of them being misspelt in as many as two or three different varieties. Another error, which ought not to have existed, as it has been corrected in this country long since, is as to the existence of Bathybius. The chapter on biology also furnishes us with many blunders, a few of which are the following: there is an absolute contradiction as to the nature of cell-life; in one instance it is the substance of the cell, in another it is the nucleus alone that possesses the power of reproduction. The divisions of organic life into Animals, Vegetables, and Fungi is manifestly absurd, and equally so is the idea, put forth in solid earnest, that Bacteria are the germs of fungi; finally, the Poduræ are wrongly placed.

The chapter on pathology is in great part of no interest whatever to the microscopist at all. What, for example, will he think of long paragraphs about the examination of urine for sugar, albumen, and so forth. These things are very well in their way, but they should not be thrust into a treatise on microscopic work.

There are, so far as we can see, but two good chapters in the work, and these are on the microscope in geology, which is a summary of David Forbes's well-known paper in the 'Popular Science Review,' with a reproduction of his plate, and on the same instrument in chemistry, which is an interesting account of some of the more recent results that have been established. These are, so far as we can see, the only really good points that this work possesses.

If we have been perhaps severe in our notice, it has been simply because we felt that the book heartily merited an acute critique, and because we should wish to see that habit of mere book-making, which has of late years become so huge a plague, most seriously diminished.

PROGRESS OF MICROSCOPICAL SCIENCE.

Cryptogamic Botany at Harvard University, U.S.A.—On the 6th of last month (July) a course of practical instruction on cryptogamic botany was begun in this locality, and we think the idea deserves to be carried out in some of our own universities and schools. The following is the plan of operations:—Microscopes and all necessary equipments are provided by the university, but students are expected to bring sharp razors, razor strops, dissecting needles, slides, and covering glasses. No provision, however, is made for drying and preparing specimens other than microscopic. A knowledge of the rudiments of phænogamic botany is required of those taking this course, or in case of those wishing to pursue the subject in connection with zoological studies, a practical acquaintance with the working of the compound microscope. A general course of lectures will be given upon the structure and development of Thallogens, and on one day of the week an excursion will be made either into the country or to the sea-shore. Laboratory instruction will be given every day except Saturday, and the method of examining Fungi and Algæ and the manner of making microscopic preparations will be taught. Illustrations of the structure, and, as far as time will allow, of the development of the principal orders of Fungi and Algæ will be afforded each student, and an opportunity will be given to become familiar with the more common moulds, blights, and with a few agarics. Students who have attended a previous course can pursue more in detail any branch of the subject they may prefer. Under certain restrictions, students may consult the extensive cryptogamic collections and library of the University.

The Structure of the Genus Siphonia.—Mr. W. J. Sollas read a paper on the above subject before the Geological Society on May 23. This paper contained, first, a full account of the history of the genus *Siphonia*, including a complete list of its described species, and, next, a description of its general and minute structure. Its skeletal network was shown to consist of spicular elements belonging to the Lithistid type of sponges, and most closely allied in generic details to the recent form *Discodermia polydiscus*. Not only in this character but in every other, *Siphonia* was shown to approach *Discodermia* so closely as to be almost identical with it. The mineral replacements which have affected the siliceous skeleton of *Siphonia* were then considered. The paper concluded with a systematic description of the genus.

The Nervous Arrangements in the Ovary.—We learn from the 'Medical Record' that Herr J. Elischer has recently investigated the ovaries of the cow, sheep, and rabbit. The organs were hardened for a short time in a 2 per cent. solution of ammonium bichromate, the fluid being changed daily, and then coloured with chloride of gold and sodium after the manner of Gerlach and Boll. In all cases, fine medullated nerve-fibres were found to pass into the stroma on the vessels. From the middle of the hilus they branched in two ways.

One set of medullated fibres divided dichotomously in their passage to the follicular layer at the periphery, and there formed a network of fine non-medullated fibres, constituting a plexus around the follicle; another set formed a coarsely meshed arrangement around the vessels. The peripheral layer of the membrana granulosa in large follicles is surrounded by a fine network of nerve-fibres. The author asserts that he has seen fine branches proceed to the nuclei of the cells of the membrana granulosa.

Researches on the Acarians.—'Nature' (June 14) says that M. Meguin has lately been making important researches on Acarians, and on that strange asexual form called Hypopes, a form which is not absolutely necessary for reproduction, but which seems to occur under certain biological conditions, for the indefinite conservation of the species. In the aerial reservoirs of birds, especially Gallinaceæ, there breeds an inoffensive species, which M. Meguin calls *Kytodites glaber*, which sends colonies even into the bronchial branches, and into the marrowless bones of the limbs in communication with the air-vessels in birds. Another harmless acarian is found in the cellular tissue of birds living and dying there, and persisting after death, surrounded by a calcareous tubercle. A third species, which lives normally between the barbs of the feathers, produces at the time of moulting, and in the skin of the birds, especially domestic and wild pigeons, a hypopial vermiform nymph. Without this precaution of nature, the species would be annihilated, by reason of the fall of the feathers in the moulting season.

The Ending of Nerves in Tendon.—Herr Rollet has contributed a paper on the above to the 'Wiener. Acad. Sitzungsbericht' (vol. lxxiii.). He investigated the mode of termination of the nerves in the tendon of the sterno-radial muscle in frogs at its insertion into the upper arm. The agent employed to treat the tendon with was a half per cent. solution of perosmic acid, followed by hydrochloric acid (1 in 1000). A plexus of medullated nerve-fibres exists and ends within the tendon. The nerves divide dichotomously and end in peculiar structures, having much resemblance to the end plates of muscle. From the fact that no reflex action could be discharged from this tendon, it seems probable that the direction of the motion in the nerve is centrifugal, and not centripetal.

The Structure and Origin of Serpentine.—The Rev. T. G. Bonney, who lately read (May 23) a paper before the Geological Society on the Serpentine of the Lizard district, discussed the question of its origin at some length, calling attention in this relation to a structure commonly seen, which appeared to be a true "fluidal structure." He then described the result of microscopic examination of many specimens of the Lizard and some other serpentines. Commencing with slightly altered lherzolite (from the Ariége), he traced the change through the older gabbro of Coverack to the serpentine rock of that place, which contains a large quantity of unaltered olivine; and so to other serpentines in which the olivine is quite replaced by the mineral serpentine. He described also the mode of the change. The other minerals found in the serpentine rock are enstatite, varieties of augite, and occasionally a fair quantity of picotite, with, of course, oxides of iron. Hence he concluded that, as had been already shown as regards some other serpentines, that of the Lizard was the result of the hydrous alteration of an olivine rock, such as lherzolite.

Microscopical Structure of Rocks.—Professor Zirkel, one of the first authorities on the microscopic structure of rocks, has written a part of vol. vi. of the Reports of the United States Geological Exploration, of which an important and long notice appears in 'Silliman's American Journal' (April). The report commences with an introduction reviewing the kinds of crystalline rocks and their microscopic distinctions. In this chapter Professor Zirkel states that in his descriptions he uses the term "ground-mass" for the mass of a rock where it is distinctly crystalline granular under the microscope, and "base" when there is an amorphous paste not crystalline granular under the highest magnifying power, though containing, except in many obsidians, crystalline minerals. He remarks also on the evidence that the crystalline minerals in the "base" were formed while the latter still had a flowing movement, as shown by the minerals ranging in straight or wavy lines, and by their fractures and abrupt bends or displacements; hence the positions and forms of the crystals have been partly determined by the flowing; and hence, also, the rock has not undergone any metamorphic changes since solidification took place. Those rocks whose micro-fluidal structure is particularly distinct are generally proportionally rich in broken crystals shivered into detached sharply angular fragments. Then follows a minute classification of the series of rocks.

The Study of Pycnidia.—It seems that in recent papers by MM. Cornu and Bauke an attempt has been made to discover the nature of the organs known as *spermatia*, *stylospores*, and *pycnidia*. The two last-named organs, since the publication of Tulasne's Carpologia, have been generally admitted to be secondary forms of species of Ascomycetes. Certain cases, however, seemed to point to the conclusion that some pycnidia were independent organisms, and it was to settle this point that Dr. Bauke made his investigations. His method consisted in the artificial cultivation of different spores, and resulted in a general confirmation of Tulasne's views. The observations of Cornu have extended over several years; and, in regard to the spermatia, he comes to the conclusion that they cannot be considered male organs. He has observed that they germinate, and thinks that they must be regarded as a form of stylospore. Although contrary to the view generally maintained as to the nature of spermatia, and to the views expressed by Stahl in the 'Bot. Zeitung,' March 20, 1874, Cornu's view coincides with what has recently been published in the 'Bot. Zeitung' and 'Comptes Rendus' with regard to the supposed spermatia of species of Coprinus by Brefeld and Von Tieghem. The reason why the germination of spermatia has not been seen until recently is explained by Cornu by the fact that most cultures of spermatia have been made with pure water, whereas the presence of some special nutritive fluid, as solution of gum, bark, &c., seems to be necessary. Cornu was led to this conclusion by noticing that, when sown on a glass slide, under a cover-glass, the spermatia germinated more readily on the side next the gummed label.

New Infusoria.—At one of the meetings of the Academy of Natural Sciences, Philadelphia, Dr. Leidy stated that, in seeking small animals beneath stones and decaying logs in our forests, and observing the common white ants, *Termes flavipes*, he noticed that the intestine seen through the translucent abdomen appeared distended with brown matter. Feeling curious to know the nature of the food of the insect, on examining the abundant intestinal contents, he was surprised to find enormous quantities of infusorial and other parasites. The brown matter appears to be minute fragments of vegetable matter, mainly decaying wood, but it not only occupies the intestine of the ants, but in some cases in greater part is distributed as morsels of food occupying the interior of the parasites. In many instances the parasites are so numerous as to make up the greater portion of the bulk of the intestinal contents of the ants, and may be estimated by millions. As the discovery was a recent one, he was not able yet to say to what extent these ants were generally infected with the parasites, but he had found every individual that he had examined collected from a single nest containing them. The, to him, new world of parasites exhibited five different kinds, of which there are infusoria with cilia, and the others are vegetal in character. The latter consisted of a filamentous algous plant, and a spiral bacterium. One of the ciliate infusoria is a remarkable form, apparently different from any heretofore described, and therefore has been referred to a new genus under the name *Trichonympha agilis*. The animal is about $\frac{1}{300}$ of an inch long, and about half the breadth of the length. It is fusiform, and is clothed with cilia of extraordinary length, some of them extending from the head, one-third the length of the body beyond its posterior extremity. The arrangement of these cilia, clothing the body, reminded him of the nymphs of a recent spectacular drama, in which they appeared with their nakedness barely concealed by long cords suspended from the shoulders, and this arrangement suggested to him the name he has applied to the species. This animalcule did not seem to possess a mouth similar to that found in nearly related forms, and yet the presence of solid food in the interior indicates the existence of a mouth. To determine the exact structure of the creature requires more time than he has yet been able to devote to it, but on superficial inspection the interior appears to be composed of two principal portions, an anterior oval finely granular body, connected with a posterior larger and more coarsely granular mass. The animal, although actively and incessantly in motion, remains stationary in position. The chief movement consists in frequent retraction or shortening and bending of the head end, with narrowing and lengthening or shortening of the whole body, with swelling outwardly and waving downward or backward of the long cilia, and waving of the shorter ones at the summit of the head. The second infusorian, for which the name *Pyrsonympha vertens* is proposed, is larger but less frequent than the former. It is about $\frac{1}{200}$ of an inch in length. It is also more active in its motions, less distinctly defined, and of greater delicacy, so that it undergoes rapid destruction, while the other is more persistent. It also remains stationary in position, while actively moving the parts of the body and writhing like a vinegar eel. Ciliary motion is active, and appears as a rapid waving motion especially visible along the lateral borders, resembling the rise of heated air or the ascent of a flame.

Microscopical Contents of Recent Journals.

Revue des Sciences Naturelles, publiée sur la direction de M. E. Dubrueil. Tome 6, No. 1.—This, besides various other papers not microscopical, contains one which is. It is entitled, "On the Diatomaceæ: a word in favour of their study," by M. E. Guinard. It is an interesting paper, which advances several arguments in favour of the study of diatoms. It states among other things that the name of Diatom is due to the illustrious De Candolle.

Archiv für Mikroskopische Anatomie, herausgegeben von la Valette St. George und W. Waldeyer. Band 14, Heft 1.—This is an excellent number of the best microscopical journal in the world. The first paper is one interesting alone to the physiologist. It is by Dr. B. Afanassiew, of St. Petersburg, and is devoted to the subject of the structure of the Thymus gland. It is accompanied by a plate. It, however, does not add very much to our existing knowledge.—The next paper is on the development of the Myriapoda, by A. Stecker, of Prague. In this he first traces the history of the subject so far as it has been given by fine memoirs of Newport, of Fabre, and of Metschnikoff; and then he gives his own observations which are valuable on the subject of the development of Iulus. The plate accompanying the paper gives excellent coloured drawings, some of them of the entire ovum, and others sections of the ova of *Iulus fasciatus*, *I. fœtidus*, and also of the genera *Craspedosoma*, *Polydesmus*, and *Strongilosoma*.—Another contribution, of interest only to the human anatomist, is that on the minute structure of portion of the reproductive system in man, which is accompanied by a plate.—A short note on the connective tissue in Cephalopods, by Dr. F. Forster, of Munich, is likewise a good histological paper.—An excellent contribution is that of Dr. John Dogiel, on the muscles and nerves of the heart in Mollusks. In this the author refers especially to Dr. M. Foster and Mr. Dew-Smith's recent paper before the Royal Society on the influence of electric currents on molluscan hearts. Then he goes on to point out the minute structure of the heart in *Pecten*, *Helix*, *Salpa*, *Anodonta*, and *Aplysia*; and he also dwells on the relations of the heart to other parts, more particularly dealing with the nervous system. It is altogether a most valuable paper. The notice of this number will be continued in our next number.

Botanische Zeitung (March).—In this L. Celakovsky has a paper on Phyllody of the Ovules in *Trifolium repens*.

Flora (March).—In this are the following:—F. Buchenau, Dehiscence of the Capsule in German Species of *Juncus* (continued).—A. Batalin, Mechanism of Movements in Insect-eating Plants (continued).—E. Stahl, On the Importance of the Hymenial Gonidia.

Bull. Bot. Soc. France (1876, part 4).—In this M. E. van Tieghem gives New Observations on the Development of the Perithecium of *Chætonium*.—P. Petit, Attempt at a Classification of the *Diatomaceæ*.

Nuovo Giorn. Bot. (April 5).—In this, two papers are of interest, viz., Sig. A. Mori, On Structure of Leaves of *Ericaceæ;* and Sig. T. Caruel, On a singular behaviour of Zoospores in *Cladophora*.

Ann. des Sc. Nat. (ser. 6, vol. iv., part 1).—M. S. Arloing, Anatomical Researches on the Cuttings of Cactaceæ; and M. N. Sorokine, Note on the Vegetable Parasites on Anguillulæ.

Bot. Zeitung (May).—Herr J. Peyritsch, On the Ovular Theory.—Herr H. Bauke, On the Development of Ascomycetes.

Botaniska Notiser (May 18).—F. W. C. Areschoug, On Mechanical Cell Thickening in Leaves.

NOTES AND MEMORANDA.

Zentmayer's Turn-table.—The 'American Naturalist' (July) says that Mr. Zentmayer has recently contrived a turn-table on which the slide is self-centred for width, by the absurdly simple device of bringing its two sides up to the opposite sides of a couple of brass pins equally distant from the centre of rotation. The adjustment for length is made by hand, guided by circles on the brass plate, or for slides of standard size by a pin at one end. The slide may be of any reasonable width, and can be easily and instantly decentred for refinishing old slides. The table is mounted with a clamp for attaching it to a table, though it can be furnished on a heavy block in the usual manner, if desired.

Three Foreign Members of the Linnean Society, recently elected, have all been more or less distinguished in the pursuit of microscopic work. They are as follow:—Pierre du Charte, of Paris, highly distinguished for his researches in teratological, physiological, and other branches of botany; Professor Carl Gegenbauer, of Heidelberg, whose labours in zoology and the comparative anatomy of the vertebrates and invertebrates are acknowledged as of the highest standard; and Professor Rudolph Leuckardt, of Leipzig, to whose philosophical investigations into the morphology and physiology of the lower forms of animals, and establishment of the group Cœlenterata, zoologists of all countries are highly indebted.

PROCEEDINGS OF SOCIETIES.

San Francisco Microscopical Society.

The fifth annual reception of the San Francisco Microscopical Society was held on Thursday evening, May 24, at Mercantile Library Hall, and was largely attended.

At the reception, which was, as usual, a gratuitous offering on the part of the Society to the intelligent curiosity of the acquaintances of the members, there was arranged a programme of three objects for each of the exhibitors to present, and most of the slides were selected from specialities cultivated by the members. On a number of tables arrayed about the hall were placed twenty-two fine instruments, most of them first-class stands, and as the audience moved from one table to the other, the gentlemen in charge took occasion to explain the objects exhibited and reply to the many questions propounded. [The objects were of the usual class, but their description would occupy two pages of this Journal, which cannot be given up to such matters.—Ed. 'M. M. J.']

Microscopical Society of Dunkirk, U.S.A.

At the annual meeting of the Dunkirk Microscopical Society, held at the Library Rooms, in the City Hall, on Friday night, June 8, 1877, the address of the President, Geo. E. Blackham, was delivered. It was of considerable length and interest; but the following is all that we can afford space for.

To the members of the Dunkirk Microscopical Society:—It is an excellent custom in societies like this of ours for the retiring President to read before the Society at their annual meeting an address, partly made up of a review of the Society under his administration, and partly of a statement of the results of his own researches or of advances made in any part of the world in the particular branch which he has selected as his specialty. For reasons not now necessary to enter into, the custom has never been followed by this Society, and in consequence the mass of material which has accumulated during the three years of our corporate existence has become so great as to furnish an ample basis for an address which shall consist solely in a review of our successes and failures in the past, and a brief glance at the promises and possibilities of the future, and leave no room for any special discussion of recent advances in the optics of microscopy, which is, as you know, the special field to which my own studies have been for some time directed.

Since 1875 our reports have appeared with considerable regularity in the 'Cincinnati Medical News,' and occasionally in other journals, including the famous London 'Monthly Microscopical Journal,' and have attracted considerable attention, and done much to make the name of our Society and of our town well and widely known.

At the regular meeting, January 12, 1877, Mrs. O. N. Shelton read a brief but valuable paper recording her original investigations of "Martyina as an Insectivorous Plant."

The next meeting worthy of special record was held February 22, 1877. The paper for this evening was "On the Use of High Powers on Opaque Objects," by George W. Morehouse, Esq., of Wayland, New York. Unfortunately Mr. Morehouse was unable to be present, and his paper was read by the President. It was an able and original paper, and has been printed in full in the 'Cincinnati Medical News.'

The regular meeting of March 9, 1877, was notable for the reading of an able paper by our worthy and efficient Secretary, C. P. Alling, M.D., on the "Microscopy of the Blood." This paper gave rise to a spirited discussion, in the course of which the President exhibited some beautiful photographs of blood-disks kindly sent him by Lieut.-Col. J. J. Woodward, M.D., the famous micro-photographer of the U.S. Army Medical Museum at Washington.

March 19, a regular meeting was held, and largely attended; and George E. Fell, Esq., C.E., of Buffalo, N.Y. (a corresponding member), read an excellent and interesting paper on "the Acarinæ."

At the next regular meeting, May 11, 1877, little but routine business was done, as the regular essayist, Mr. G. W. Fries, of Friendship, was unable to be present. An adjourned meeting was therefore held in the City Hall, May 22, when Mr. Fries was present, and read an excellent paper on "Work for Amateur Microscopists," in which he took strong ground in favour of specializing our studies, and directing them to some special and useful object rather than towards the acquisition of a miscellaneous collection of pretty or curious objects which, however interesting, would have no special scientific value. On this occasion, Professor J. E. Smith was also present, and read a valuable and original paper having special reference to two new illuminators which he had devised and now presented to the public for the first time. They were, first, a new sub-stage illuminator, which is a modification of the Wenham Reflex Illuminator, but which, unlike that, could be used for the direct illumination of objects mounted dry as well as those in balsam, and gave all the advantages of the thin stage at a very moderate expense; and, second, a modification of the Beck Vertical Illuminator for use with high powers on opaque objects. With the latter and his now famous duplex $\frac{1}{10}$th constructed for him by Tolles, of Boston, he exhibited for the first time in public Nobert's 19th band as an opaque object.

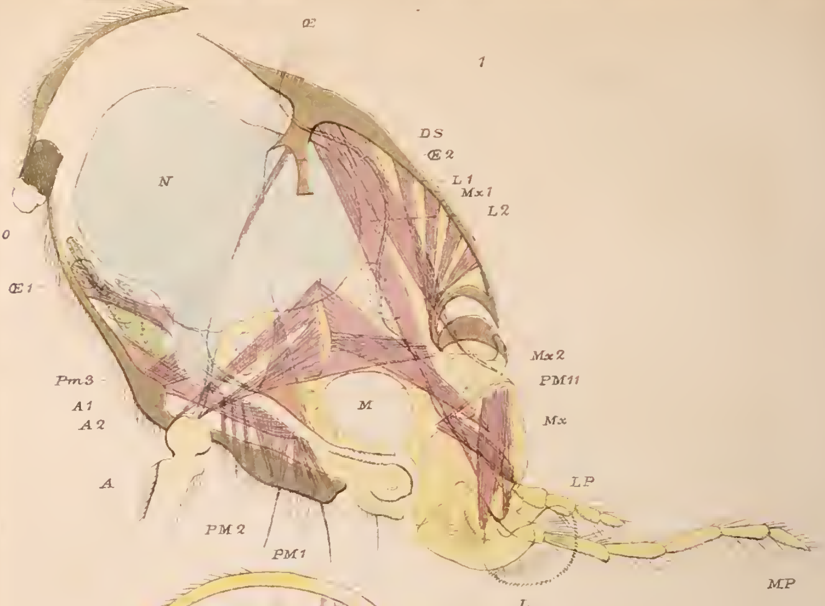
The meeting was largely attended, being honoured by the presence of well-known microscopists from Buffalo and Jamestown, and of the Principals of the New York State Normal Schools who were holding a convention in Fredonia.

Such, then, is the record of the Society for the three brief years of its existence; beginning in the humblest way, it has gradually grown in members and influence, and that without any special effort to make it popular merely for the sake of popularity. While all who have applied for admission have been welcomed, no one, so far as I know, has been solicited to join our ranks. Our expenses have purposely been kept light, and have been paid by the Society entirely out of its own funds, no aid having been solicited or accepted from any outside parties whatsoever, except some donations of valuable books and material from the Smithsonian Institution and others. We have been somewhat hampered for lack of funds to procure books and a permanent abiding place, but the latter want has been supplied by the managers of the Dunkirk Library, who have kindly given us the use of their cosy room in the City Hall building for our meetings, free of all expense. There have been times when I despaired of the success of the Society, when our lack of instruments, of a library, and of rooms of our own, and an apparent falling off in interest on the part of some of our members, disheartened me; but when I come to look back over our record, when I see that a little organization like this, started only three years ago, without money, without influence, and without the prestige of great name, has had such a list of papers, everyone from a resident or corresponding member; when its doings have come to be quoted with respect if not with entire acceptance by the leading organ of our special branch of science in the Old World; when such men as Professor H. L. Smith, the greatest living authority on the Diatomaceæ; Mr. W. H. Walmsley, of Philadelphia; Professor J. E. Smith, of Ashtabula, Ohio, and others of like fame, are not ashamed to be ranked among its corresponding members, I cannot but feel that it is an honour to be a member of the Dunkirk Microscopical Society.

In the past we have exercised a wise liberality; we have done well and wisely in admitting ladies to membership. We have in our papers covered wide ground. Dr. Alling has discovered of our native Lepidoptera, and Rev. Mr. Adams has explained for us some of the wonders of their anatomy. The Rev. Dr. Armstrong has told us of the life-history of the Diatomaceæ, those marvellously minute and beautiful organisms so long tossed about between the animal and vegetable kingdoms. Professor Mark has told us of the Protista, the lowest of organisms, neither animals nor plants, which Haeckel has erected into a kingdom of their own; and Mrs. Shelton has recorded her observations on one of the plants possessing functions heretofore supposed to be the exclusive prerogative of animals. Mr. Fell has treated of the Acarinæ, the miths; and Dr. Alling has set before us the microscopy of the blood, the vital fluid on which our earthly being depends. Professor Smith and Mr. Morehouse have discoursed of methods of illumination and manipulation, and the former has shown us how great skill may be obtained by careful and patient labour, and initiated us to the methods of testing our lenses, which, by discovering their faults, have led to their improvement; and your President has endeavoured to lay before you the principles which govern the construction and use of the microscope itself.

Thus no side of our subject has been neglected; the optical and physical, the test-object side if you will, has received attention, while we have not neglected what a writer in the 'American Naturalist' has somewhat impertinently termed "the legitimate natural history applicatives of the microscope," as if it was not as legitimate to apply the microscope to the investigation or settlement of a moot point in physics as of zoology, histology, or pathology. Once more, then, I ask if the record is not one in which we may take a reasonable pride, and from which we may draw inspiration for renewed efforts to do still better in future. Let us then continue to work together, not for the sake of popularity, not for the sake of reputation, of natural gain, nor even for the material gain our labours may bestow upon the world, but purely for the love of science, and the successes of the past shall be but a feeble prelude to the greater and better successes that are to come.

I have rendered an account of my stewardship; I acknowledge my many shortcomings as a presiding officer and executive; it only remains for me to thank those who have aided us, and especially our Secretaries, Mrs. Shelton and Dr. Alling, for their efficient aid, and to resign my charge into other abler and more energetic hands.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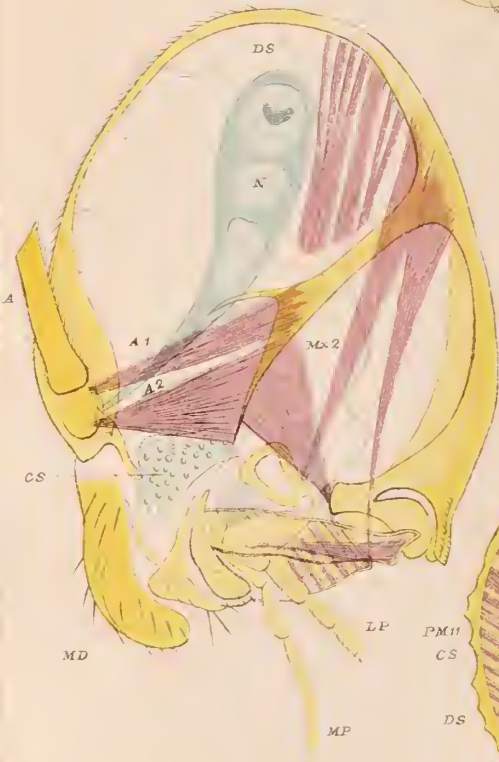
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THE

MONTHLY MICROSCOPICAL JOURNAL.

SEPTEMBER 1, 1877.

I.—*On some Points in the Anatomy of Ants.*

By Sir John Lubbock, Bart., F.R.S., M.P., D.C.L., &c.

(*Being the first Quekett Lecture delivered before the* Royal Microscopical Society, *April* 1877.)

Plates CLXXXIX., CXC., CXCI., and CXCII.

The Council of our Society having, as our excellent President has explained, determined to found an Annual Quekett Lecture, have done me the distinguished honour of requesting me to deliver the first of the series. With this gratifying invitation I cheerfully complied; and the more gladly because though of course I did not know Mr. Quekett as well as some of you who are now present, still, being so much his junior, I was perhaps, on that very account, in one respect, better able to appreciate the kindliness of his nature, and his readiness to assist those who were but beginners in the science of which he was a master. I am glad, therefore, to have this opportunity of expressing my warm acknowledgment of his kindness towards me personally. In commencing the first Quekett lecture, it has been thought not inappropriate that I should give a slight account of the distinguished biologist in whose honour these lectures have been founded—a biologist, moreover, specially distinguished in those branches of natural history with which our Society is peculiarly concerned.

EXPLANATION OF PLATES.

Plate CLXXXIX.

Fig. 1.—Longitudinal and vertical section through the head of *Lasius niger* ♂ × 75.
„ 2.—Longitudinal and vertical section through the head of *Lasius flavus* ♀ × 75.
„ 3.—Longitudinal and vertical section through the head of *Myrmica ruginodis* ☿ × 75.

Plate CXC.

Fig. 1.—Head of *Lasius flavus* ☿ seen from below, showing the arrangement of the muscles × 75.
„ 2.—Longitudinal and horizontal section through the middle portion of the head of *Lasius flavus* ☿ × 75.
„ 3.—Longitudinal and horizontal section through the upper portion of head of *Lasius fuliginosus* ☿ × 75.

[Plate CXCI.

John Thomas Quekett was born at Langport on the 11th August, 1815. From his earliest childhood he seems to have been devoted to the study of nature. This, however, is no special characteristic. Many, perhaps most, children are born with a love of science, which it takes all our so-called education to eradicate. This is generally effected by sowing the entangling tares of grammar, and the dry dates of history, in the virgin soil—so that intellectual tastes are choked by the very process which ought to develope them. In some cases even more direct means are resorted to, as in that of Edwards, of Banff, who was expelled from three schools for his incorrigible (though, it must be admitted, somewhat ill-regulated) love of nature. But even if actual expulsion be not resorted to, the cold shade of indifference, or disapproval, is generally sufficient to check the love of science.

Quekett, however, had none of these evil influences to contend with. His father, the master of the Grammar School at Langport,

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PLATE CXCI.

FIG. 1.—Portion of upper surface of head of *L. flavus* ☿ × 110.
„ 2.— „ „ „ „ „ × 110.
„ 3.—Horizontal section of head of *L. flavus* ☿ × 75.

PLATE CXCII.

FIG. 1.—Upper surface of head of *Lasius flavus* ☿ × 75.
„ 2.—Attachment of abdominal segments of *Lasius flavus* ☿ × 225.
„ 3.—Lobules of cephalic salivary gland of *Formica rufa* ☿ × 75.
„ 4.—Group of cells from labial salivary gland of *Formica rufa* ☿ × 225.
„ 5.—Tibia of *Lasius flavus* ☿ × 75.
„ 6.—Terminal segment of antenna of *Myrmica ruginodis* ☿ × 75.
„ 7.—Bases of labium and maxillæ in *F. rufa* ☿, showing mode of attachment to the head.

REFERENCES TO THE FIGURES.

A.—Antenna.
A.—1–3. Muscles of the antenna.
B.—Labium.
C.—Clypeus.
C S.—Cephalic salivary gland.
D S.—Duct of the salivary gland.
E.—Eyes.
F.—Frontal laminæ.
fl.—Mouth flap.
I.—Antero-posterior cranial apophysis.
L.—Labium.
L.—1–3. Labial muscles.
L P.—Labial palpus.
L S.—Labial salivary gland.
M.—Mouth sac.
M*d.*—Mandible.
M*d.*—1–3. Mandibular muscles.
M P.—Maxillary palpus.
M*x.*—Maxilla.
M*x.*—1 and 2. Maxillary muscles.
M M.—Muscles of mouth flap.
N.—Nervous system.
O.—Ocellus.
œ.—Œsophagus.
œ.—1–3. Œsophageal muscles.
P.—Pharynx.
P M.—1–11. Pharyngeal muscles.
P S.—Pharyngeal salivary gland.
R.—Chitinous rod at base of antenna.
r t.—Recurrent trachea in tibia.
T S.—Thoracic salivary gland.
X.—Conical striated body in tibia.

The transverse striæ of the muscles are not in all cases inserted, nor the external hairs.

encouraged him in his scientific tastes. He was, moreover, the youngest of the family, and his elder brothers shared and fostered his love of natural history. One of them indeed—Edwin—is said to have possessed remarkable ability, and would probably have done much in science, had he not unfortunately died early. He was for some time lecturer on botany at the London Hospital, and may be regarded indeed as the founder of the Microscopical Society.

In their boyish rambles he appears to have been the botanist of the party, while Edward devoted himself to ornithology, and John was the entomologist. Accompanied by their sister Eliza, their inseparable companion on such excursions, they had many a pleasant day along the banks of the Parret, in the rich meadows of Langport, and among the woods and ruins of Muchelney. Thus they gradually filled their father's house with treasures, recently presented by Mr. Edward Quekett to the Somersetshire Archæological Society, and placed in the Museum of Natural History at Taunton.

In fact, birds and flowers and insects seem to have been to John Quekett what games are to many children. He is described as "strangely sedate, careless of his appearance, heedless of conventionalities, and unattracted by the ordinary amusements of children." Like many other men with similar tastes, he never seemed quite young, and never grew old.

Microscopes in those days were not so common as they have happily become; Quekett is said to have constructed one for himself out of a roasting-jack, a parasol, and some fragments of brass; and with the assistance of this remarkable instrument to have given, when still only sixteen, a course of lectures at Langport.

Soon afterwards he was apprenticed to his brother Edwin, then practising as a surgeon in the east of London. He studied at the London Hospital, became a licentiate of the Apothecaries' Company, and subsequently a member of the College of Surgeons. In 1840 he obtained there the Studentship in Human and Comparative Anatomy, then recently established. This appointment he held for three years, during which time he formed a large collection of histological preparations, which were subsequently purchased by the College. In 1844 he was nominated Assistant-Conservator of the Hunterian Museum, and on the retirement of Professor Owen in 1856 he was elected his successor, and also Professor of Histology. The rest of his life was spent at the College of Surgeons, and he died at Pangbourne, after a useful, though quiet and uneventful life, on the 20th August, 1861, at the early age of forty-six, leaving behind him four sons.

Professor Quekett's principal works were the illustrated Catalogue of the Hunterian Museum, to which he devoted five years of earnest application; 'Lectures on Histology;' and 'Practical Treatise on the Use of the Microscope.'

He also contributed numerous memoirs, a list of which is hereafter given, to our own and other scientific bodies.

In character Quekett was thoughtful, quiet, gentle, kindly, unobtrusive, and genial; he had a fine massive head, broad forehead, thick eyebrows, and deep-set grey eyes.

As already mentioned, I am glad to have the opportunity of gratefully corroborating, from my own experience, the statement of a writer in the 'Quarterly Journal of Microscopical Science,' that "few men were so ready to assist others in their microscopical difficulties . . . . and a day seldom passed without a portion of his time being devoted to the examination of various morbid structures for his medical friends." *

Papers read by John Quekett at the Meetings of the Microscopical Society, and elsewhere.

I. On an Electro-magnetic Indicator. Sturgeon, Ann. Electr., III., 1838–39, pp. 486–488.

II. Observations on the Blood-discs and their Contents. Microsc. Journ., I., 1841, pp. 65–67.

III. On the presence, in the Northern Seas, of Infusorial Animals analogous to those occurring in a Fossil state at Richmond, in Virginia. Microsc. Journ., II., 1842, p. 28; Ann. Nat. Hist., IX., 1842, p. 66.

IV. On the Minute Anatomy of the Horse-leech, Hæmopis sanguisorba, Sav. Hirudo vorax; Johnston, Newman, Zoologist, I., 1843, pp. 12–17, 88–94, 324–330.

V. Anatomy of four species of Entozoa from the Delphinus phocœna.
Observations resulting from the examination of three porpoises recently dissected. Read August, 1841. Vol. i. p. 44.

VI. Structure of Bats' Hair.
Describing certain peculiarities of structure, in some degree resembling that of feathers. Read October, 1841. Vol. i. p. 58.

VII. Peculiar arrangement of Blood-vessels in the Air-bladder of Fishes.
Especially illustrating the fact that the air-bladder "performs in some fishes some other function than that of a float." Read July, 1842. Vol. i. p. 99.

VIII. Phenomena connected with the movement of Ciliæ in the Common Mussel.
Exhibiting some analogy "to that of the quills in the wings of birds during their flight," or "the feathering of the oar in rowing." Read April, 1844. Vol. ii. p. 7.

IX. Certain peculiarities in the Structure of the Feathers of the Owl tribe.
Describing particularly the "tarbulettes" by which, as distinguished from other birds, noise during flight is avoided. Read January, 1845. Vol. ii. p. 25.

X. Structure of the Flabella of certain Crustacea.
Showing that the use of that organ "is not merely to ensure the formation of currents in the water," but in some of the higher orders, at least, to assist the function of respiration. Read May, 1845. Vol. ii. p. 37.

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* I am indebted to Professor Quekett's family for their courtesy in communicating to me the above particulars of his life, and for the following list of his papers.

XI. Intimate Structure of Bone.

Results by means of continued researches, during which it had been found "that in each of the four great classes of animals the bones present certain peculiarities in their form, which, when once an observer is conversant with them, would be enabled to satisfy himself as to the true affinities of doubtful specimens of organic remains;" that the "same regularity of structure, the same method of arrangement, has existed from the time when the surface of our planet was first inhabited by a vertebrate animal up to the present period." Also, referring to recent investigations of the comparative size of the blood-disc in the "four great classes of animals, drawn up with much care and attention by Mr. Gulliver," suggesting that, as "the bone-cells are the largest in the reptiles, the next largest in the mammal, and the smallest in the bird," "it would indeed be a curious result if it should ultimately turn out that the bone-cells of an animal are always in proportion to the size of the blood-discs;" and that "should this mode of generalizing ultimately prove to be applicable to the bone-cells," as to other tissues, "we shall be able not only to determine the class of a fossil fragment, but to predict the size of the blood particles; and when they are once known, the size and proportion of the other soft tissues may at once be inferred." Read March and November, 1846. Vol. ii. p. 46.

XII. Value of the Microscope in the determination of Minute Structures of a doubtful nature, as exemplified in the identification of Human Skin attached many centuries ago to the Doors of Churches.

Showing that the presence of *hair* is essential for conclusive determination. Read April, 1848. Vol. ii. p. 151.

XIII. Nature of Capillaries, and on the mode of arrangement of those in the Gills of Fishes. Read May, 1847. Vol. iii. p. 1.

XIV. Vascularity of the Capsule of the Crystalline Lens, especially that of certain Reptilia. Read January, 1847. Vol. iii. p. 9.

XV. Elastic Tissue in the Ligamentum Nuchæ of the Giraffe.

Describing certain "transverse markings or striæ, somewhat resembling those of fibrillæ of voluntary muscle in particular animals." "A striated form of elastic tissue has, I believe, never yet been noticed by any anatomist." Read April, 1849. Vol. iii. p. 46.

XVI. Scales of the Viviparous Blenny.

"I found that certain spots which had been described as circular depressions were in reality scales." Read January, 1851. Vol. iii. p. 136.

XVII. Structure of the Raphides of Cactus enneagonus.

Including description of the artificial production of similar bodies in "rice paper," by his brother, Edwin Quekett. Read January, 1852. Quarterly Journal, No. 1, p. 20.

XVIII. Presence of a Fungus and of Masses of Crystalline Matter in the Interior of a Living Oak Tree.

Observations suggested by the sudden fall of a large limb of an oak in Marlborough Forest, in the presence of a picnic party, of which the writer was one. "At one of the early meetings of this Society we had two papers on the 'Decay of Fruit,' in which Dr. Hassall showed that the rottenness of bruised or overripe apples, pears, &c., depended upon the growth of fungi. We have now another instance of it in the oak." Read January, 1853. No. 3, p. 72.

XIX. On the Microscopical characters of the insect White Wax of China. Pharmaceut. Journ., xii., 1853, pp. 482–484.

XX. Minute Structure of a peculiar Combustible Material from the Coal Measures of Torbane Hill—"Boghead Cannel Coal."

Observations undertaken chiefly in reference to a trial in Edinburgh, "having for its object the determination whether the Torbane Hill material should be called a coal or not, and whether it should be included in the missive of agreement for a lease, and let as coal." "With four of these classes of scientific witnesses" (geologists, chemists, &c., &c.) "I have no immediate concern, and will therefore leave them to settle their own differences; but not so with the microscopists, with many of whom my opinions are entirely at variance." The course of the trial was much enlivened by some remarks of the judge, who represented the two principal witnesses (the Professor and Mr. Bowerbank), as not "conversant or skilful in fossil plants," and informed the jury that the Microscopical Society of London "is a learned body who make it their object to pry into all things." Read December, 1853. No. 6, p. 34.

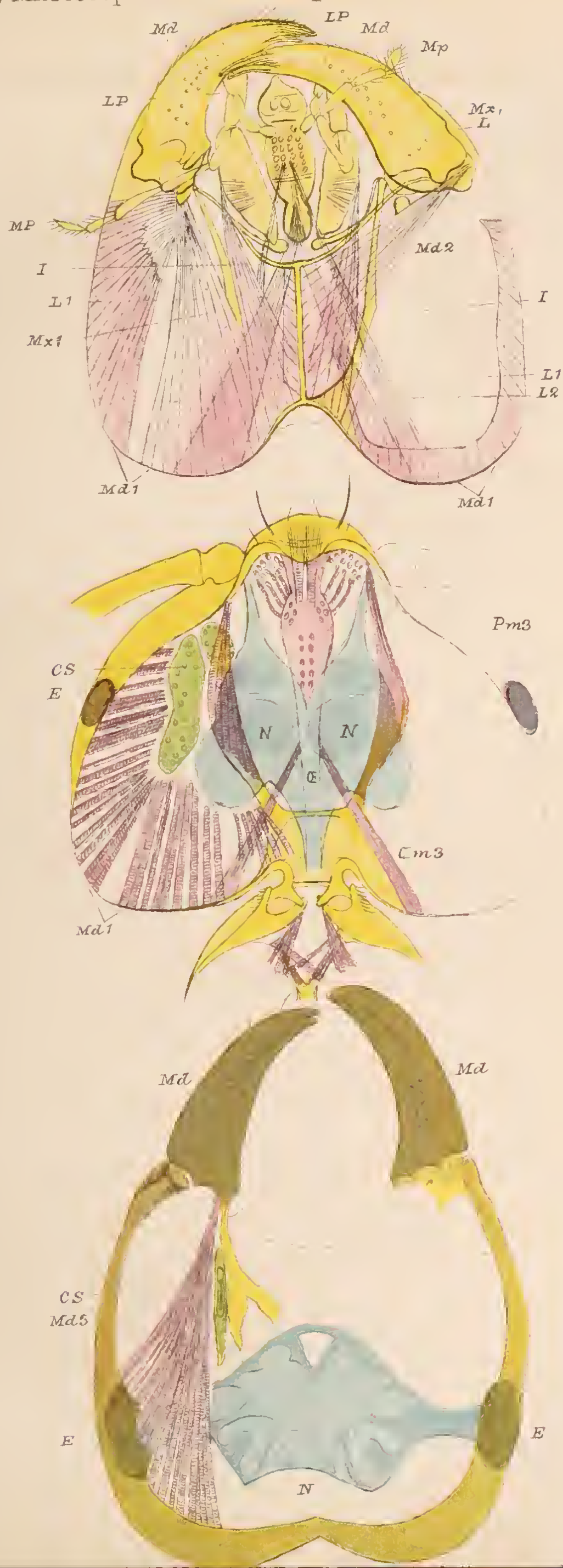
XXI. Structure of the White Filamentous Substance surrounding the so-called Mealy Bug (*Cocus vitis*) of the Vine. Read January, 1857. No. 21, p. 1.

And now, Mr. President, passing to the anatomy of ants, I had hoped to have been able to give, not of course a complete, but at least a more detailed account of their structure than I am now able to lay before you. The pressure, however, of other duties, and the complexity of organization of these wonderful insects, have prevented me from executing the task, which I had set to myself, so thoroughly as I could have wished. I must therefore confine myself within narrower limits, and must express my regret that I cannot deal with the subject in a more satisfactory manner, though I venture to hope that some of the points which I shall have to bring before you are not altogether without interest.

The body of ants consists of three principal parts—the head, the thorax, and the abdomen.

The head is arched above and more or less flattened on the under side. On the upper surface are placed the eyes and the antennæ, in front is the mouth, surrounded by the labrum or upper lip, the first pair of jaws or *mandibles*, the second pair of jaws or *maxillæ*, and the lower jaw or labium. At the posterior end is the occipital orifice, through which the œsophagus, the nervous system, the tracheæ, the duct of the large salivary glands, &c., pass from the head into the thorax.

On the upper side of the mouth, between the mandibles and the antennæ, and forming the front edge of the upper side of the head, is the clypeus (Plate CXCII., Fig. 1, *c*). It is more or less distinctly separated from the rest of the head by a furrow corresponding with an internal inter-antennal ridge, shown in section in Plate CLXXXIX., Fig. 3. The clypeus is sometimes divided by a median ridge. It varies considerably in form in different species, but is generally either quadrangular, or triangular with the broader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CS
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end in front. The front edge of the clypeus is sometimes straight, sometimes arched; sometimes entire, sometimes provided with teeth.

Behind the clypeus is the forehead. Posteriorly it passes imperceptibly into the general upper surface of the head, but at the sides it ends in a sharp escarpment (Plate CXCII., Fig. 1, F F). These lateral edges are generally termed ridges ("Stirnleisten," Mayr), an expression which, however, scarcely gives a correct idea. The forehead is sometimes divided into two halves by a median line. Between the clypeus and the forehead there is in some species a small triangular piece or area frontalis—the stirnfeld of Mayr, aire frontal of Forel.

Along the middle line of the under surface of the head, from the posterior end of the head to the base of the buccal organs, a strong ridge projects inwards. There is also on each side of the head a chitinous process or apophysis (Plate CLXXXIX., Fig. 2, I; Plate CXC., Fig. 1, I), which, originating from the occipital ring, passes forwards and is attached to the anterior wall of the head near the base of the antennæ. Towards the middle of the apophysis exists a wing-like expansion, which, like the apophysis itself, serves as a basis of attachment for muscles.

Plate CXCII., Fig. 1, represents the head of an ant (*Lasius flavus*), ☿, seen from above; and Plate CXC., Fig. 1, that of the same species and sex seen from below. In the former, F are the so-called frontal laminæ (stirnleisten of Mayr). They diverge as they pass backwards. In other species they are parallel, while in some cases they are curved like an S.

The antennæ rise, as just mentioned, under the ridges of the laminæ frontales, sometimes close to the hinder edge of the clypeus, sometimes a little farther back.

They consist of a short spherical basal piece, a long shaft, known as the scape, and a flagellum of from six to seventeen (generally, however, from ten to thirteen) short segments, the apical ones sometimes forming a sort of club. The number of segments is generally different in the males and females.

On each side of the head are the large compound eyes. The number of facets differs greatly in different species, and in the different sexes, the males generally having the greatest number. Thus, in *Formica pratensis* there are, according to Forel, in the males about 1200 in each eye, in the fertile females between 800 and 900, in the workers about 600. Where the workers vary in size they differ also in the number of facets. Thus, again following the same authority, the large workers of *Camponotus ligniperdus* have 500, the smaller ones only 450; while in the Harvesting ant (*Atta barbara*) the contrast is even greater, the large specimens having 230, the small ones only from 80 to 90.

The ordinary workers have in *Polyergus rufescens* about 400, in *Lasius fuliginosus* 200, in *Tapinoma erraticum*, 100; in *Plagiolepis pygmæa*, 70 to 80; in *Lasius flavus*, about 80; in *Bothriomyrmex meridionalis*, 55; in *Strongylognathus testaceus*, *Stenamma Westwoodii*, and *Tetramorium cæspitum*, 45; in *Pheidole pallidula*, about 30; *Myrmecina Latreillei*, 15; *Solenopsis fugax*, 6 to 9; while in *Ponera contracta* there are only from 1 to 5, and in *Typhlopone* the eyes are altogether wanting.

The number of facets seems to increase rather with the size of the species than with the power of vision. The whole subject is one of great interest and difficulty.

The ocelli are never more than three in number, disposed in a triangle with the apex in front. Sometimes the anterior ocellus alone is present. In some species the workers are altogether without ocelli, which, however, are always present in the queens and in the males.

The mouth parts are the labrum, or upper lip; the first pair of jaws or mandibles; the second pair of jaws or maxillæ, which are provided with a pair of palpi; and the lower lip, or labium, also bearing a pair of palpi.

The thorax is generally considered to consist, as in other insects, of three divisions—the prothorax, mesothorax, and metathorax; there are, however, grounds into which I will not at this moment enter, for considering that the first abdominal segment has in this group coalesced with the thorax. Each segment of the thorax bears a pair of legs, consisting of the coxa, trochanter, femur, tibia, and tarsus, the latter consisting of five segments and terminating in a pair of strong claws.

In the males and females the meso- and meta-thorax each bear a pair of wings, which, however, are stripped off by the insects themselves soon after the marriage flight.

The workers never possess wings, nor do they show even a rudimentary representative of these organs. Dr. Dewitz, however, has shown that the full-grown larvæ of the workers possess well-developed "imaginal disks," like those which, in the males and females, develope into the wings. These disks, during the pupal life, gradually become atrophied, until in the perfect insect they bear no trace excepting two strongly chitinized points lying under the large middle thoracic stigmas. No one not acquainted with the original history of these points would ever suspect them to be the rudimentary remnants of ancestral wings.*

Each of the thoracic segments bears a pair of spiracles.

The abdomen consists of six segments, in the queens and workers, that is to say in the females, and seven in the males. The first segment, as a general rule, in the Formicidæ forms a sort of

* 'Zeit. f. Wiss. Zool.,' vol. xxviii. p. 555.

peduncle (known as the scale or knot) between the metathorax and the remainder of the abdomen. In the Myrmicidæ two segments are thus detached from the rest. Forel indeed considers this latter portion as alone constituting the abdomen—or rather speaks as if he did. "Nous appellerons donc," he says, "premier segment de l'abdomen, le second segment réel des deux premières sousfamilles, et le troisième segment réel des Myrmicidæ." This seems to me an ambiguous, and therefore inconvenient system of nomenclature.

The Poneridæ form, as regards the peduncle, and in some other respects, an intermediate group between the Formicidæ and the Myrmicidæ. The second abdominal segment is contracted posteriorly, but not so much so as to form a distinct knot.

The form of the knot offers in many cases valuable specific characters.

I have sometimes been tempted to correlate the existence of a second knot among the Myrmicidæ with their power of stinging, which is wanting in the Formicidæ. Though the principal mobility of the abdomen is given in the former, as in the latter, by the joint between the metathorax and the knot, still the second segment of the peduncle must increase the flexibility, which would seem to be a special advantage to those species which have a sting. It must indeed be admitted that Œcophylla * has a sting, and yet only one knot; but this, of course, does not altogether negative my suggestion, which, however, I only throw out for consideration.

The knot is provided with a pair of spiracles, which, however, are situated, as Forel states, in the front of the segment, and not behind, as supposed by Latreille.

In most entomological works it is stated that the Myrmicidæ have a sting, and that, on the contrary, the Formicidæ do not possess one. The latter family, however, possess a rudimentary structure representing the sting, but it seems merely to serve as a support for the poison duct. Dr. Dewitz, who has recently published † an interesting memoir on the subject, denies that the sting in Formicidæ is a reduced organ, and considers it rather as in an undeveloped condition. The ancestral *Hymenoptera aculeata*, in his opinion, had a large poison apparatus, with a chitinous support like that now present in Formica, from which the formidable weapons of the bees, wasps, and Myrmicidæ have been gradually developed. I confess that I am rather disposed, on the contrary, to regard the condition of the organ in Formica as a case of retrogression contingent upon disuse. I find it difficult to suppose that organs —so complex, and yet so similar—as the stings of ants, bees, and wasps, should have been developed independently. On the

* 'Proc. Linn. Soc.,' vol. v. p. 101.
† 'Zeit. f. Wiss. Zool.,' vol. xxviii. p. 527.

other hand, it is certainly, at first sight, difficult to understand why ants, having once acquired a sting, should allow it to fall into desuetude. There are, however, some considerations which may throw a certain light on the subject. The poison glands are much larger in Formica than in Myrmica. Moreover, some species have the power of ejecting their poison to a considerable distance. In Switzerland, after disturbing a nest of *Formica rufa*, or some nearly allied species, I have found that a hand held as much as 10 inches above the ants was covered with acid. But even when the poison is not thus fired at the enemy from a distance, there are two cases in which the aculeus might be allowed to fall into disuse. Firstly, those species which fight with their mandibles might find it on the whole most convenient to eject the poison (as they do) into the wounds thus created. Secondly, if the poison itself is so intensified in virulence as to act through the skin, a piercing instrument would be of comparatively small advantage. I was amused one day by watching some specimens of the little *Cremastogaster sordidula* and the much larger *Formica cinerea*. The former were feeding on some drops of honey, which the Formicas were anxious to share, but the moment one approached, the little Cremastogasters simply threatened them with the tip of their abdomen, and the Formicas immediately beat a hasty retreat. In this case the comparatively large Formica could certainly have had nothing to fear from physical violence on the part of the little Cremastogaster. Mere contact with the poison, however, appeared to cause them considerable pain, and generally the threat alone was sufficient to cause a retreat.

Turning now to the internal anatomy, the brain in the social Hymenoptera is large and very complex. Its internal structure has been studied by Leydig * and more recently by Rabl Ruckhard † and Dietl. ‡ From the lower and hinder margins of the sub-œsophageal ganglia, two commissures pass through the occipital foramen into the thorax, each segment of which has a ganglion of its own. There is also a small ganglion in the peduncle, and six in the expanded portion of the abdomen, corresponding with the number of the abdominal rings.

The principal parts of the intestinal canal are the pharynx, the mouth sac, œsophagus, ventriculus, pylorus, duodenum, ilium, colon, and rectum. To it belong also the salivary glands and the malpighian vessels. The œsophagus, almost immediately after entering the swollen portion of the abdomen, expands into the ventriculus. Between the ventriculus and the abdomen is the pylorus, characterized by the presence of four flattened, leaf-shaped, chitinous plates. The posterior portion of the pylorus is sunk in the

* Vom Bau des Thier-Körpers, 1864. † 'Ar. f. Anat.,' 1875.
‡ 'Zeits. f. Wiss. Zool.,' 1876.

duodenum, though not so much so as in bees and wasps, where it forms a peculiar organ which I have never yet seen described. The duodenum is short and wide. The malpighian vessels open into the intestine between the duodenum and the ilium. The number varies according to the sex and species, from 4 to 40, the males often having fewer than the females. In the Myrmicidæ, according to Meinert,* they never exceed six in number.

The ilium is a narrow bent tube: the colon is again wider, and bears from three to twelve flattened, circular glands. The rectum is again narrower, and after a short, straight course opens into the cloaca.

The male generative organs consist of the testes—short tubes —contained in a thin common membrane: of a short vas deferens, and two vesiculæ seminales.

In the female generative organs the ovaries consist of short egg-tubes varying in number from 6 to 45. In Myrmica the number varies from 12 to 20. In Formica they are more numerous. According to Leuckart *F. rufa* has from 100 to 120, but Meinert, whom I believe to be correct, only gives 45. *F. fusca* has from 20 to 25; *F. cunicularia* about the same number. Léon Dufour,† indeed, says that Formica has only six egg-tubes, but I think he is perhaps speaking of the workers. The oviduct, to which is attached the seminal capsule, is quite short.

To the cloaca are also attached the poison glands.

After this short general description, the first point to which I should like to draw your attention are the curious organs (Plate CXCII., Fig. 6), first described, so far as I am aware, by Dr. J. B. Hicks in his excellent paper on the "Antennæ of Insects," published in the 22nd volume of the 'Linnean Transactions;' and, again, by Dr. Forel in his 'Fourmis de la Suisse.' These organs seem to me to deserve more attention than they have yet received. Dr. Hicks, after describing the curious champagne cork-shaped sacs (Plate CXCII., Fig. 6, *c*) which occur in the antennæ of ants, and which resemble those in other allied insects, continues: "but, besides, there is another form of what seems to be the same structure, and which has a rather less marked parallel in the antennæ of *Pronæus irritabilis* (to be described next). There will be observed at N, fig. 1 *b b b*, a number of small closing-in membranes, of a diameter of $\frac{1}{4000}$ inch; behind each is a very small sac (Plate CXCII., Fig. 6, *s*), leading to a long delicate tube (*t*), which, bending towards the base, dilates into an elongated sac (*w*), having its end inverted, as may be also seen in the larger sacs (see N, figs. 2 and 3 *b*). What their specific use may be, it is at present impossible to say; but, supposing these organs to be

* 'Danske Videnskabernes Selskabs Skr.,' 1861.

† *Loc. cit.*, pp. 408 and 482.

auditory, we may easily conjecture that they would be able to appreciate notes in a higher key. The nerve in this antenna is well seen, throwing off branches to the organs in its course upwards." *

Forel † also describes these curious organs with some further details. He appears to consider that the number varies considerably, namely, from 5 to 12. My own impression is that this difference is only apparent, and that in reality the numbers in each species vary little. Though sometimes the presence of air renders them very conspicuous, they are in others by no means easy to make out; and I think that when a small number only are apparently present, this is probably due merely to the fact that the others are not brought out by the mode of preparation.

In addition to the group of these organs situated in the terminal segment, there is one, or in some rare cases I have found two, in each of the small preceding segments. The tubes in these segments appeared to the eye to be nearly of the same length as those in the terminal segment, but I could not measure their exact length, as they do not lie flat. In some cases, when the segment was short, the tube was bent—an indication, perhaps, that the exact length is of importance. It is possible that these curious organs may be auditory, and serve like microscopic stethoscopes. Professor Tyndall, who was good enough to examine them with me, concurred in the opinion that this was very probable. I believe I am correct in saying that the bending of the tube in the short segments would make little difference in its mode of action.

As mentioned, indeed, in the 'Linnean Journal' (vols. xii. and xiii.), I have never succeeded in satisfying myself that my ants heard any of the sounds with which I tried them. "I have over and over again made the loudest and shrillest noises I could, using a penny pipe, a dog-whistle, a violin, as well as the most piercing and startling sounds I could produce with my own voice, without effect." At the same time I carefully guarded myself against inferring from this that they are really deaf, though it certainly seems that their range of hearing is very different from ours.

There are indeed some observations on record which certainly seem to indicate that ants possess the power of hearing. Thus, though M. Forel believes that ants possess no power of hearing, several of his very interesting observations point in the opposite direction. For instance, on one occasion an army of Amazon ants (*Polyergus rufescens*) was making an expedition to attack a nest of *F. rufibarbis*. They were not, however, quite acquainted with the locality. At length it was discovered: "aussitôt," he observes, "un nouveau signal fût donné et toutes les amazones s'élancèrent dans cette direction." On another occasion he says: "Je mis un gros tas

* 'Trans. of Linnean Soc.,' p. 391, vol. xxii.
† 'Fourmis de la Suisse,' p. 301.

de T. cæspitum d'une variété de grande taille à un décimètre d'un des nids d'une colonie de Pheidole pallidula. En un clin d'œil l'alarme fut répandue, et des centaines de Pheidole se jetèrent audevant de l'ennemi."

The species of *Camponotus*, when alarmed, "non seulement se frappent vivement et à coups répétés les uns les autres, mais en même temps ils frappent le sol deux ou trois fois de suite avec leur abdomen, et répètent cet acte à de courts intervalles, ce qui produit un bruit très marqué qu'on entend surtout bien lorsque le nid est dans un tronc d'arbre." *

It would even seem that some species understand the signs of others. Thus *F. sanguinea*, he says,† is able to seize "l'instant où les Pratensis se communiquent le signal de la déroute, et elles savent s'apprendre cette découverte les unes aux autres avec une rapidité incroyable. Au moment même où l'on voit les Pratensis se jeter les unes contre les autres en se frappant de quelques coups rapides, puis cesser toutes résistance et s'enfuir en masse, on voit aussi les Sanguinea se jeter tout-à-coup au milieu d'elles sans la petite retinue, mordant à droite et à gauche comme des Polyergus, et arrachant des cocons de toutes les Pratensis qui en portent."

I am indebted to Mr. Francis Galton for the following quotation from Col. Long's recent work on Central Africa: ‡—"I observed," he says, "the manner of catching them" (the ants, for food), "as here pictured" (he gives a figure). "Seated round an ant-hole were two very pretty maidens, who with sticks beat upon an inverted gourd, 'bourmah,' in cadenced time to a not unmusical song, that seduced from its hole the unwary ant, who, approaching the orifice, was quickly seized." (The species of ant is not mentioned.)

Dr. Landois, in his excellent little work on the voice of Animals,§ has called attention to a structure in ants which, so far as I am aware, had not previously been observed, and which he considers to be an organ for the production of sound. Kirby and Spence were, I believe, the first to notice that an allied Hymenopterous insect, *Mutilla Europœa*, has the power of making a sibilant, chirping sound, but they did not ascertain how this was effected. Goureau subsequently called attention to the same fact, and attributed it to friction of the base of the third segment of the abdomen against the second. Westwood,¶ on the other hand, thought the sound was produced "by the action of the large collar against the front of the mesothorax." Darwin, in his 'Descent of Man,' adopts the same view. "I find," he says,** "that these surfaces (i. e. the over-

* *Loc. cit.*, p. 355. † *Loc. cit.*, p. 359.
‡ 'Central Africa,' by Col. C. C. Long, p. 274.
§ 'Thierstimmen,' von Dr. H. Landois, Frieburg, 1874.
‖ 'Ann. de la Soc. Ent. de France,' 1837.
¶ 'Modern Class of Insects,' vol. ii.
** 'Descent of Man,' vol. i. p. 366.

lapping portions of the second and third abdominal segments) are marked with very fine concentric ridges, but so is the projecting thoracic collar, on which the head articulates; and this collar, when scratched with the point of a needle, emits the proper sound." Landois, after referring to this opinion, expresses himself strongly in opposition to it. The true organ of sound is, he maintains,* a triangular field on the upper surface of the fourth abdominal ring, which is finely ribbed, and which, when rubbed, emits a stridulating sound. It certainly would appear, from Landois' observations, that this structure does produce sound, whether or not we consider that the friction of the collar against the mesothorax may also assist in doing so.

Under these circumstances, Landois asked himself whether other genera allied to Mutilla might not possess a similar organ, and also have the power of producing sound. He first examined the genus Ponera, which, in the structure of its abdomen, nearly resembles Mutilla, and here also he found a fully developed stridulating apparatus.

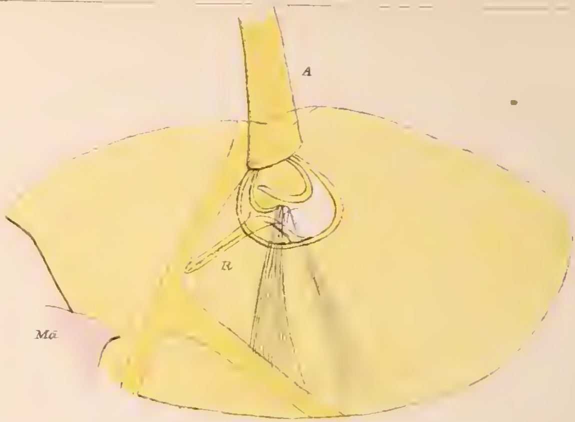
He then turned to the true ants, and here also he found a similar rasp-like organ in the same situation. It is indeed true that ants produce no sounds which are audible by us; still, when we find that certain allied insects do produce sounds appreciable to us by rubbing the abdominal segments one over the other; and when we find, in smaller species, an entirely similar structure, it certainly seems not unreasonable to conclude that these latter also do produce sounds, even though we cannot hear them. Landois describes the structure in the workers of *Lasius fuliginosus* as having 20 ribs in a breadth of 0·13 of a millimeter. He gives no figure, however. Plate CXCII., Fig. 2, represents the junction of the second and third abdominal segments in *Lasius flavus*, × 225, as shown by a longitudinal and vertical section. There are about ten well-marked ribs (r), occupying a length of about $\frac{1}{100}$ of an inch. Similar ridges also occur between the following segments.

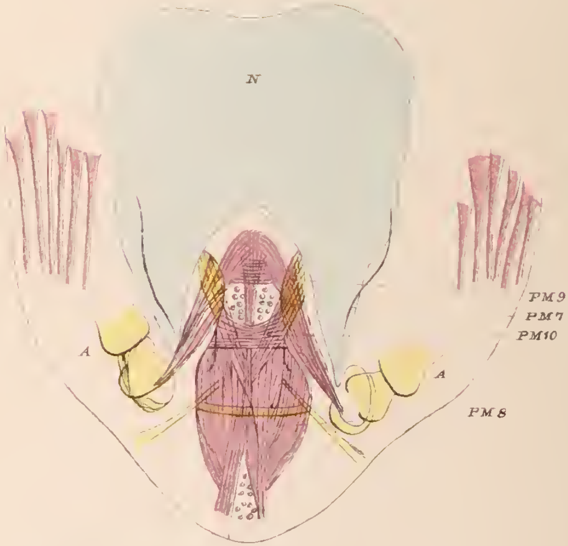
In connection with the sense of hearing there is another very interesting structure to which I must now call your attention. In the year 1844, Von Siebold described† a remarkable organ which he had discovered in the tibiæ of the front legs of Gryllus, and which he considered to serve for the purpose of hearing. These organs have been also studied by Burmeister, Brunner, Hensen, Leydig, and others, and have recently been the subject of a monograph by Dr. V. Graber,‡ who commences his memoir by observing that they are organs of an entirely unique character, and that

* *Loc. cit.*, p. 132.

† 'Uber das Stimm. und Gehörorgan der Orthopteren.' Wiegmann's Art. f. Natur., 1844.

‡ 'Die Tympanalen Sinnes apparate der Orthopteren.' Von Dr. Vitus Graber, 1875.





J. Lubbock del. W. West & Co. lith.

nothing corresponding to them occurs in any other insects, or indeed in any other Arthropods.

I have therefore been very much interested by discovering in ants a structure which seems in some remarkable points to resemble that of the Orthoptera. As will be seen from a glance at Dr. Graber's memoir, and the plates which accompany it, the large trachea of the leg is considerably swollen in the tibia, and sends off, shortly after entering the tibia, a branch which, after running for some time parallel to the principal trunk, joins it again. See, for instance, in his monograph, plate ii., fig. 43; plate vi., fig. 69; plate vii., fig. 77; &c.

Now, I have observed that in many other insects the tracheæ of the tibia are dilated, sometimes with a recurrent branch. The same is the case even in some mites. I will, however, reserve what I have to say on this subject, with reference to other insects, for another occasion, and will at present confine myself to the ants. If we examine the tibia, say of *Lasius flavus*, we shall see that the trachea presents a remarkable arrangement (Plate CXCII., Fig. 5), which at once reminds us of that which occurs in Gryllus and other Orthoptera. In the femur it has a diameter of about $\frac{1}{3000}$ of an inch; as soon, however, as it enters the tibia, it swells to a diameter of about $\frac{1}{500}$ of an inch, then contracts again to $\frac{1}{800}$, and then again, at the apical extremity of the tibia, once more expands to $\frac{1}{500}$. Moreover, as in Gryllus, so also in Formica, a small branch rises from the upper sac, runs almost straight down the tibia, and falls again into the main trachea just above the lower sac.

The remarkable sacs (Plate CXCII., Fig. 5, *s s*) at the two extremities of the trachea in the tibia, may also be well seen in other transparent species, such, for instance, as *Myrmica ruginodis* and *Pheidole megacephala*.

At the place where the upper tracheal sac contracts (Plate CXCII., Fig. 5), there is, moreover, a conical striated organ (*x*), which is situated at the back of the leg, just at the apical end of the upper tracheal sac. The broad base lies against the external wall of the leg, and the fibres converge inwards. In some cases I thought I could perceive indications of bright rods, but I was never able to make them out very clearly. This also reminds us of a curious structure which is found in the tibiæ of Locustidæ, between the trachea, the nerve, and the outer wall, and which is well shown in some of Dr. Graber's figures.

Although I am not yet able to give anything like a complete or satisfactory account of the structure of the head, partly in consequence of its minuteness and partly of its complexity, still I hope to be able to bring before you some points of interest. Meinert's admirable memoir, "Bidrag til de Danske Myrers Naturhistorie,"*

* 'Danske Vid. Selskabs Skr.,' 1861.

gives a good account of the anatomy of ants, especially with reference to the digestive and reproductive organs. The cephalic ganglia, as already mentioned, have been described by Leydig and Rabl Ruckhard, but no one has yet described the muscular system, to which therefore I have specially directed my attention.

According to Burmeister, the antennæ in insects "have three muscles which move them—an extensor, which originates from the forehead in front of the eyes, and affixes itself to the exterior margin of the basal joint; a flexor, which originates from the anterior apex of the inside of the skull, and affixes itself to the inner margin of the basal joint; and an elevator, which originates exteriorly contiguous to the extensor from the margin of the eye, and inserts itself at the lower margin of the basal joint."

This description, which is given as applicable to insects generally, appears to be founded mainly on Strauss-Durckheim's account of Melolontha. It certainly, however, does not apply to Formica, in which two of the muscles arise, not directly from the skull itself, but from the lateral branches of the antero-posterior cranial apophysis. Plate CLXXXIX., Fig. 1, A 1 and A 2, Fig. 2, A 1 and A 2.

It would be very interesting to work out the gradual stages through which this remarkable difference was effected.

One of these muscles draws the antenna forwards, the hinder one outwards. There is also a smaller muscle which draws the antenna backwards and upwards. Below the attachment of the antenna is a chitinous process (Plate CXCI., Fig. 1, R), which is free at the lower end, while at the base of the antenna it divides into two branches, which are attached to the lower ring of the antenna.

The more or less flexible portion of this rod is bent when the antenna's muscles contract, and when they relax the elasticity of the rod at once brings the antenna back into its normal position.

This mechanism, therefore, differs very much from that of Melolontha, and from the general descriptions given by Burmeister. Mr. Busk, who has been good enough to look through my preparations with me, concurs in the above view.

The mouth, as will be seen in Plate CLXXXIX., Figs. 1 and 3, opens immediately above the labium, or lower lip. Various opinions have been entertained by different naturalists as to the true position of the mouth in Hymenoptera. Swammerdam considered the proboscis of bees as their mouth, regarding it as a tube through which liquid was sucked up. He recognized, however, that wasps had another channel through which they took in nourishment. Réaumur thought that in wasps the mouth was situated on the under side of the proboscis. Latreille appears to have mistaken the entrance into the salivary duct for the mouth. Treviranus, like Swammerdam, regarded the proboscis of bees as a hollow tube, through which fluid could be sucked up. I merely refer to these opinions to show the difficulty of determining the true relations and functions of these complex organs.

Savigny appears to have been the first who arrived at a correct view of them. More detailed accounts have subsequently been given, especially by Brants,* Meinert,† and Wolff,‡ while we are also indebted to Dr. Hermann Muller for excellent descriptions and figures, firstly, in a special memoir on the application of the Darwinian theory to bees, § and, secondly, in his admirable work on the fertilization of flowers by insects.‖

The description which Dr. Brants has given of the mouth and pharynx of the wasp coincides generally with what I have been able to observe in the ant. I am happy, moreover, to find myself generally in accord with the views and descriptions given by Meinert in his excellent memoir. His figures, however, give the various internal organs after removal from the body. I have, on the contrary, used principally thin sections taken from imbedded specimens.¶ This mode of examination shows well the relative position of the various parts, and especially the arrangement of the muscles, so that I venture to hope that my observations may in some measure serve to supplement those of previous authors.

The labium of *Lasius flavus* is horny, and emarginate, though less so than in some other species of Formicidæ; as, for instance, in *Formica rufa*. In both these species the margin of the clypeus is entire, while in other species, as for instance in *Atta barbara*, it is toothed.

The mandibles are strong, horny, and convex exteriorly. When seen in profile they show seven strong, blunt teeth—that is to say, in the workers. At the base is a pyriform gland. The mandibles differ in the different sexes, and in certain species, as for instance in *Melissotarsus Beccarii*, recently described by Emery, and in the remarkable genus Pheidole there are two classes of workers which differ in the form of the mandibles.

The mandibles of the slave-making *Polyergus rufescens* are very unlike those of other Formicidæ. They are generally described as toothless; the margins are, however, crenate. It is interesting that those of Strongylognathus, which is also a slave-making species, have a similar character.

The maxillæ of *L. flavus* (Plate CLXXXIX., Figs. 1, 2, 3 *mx*; Plate CXC., Fig. 1, *mx*), though not so strong as, are more

* 'Tydschrift voor Natuurlike Gesch. en Phys.,' 1841.

† 'Danske Vid. Selskabs,' 1861, p. 275.

‡ 'Das riechorgan der Biene.' V. Dr. O. J. B. Wolff, Nova Acta, Deut. Acad. Natur., 1874.

§ 'Anwendung der Darwinschen Lehre auf Bienen. Verh. d. Naturhis. Vereins für preuss. Rhienlde. u. Westfalen,' 1872.

‖ 'Befruchtung der Blumen durch Insekten,' 1875.

¶ I am indebted for these preparations to Mr. E. J. Newton and Mr. C. Robertson.

complex than, the mandibles. Commencing from the base, the hinge (*cardo*), Plate CXCII., Fig. 7, *e*, is a short, transverse, chitinous rod, somewhat expanded at both ends, if seen from the sides, but if seen in front it is shaped more or less like a racket. It articulates with the stem of the organ, by a short, small, intermediate piece. The stem of the organ is elongated, and bears a few scattered hairs. The base only of the stem is shown in Plate CXCII., Fig. 7. The next segment is so much expanded on its inner side, that it and the following segments almost seem to lie transversely and side by side at the free end of the stem. The inner edge has a row of fine spines. The terminal segment is setose at the extremity, and moreover has a longitudinal row of palisade-like hairs, very closely apposed, and indeed almost touching one another. Diverging from their upper end there is a row of papillæ.

The palpus (Plate CLXXXIX., Figs. 1 and 2 *m p*) is six-jointed. The segments are elongated, the basal is somewhat shorter than the second and third; the fourth is about as long as the first, while the two apical are again rather shorter.

The maxilla of *F. rufa* very much resembles that of *L. flavus*. That of *Polyergus rufescens* is smaller in proportion, but the principal difference consists in the fact that the palpus is only four-jointed, as is also the case in *Atta barbara;* while in other species, as, for instance, according to Westwood, in *Pheidole providens* and *Typhlopone fulva*, there are only two segments.

The labium, or lower lip, is also very complex. It is firmly attached to the maxilla. The basal portion (mentum of Meinert) is compressed laterally, and strengthened by chitinous ridges. At the upper side of the free end are two lobes, known as the paraglossæ, at the base of each of which is a row of rod-like hairs, shaped much like marrow spoons. On the under side rise the labial palpi (Plate CLXXXIX., Figs. 1 and 2 L P), which in Lasius and Formica are four-jointed. Between the paraglossæ and the palpi is a hemispherical cushion, the lingua (Plate CLXXXIX., Fig. 1, L), which shows a beautiful and very complex system of projecting chitinous ridges, which perhaps serve to raise up the fluid nourishment into the mouth. Between the last of these ridges and the paraglossæ is a row of fine orifices. At the extremity of the lingua are two small leaf-shaped laminæ.

The lower lips of *Polyergus rufescens* and of *Atta barbara* are constructed on a very similar plan, but the segments of the labial palpi, like those of the maxillary, are diminished in number, being reduced to three in *Atta barbara*, and two in other species, as, for instance, *Polyergus rufescens*, *Atta cephalotes*, *Pheidole providens*, *Typhlopone fulva*, &c. In *Atta* moreover, the ridges of the lingua appear to be less projecting than in the other species.

Passing now to the muscular system, the largest muscles in the head are those which move the mandibles, and of them the flexors are more powerful than the elevators or extensors. In fact, they occupy a large part of the upper and hinder portion of the head. The fibres are attached separately to the wall of the head, and form two principal groups, which, however, are attached to a single tendon, running to the inner angle of the base of the mandible. They are shown in Plate CXC., Figs. 1 and 2, *md* 1. The spaces between the groups of fibres constituting this muscle are occupied by tracheal sacs. Some of the cut ends of these muscles are also shown in Plate CLXXXIX., Figs. 2 and 3. The elevators (Plate CXC., Fig. 3, *md* 3) are attached to the upper side of the head, and pass downwards and forwards to the inner angle of the mandibles.

The extensor muscles (Plate CXC., Fig. 1, *md* 2) are much less powerful. They rise by several separate fibres along the central neural ridge, and passing forwards and outwards are attached to the external angle of the mandible.

The muscles of the maxillæ, though less powerful, are more complex than those of the mandibles. The principal ones are shown in Plate CLXXXIX., Fig. 1, *mx* 1 and *mx* 2. Plate CXCII., Fig. 7, shows the base of the maxilla with the hinge, or cardo. The organ is thrown outwards by the muscle shown in Plate CLXXXIX., Fig. 1, *mx* 1, while, on the other hand, it is retracted by the muscle (Plate CLXXXIX., Fig. 1, *mx* 2) which is attached to the antero-posterior process. The bases of the maxillæ and labium being firmly attached together, the muscles which move that portion of the labium affect the maxillæ also.

The muscles which move the maxillæ necessarily also affect the labium. The labium has, however, also special muscles of its own. Plate CLXXXIX., Fig. 1, L 1, L 2, and L 3; Plate CLXXXIX., Fig. 3, L 1 and L 2.

In the posterior wall of the mouth is an orifice which leads into a large globular sac (Plate CLXXXIX., Fig. 1, Plate CLXXXIX., Fig. 3, *m*) which was, I believe, first observed by Brants, and to which he gave the name of "Lijmholte." Its membranous walls appear to be firm and elastic. I have not found any muscles attached to it, and presume that it is kept open by the elasticity of the walls. The orifice of the mouth sac can be closed at will by a small flap (Plate CLXXXIX., Fig. 3, *fl*), which is supplied with several muscular fascicles (Plate CLXXXIX., Fig. 3, M M). The cavity generally contains a brown, spongy mass, in which I once (in a specimen of *Formica rufa*) found a small hematoid worm. Brants is of opinion that the mouth sac is emptied by the action of the muscles which retract the proboscis, while the lingualis (*i* in Brants' fig. 11) as he supposes, by raising the hypopharynx, opens the cavity. His account does not seem to me very clear. The mouth sac appears to lie well above the proboscis, so that the retraction of the latter could not, I think, exercise much pressure on the sac, while the contraction of the lingualis, from the relative position of the parts, as shown in Brants' figure, would, as it seems to me, depress the upper walls of the mouth sac, and therefore diminish the cavity. I merely, however, suggest these as difficulties which have occurred to me, and I have great hesitation in expressing an opinion in opposition to that of so good and careful an observer as Dr. Brants.

The explanation, however, which Dr. Brants has given stands necessarily in connection with the function which he attributes to the mouth sac. As he very truly observes, in attempting to determine the function of the mouth sac, we must have regard to the habits of the species in which it occurs. He discovered it, as we have seen, in wasps, and considers that it is absent in bees; hence he infers that it is connected either with the construction of the paper-like cells of wasps, or with the manner in which they feed their larvæ. Adopting the former view, he considers the mouth sac to be an organ in which the cement is prepared with which the particles of wood and other substances are glued together to form the paper-like material of which wasps' nests are composed.

As, however, Meinert has pointed out, this theory is scarcely tenable if we consider that ants also, which do not, as a general rule, build in this manner, also possess a mouth sac.

In fact, as it seems to me, the contents of the mouth sac are not intended only to pass outwards through the mouth, but, on the contrary, into the œsophagus through the pharynx. Hence it is natural that I should regard the mechanism from a different point of view.

In ants, as it seems to me, the general action of the muscles which open the pharynx would tend to empty the mouth sac; those which draw down the lower wall of the pharynx, by directly constricting the mouth sac, while even those attached to the upper wall of the pharynx would tend to empty the mouth sac by sucking out its contents. The muscles of the pharynx, as will be seen by the figures, are very complex.

The anterior wall of the pharynx is drawn downwards by the muscles (Plate CLXXXIX., Fig. 1, and Plate CLXXXIX., Fig. 3, *p m* 1 and *p m* 2) which pass from the anterior wall to the clypeus; it is extended laterally by the muscles (Plate CXC., Fig. 2, *p m* 3) which pass forwards and outwards, to be attached to the head close to the base of the antennæ, while it is drawn backwards and upwards by the muscles (Plate CLXXXIX., Fig. 1, and Plate CLXXXIX., Fig. 3, *p m* 4–6).

It has four sets of constrictors, two running (Plate CXCI.,

Fig. 2, *p m* 7 and 8) longitudinally along the upper wall of the pharynx, while the others run at right angles to the first, across the upper wall of the pharynx (Plate CXCI., Fig. 2, *p m* 9 and 10). Lastly, there is a single retractor (Plate CLXXXIX., Figs. 1 and 3, *p m* 11) which is attached to the hinder wall of the pharynx, and passing just over the mouth sac, contracts into a long tendon, which is attached to the end of a short median process of the transverse bar which supports the two antero-posterior processes.

The walls of the pharynx are more or less chitinous, and the lower portion immediately above the entrance to the mouth sac is covered with small teeth, which point downwards. This arrangement is unusual, since in most animals the palatal teeth point backwards, so as to prevent any food which has once entered from returning; and, on the contrary, to promote its passage down the throat. I presume, however, that in ants, which feed principally on animal and vegetable juices, it is advantageous to prevent the entrance of solid particles.

After arriving opposite the antennæ the pharynx arches round and passes into the œsophagus, which then passes directly through the back part of the head, between the great cephalic ganglia, through the thorax, and the constricted portion of the abdomen.

Léon Dufour, indeed, described the front part of the pylorus as lying in the petiole, but, like Meinert, I have found it in all the species which I have examined in the swollen portion of the abdomen.

Shortly before reaching the great cephalic nervous mass, the œsophagus receives a muscle (Plate CLXXXIX., Fig. 1, *œ m* 1) which descends upon it from the upper surface of the head, some little distance in advance of the central ocellus. A little farther back it receives also the anterior ends of three retractor muscles. One of these passes backwards, and is attached just above the posterior end of the retractor of the pharynx to the median process of the crossbar connecting the antero-posterior processes. Plate CLXXXIX., Fig. 1, *œ* 2.

The other two (Plate CXC., Fig. 2, *œ m* 3) are attached, one on each side, to the upper posterior wall of the head, whence they pass straight forward, and are attached to the sides of the œsophagus.

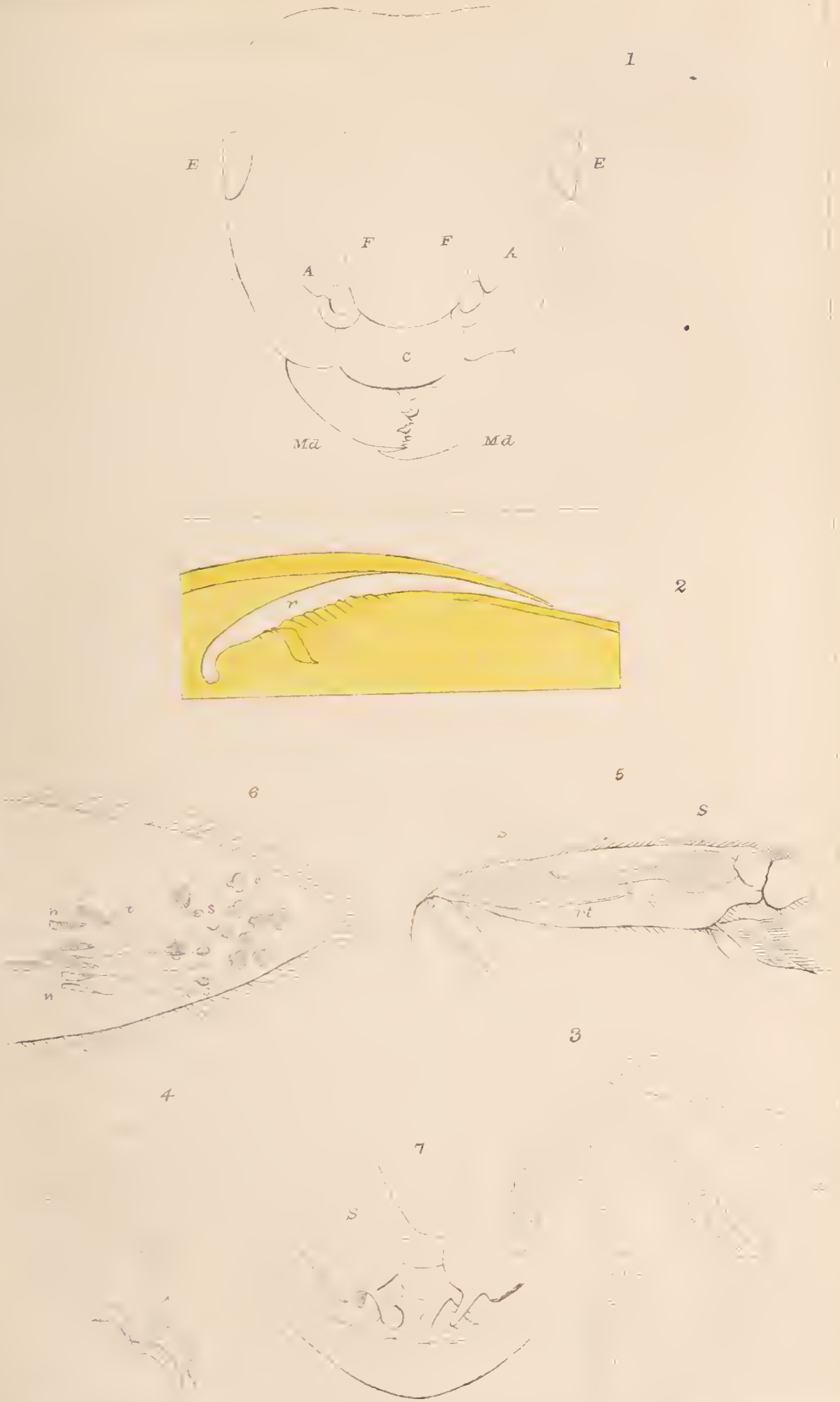
The principal salivary glands are six in number. The largest ones are situated in the upper and anterior part of the thorax. They consist of a number of branched and twisted tubules, which gradually unite into a single duct. This duct then swells into a capacious receptacle, after which it contracts again, and, after joining the corresponding duct from the other side, passes through the neck into the head, and then after a meandering course, as shown in Plate CLXXXIX., Figs. 1–3, D S, opens at the upper side of the under lip. The duct consists of an epithelial layer of cells, within which is a structureless membrane, strengthened, as is so often the case with the ducts of glands, by chitinous ridges, which give it very much the appearance of a trachea.

The cephalic salivary glands (Plate CLXXXIX., Figs. 1–3, *c s*; Plate CXC., Figs. 2 and 3, *c s*; Plate CXCI., Fig. 3, *c s*; Plate CXCII., Fig. 3) are situated on each side of the head, in the space between the supra-œsophageal ganglion, the eyes, and the antennæ. They consist of a number of short, stout tubules, some of which are branched at the base; in *F. rufa* there are about 30, in other species the number is considerably less. They are of a yellowish hue, and, after combining to form a very short duct, open into the pharynx.

The labial salivary glands lie on the under side of the mouth; they are globular in form, and composed of a number of glandular cells (Plate CXCII., Fig. 4), each with a thin hair-like duct; these ducts, according to Meinert, open into a common receptacle.

In addition, there are also two pharyngeal salivary glands, which were, I believe, first observed by Meinert. According to his description, if I understand it correctly, the gland consists of about 20 cells, each with a duct which opens directly into the pharynx, by a separate orifice in the pharyngeal plate.

Thus, then, these glands are curiously dissimilar in structure. It seems not improbable that they differ somewhat in the nature of the secretion to which they give rise. Wolff seems at least to have satisfied himself that this is the case in the hive bee.



W. West & Co. lith.

II.—*List of Plants which afford Raphides, Sphæraphides, Long Crystal Prisms, and Short Prismatic Crystals.*

By George Gulliver, F.R.S.

(*Taken as read before the* Royal Microscopical Society.)

Having often been asked for the names of the plants in which these crystals may be most conveniently examined and distinguished, probably a short list of them, with a few explanatory remarks, would be useful to the students of this interesting and too much neglected branch of microscopic phytotomy. At all events, the present list is wholly the result of my own researches, and I know not that anything like it has ever been published. Figures of the different forms of the crystals are given in 'Hardwicke's Science-Gossip,' May 1873, and in the 'Monthly Microscopical Journal' for December of the same year; and many of my former memoirs on the subject, including extensive observations on the exotic flora, are cited in the Royal Society's 'Catalogue of Scientific Papers.'

As the microscope is now bidding fair to rival—if not supersede—the piano in intelligent families, the present list may form an acceptable guide to a supply of materials for pleasure and profit in an interesting department of microscopic botany, and this too at all seasons; and the objects are in themselves so beautiful, and their preparation and preservation so easy, that slides of them cannot fail to become favourites, as they proved to be when Mr. Hammond exhibited specimens of the different forms of the crystals at a meeting, lately, of the East Kent Natural History Society.

But, quite independently of mere materials for the microscope, plant-crystals deserve far more attention in the cause of science than they have yet received. They are lamentably neglected or confounded, especially as regards the diagnostic characters and taxonomic and physiological significance of the crystals, in our botanical and micrographical books, which will probably have to be corrected by persons who cannot pretend to the rank of botanists. As it might appear invidious to specify the prevailing errors, either of commission or omission, and the names of their authors, I would merely ask the student to consult our current treatises on phytotomy, micrography, and systematic botany, and then compare what is found in those books with what he will easily find far more plainly in the book of nature.

To enter fairly, however, on this true book, we must first understand clearly the diagnostic characters of the crystals; and these, briefly, are as follows:

1. *Raphides.*—Small needle-like crystals, with long rounded shafts gradually tapering to points at the ends, devoid of angles,

and occurring loosely together in bundles of about a score or more, commonly within a cell.

2. *Sphæraphides.*—Globated forms made up of minute crystals or granules, and either smoothish, granular, or still rougher from projecting crystalline tips, and generally within a distinct cell; the cells often forming a tissue, like mosaic work.

3. *Long Crystal Prisms.*—Acicular forms with angular shafts and tips, never occurring loosely in bundles, but either singly or two or more fused together and firmly seated in the plant-tissue.

4. *Short Prismatic Crystals.*—Cubical, long and short squares, polyhedrons, rhombs, and many forms defying definition, though generally more or less prismatic, often not at all so, and occasionally mere crystalline granules; occurring mostly in distinct cells, frequently arranged in chains along the vascular bundles of the leaves and other parts of the plant, or spread in a tissue in the testa.

More ample descriptions are given in my former memoirs. In searching for the crystals, a fragment of the plant should be mashed to a pulp by the point of a penknife in a drop of water on the object-plate, then pressed by a thin cover of glass, and examined under an objective of half-an-inch or deeper focus; and if the part of the plant be first boiled for a few minutes in a solution of caustic potass, the distinctness of the crystals and their cells will be much improved. Thus there can be no difficulty in finding and discriminating the different crystals to which the list is a guide.

It must, however, be borne in mind that several forms may occur either together or in diverse parts in the same plant. To cite a few examples: while raphides are so abundant in the leaves and other parts of Tamus, very fine short prismatic crystals are present in the testa; in Geraniaceæ the sepals contain sphæraphides, and the pericarps the short prismatic crystals; in *Thelygonum* and some Liliaceæ raphides and long crystal prisms occur together; in Vitaceæ raphides and sphæraphides, and so too in Melanthaceæ; in Aceraceæ the leaves have sphæraphides and the short prismatic crystals, while the testa has only the last forms; which, too, are remarkable in the testa of Ulmaceæ, while sphæraphides are contained in the leaves of this order; in several Mesembryaceæ raphides abound, and therewith occur other forms, acicular, flattened, and irregularly angular; in some Commelynaceæ and Bromeliaceæ three or all the four forms of crystals appear together in the leaves and stems. It is further noteworthy that, while in the fruit of one Composite plant, as *Serratula tinctoria* or *Centaurea nigra*, the long prisms occur, in the same part of some allied plants, as *Centaurea scabiosa* and *Arctium intermedium*, the short crystals only are found; and this curious specific difference appeared constantly in several specimens from different localities.

In the following list the systematic names are taken from the fourth edition of Professor Babington's 'Manual of British Botany,' and in most cases the orders only are given; while, except a few common and excellent examples printed in italics, the list is confined to our native plants, and to these only the concluding remarks on the taxonomic value of raphides refer. Even as regards the British flora, this list of plants which afford crystals is neither complete nor always unexceptionable; and though to go abroad might add much to the interest, it would extend the subject inconveniently.

I. Raphides.

Balsaminaceæ.	Liliaceæ (part of).
Onagraceæ.	Typhaceæ.
Rubiaceæ.	Araceæ (part of).
Trilliaceæ.	Lemnaceæ (except Wolffia).
Dioscoreaceæ.	*Vitaceæ.*
Orchidaceæ.	*Squill-bulb* (*Urginea*).
Amaryllidaceæ.	*Hydrangia.*
Asparagaceæ.	*Veratrum.*

II. Sphæraphides.

Caryophyllaceæ.	Polygonaceæ (part of).
Geraniaceæ.	*Rhubarb.*
Oxalidaceæ.	*Aralia spinosa.*
Celastraceæ.	Urticaceæ.
Rhamnaceæ.	Tofieldia.
Myriophyllum.	*Passifloraceæ.*
Paronychiaceæ.	Pulp of Pear.
Viburnum lantana.	*Cactaceæ.*
Chenopodiaceæ (part of).	*Tetragonia expansa.*
Mercurialis annua.	*Veratrum.*

III. Long Crystal Prisms.

Inuleæ.	*Sweet Orris.*
Serratula.	*Fourcroya gigantia.*
Centaureæ.	*Guaiacum bark.*
Carduineæ.	*Quillaja bark.*
Silybum.	*Bulb-scales of Onion, Shallot, Garlick,* and *Leek.*
Iridaceæ.	

IV. Short Prismatic Crystals.

Arctium intermedium.	Tiliaceæ.
Centaurea scabiosa.	Aceraceæ.
Cichorium intybus.	Leguminosæ.
Crepis virens.	Amentiferæ.
Crepis biennis.	Testa of Anagallis.

Remarks.

I. *Raphides* afford such valuable natural characters that they must be adopted sooner or later in systematic botany. All the species of the first three orders in this list contain an abundance of raphides, and these three are the only orders of British Exogens so characterized. This may be a more fundamental and universal diagnostic than any other single one afforded by these plants; fundamental, because it appears from the beginning, sometimes in the ovule, and regularly in the seed-leaves and plumule; universal, because thereafter the raphides pervade the plant generally, at all times, in mere fragments of the species, and even after its decay. Thus, for example, a plant of one of these three orders may, at any period of its growth, or even in rotten portions, be surely known from the species of the allied orders. Accordingly, Onagraceæ may be truly and sharply defined thus—Calycifloral Exogens in which raphides abound; and so in like manner of the orders Balsaminaceæ and Rubiaceæ. Though no exceptions to this rule have yet been found in the British flora, it would be rash to assert that none exist; for even some of the best botanical definitions in universal use are by no means unexceptional. And as to the flora of the world, far more investigations are necessary to determine the taxonomic value of the crystals; but we already know they may in many respects afford useful diagnostics in practical pharmacy and gardening. In floriculture, using this character, I have been able to extricate accidental confusion among young thick-leaved things, truly selecting the Mesembryaceæ from the Crassulaceæ, and to distinguish other plants before they had grown above ground in the reserve beds of the garden. Thus we have before us another pleasing and instructive employment for the microscope in rural economy. In pharmacology this kind of diagnosis has long been known; and it is ready for useful service, though not yet enlisted, in the British flora.

II. *Sphæraphides.*—These are more frequent in Exogens than raphides, and are common too in Endogens. The distribution of sphæraphides has not yet been well determined in the British flora, and in the flora of the world has been still less accomplished.

III. *Long Crystal Prisms* are much less frequent than the three other forms, and in British plants are by no means common. In the Compositæ of the above list these prisms are comparatively small; they occur in the fruit, and may be best seen in the ovary while it is yet soft, and seldom or never elsewhere in the plant. The exotic examples mentioned in the list are all excellent, larger, and easily procurable.

IV. *Short Prismatic Crystals* are widely diffused and abundant. In the Compositæ they are, like the long prisms, confined chiefly to the pericarp; and in Leguminosæ form beautiful chains along the vascular bundles, which may be conveniently examined in the leaflets of the common white or Dutch clover, and in the young pods of most species of the order.

CANTERBURY, *July* 24, 1877.

III.—*Observations on the Structure of the Red Blood-corpuscles of living Pyrenæmatous Vertebrates.* By W. H. Hammond.*

In my last paper on the structure of the living blood-corpuscles of a young trout, I pointed out that a nucleus could be plainly seen with a power of a little more than 300 diameters. I have since then extended my observations to the structure of the same corpuscles in the blood of other vertebrates. My first observation was made on a very young duck, and in this bird I was able to see the blood as it flowed in a small vein or capillary just at one part of the web of the foot. I could see plainly with the same power as before that the red blood-corpuscles are circular, with a distinct nucleus, which could be plainly seen both when the corpuscles exposed their broad surfaces, and also when they were sideways. These corpuscles have no cylindrical ring, but are flat from the nucleus to the circumference. My next observations were made on a living minnow and roach; the corpuscles are just like those seen in the young trout with a nucleus, clearly seen with the same power as before. In the living stickleback I noticed that the corpuscles are smaller than those seen in the trout (as is shown in Professor Gulliver's Tables), but of the same shape, and the nucleus is as plainly visible. On another occasion I watched the circulation in some young tadpoles and newts. In the very young tadpole I noticed that the red corpuscles were covered with small round bodies looking like vesicles; the corpuscles were oval when their broad surfaces were exposed, and appeared lanceolate when seen sideways. The corpuscles seemed very elastic, and were easily squeezed out of and resumed their shape when turning a corner. In the small blood-vessels in which the corpuscles flowed in single file, I had a good view of the "tailing out" of the corpuscles; but, with the same power as before, I could not make out any nucleus, though several times I thought I saw a faint appearance of it. In an older tadpole, which had two legs formed, I noticed that the corpuscles had fewer vesicles on them; in other respects they were the same as in the younger ones. In a frog's foot the corpuscles had no vesicles on them.

I then tried to see the circulation under a high power in the tadpole of the frog, in the newt, and in the frog's foot. I used a $\frac{1}{8}$th objective with B, C, and D eye-pieces, and am happy to say that I was successful. I could with this high power see a nucleus in

* It would be well if the author of this paper would refer to the splendid researches of Stricker, Schweigger-Seidel, Max Schultze, and Brücke, the last of whom describes the mammalian blood-globule as consisting of two separate parts, the *zooid* and the *oekoid*. It may be remarked that Mr. Hammond's researches have this especial value, that they are confined to the *living* corpuscles of pyrenæmatous vertebrates.

nearly all the red blood-corpuscles of the tadpole. The corpuscles are oval, and the nucleus is very large. When the corpuscles were sideways, I could plainly see the nucleus projecting on both sides; the nucleus does not project so boldly as in fishes, but is bigger and longer. This accounts for the lanceolate or fusiform appearance when seen under a lower power.

The tailing-off of the red corpuscle is due to the nucleus being displaced to the forward part of the envelope, as shown in the annexed woodcut, and this fact is submitted as one of the proofs of the heterogeneity of the living corpuscle; in other words, that it is a compound body, and by no means simple and structureless.

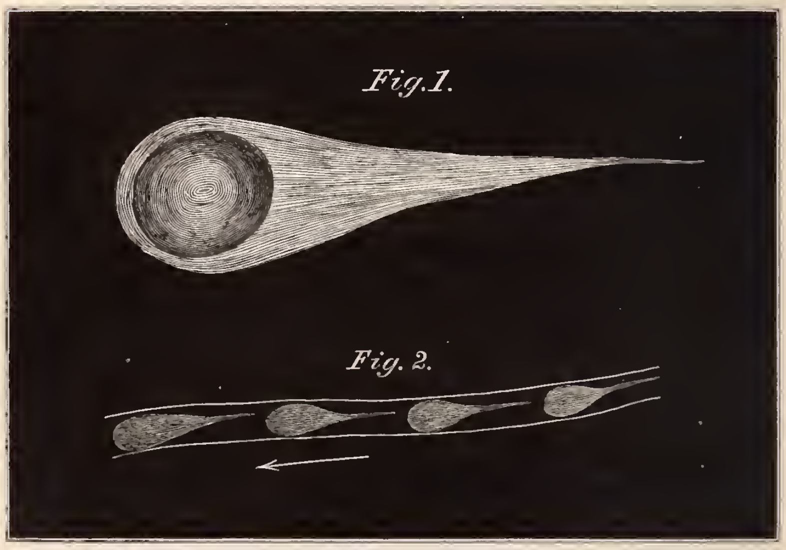


FIG. 1.—Tailing-off of the red corpuscle under a high power.
„ 2.—Tailing-off of the red corpuscle under a lower power.

In the young newt I could also plainly see the nucleus in the corpuscles. They are similar to the frog-tadpole's, but larger; the nucleus is very large, and the marginal portion very thin. I have several times seen this portion double back over the nucleus.

After the newt had been under the microscope some time, the circulation stopped in some of the small veins; the corpuscles then looked circular, were not so transparent, and showed no trace of a nucleus. I would ask, may not this have been the appearance which was seen by Professor Savory, and which led him to the conclusion that the red blood-corpuscles have no nucleus?

In the living blood-corpuscles the nucleus has a very different appearance to what it has when seen in the corpuscles after they have been drawn from the body and put on a glass slide.

In conclusion, I think I have now proved the existence of a nucleus in the living red blood-corpuscles of fishes, batrachians, and birds. I have been as careful as possible when making my observations to guard against errors, and when making the observations under the high power, I sat a whole day watching the circulation in the tadpole of the frog and newt.

I must add that though the nucleus can be seen in fishes very plainly under a half-inch objective, with ordinary illumination, yet in frogs, newts, and tadpoles, it requires a much higher power, and even then, unless the light is carefully regulated, the nucleus may be missed. I used a Webster condenser with the iris diaphragm, and found that as much care was required with the illumination as when resolving difficult diatoms.

August 2, 1877.

NEW BOOKS, WITH SHORT NOTICES.

An Introduction to Practical Histology. By George Thin, M.D. London: Baillière, Tindall, and Cox. 1877.—This is essentially a practical book, by an experienced and thoroughly practical man. To those who are familiar with Dr. Thin's writings, and with his excellent manipulative skill as a worker, and with his valuable conceptions as a thinker, there is no need for any remarks of ours on the subject of his present book. But as we fancy that not a few of our non-medical readers are unacquainted with his valuable labours, a few observations are demanded. And in the first place it must be said that the volume under notice is a book *sui generis.* It is as unlike anything with which the microscopist is acquainted as possible. It is essentially a treatise giving the author's experience of many ways of recent workers, and of many devices of his own for the successful examination of the tissues of the body. Being a volume intended for the medical man alone, it is devoid of illustrations, and we think this is a circumstance to be regretted. Assuredly few know better than the author how completely histology has been modified by the use of particular methods of mounting and of treating tissues. He is well aware that the structure of connective masses and of nerve and muscle has been discovered to be different from what was taught a few years since. It is therefore in our opinion a source of regret that a greater number of cuts have not been used in illustration of the author's observations. But having said this, our criticism is almost entirely favourable to Dr. Thin.

The volume is unfortunately not divided into regular chapters, being, in point of fact, almost continuous throughout. But in the first place the author gives some exceedingly useful hints to the beginner of histology. They are thoroughly practical and to the point. Iodized serum he appears to lay stress on as a fluid for the preparation and preservation of delicate tissues. But it is a pity that in detailing the method of obtaining this fluid, he has not given the exact proportions in which the iodine should be used. Another fluid which appears of special value in cases of amyloid degeneration is the violet of Methylaniline, of which he gives an account of M. Cornil's. Accounts are also given of the best mode of killing animals, and then of injecting them; of the use of Recklinghausen's moist chamber; of the mode of preparing sections of hard tissue with the microtome; and lastly, of the different ways of mounting tissues.

The section devoted to the blood is in our opinion hardly so full as it might be, even for a beginner. Still the author's remarks are always terse and to the purpose. He gives also the mode of estimating the number of corpuscles. But the method he advocates is that of M. Malassez, which, though excellent in its way, is inferior in respect of convenience and of time, to that devised more recently by MM. Nachet and Hayem. With regard to the mode of preventing the corpuscles from running together, he thinks the use of sulphate of soda as an artificial serum is best. After this comes the author's observations on various forms of cells, and on connective tissue in its different varieties. This portion of the work is extremely fully done. It seems to us that the following remarks are of much importance, especially in regard to the distribution of so-called nerves in the cornea:

"Endothelial cells are usually flattened, delicate, frequently somewhat polygonal bodies, with a round or oval nucleus, and form single layers. The cells being usually somewhat rounded, minute angular spaces are left between them, and as these spaces are generally filled by an albuminous substance, they are indicated in silver preparations by a black deposit of albuminate of silver. They are then described as the so-called 'stomata.' These are always seen in silver preparations of serous membranes, and are especially marked if the albuminous substance has not been previously removed in part by irrigation with water."

The author's observations on the study of connective tissue generally are peculiarly instructive, and will be read with interest by the practical worker. His modes of preparation are very various; some of them are very lengthy, and many of them are of his own devising. In this part there is a curious argument in support of the view that certain spiral fibres are elastic ones, which, however, appears to be the correct aspect of the matter. The subject of bone is not one that the ordinary student takes up to work at with pleasure. It gives him too much trouble. Still he will find from the author's account of Von Ebner's recent researches that there are many novel points of interest connected with this matter. The subjects, too, of muscle—especially voluntary—nerve-fibres, the pacinian corpuscles, the heart, the lymphatics, the intestinal canal, the liver, the spleen, and the kidneys are all dealt with fairly, and some of them at considerable length. It is when we come to the brain and spinal cord that we find the author has not done his work fully. In fact, this, which is a most important branch of histology at present, is left almost untouched. We wonder why this part of the work has been so briefly dealt with; and we suppose it is because Dr. Thin considers it too vast to be introduced into a mere student's handbook. However, this absence is almost compensated for by the extremely long and lucid explanations which the author has given with regard to the structures of the eye and the best modes of examining them. This chapter, almost the last in the volume, is full to overflowing, of useful hints and suggestions to the practical histologist. Indeed, we have never before read of the long-detailed process which he gives for the preparation of the cornea for investigation, but we doubt not it will be found useful by those who have sufficient experience to put it in practice.

Indeed, it will be evident from what we have already said that this book of Dr. Thin's is a vast accumulation of original and other modes of examining the tissues, and that it is tersely worded. If we have any complaint to urge, in concluding our notice of his labours, it is that in preparing his volume he seems not to have possessed that faculty of "licking into shape," as the somewhat vulgar phrase goes, the various masses of his work. If this is borne in mind by the author in preparing his next edition, the result will be eminently satisfactory.

PROGRESS OF MICROSCOPICAL SCIENCE.

Bacteria and Vibrios.—We wish much that some one who is familiar with microscopic research would undertake the naming and description of these bodies. There has been a recent effort made in this direction on the Continent, but it is not entirely satisfactory. And it is the more necessary because in some recent investigations into the relations of bacteria to the disease of cattle, termed *Charbon* by the French, M. Pasteur has made some startling observations. He has asserted that bacteria may present themselves under two forms—first, as the rods which alcohol, compressed oxygen, desiccation, and a temperature lower than 100° C. can destroy; and, secondly, as highly refracting corpuscles which, on the other hand, resist a temperature of 120°, and resist also the action of alcohol and of compressed oxygen. These he regards as a mode of generation of the bacteria. They do, of course, also multiply by segmentation, but often, on one or several points of the bacterium, globular, highly refracting corpuscles arise, the diameter of which is not greater than the thickness of the bacterium. After these appear, the rest of the rod quickly disappears. If an appropriate liquid is inoculated with these corpuscles bacteria are developed in it just as if the liquid were inoculated with rod-like bacteria, and they constitute the resisting power of the liquids experimented on by some authors. However, we should like to have the evidence of some experienced microscopist on this subject.

Dr. Roberts on Spontaneous Generation.—Few higher authorities could be cited on the question whether spontaneous generation takes place or not than the gentleman who last month (August) delivered the address on medicine before the British Medical Association at Manchester. His remarks on that occasion, of course, referred to the question of the origin of infectious disease. He said, though the notion of contagious diseases arising from some minute organisms had existed since remote ages, only since the time of Pasteur had this idea assumed the form of a serious pathological doctrine. The discovery during the last decade of organisms in the blood, and their extensive influence upon the treatment of wounds, under the guidance of Professor Lister, had brought to this question universal attention. The author detailed carefully-conducted experiments showing a supported analogy between the action of the yeast plant in fermentation. Also of the *Bacillus subtilis*, and the action of certain contagious fevers. As in small-pox, so in the experiments detailed, there was alike in both cases the same succession of events—viz. a period of incubation, followed by a period of disturbance, succeeded by a period of subsidence, and finally restoration to the normal state. There was also great increase of the infective material, and immunity from further attack by the same contagion. Saprophytes, of which the yeast plant and the bacillus are types, are the essential agents in all fermentations, decompositions, and putrefactions, the vast importance of which in the economy of nature and the life of man we are only beginning to realize. All the organisms hitherto found associated with infective inflammations and contagious fevers are of the tribe of bacteria, and in order to a fuller understanding of this association a further knowledge of the origin and attributes of these organisms is necessary; a circumstance to which we have referred elsewhere in the present number (p. 152). In connection with the origin of these organisms the aphorism *Omne vivum è vivo* had been assailed. It had been alleged that their origin may be spontaneous by a process of abiogenesis, and that they are not the agents but the products or accompaniments of decomposition. These allegations are, the lecturer said, unsustainable, and he proposed to prove that these bacteria, like other organisms, arise from pre-existing parent germs, and in no other way, and that they are the actual agents in all decomposition and putrefaction. After a minute account of certain other experiments the author claimed to have established: 1st. That organic matter has no inherent power of generating bacteria, and no inherent power of passing into decomposition. 2nd. That bacteria are the actual agents of decomposition. 3rd. That the organisms which appear as if spontaneously in decomposing fluids owe their origin exclusively to parent germs derived from the surrounding media. Facts, apparently contradictory to these propositions, were due to its being not understood till lately that while living monads are killed by a temperature of 140°, the spores of the same variety of monad may survive a temperature of 300°, and that therefore the spores of bacteria may probably survive the feebler heat of boiling water. The practical point to be noted is that a contagium consists in the majority of cases of an independent organism or parasite, and that all infective diseases conform in some fashion to one fundamental type. If septic bacteria are the cause of septicæmia, if the spirilla are the cause of relapsing fever, if the *Bacillus anthracis* is the cause of splenic fever, the inference is almost irresistible that other analogous organisms are the cause of other infective inflammations and of other specific fevers. The occasional production of diphtheria by scarlet fever, the author explained by the capacity for variation or sporting of the contagium in question. And in the same way he suggested an explanation for the otherwise unaccountable occasional outbreak of cholera in India; the cholera virus in this case being an occasional sport from some Indian saprophyte which, by variation, has acquired a parasitic habit, and having run through countless generations, either dies out or reverts to its original type. In concluding, the author said, "I believe that the doctrine of a contagium vivum is established on a solid foundation, and that the principle it involves, if fairly grasped in capable hands, will prove a powerful instrument of future discoveries."

The Address to the British Association by Dr. Allen Thomson, F.R.S., is, so far as biology is concerned, everything that could be desired. It is a masterly summary of the great principles that have been supported by Darwin, Spencer, Huxley, and others, together with an admirable epitomo of the results that have been arrived at by those who have studied the development of animal life in all its lower stages, and those who have worked out the development especially of the vertebrate sub-kingdom. The address will bo found fully reported in 'Nature,' Aug. 16. Tho only fault we have to find is that Dr. Allen Thomson has not correctly named either this Journal or its quarterly rival, in the notes he has given references.

Decision (?) of the French Academy, on the discussion between M. Pasteur and Dr. Bastian, in reference to spontaneous generation.—Dr. Bastian has sent to 'Nature' and to the 'British Medical Journal' tho correspondence which he has had with M. Dumas in regard to this subject, and a statement of the general results. From these it seems that Dr. Bastian has been treated with a good deal of rudeness by the French authorities, and it also appears that no experiments were made, and that Dr. Bastian has returned to London without having entered on the subject at all. We have seen no French account of the transactions yet, and until we do we must reserve our comments to the next or some future number.

General conclusion of the President of the British Association.—In summing up his remarks (Aug. 14), the President said:—"In tho statement which I have made of some of the more remarkable phenomena of organic production—too long, I fear, for your endurance, but much too brief to do justice to the subject—it has been my object mainly to show that they are all more or less closely related together by a chain of similarity of a very marked and unmistakable character; that in their simplest forms they are indeed, in so far as our powers of observation enable us to know them, identical; that in the lower grades of animal and vegetable life they are so similar as to pass by insensible gradations into each other; and that in the higher forms, while they divergo most widely in some of their aspects in the bodies belonging to the two great kingdoms of organic nature, and in the larger groups distinguishable within each of them, yet it is still possible, from the fundamental similarity of the phenomena, to trace in the transitional forms of all their varieties one great general plan of organization.

"In its simplest and earliest form that plan comprises a minute mass of the common nitrogenous hydrocarbon compound to which the name of protoplasm has been given, exhibiting the vital properties of assimilation, reproduction, and irritability; the second stage in this plan is the nucleated and enclosed condition of the protoplasmic mass in the organized cell. We next recognize the differentiation of two productive elements, and their combination for the formation of a more highly endowed organizing element in the embryonic germ-sphere or cell; and the fourth stago of advance in the complexity of the organizing phenomena is in the multiplication of the fertilized embryo-cell, and its conversion into continuous organized strata, by further histological changes in which the morphological foundations of the future embryo or new being are laid.

"I need not now recur to the further series of complications in the formative process by which the bilaminar blastoderm is developed, and becomes trilaminar or quadrilaminar, but only recall to your recollection that while these several states of the primordial condition of the incipient animal pass insensibly into each other, there is a pervading similarity in the nature of the histological changes by which they are reached, and that in the production of the endless variations of form assumed by the organs and systems of different animals in the course of their development, the process of cell production, multiplication, and differentiation remains identical. The more obvious morphological changes are of so similar a character throughout the whole, and so nearly allied in the different larger groups, that we are led to regard them as placed in some very close and intimate relation to the inherent properties of the organic substance which is their seat, and the ever-present influence of the vital conditions in which alone these properties manifest themselves.

"The formative or organizing property, therefore, resides in the living substance of every organized cell and in each of its component molecules, and is a necessary part of the physical and chemical constitution of the organizing elements in the conditions of life; and it scarcely needs to be said that these conditions may be as varied as the countless numbers of the molecules which compose the smallest particles of their substance. But, setting aside all speculation of a merely pangenetic kind, it appears to me that no one could have engaged in the study of embryological development for any time without becoming convinced that the phenomena which have been ascertained as to the first origin and formation of textures and organs in any individual animal are of so uniform a character as to indicate forcibly a law of connection and continuity between them; nor will his study of the phenomena of development in different animals have gone far before he is equally strongly convinced of the similarity of plan in the development of the larger groups, and, to some extent, of the whole. I consider it impossible, therefore, for anyone to be a faithful student of embryology, in the present state of science, without at the same time becoming an evolutionist. There may still be many difficulties, some inconsistencies, and much to learn, and there may remain beyond much which we shall never know; but I cannot conceive any doctrine professing to bring the phenomena of embryonic development within a general law which is not, like the theory of Darwin, consistent with their fundamental identity, their endless variability, their subjugation to varying external influences and conditions, and with the possibility of the transmission of the vital conditions and properties, with all their variations, from individual to individual, and, in the long lapse of ages, from race to race.

"I regard it, therefore, as no exaggerated representation of the present state of our knowledge to say that the ontogenetic development of the individual in the higher animals repeats in its more general character, and in many of its specific phenomena, the phylogenetic development of the race. If we admit the progressive nature of the changes of development, their similarity in different groups, and their common characters in all animals, nay, even in some respects in both plants and animals, we can scarcely refuse to recognize the possibility of continuous derivation in the history of their origin; and however far we may be, by reason of the imperfection of our knowledge of palæontology, comparative anatomy, and embryology, from realizing the precise nature of the chain of connection by which the actual descent has taken place, still there can be little doubt remaining in the minds of any unprejudiced student of embryology, that it is only by the employment of such an hypothesis as that of evolution that further investigation in these several departments will be promoted so as to bring us to a fuller comprehension of the most general law which regulates the adaptation of structure to function in the universe."

Staining the Human Body by administering Nitrate of Silver.—It used to be a common thing some years ago to see a man whose face was reduced to a blackish shade by the habit he had formerly had of taking nitrate of silver. The 'Medical Record' (May 15) says that Dr. Neumann gave an historical sketch of the observations on the effect of administration of nitrate of silver, and described the results of microscopic examination, which he had lately had the opportunity of making. All the cellular organs, the epidermis, the rete Malpighii, the covering of the sweat-gland, the cells of the inner and outer root-sheaths, were quite free from silver. The metal, however, was abundantly deposited in granules in the upper portion of the cutis, also, in a thin layer, in the walls of the sweat-glands, as well as in the connective tissue portion of the hair-follicles, in the sarcolemma of the striated muscles, between the cells of the unstriped muscular fibres, in the neurilemma of the nerves, and in the tunica adventitia, and between the cells of the middle coat of the blood-vessels. The subject was an Italian, aged fifty, who had, during twenty-six years, been in the constant habit of applying nitrate of silver for the removal of enlarged papillæ on his tongue. He had observed, when in hospital, that the nitrate was applied to morbid growths. There was distinct coloration of the conjunctiva bulbi, of the mucous membrane of the mouth and pharynx.

The Microspores of Enteromorphæ compressæ.—In a notice of the memoir 'De Copulatione Microzoosporarum Enteromorphæ compressæ,' (L.) Scripsit J. E. Areschoug, ex Botaniska Notiser, 'Silliman's Journal' says that in their 'Observations sur quelques Algues possédant des Zoospores Dimorphes," Janczewski and Rostafinski called in question the observations of Areschoug in which he maintained that the microzoospores of *Enteromorpha compressa* conjugated. In the present paper, Areschoug gives a detailed account of repeated observations of the conjugation of microzoospores of *Enteromorpha compressa* made during the past summer, and it would appear that

Janczewski and Rostafinski had been too hasty in their criticisms. Areschoug mentions that Wittrock has found zygospores in *Hæmatococcus lacustris* (*Protococcus nivalis*), the existence of which Rostafinski denied.

The Effect of Frost on Chlorophyll Granules.—Herr Haberlandt states that the granules, except in evergreens, undergo changes at 4° to 6° C. The granules thus affected contain cavities (vacuoles), become rent on the outside, and aggregate into larger or smaller masses. The granules which contain starch are more easily destroyed by frost than those which contain none. The chlorophyll in the palisade tissue (the denser parenchyma) is more easily injured than that in the spongy tissue, and the latter than that in the guardian cells of the stomata.

Structure of the Testa in Cucurbitaceæ.—The 'Journal of Botany' gives an abstract of a recent paper on this object in the 'Botanische Zeitung' (December, 1876) by Herr Dr. Fickel. After fertilization of the ovule, the outer (epidermal) layer of cells of the outer integument undergoes division, and gives origin to two underlying cell-zones. In the full-grown seed of most genera the epidermal cells of the testa are provided with bands of thickening, which either extend wholly or partially across the cell, and are then either simple or branched, or else run up and down the cell-wall, the opposite thickenings being sometimes connected by cross-bands. The cell-zone immediately below the epidermis consists either of one layer or several layers, which, in the latter case, are more numerous at the margins of the seed than elsewhere. The succeeding zone is generally several-layered, and the cells being usually very thick-walled, it takes in most instances the principal share both in protection of the embryo and in the due adjustment of the supply of water during germination. The layers of cells lying under this zone and produced from the outer integument, as well as all those derived from the inner integument, remain thin-walled and are pressed together by the growing embryo.

NOTES AND MEMORANDA.

Beck's Vertical Illuminator and Wenham's Reflex Illuminator in Professor J. E. Smith's (U.S.A.) Hands.—The 'Cincinnati Medical News' (June) contains a paper descriptive of Professor Smith's modification of both of these instruments, with the most startling results appended. However, as the improver not only does not state the nature of the modification he has made nor the results of his observations, we are not justified in giving his remarks at any length. Moreover, we must beg of Professor Smith to be a little more cautious in his expression of results. It is not satisfactory to anyone who is at all familiar with modern microscopic research to read either of the following quotations:—"One of my most interesting test-objects, namely, *human blood* disks, are shown by the vertical illuminator in a most remarkable manner, at once inconsistent with the teachings of the books. The matter is receiving my earnest attention, and I simply make this mention now, but at some future time, and after more mature study, I shall report the results to the Dunkirk Society."—"The work obtainable by the use of the oblique prism is very superior; all of the before-mentioned tests, including the same mounted in balsam, are shown by it in a most charming manner. Its resolutions of the Möller plate are quite as acceptable as those obtained with the Wenham 'Reflex.' Its work over human blood disks is truly remarkable, and I may add, not precisely in harmony with that of the vertical illuminator. As before stated, the matter is now engaging my serious attention, and will be again referred to at some future time."

Mr. Gundlach's Reply to Dr. Hunt's Charge.—In our number for July we reprinted an article by Dr. Hunt on "the microscopes of the American Exhibition," in which he says: "It is stated in the 'American Naturalist' for December, that a firm from Rochester, New York, 'hinged the sub-stage bar at the level of the object,' but the small stands exhibited by said firm at the *opening* of the Exhibition were not so made, neither had they any facility for registering obliquity. The firm in question did not grasp Zentmayer's idea at all, and hence can justly claim no priority of invention." To this statement Mr. Gundlach has offered a very calm and temperate reply, which we regret we have not space for in its entirety. (It would occupy more than two pages.) It is addressed to the firm referred to. It states at first that, "For obvious reasons, the 'firm from Rochester, New York,' mentioned in the above note, can be no other than the Bausch and Lomb Optical Company, of this city, and as the microscope department of your company has been under my sole superintendence since you began making these instruments, it must be myself individually who, in the opinion of the writer of said note, failed to 'grasp Zentmayer's idea.' Feeling thus my integrity called in question, I beg leave to submit to you, and to the public generally, the following statement." Then follows a long account of the nature and period of certain inventions. The writer concludes as follows:—"What I contend for and stand ready to prove is, that stands of my construction, exhibited at the opening of the Philadelphia Exposition, had the arrangement of the swinging mirror bar (with diaphragm attached) hinged in the (as near as attainable) optically correct plane of the object, with a view to the use of a solid glass stage without central opening, and the change necessary to fit the same for the use of stages of different descriptions was simply not then effected for want of time. Other stands were then in process of construction, arranged to meet the altered circumstances, and were afterwards exhibited at the Centennial Exhibition in Philadelphia, all of them conceived by me, and executed under my superintendence, before I had seen or heard of Mr. Zentmayer's efforts in the same direction. I may not be the only, nor the first, inventor of this arrangement, and the very moderate amount of inventive faculty involved therein makes it easy to believe that others have conceived the same idea at the same time, or even before me. It is far from me to disparage the honest efforts of others, and to charge plagiarism on anyone; but I believe I am pardonably sensitive when such a charge as is contained in the footnote to Dr. Hunt's article is brought against me, a charge which, as you yourselves well know, is utterly groundless, and entirely inconsistent with the facts in the case."

[We have thought it but fair, as we reprinted Dr. Hunt's paper, to append the above reply. The real state of the case appears to be that of equality between Zentmayer and Gundlach with regard to the question who was first?—Ed. 'M. M. J.']

The Shower of Sand at Rome.—The 'Times' publishes the following note in reference to this remarkable shower which occurred on June 22. It is taken from the account given by an Italian priest:—"The rain of sand continued, although to a smaller extent, on the 23rd of June, on which day the heavens were deeply overcast. The sand fell in small perfectly spherical masses of about $\frac{1}{25000}$ of an inch in diameter, at a *maximum*. It would appear that vesicular vapour, by the action of the wind, had cemented the grains of sand so as to form globules, analogously to what we see on a larger scale in the formation of hail. We are entitled to assert this, seeing the speedy disaggregation of these globules into grains of sand, when brought into contact with a little drop of water in the field of a microscope. The fall on the 22nd was so abundant in Rome that from the amount, 0·25 gramme, gathered on an earthenware disk of 30 centimetres in radius, we argue a fall of not less than eight quintals per square kilometre." The correspondent himself writes: "I am by no means satisfied that the rain was of sand and water. The drops on my drawing paper were easily absorbed by a pocket-handkerchief, and left no stain on the paper; but my drawing still bears many stains from drops which apparently I had not touched. Since then I have washed the sky over with them, and have afterwards sluiced the surface of the paper with water from a sponge; yet there they remain. If sand they be, that material appears to have a most unusually tenacious affinity for the paper. If the drops were of sand and pure water I should expect to find that as soon as the water had evaporated, the sand would no longer adhere to the paper, and that the spots would no longer be on my drawing."

Double and Single Staining Leaves.—A very useful summary of one of the modes of operating for this purpose is given in a letter addressed by Mr. R. L. Peet to the editor of the 'Cincinnati Medical Journal.' It is of some length; but, omitting a couple of pages which contain general remarks alone, the following, though long, is yet a useful summary. Mr. Peet, who, in writing, takes it for granted that the reader has had some experience of balsam-mounting, says:—The first thing to be gravely considered is dishes. There should be three glass jars, with smooth bottoms, holding half an ounce each; two milk-glass jars of about the same capacity; two morphia vials; an earthen bowl, holding a quart; a small tin strainer. This is the least possible outfit for preparing the tissue in question. The remaining appliances for mounting are pre-supposed. Pick the leaf with care (one, say, a half or three-fourths inch long), handling it always by the stem end, and with tenderness, so that pubescence of any kind may not be lost, and the epidermis receive no bruise. Put the leaf in water for two or three hours; then into common alcohol for about the same length of time; then into a morphia vial, into which pour of Labarraque's solution enough to well cover the leaf, corking closely. At intervals of a few hours gently shake the vial. As soon as the chlorophyll has disappeared, which, according to the nature of the leaf, will take place in from two hours to seventy-two, remove the leaf to about a pint of clear, cold water. This water should be changed every three or four hours, and the leaf kept in for at least twenty-four hours, and at most, forty-eight. For example, an *Aucuba japonica*, or a *Magnolia grandiflora*, should, because of their density, remain in the water forty-eight hours, with five or six changes. The thinner and less dense leaves, as *Momordica balsamia*, *oxalis*, or *drosera*, should not lie longer than twenty-four hours. The leaf being washed, it is placed in common alcohol in a jar, enough to cover it. In this it remains for twenty-four hours. After an immersion of one hour in fresh alcohol it is ready for the dye. Sections of leaf, petiole, or twig, require from two to twelve hours in the solution. They may be removed when the natural colour is gone. If they contain much thickened cells, they may remain five or six hours longer. Sections are washed just like leaves, not needing, however, so many changes. Being cleansed of the solution, they are placed in common alcohol for several hours; then into absolute alcohol for at least one hour. If very open in structure, like the *Pontederia*, they should lie four or five hours in absolute alcohol. Single Staining.—For a single colour, logwood is probably the best. That prepared according to Arnold's formula, being redder, is most satisfactory. A small quantity is poured into a jar. The object is immersed for two or three minutes in alum water, then placed in the dye, where it remains, until, on lifting it out, it is found to have quite a dark hue. It is then removed to clear, cold water for ten minutes; then change the water, carefully brushing the object with a camel's-hair brush; then remove to common alcohol for two hours; after that to absolute alcohol for one hour; to oil of cloves, until, on holding it to the light, it scintillates in every part. Then mount in balsam.

This is the formula for preparing the carmine dye:

Carmine	24 grains
Aqua ammonia	72 drops
Water	4 ounces
Alcohol	8 drachms

Pulverize the carmine; put in a test-tube; add the ammonia; bring twice to boiling point. Set aside for twenty-four hours, uncovered, to allow the ammonia to evaporate; add then the water and alcohol, and filter. Before putting the object in the dye, dip it for a few seconds in water. To obtain the proper depth of hue, the object should lie in the dye from three to five hours, Ferns, buchu, and leaves of similar structure, may be stained in from two to three hours. When the hue has become tolerably pronounced, the object is placed in common alcohol, where it is immediately brushed with care, yet thoroughly, and passed to absolute alcohol, to lie from one to two hours. Changing the alcohol once is advantageous. Then to oil of cloves, as above, and mounted. Of the anilines, blue is the best colour to use alone. This dye is prepared by putting four grains of the powder in one ounce of common alcohol, previously triturating the powder thoroughly. If the powder does not readily dissolve, add one drop of nitric acid. It is better for the colour to use no acid, as that ultimately produces a reaction; but some brands of aniline are so far insoluble in alcohol as to make it necessary to introduce a quickening agent. It is true, all the anilines readily dissolve in water; but he who has used a water dye for colouring leaves is very likely willingly to leave the subsequent use of it to others. Remove the object from the alcohol to the dye, and let it remain there until, on examination, it is found to have reached the desired depth of hue; then, after letting it drip a moment, place it in oil of cloves, to be mounted like the others. I apply oil of cloves by dropping it fresh upon the object until the saturation is complete. Double Staining.—My attention was first called to the possibility of distributing two or more colours through vegetable tissue by the result of staining a leaf in freshly mingled aniline blue and poke-berry juice. The hairs were purely blue, while the other portions were of different shades of red. Not duly appreciating my discovery, I neglected it for several months. I ultimately instituted a series of experiments with various forms of mingled dyes, producing results so entirely satisfactory, that I have never since stained with a single dye. My method, now perfected by long practice, is this, for anilines: The required quantity of dye is dropped into a jar, in the proportion of one drop of red to three, four, or five—in some rare cases even eight drops of blue, both dyes being of the same strength. For tissue which rapidly absorbs colour, such as the ferns, the drosera, the pinguicula, and the like, I prefer one to three; for tissue that takes colour slowly, as laurus, aucuba, oleander, &c., the proportion of blue should be greater. It is idle to try to give exact proportions, as the experimenter will soon perceive. If the dye is of full strength, four grains to the ounce, the first class of objects are sufficiently coloured in one minute; the second class may remain in from fifteen minutes to half an hour. They should, however, be carefully watched. I prefer diluting the dye by adding alcohol, eight drops to one of the dye, and strengthen the latter by dropping in fresh dye from time to time in the proportion mentioned at the beginning. The required hue being reached, treat the objects as those in one colour are treated, except that, if there seem to be too much red, immerse the object for a short time in absolute alcohol. It is well always to examine an object in oil of cloves under a moderate power. If the surface be very tender, this should be done without a cover. After the absolute alcohol, return to clean oil of cloves, to be mounted after a minute or two. Sections are best treated with dye of one grain to the ounce. Most sections require only from five to ten seconds immersion—rarely ten. Otherwise the manipulation is the same as with leaves. A compound dye of carmine with aniline green in powder I have found excellent in some leaves, as the deutzias, mature laurus, poeolonia, momordia, &c.; and, for some sections, such as most woods, for longitudinal sections of petiole, or transverse sections, where the spirals are marked, as of the axilla of ricinus communis, I prefer it to other combinations. As the quantity required for any given staining is a good deal less than a grain, and as the anilines differ in strength, no formula can be given. I usually put six or eight average granules of the powder in twelve drops of carmine, stirring well together. Green may be mingled in the same manner with logwood.

Mr. Peet means to continue his papers on this subject in a future number of the same journal as the present one has appeared in.

CORRESPONDENCE.

Professor Holmes' Address.

To the Editor of the 'Monthly Microscopical Journal.'

Boston, *August* 6, 1877.

Dear Sir,—May I ask a little of your valuable space for the purpose of correcting an erroneous impression that will probably be caused by the reference, in your July number, to the address of Professor Holmes before the Boston Microscopical Society.

You will find in the accompanying copy of the address that due credit is given to the labours of Schleiden, Schwann, and Ehrenberg; * their works form part of the elegant library of Professor Holmes; more than that, as Professor of Anatomy in Harvard Medical School, he yearly imparts the results of their labours to his classes; he has probably done more than any teacher in our profession in America to encourage microscopic research. We felt that the Nestor of medical microscopy in America was an eminently fitting personage to deliver the first address before our Society.

It is true that he is known rather as a creator in the domain of art than as an observer in the fields of science; considering the nature of the work demanded of the Professor of Anatomy in America for the last thirty years, it is hardly wonderful that Pegasus slipped the yoke. It may be interesting to know that he is still a faithful teacher of anatomy, and interested in the latest results of histological research.

May I add the following translation from V. Baer's 'Entwickelungs-

* We have received this address, but we see in it nothing that leads us to modify our original remarks.—Ed. 'M. M. J.'

geschichte der Thiere,' as confirming the opinion expressed by Professor Holmes in the portion of his address which you quote.

"My investigations have led me on much more rapidly since I have commenced observing with a lens of five lines focal distance, under which I can work with both hands, upon the embryo lying in a watch-glass full of water. I have used for this purpose a pocket microscope made by Adams, of London, which can be used not only as a simple microscope with from one to three lenses, but also as a compound microscope. I have but seldom added one or two glasses to the first, seldom used the tube of the compound microscope, and only very seldom had recourse to a more powerful microscope, and then generally without obtaining the desired result." (Erster Theil, S. 146.)

Was not this the verdict of the time upon the microscope as an aid in medical studies?

Professor Holmes endeavoured to impress upon the infant Society the necessity of regarding the instrument as an aid in scientific research, and to warn the members from regarding it of itself as an end. The latter tendency is displayed in a characteristic manner in the article by Dr. J. G. Hunt, quoted in the same July number of your Journal.

We endeavour as a Society to discourage this worship of objectives that has fostered only a dilettante microscopy, leaving us to boast of our glasses while we are barren of results that should have crowned their use. We hope to encourage a more symmetrical growth by fostering a demand for instruments for laboratory work, and thus to develope a branch of microscopy that has been fearfully neglected in America and not more than satisfactorily cultured in England.

Professor Holmes speaking from his eminence in literature gave us sounder advice to this end than we should have received from those who would have addressed us fresh from the midst of their eager battles concerning angle of aperture and definition.

Our skilful workers on diatoms and test lines deserve the heartiest praise; they have done much to favour the production of glasses of the highest quality, they have accomplished much for the histology of the future: but the histology of to-day, in our own country at least, is in such an embryonic condition, that we feel that much of our effort must be given to fostering it.

Very respectfully yours,

David Hunt, M.D.,

President of the Boston Microscopical Society.

PROCEEDINGS OF SOCIETIES.

San Francisco Microscopical Society.

The meeting of the San Francisco Microscopical Society was held on July 19, with Mr. C. L. Murdock in the chair.

Colonel C. Mason Kinne exhibited the luminous larvæ of some more fully developed insect, which emitted, at night, from the under part of the last two segments of the body, a very brilliant light, similar to that of the fire-fly of the Eastern States. They were found by C. S. Capp, Esq., on the ground, close by the flume near Pillarcitos Lake, in San Matteo county, and the trio of glow-worms will be handed to Mr. H. Edwards for identification.

Mr. E. J. Wickson brought before the members a very interesting matter in the shape of some coffee-berries, which were filled with hundreds of acari. He stated, as he placed a fragment of the berry on the stage, that there was received, some time since, from Mr. Morris, the Liberian Commissioner to the Centennial Exposition, a number of capsules containing the ripened seeds of the well-known Liberian coffee. These were planted some weeks ago, and as they failed to germinate, he naturally desired to ascertain the reason, and, removing some of the kernels from the ground and the outer shell, he found the substance of the coffee-berry in a soft and decomposing condition. The suspicious appearance of a mealy mass in one caused him to probe the matter further, and by means of the microscope he soon found that the interior of all the capsules were filled with a kind of acarus, which bore a strong resemblance to the sugar insect.

Under a two-thirds objective, the members could see the young and also the fully developed acarus, busily engaged in the pursuit of happiness, by absorbing the moisture from the decaying mass. As the berries had been some weeks under ground, there seemed to be considerable ground for conjecture as to how they had become ensconsed in so fruitful a home for them. The acari having received some attention from Colonel Kinne, and the members being desirous of knowing more of the characteristics of this variety, Mr. Wickson handed a kernel to the Colonel, for the purpose of a careful study of the minute parts, by which the species are identified.

Dr. Winter, who has just returned from an extended trip south, stated that the scale insect, and other pests which have received the attention of microscopists and entomologists, he has been able to remove from a hundred orange trees, which he selected for the purpose of the experiment from his grove at Orange, about seven miles from Anaheim, by a systematic and free use of whale-oil soap and water applied with a brush. The trees are a third larger than the others, and generally more thrifty from this system of grooming.

Colonel Kinne alluded to a very pleasant microscopical reception given by Dr. S. M. Mouser, in his new lecture-room, built in the rear of his dwelling, at 707, Bush Street.


a 1 b
a 2 c
3
4
9a
9b
8c
8b
8a
5a
6
7
5b

THE

MONTHLY MICROSCOPICAL JOURNAL.

OCTOBER 1, 1877.

I.—*New Diatoms from Honduras.* Described by Herr A. Grunow. With Notes by F. Kitton, Hon. F.R.M.S.

(*Taken as read before the* Royal Microscopical Society, 1877.)

Plates CXCIII., CXCIV., CXCV., and CXCVI.

In the year 1867, a paper entitled "Diatomeen auf Sargassum von Honduras gesammelt von L. Lindig, untersucht von A. Grunow," appeared in Hedwigia. Herr Grunow has very kindly sent me for publication in this Journal, extracts and supplement (translated into English), with the request that I would see it through the press, and also correct any errors in the translation (from which by the way it is singularly free); he has also added some valuable remarks on allied species and genera. The figures are from his own drawings and have not been previously published.

(The species which are now described for the first time are marked "n. sp.")

Licmophora.

L. Remulus Grun. L. a latere primario anguste cuneate, valvarum parte inferiore plus minus elongata, anguste lineari stipitiformi, subito in laminam oblongam, vel lineari oblongam, apice rotundatum dilatata, linea media in parte superiore conspicua, striis transversis tenuissimis 33–34 in ·01 mm.* Longit. ·05–·24 mm., latit. valvæ partis superioris ·01–·013 mm., latit. stipitis ·0015–·002 mm. Tab. CXCIII., Fig. 1, *a*, *b*.

I have a similar Licmophora from the Samoa Islands, in which the inferior part of the valve does not widen so abruptly into the upper portion; the striæ are also coarser (27 in ·01 mm.). I have named it *L. Remus*, but I am doubtful if it be sufficiently distinct from *L. Remulus*. Both species have short gelatinous stipes, and would therefore belong to the genus Podosphenia or Rhipidophora, Kütz., but as the length of the gelatinous stipes is of no generic value, these genera must be united to Licmophora. (See Hedwigia, *l. c.*)

* About 84 in ·001 of an inch. Two and a half times the number of striæ in ·01 of a mm. very nearly agrees with the number in ·001 of an English inch. —F. K.

Asterionella.

Asterionella Bleakeleyi Wm. Sm. *var. notata* Grun. Valvarum parte inferiore inflata, costa transversa arcuata notata. Striæ transversæ tenerrimæ 36–38 in ·01 mm. Tab. CXCIII., Fig. 2.

I am doubtful whether this form should be referred to *A. Bleakeleyi*, as I can find no trace of the very conspicuous transverse costa in the various delineations of this diatom (' Q. M. J.,' vol. viii. pl. 7, fig. 10. Lewis' Diatoms of the United States Seaboard, pl. 2, fig. 9).

Synedra.

Synedra lævigata (Grun.) n. sp. (*S. gracilis* var. ? tenuissime striata, Grun. in Hedwigia, s.p.). S. major a latere primario linearis, ad polos paululum attenuata, valvis anguste lineari lanceolatis acutiusculis, striis transversis tenuissimis (plus quam 38 in ·01 mm.). Longit. ·08–·24 mm. Tab. CXCIII., Fig. 3.

I have seen this diatom from various localities (Honduras, Mauritius, Samoa Islands,) but I have never been able to detect more than traces of a striation even by monochromatic illumination.

Allied to this species is another, and often accompanying it, but which differs in the valves being more linear and the apices more obtuse; the striation is also coarser, and exactly resembles that of *Amphipleura pellucida*. I have named it *S. lævigata var.? obtusiuscula*. Length ·08–·30 mm. Striæ 38 in ·01 mm. Pl. CXCIII., Fig. 4.

Mauritius (by Ida Pfeiffer), Samoa Islands (Dr. Graeffe). A third species or variety nearly allied is

Synedra lævigata var.? hyalina, which I found on *Haloplegma Preissii*, from South Australia. It is much smaller, with lanceolate valves and slightly produced obtuse apices. Length ·04–·052 mm. Striæ about 38 in ·01. Pl. CXCIII., Fig. 5, *a*, *b*.

The median line of all these Synedreæ is narrow. A fourth allied Synedra with coarser striation is

Synedra provincialis (Grun.) n. sp. S. minor a latere primario sublinearis, valvis lineari lanceolatis, polis paululum tumidulis, subtruncatis, linea media angusta, striis transversis tenuibus 30 in ·01 mm., nodulis terminalibus conspicuis. Longit. ·065–·11 mm. Tab. CXCIII., Fig. 6.

Habitat in mari Meditteraneo ad oras Galliæ prope Cette (leg. L. Lindig).

S. provincialis var. tortuosa. Valvis plus minus undulato tortuosis. Tab. CXCIII., Fig. 7. Upolu, Samoa Islands, leg. Dr. Graeffe. The peculiar undulations of this variety occur also in other species of Synedra (*S. ulna*, *S. oxyrhynchus*, &c.).

Synedra undosa Grun. S. longissima, linearis, in media parte tumidula, tumore lanceolato oblongo, cornibus longissimis, linearibus, eximie undulatis, ad apicem subclavatis, striis transversis 19 in ·01 mm. Longit. variabilis, ad ·85 mm. Tab. CXCIII., Fig. 8, *a, b. c.*

Common in the Honduras gathering; Gollmer found it at Caraccas, and Hauck in the Adriatic Sea near the isle of Chesso.

It is a very distinct species, resembling *S. undulata* (*S. longissima* Lobarreuski) in outline only, but differs completely by its sharp and fine transverse striæ. The valves of the latter species are irregularly and coarsely punctate, the puncta forming short striæ near the margin only. *S. undosa* seems to be related to a Synedra, found by Mr. Hauck near the island of Cherso, which has straight horns, and is perhaps an extreme variety of *S. fulgens*, to which I have given the name of *S. cornigera;* it attains a length of ·4 mm., the valve is lanceolate (·005–·02 mm. in breadth), with longer or shorter horns (·006–·008 mm. broad), which become wider towards the apices. The striæ (14 in ·01 mm.) are interrupted by a very narrow median line, and two longitudinal furrows near the margins, which are more or less conspicuous, Pl. CXCIII., Fig. 9. To *S. undulata*, *S. Hennedyana*, and *S. rostrata* is allied my *S. Frauenfeldii*, and which is somewhat inefficiently represented in 'Verh. Wien zool. bot. Gesellsch.,' 1862, tab. vii., fig. 26. The striæ of this species consist of two or three coarse dots which become more scattered near the centre and apices of the valve. It is distinguished from *S. Hennedyana* by its much shorter and less pronounced horns. Pl. CXCIII., Fig. 10, *a, b, c.*

[In a gathering from the West Indies I found several short filaments of ten or twelve frustules, the side views of which were exactly like *S. Hennedyana.*—F. K.]

Synedra crystallina Kg. *var. insignis* Grun. (n. sp.?). S. major vel maxima, valvis elongatis lineari-lanceolatis, polis paullum incrassatis truncatis, linea media distincta, sulcis longitudinalibus marginalibus obsoletis, striis subtiliter punctatis, validis (10–11 in ·01 mm.) in media parte sæpe irregularibus, ante apices radiantibus. Longit. ad ·8 mm., latit. valvæ ·013–·019 mm. Tab. CXCIII., Fig. 11.

Rare in the Honduras gathering.

S. crystallina var. bacillaris Grun. S. major, valvis linearibus, polis rotundato obtusis, linea media distincta, sulcis longitudinalibus marginalibus obsoletis, striis subtiliter punctatis, validis ($8\frac{1}{3}$–9 in ·001 mm.) in media parte sæpe irregularibus, ante apices radiantibus. Longit. ·32–·36 mm., latit. valvæ ·016–·017 mm. Tab. CXCIII., Fig. 12, *a, b, c.*

Honduras, Adriatic Sea, near Lesma.

These Synedreæ differ from *S. crystallina* by the very obscure longitudinal furrows near the margin of the valve, which are almost invisible. But as these furrows are very variable in some species, I dare not separate these forms into distinct species.

Another variety of *S. crystallina* is perhaps

S. (*crystallina var.*) *decipiens* (Cleve and Grunow) from Cap. de la Néve. The valves of this form are only ·2–·21 mm. long, and ·009 mm. broad, narrow, lanceolate, with rounded apices, very conspicuous median line and longitudinal furrows. Striæ $11\frac{1}{4}$ in ·01 mm.

Synedra Baculus Greg. *var. minor* Grun. S. valvis sublinearibus, in media parte et ad polos vix incrassatis, linea media fere nulla, striis subtillime punctatis, validis (11–12 in ·01 mm.) ante apices radiantibus. Sulcæ longitudinales marginales inconspicuæ. Longit. ·22 mm., latit. valvæ ·0055–·007 mm. Tab. CXCIV., Fig. 1.

Rare in the Honduras gathering.

S. Baculus Greg. and *S. superba* Kg. have no true median line, but only a slight central depression running from one end of the valve to the other. *S. superba* has more or less conspicuous longitudinal furrows near the margin, and distinctly granulated striæ ($10\frac{1}{2}$ in ·61 mm.). The valves are ·02–·024 mm. broad, but I have seen a small variety from Finmark with valves not more than ·015 mm. in breadth.

S. capillaris Grun. (n. sp.). S. angustissima valvis linearibus, in media parte vix incrassatis, linea media angusta distincta. Striis transversis subtilibus (19 in ·01 mm.). Longit. ·225 mm., latit. valvæ ·0015–·002 mm. Pl. CXCIV., Fig. 2.

Rare in the Honduras gathering.

It is probable that many of the marine forms hitherto classed with the Synedræ should be placed in the genus Toxarium of Bailey. I have not seen living specimens of *T. undulatum*, and am therefore unable to say whether the cell-contents are arranged in longitudinal plates or divided into numerous globules like those of *S. fulgens* and its allies. Pfitzer has seen the cell-contents of several marine Synedræ divided into numerous small portions, but he thinks they are not identical with the endochrome globules of his great family of Coccochromaticæ.

The valves of a Synedra like *S. splendens* are very different in many respects from those of *S. fulgens*, *S. superba*, &c., and it is possible that the cell-contents also differ in a manner which make a division of the genus necessary, like that of Staurosira Ehr. and Fragilaria. Staurosira (Dimeregramma Ralfs ex parte Odontidium ex parte Fragilaria species plurime) is a genus nearly allied to the Synedreæ of the type of *S. splendens*. *Fragilaria virescens* and its few allies are coccochromatic diatoms, as Pfitzer has stated, and nearly related to Diatoma, Odontidium, &c. I had employed the name of Staurosira as a sub-genus of Fragilaria, but both genera must be separated and even placed in different families. To Staurosira belongs the greater part of Fragilaria, and it would perhaps be better to retain the name of Fragilaria for it, but then a new name would be necessary for *Fragilaria virescens*, a thing to be avoided if possible.

Sceptroneis.

Sceptroneis cuneata Grun. (*Synedra cuneata* Grun. in Hedwigia, *l. c.*). S. valvis elongatis clavatis in apice cuneatis, obtusis, linea media nulla (vel indistincta), sulcis duabus longitudinalibus margin approximatis aut distinctissimus aut obsoletis, interdum vix conspicuis, striis transversis (12–13 in ·01 mm.) subtiliter punctatis (punctis lineas longitudinales densas efficientibus). Longit. ·21–·32 mm., latit. valvæ ·018–·024 mm. Tab. CXCIV., Fig. 3, *a*, *b*, *c*, *d*.

Common in the Honduras gathering.

S. cuneata is nearly related to *Synedra clavata* Greville [' Trans. Mic. Soc.,' vol. xiii. p. 25, Greville notices the resemblance of his form to *S. robusta*, Ralfs, and I have seen the latter species as distinctly cuneate as *S. clavata.*—F. K.], and *S. Gomphonema* Janisch et Rabenhorst, but differs from both of them by the absence of a distinct median line. *S. clavata* has much coarser striæ (6 in ·01 mm.) and a greater breadth (·038 mm.). [In a paper by Otto Witt, in the Journal of the Godeffroy Museum, Part I., a form resembling *S. cuneata* is described and figured under the name of *Synedra clava*, O. W. I have a similar species from Colon.—F. K.]

Synedra Gomphonema is known to me only by the delineation, which shows a broad median line. The striæ are described as fine, which cannot be said of *Sceptroneis cuneata.* I have seen another form (but only once) in the Honduras gathering. This is

S. dubia, Grun. S. valvis clavatis, basi rotundatis, apice paullum producto, obtusiusculo, linea media distincta, sulcis marginalibus nullis, striis subtiliter punctatis ($10\frac{1}{2}$–$11\frac{1}{2}$ in ·01 mm.) in basi radiantibus, in apice subradiantibus. Longit. ·116 mm., latit. valvæ ·015 mm. Tab. CXCIV., Fig. 4, *a*, *b*.

Very rare in the Honduras gathering.

Is this an abnormal form of *Synedra crystallina?* I am not inclined to think so, the striation on the ends of the valve being so very different.

In a slide of diatoms found in stomachs of Holothuriæ from Java, communicated by Herr Weissflog, I have seen a variety of *S. cuneata* with a more slender outline and coarser striæ (8 in ·01 mm.) and no submarginal furrows; this form I have named *S. cuneata var. Javanica.* Length ·4 mm., breadth below

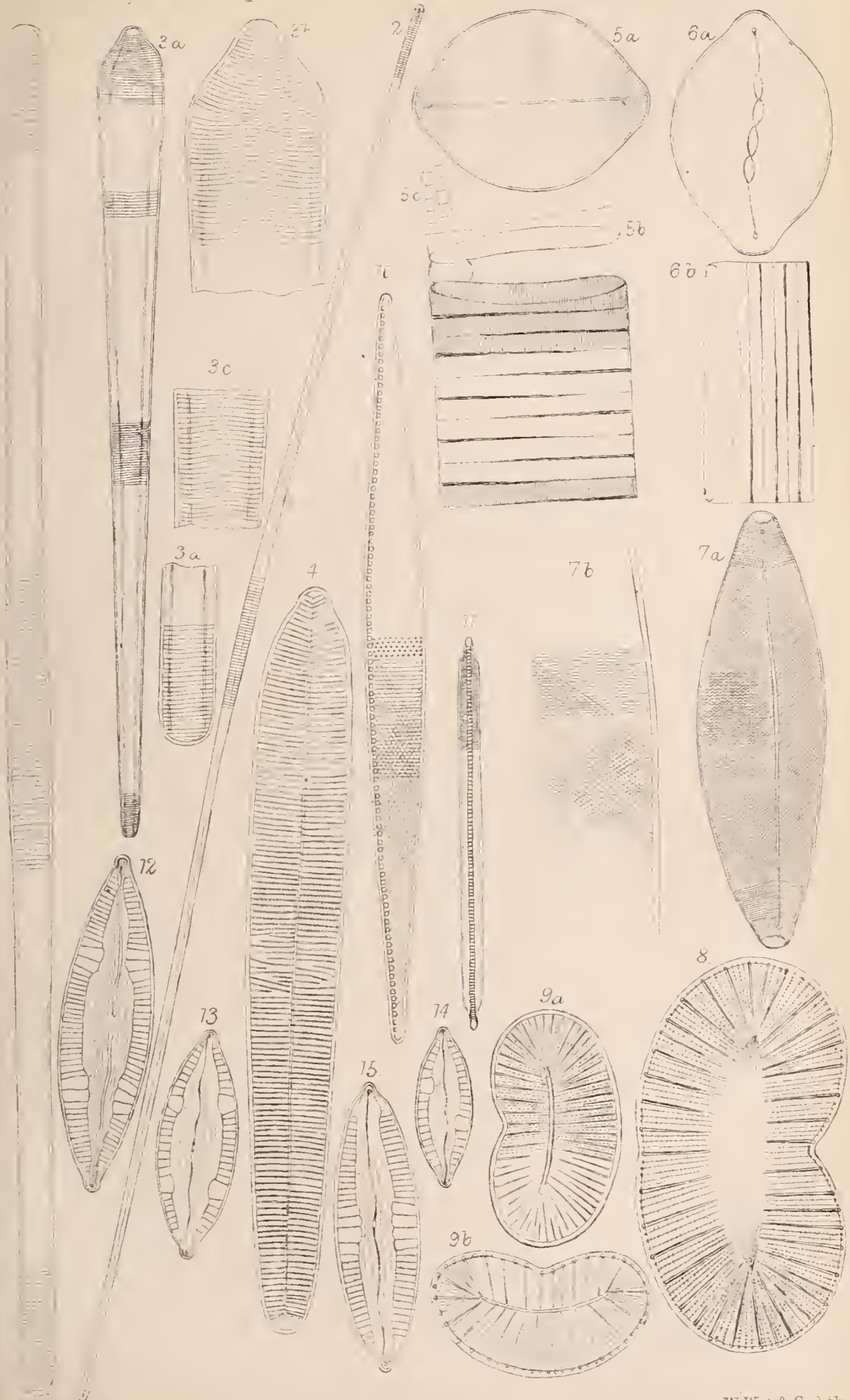
·008 mm., above ·019 mm., summit more rounded than in *S. cuneata.*

The genus Sceptroneis Ehr. is only distinguished from Synedra by its cuneiform valves. It contains the following species: *Sceptroneis caduceus* Ehr., *S. clavata* Greville, *S. Gomphonema* Jan. et Rab., *S. cuneata* Grun. *et var. Javanica, S. dubia* Grun., and perhaps *S. marina* Greg. = *Meridion marinum* Greg. *Campylostylus striatus* Shadbolt (*Synedra Normaniana* Greville) occurs now and then in the Honduras gathering, but I am uncertain whether this species should be placed in the genus Synedra or with *Ceratoneis arcus.* The latter is distinguished from Synedra by its curved valves and very distinct pseudo-nodules. [I am not prepared to admit that the forms now described are rightly placed in the genus Sceptroneis; if striation has any distinctive value, they certainly are not. Herr Grunow's figures show that the transverse lines are composed of short lines like those on *Synedra robusta;* those on *Sceptroneis caduceus* are composed of large distinct moniliform granules like those on *Doryphora amphiceros.* Professor H. L. Smith unites Sceptroneis with Synedra.—F. K.]

I have removed from Ceratoneis all the other species that I had united with it several years ago, and consider *C. arcus* the only representation of the genus. *Eunotia* (*Synedra*) *lunaris* and its varieties, as well as *E. flexuosa, E. biceps,* Bréb., &c., are true Eunotiæ, having the terminal nodules and the longitudinal line situated near the lower (central) margin of the valve, and no trace of a (central) pseudo-nodule like *Ceratoneis arcus*, and many species of Synedra. In Ceratoneis and Synedra the median line and terminal nodules are central. Schumann has delineated something like a central median line in some of the species I had erroneously placed in Ceratoneis and Kützing in Synedra, but I have never seen it, and am of opinion that these details are about as correct as several other things delineated by Schumann, who seems to have been sometimes deceived by an excess of sunlight or other causes in the interpretation of minute structures.

A remarkable example is the duplication of the striæ of many diatoms, but which can only be seen in entire frustules when the focus of the microscope is situated exactly between the two valves (this fact was communicated to me by Professor Pfitzer, who had also observed it). Every line is then divided by diffraction into two, and every dot into : : . The latter phenomenon is very interesting, and may be easily seen in some of the larger species of Cocconema (*Cocconema mexicanum*, &c.), with coarse granulations.

I cannot avoid noticing here the exceedingly fine striation which Schumann has delineated on the smooth parts of some of



del. W West & Co lith.

Honduras Diatoms

the Pinnularia, but which I have been unable to see even with a power capable of resolving the striation of *Amphipleura pellucida* into rows of dots, and as far as I know no one else has been more successful. It is true that the coarse striation of Pinnularia often reaches as far as the median line, but these prolongations of the costæ are very shallow and in most cases quite invisible. In corroded valves they are more distinct as well as the granulations of the costæ which are now and then very evident; but as I previously remarked, I have never been able to detect the fine striation as represented by Schumann. In oblique sunlight various short irregular and fine striæ appear, but they are produced by diffraction, and which may have induced him to presume a fine striation over the whole of the valve, and really exists in many diatoms. Further examination with the best objectives would be very useful.

Striatella.

Striatella Lindigiana Grun. S. articulis subcylindraceis, isthmis crassis gelatinosis, dissepimentis alternatim a summo ad imum incrassatis, membrana connectiva longitudinaliter et transverse subtiliter striato punctata, valvis late ovatis vel suborbicularibus, linea media ante polos extincta vel obsolete bifida, striis punctatis subradiantibus 15–17 in ·01 mm., ad polos tenuioribus 22–23 in ·01 mm., radiantibus. Longit. valvæ ·07–·087 mm., latit. valvæ ·05–·065 mm. Tab. CXCIV., Fig. 5, *a*, *b*, *c*.

Not rare in the Honduras gathering, but never seen by me from any other locality; the dots composing the striæ are hexagonal when seen with a higher power.

S. intermedia Grun. S. Lindigianæ affinis, dissepimentis magis confertis, valvis ovatis vel oblongis, apice vix producto, obtuso, linea media interdum undulata, nodulis, terminalibus conspicuis, striis punctatis subradiantibus 24–27 in ·01 mm., striis longitudinalibus 28–30 in ·01 mm. Longit. valvæ ·69–·126 mm., latit. valvæ ·042–·062 mm. Tab. CXCIV., Fig. 6, *a*, *b*, *c*.

Not rare in the Honduras gathering.

The median line is sometimes divided into two branches, which by reuniting and dividing form 2-4 little oval spaces.

The structure of *S. unipunctata* resembles an obliquely striated Pleurosigma. Oblique striæ 18–20 in ·01 mm., transverse striæ 30 in ·01 mm. Not being aware of the existence of any exact delineation, I have represented the valve of this species in Pl. CXCIV., Fig. 7, *a*, *b*.

Climaconeis.

Climaconeis Lorenziana Grun., 'Verh. Wien zool. bot. Gesellsch.,' 1862, tab. v., fig. 7. *C. Frauenfeldii* Grun., 'Verh. Wien zool. bot. Gesellsch.,' 1862, tab. vii., fig. 2. *Climacosphenia* *linearis*, Janisch et Rabenhorst in Rabenh. 'Beitr.,' I., tab. ii., fig. 2 (1863). *Stictodesmis australis* Greville in 'Edinburgh New Phil. Journ.,' vol. xviii., No. 5, pl. i., figs. 1–4 (1863). Rare in the Honduras gathering, Adriatic and Red Sea, New Caledonia, &c. Climaconeis seems to be rather an abnormal or craticular state of *Navicula scopulorum* Bréb. (*Pinnularia Johnsonii* Wm. Sm.) than a distinct genus. The valves of both of them are characterized by their very small oblong central nodules, and the striæ radiating round the terminal nodules, which are somewhat removed from the apices. The striæ are distinctly moniliform and more or less parallel until they approach the central nodule, when they become radiant (18–20 in ·01 mm.). This craticular state of *N. scopulorum* seems to occur only in the warmer seas. I have not yet seen it from the northern seas, and rarely from the Adriatic, where it is mixed now and then with unaltered *N. scopulorum*. I may here mention *Surirella craticula* Ehr., to which I had previously given the name of *Craticula Ehrenbergii*, but which is only an abnormal state of *Navicula cuspidata* [G. Norman, of Hull, also considered it to be a state of *N. cuspidata*, but it seems to me to more nearly resemble *N. ambigua*. —F. K.]. *C. Perrotettii* Grun. must be named *Navicula Perrotettii*, a species found not only in the Senegal river but also in Bengal and Italy.

[Professor H. L. Smith, 'Lens,' vol. i. p. 77, retains the genus Stictodesmis to which he relegates *Surirella craticula*. If either of the two genera is to be retained it must be Climaconeis, as Grunow's genus has the priority of publication.—F. K.]

Grammatophora.

Grammatophora anguina Kütz. *var. delicatula* Grun., minor et angustior, striis 17–18 in ·01 mm. Common in the Honduras gathering.

G. oceanica Ehr. *var. intermedia* Grun. Striis 21–22 in ·01 mm. Common. Between *G. marina* and *G. subtilissima* there seems to be an uninterrupted series of forms, the striation of which becomes gradually finer.

Plagiodiscus, Grunow et Eulenstein.

Genus novum, Surirellis affine, frustrulis cuneatis valvis reniformibus, costis radiantibus.

P. Martensianus Grun. et Eulenst. Area media lævi lineari oblonga, leviter curvata. Tab. CXCIV., Fig. 8.

Rare, Mauritius, Amboyna, Viti Islands, Seychelles.

P. nervatus Grun. Linea media angusta, curvata, area lævi nulla. Tab. CXCIV., Fig. 9, *a*, *b*.

More common. To the above localities may be added Honduras, Caraccas, Samoa, Constantinople.

I am not sure whether the two species are distinct; in case they should prove not to be so, I wish to retain the name of *P. Martensianus* for both forms. The structure of the valves resembles that of *Surirella gemma*. In the middle of the concave margin a small dot like a terminal nodule may be perceived.

[This form has been long known to diatomists by the MS. name of *Surirella reniformis*. I should be inclined to consider it a distorted form of Surirella. *S. gemma* sometimes occur with a deep indentation in one of the margins.—F. K.]

Nitzschia.

N. Kolaizeckii Grun. N. valvis lanceolatis, ad utriumque finem versus leviter attenuatus acutiusculis, carina marginali, punctis carinalibus 8–9 in ·01 mm. valvis striato punctatis, granulis ita dispositis ut striarum directiones in angulo acuto sese serantes tres efficiant, striis transversis 17–18 in ·01 mm. obliquis 13–16 in ·01 mm. Longit. ·067–·12 mm., latit. valvæ ·0075–·01 mm. Tab. CXCIV., Fig. 10.

Very rare in the Honduras gathering, more plentiful in the stomach contents of *Salpa spinosa* from the Southern ocean, kindly communicated by Herr Weissflog. This species is nearly related to *N. lanceolata*, but differs widely in its markings, which resemble those on *Pleurosigma angulatum*.

Bacillaria.

B. paradoxa var. tropica Grun. Valvis linearibus (hinc inde lateraliter monstrosa inflatus) apicibus paullum attenuatis, obtusis, punctis carinalibus 6–7 in ·01 mm. striis transversis 24–25 in ·01 mm. Longit. ·10–·16 mm., latit. valvæ ·0065 mm. Tab. CXCIV., Fig. 11. Common in the Honduras gatherings, Bengal, Polynesian Islands.

Distinguished from *B. paradoxa* by its finer striæ, the striæ of which are 20–21 in ·01 mm., and the valves linear with obtuse apices or linear lanceolate.

The genus Bacillaria is only distinguished from Nitzschia by the union of the frustules into longer or shorter filaments [? and also by the remarkable movement of the frustules.—F. K.], a difference which becomes extremely dubious as several species of Nitzschia sometimes occur in filaments. A similar difficulty exists in distinguishing the exact separation of other genera allied to Nitzschia, all marks of distinction between them being inconstant.

There are a few species of Nitzschia allied to *N.* (*Eunotia*) *amphioxys* which must be separated not only from the genus Nitzschia, but probably from the family of Nitzschieæ. I long ago proposed (in letters to various friends) a new genus (Hantzschia, in honour of Mr. Hantzsch and his valuable researches on Nitzschia) for their reception.

The carinæ of the valves of Hantzschia are not opposed diagonally, but are situated at the same side of the frustule which bears a great resemblance to those of Epithemia and Eunotia. The following are the species belonging to the genus Hantzschia:

H. amphioxys	=	*Eunotia and Nitzschia.*
H. vivax	=	*Nitzschia vivax.*
H. elongata	=	„ *elongata.*
H. virgata	=	„ *virgata.*
H. marina	=	*Epithemia marina.*

and a few other which are more or less dubious.

Mastogloia.

M. erythræa Grun., 'Verh. Wien zool. bot. Gesellsch.,' 1860, tab. vii., fig. 4 (mala). Common in the Honduras gathering, Red and Adriatic seas. My former delineation of this diatom was not very correct, having been made from a small and badly cleaned specimen. I therefore give better in Pl. CXCIV., Figs. 12, 13, 14. The loculi are very narrow (12 in ·10 mm.), and interrupted at two places by one, two, or three loculi of somewhat larger dimensions. The slightly radiating transverse lines are very fine, the longitudinal are coarser (12–14 in ·01 mm.) and undulating like the median line.

M. erythræa var. biocellata Grun. n. var.? loculis mediis ceteris majoribus, striis distantioribus (24 in ·01 mm.). Tab. CXCIV., Fig. 15.

Very rare in the Honduras gathering.

The enlargement of some of the loculi seems to be of little specific value; I have seen a var. of *M. quinquecostata* where the large loculi are arranged in the same manner as in *M. erythræa.* In some other species (*M. apiculata* and *M. Braunii*) only two or three loculi in the centre of the valve are occasionally enlarged.

Mastogloia Jelineckii Grun. (Grun. in 'Verh. Wien zool. bot. Gesellsch.,' 1863, tab. v., fig. 12). Honduras, Brazil, Campeachy Bay, Virgin Island, West Indies, &c. This is a species of Mastogloia with very small loculi resembling those of some varieties of *M. quinquecostata.* Pl. CXCV., Fig. 1.

M. rostellata Grun. (*M. Jelineckii var.? rostellata* Grun. in Hedwigia). M. valvis oblongis medio minime constrictis, polis cuneato productis acutiusculis, fascia marginali loculorum oblongorum angusta, loculis terminalibus ceteris paullum majoribus, striis punctatis subradiantibus, 14 in 01 mm. granulis oblongis (illis *Stauroneis asperæ* similibus). Longit. ·042–·058, latit. valvæ ·02 mm. Tab. CXCV., Fig. 2. Rare in the Honduras gathering, Campeachy Bay. This is not a variety of *M. Jelineckii*, as I at first thought. The valves of that species have six very shallow depressions, three on each side of the median line, but which I cannot detect on *M. rostellata*. The dots composing the striæ are shorter in *M. Jelineckii* and form irregular longitudinal lines, those on *M. rostellata* are arranged in an irregular quincunx like the dots on most of the varieties of *Stauroneis aspera*.

M. angulata Lewis, *var. pusilla*. M. minor valvis ovato lanceolatus polis paululum productis, obtusiusculis, loculis 4–5 in ·01 mm., striis obliquis decussatis: 14–86 in ·01 mm., transversis tenuioribus. Longit. ·026 mm., latit. valvæ ·014 mm. Tab. CXCV., Fig. 3. Rare in the Honduras gathering.

M. ? reticulata Grun. (*Navicula reticulata Grun.* in Hedwigia, *l. c.*). M. valvis bilobatis, lobis ovatis obtusis, isthmo profundo, margine cellulis majoribus (loculis ?) cincto, structura duplex e cellulis irregulariter hexagonis, reticulatis in area oblonga vel suborbiculari nodulum centralem ambiente deficientibus, et striis transversis subtilibus punctatis totam valvam obtegentibus (21–22 in ·01 mm.) composita. Longit. ·1–·13 mm., latit. lobum ·034–·37 mm., latit. isthme ·014 mm. Color valvæ exsiccata fuscescens. Tab. CXCV., Fig. 4. Rare in the Honduras gathering.

M. ? reticulata is allied to a series of diatoms considered till now to be species of the genus Navicula, but differing from all other Naviculæ by a row of larger cells bordering the margin, and which seem to be analogous to the loculi of the Mastogloia.

The following species I refer to this genus: *Navicula marginata* Lewis, *N. strangulata* Grev., *N. spectatissima* Grev., and perhaps *N. Jamaicensis* Grev.; to these I can add four or five more. It would perhaps be better to found a new genus for these species, but before doing so a more critical examination into the nature of the marginal cells which seem to belong to the valve, and not to a second plate inserted between the valve and connecting membrane, as in Mastogloia, is requisite. The central constriction is of no generic value. I have seen forms with a very slight constriction, and others with a lanceolate outline, and no constriction, without being able to separate them into distinct species, outline as well as granulation being exceedingly variable in this group of diatoms. I intend to describe a larger number of these forms in a future paper on Mastogloia.

M. marginulata Grun. Novara Exp. tab. 1, *fig.* 12 (a translation of the new forms described in this paper, with copies of the figures, will be found in 'Grevillea,' vol. i. p. 41, pl. ii., fig. 12 *a*, *b*). Valves lanceolate with obtuse apices: the marginal border of loculi (12–14 in ·01 mm.) more or less narrow, striæ punctate very fine. Length ·025–·08 mm., breadth ·0057–·11 mm. Rare in the Honduras gathering, Valparaiso, Tahiti, New Zealand, Polynesian Islands, Australia, Adriatic Sea, &c.

M. undulata Grun., 'Verh. Wien zool. bot. Gesellsch.,' 1860, tab. vii., fig. 5. Honduras, Adriatic, Mediterranean and Red seas, Polynesian Islands, Australian seas, Seychelles, &c. This form cannot be *Ceratoneis meleagris*, as I at one time thought. The dots composing the striæ (16–18 in ·01 mm.) are oblong, and form coarse, irregularly undulating lines. *M. erythræa* has much finer striæ and more crowded loculi, which are interrupted at two places by several loculi of larger size.

Navicula Meleagris Kütz. is perhaps identical with my *Mastogloia Braunii*, a form by no means rare in the Baltic, but I am unable to say for a certainty to what species of Mastogloia, *N. Meleagris* of Kützing from the eastern shore of the island of Jütland belongs. *M. Braunii* is well characterized by the longitudinal furrows near the median line, which resemble those of *Navicula Lyra*. W. Smith has confounded this form with *M. lanceolata* Thwaites, a form I could not find in a slide (from Lancing, in Surrey) determined by Smith himself. It contains a small variety of *M. Braunii*, with loculi sometimes enlarged, but no *M. lanceolata*.

The latter form corresponding with Smith's figure is by no means common. The striæ on this species are not radiant near the apices, but slightly convergent towards the margins of the valve, and show no traces of longitudinal furrows near the median line.

M. bisulcata Grun. n. sp. *M. minuta*, valvis late ovato lanceolatis, polis parum productis obtusis, loculis latiusculis æqualibus 5–6 in ·01 mm. Striis subradiantibus, subtiliter punctatis $10\frac{1}{2}$ in ·01 mm. utrinque area lævi lineari lanceolata subarcuata interruptis linea media undulata, nodulo centrali parvo oblongo. Longit. ·017–·03 mm., latit. valvæ ·009–·011. Tab. CXCV., Fig. 6.

Not rare in the Honduras gathering. This species is very like *M. minuta* Grev. in outline, but differs widely by its much coarser striæ and the two smooth furrows on each side of the valve. In the Honduras gathering occurs another Mastogloia, which I consider is the true *M. minuta* of Greville; it is very like the preceding, but has a nearly straight median line, very fine subradiant transverse striæ (25 in ·01 mm.), still finer longitudinal striæ, and no smooth furrows. Pl. CXCV., Fig. 7.

Orthoneis.

O. Crucicula Grun. n. sp. O. minuta, valvis ovatis obtusis, loculis utrinque quinque, mediis angustioribus reliquis semicircularibus, nodulo centrali transversim dilatato cruciformi, striis subtiliter punctatis subradiantibus tenuibus (20 in ·01 mm.) linea media recta. Longit. ·014–·017 mm., latit. valvæ ·008–·01 mm.

Not rare in the Honduras gathering.

This is a small but very characteristic species, distinguished by the singular shape of its loculi. *O. fimbriata* (Brightwell) Grun. Novara Exped.

Cocconeis fimbriata Brightwell, in 'Q. Mic. Jour.,' vol. vii. fol. 1, fig. 3. *Mastogloia cribrosa* Grun., in 'Verh. Wien zool. bot. Gesellsch.,' 1860, ex parte tab. vii., fig. 10 *d*. Common.

O. binotata Grun., *l. c.* page 15. *Cocconeis binotata* Grun., in 'Verh. Wien zool. bot. Gesellsch.,' 1863, tab. iv., fig. 13. *C. scutellum*, var. γ Roper, in 'Q. Mic. Jour.,' vol. vi., pl. iii., fig. 9. Common.

There can be no doubt that these species do not belong to the genus *Cocconeis*, both the valves being alike, and the frustules are not concave. It is very doubtful whether these forms are distinct from Mastogloia; the marginal loculi of this genus are represented here by small semicircular plates; these, as well as the loculi in Mastogloia, are probably intended for the secretion of the gelatinous membrane investing the frustule. This becomes most evident in *O. binotata*, where two long horns (in the living frustule) project from it at the places where the two semicircular plates are situated. A large number of horns are developed from the frustules of *O. fimbriata* (and *O. splendida* ?). I have not seen these horns on any species of Mastogloia or any other species that I have formerly attached to Orthoneis. These species must be placed in Mastogloia, and are only distinguished by their ovate valves, a difference of little specific value, and of no value as a generic distinction. The species are *Mastogloia cribrosa* (= *Cocconeis coronata* Brightwell ?), *M. cocconeiformis*, *M. ovata*, *M. Harvathiana*, and several others. [Not having specially studied the genus Mastogloia, the following remarks must only be taken for what they are worth. This genus was constituted by Thwaites for certain naviculoid forms with secondary plates, upon one of which are the loculi. The presence or absence of a mucous cushion, frond, or stipes, although formerly considered by William Smith and others as generic distinctions, are now generally admitted to be of no value, even in the determination of species. I have seen *N. serians* and *Himantidium Soleirolii* embedded in mucous like Mastogloia, *Cocconema cymbiforme* without stipes flourishing vigorously, and *Campylodiscus clypeus* with a mucous fringe apparently protruded from the caniculi; this fringe, like the horns of Orthoneis, is analogous to the stipes and fronds of Cocconema, Schizonema, &c. It seems to me to be better to restrict the genus Mastogloia to those forms where the loculi are distinct, and constitute a new genus for those species with ovate or naviculoid valves, and of which the loculi form an integral part, or include them all in Orthoneis.—F. K.]

Amphora.

A. decussata Grun. A. (complexa?) valvis semilunaribus, acutis, ventre plano vel sub concavo et subbiundulata, dorso convexo, linea longitudinali margini inferiori valvæ valde approximata subrecta vel subarcuata, nodulo centrali transversim dilatato, valvæ parte ventrali angustissima transverse striata, parte dorsali oblique striata, striis obliquis (16–18 in ·01 mm.) e cellulis elongatis concatenatis compositis, valvæ margine dorsali punctorum serie unica ornata. Longit. ·07–·17 mm., latit. valvæ ·018–·031 mm. Tab. CXCV., Fig. 9. Honduras, Adriatic Sea.

Allied to *A. ostrearia*, but well distinguished by the very oblique striæ composed of elongated puncta.

A. hyalina Kg. *var.* (= *A. hemisphærica* Grun., Hedwigia, *l. c.*), and *A. cymbelloides* Grun., are already delineated in Schmidt's Atlas (tab. xxvi., figs. 52 and 53, and tab. xxvi., fig. 10).

Navicula.

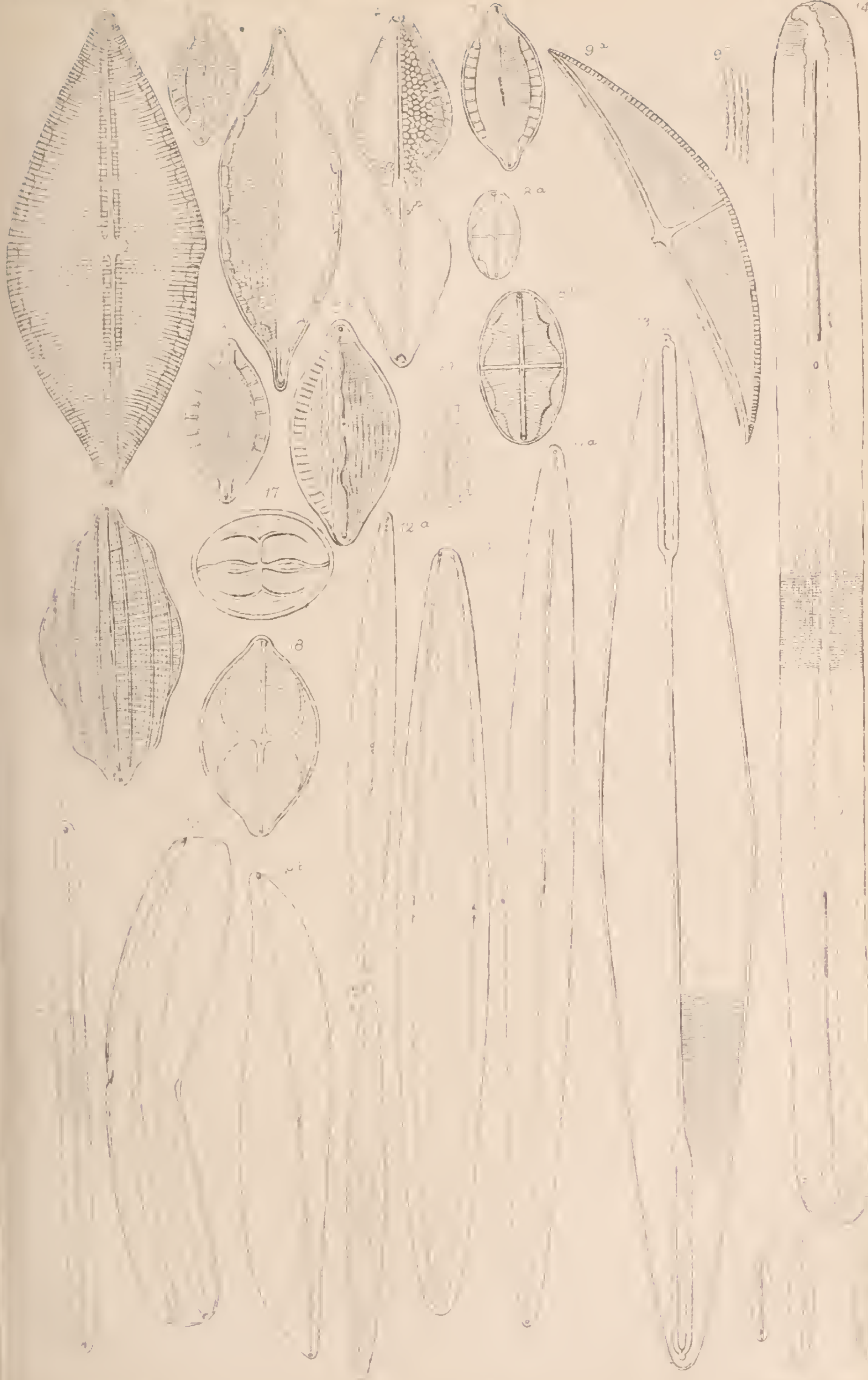
N. triundulata Grun. N. valvis latiusculis trigibbis tumore medio ceteris majore et crassiore, apicibus productis obtusis, striis punctatis subradiantibus (10 in ·01 mm.), utrinque sulcis tribus longitudinalibus interruptis. Longit. ·044–·05 mm., latit. valvæ ·023 mm. Tab. CXCV., Fig. 10.

Very rare, Honduras, Campeachy Bay.

This form is perhaps the same as *N. sulcata* Grev. in 'Trans. Bot. Soc. Lond.,' vol. viii. pt. 3, fig. 10, but not having seen an authentic specimen I am unable to decide.

N. fusiformis Grun. (*Berkeleya fusidium* Grun. in Hedwigia, *l. c.*). N. fusiformis valvis lanceolatis acutiusculis, nodulis terminalibus minutissimis, nodulo centrali minuto plerumque ægre conspicuo, striis transversis tenuissimis: 33 in ·01, longitudinalibus 36 in ·01. Longit. ·115–·15 mm, latit. valvæ ·010 mm. Tab. CXCV., Figs. 11, *a*, 11, *b*. Honduras.

N. fusiformis var. ostrearia (Turpin) minor, striis transversis 36 in ·01 mm. Longit. ·063–·073 mm., latit. valvæ ·006–·007 mm. Tab. CXCV., Fig. 12, *a*, 12, *b*.—*Vibrio ostrearius* Gaillon (1820). *Navicula ostrearia* Turpin, in 'Dict. d'hist. natur,' Levraubt II., tab. i., fig. 2 (*nec* Brébisson in Kütz. 'Spec. Alg.').


9
14
2a
17
18
12 a

Marseilles, by Lindig; Trieste, by Hauck; Huitrieres du Croisic, Loire inferieure, by Bornet. M. Bornet informs me that the oysters become greenish by feeding on this diatom, which occurs in great abundance in the oyster-beds at the mouth of the Loire.

This species differs from all other Naviculæ by its fusiform outline and resemblance to *Amphipleura pellucida.* I had formerly placed it in Berkeleya, being deceived by the two small dots on the median line, which occasionally seem to limit a small linear nodule, but more recent investigations with better objectives have convinced me that there is only a very small roundish or oblong central nodule on each valve. It is the same with my *Amphipleura Frauenfeldii,* 'Verh. zool. bot. Gesell.,' *l. c.*, tab. i., fig. 19, a species closely allied to *N. fusiformis*, but differing by a somewhat broader outline, more distinct longitudinal and much coarser transverse striæ (29 in ·01 mm.). The central nodule of this species (which must be named *Navicula Frauenfeldii*) is exceedingly small.

Amphipleura.

The genera Amphipleura and Berkeleya (incl. Rhaphidogloia Kg.) are distinguished by the absence of a central nodule, the valve is divided by a narrow longitudinal line, terminating at the end by long fork-like expansions; these are very conspicuous in Amphipleura, but less so in Berkeleya. The frustules of the former are embedded in gelatinous sheaths or in amorphous jelly.

A. (*pellucida var.?*) *Lindheimeri* Grun., 'Verh. Wien zool. bot. Gesell.,' 1862, tab. xiii., fig. 11. Valves lanceolate, ·15–·16 mm. long, ·024 mm. broad. Transverse striæ 26 in ·01 mm., longitudinal striæ 26 in ·01 mm., slightly curved and interrupted. Length of "forks" ·036 mm. Terminal nodules short, rounded. Tab. CXCV., Fig. 13. Texas.

A. (*pellucida var.?*) *intermedia* Grun. Valves narrow, lanceolate, ·19–·2 mm. long, ·013–·015 mm. broad. Length of "forks" ·044 mm. Striæ somewhat finer than in *A. Lindheimeri.* Terminal nodules short, rounded. Oregon deposit; not very rare.

A. (*pellucida var.?*) *Oregonica* Grun. Very large, valves lanceolate, ·33 mm. long, ·027 mm. broad. Length of "forks" ·063 mm. Terminal nodules somewhat elongated, linear. Striation like that of *A. Lindheimeri.* Oregon deposit; not rare.

All these forms are closely allied to *A. pellucida,* and it may perhaps be best to consider them all mere varieties of that species. The numerous forms of *Navicula rhomboides* are allied in a similar manner, although the extreme members of both series differ very widely. I may also add that *N. rhomboides* is very nearly allied to Amphipleura, and that the central nodules are occasionally somewhat elongated, thus bearing a strong resemblance to those in Amphipleura. The valves of the genuine *A. pellucida* are narrow, lanceolate, ·09–·13 mm. long and ·007–·009 mm. broad. Length of "forks" not exceeding ·02 mm. Striæ 37–39 in ·01 mm.

Schumann has found in the Baltic two large specimens of Amphipleura ('Schrift. d'Königsberg Phys. Ök. Gesell.,' 1867, tab. i., fig. 9), which are ·18–·20 mm. long and ·14 mm. broad. The striation is very coarse (16 in ·01 mm.). This is also a doubtful variety of *A. pellucida*, and may be called *A. Schumanni*. Schumann delineates the striæ of *A. Schumanni* and *A. pellucida* ('Diat. der Hohen Tatra,' tab. ii., fig. 10) as composed of three large distant dots forming coarse longitudinal striæ on each side of the valve.* But this is an optical delusion, the striæ in *A. pellucida* and all its varieties consist of rows of numerous very minute dots.

A. Weissflogii Janisch differs from *A. pellucida* and *A. Oregonica* by its exactly linear valves and rounded apices. Length ·19–·25 mm., breadth of valve ·012–·013 mm.; length of "forks" ·06–·08 mm. Striæ 25 in ·01 mm. Oregon deposit; rare. Pl. CXCV., Fig. 14. This figure represents the authentic specimen of Janisch, and shows a very abnormal condition of the terminal nodules; in normal specimens they are exactly like those of *A. Lindheimeri*.

A. danica, Kg.? This is a true Amphipleura, if Schumann's figure (*l. c.*, tab. i., fig. 3) represents the genuine species of Kützing, which, however, seems to me very doubtful. The valve of *A. danica* Schu., is linear, with rounded apices: the frustules of *A. danica* Kg., are lanceolate, and, as it seems, fusiform, like those of my *Navicula fusiformis*, to which it seems to be nearly related.

From Amphipleura must be separated *A. inflexa* Bréb., as I suggested long ago in Hedwigia. The late Dr. Eulenstein proposed naming it Okedenia, and as I am not aware of any other genus Okedenia, I adopt Eulenstein's name.

Berkeleya.

The species belonging to the genus Berkeleya are *B. Dillwynnii* Grun., including a great many species of Schizonema (see Hedwigia and Novara Exp.); *B. micans* (Lyng.), Kg.; *Bangia micans* Lyngbye; *Rhaphidogloia micans* Kg.; *Berkeleya fragilis* Greville (*nec* Smith, 'Brit. Diat.,' pl. liv., fig. 344; his figure resembles *Navicula scopulorum*); *B. Adriatica* Kg. Striæ, 24 in ·01 mm. Pl. CXCV., Fig. 15.

B. manipulata (Kg.) = *Raphidogloia* Kg.
B. medusina (Kg.) = " "
Both are very nearly related to *B. micans*.

* A copy of Schumann's figure will be found in the 'M. M. J.' ("On Dr. Schumann's Formulæ for Diatom Lines," by W. J. Hickie), vol. xiv., Pl. CIX., Fig. 1.—F. K.

B. interrupta (Kg.) = *Raphidogloia* Kg. frustules somewhat sigmoid.

B. Harveyana Grun. *Novara Exp.*, Alga quasi maxime paradoxa. Harvey, Friendly Islands, Algæ, No. 99.

B. penicillata (Grun.) (*Homœocladia penicillata* Kg. ?).

B. hospitans (Grun. n. sp.). B. parasitica, frustulis minutis, valvis lineari oblongis, acutiusculis, nodulo centrali elongato ægre conspicuo leviter arcuato, striis transversis tenuissimus. Longit. ·12–·023 mm., latit. valvæ ·003–·004, habitat. in vaginis *Hydrocolei tingentis.* Tongatabu (legit Dr. Graeffe). Pl. CXCV., Fig. 16.

Schizostauron Grun. *genus novum.*

Frustula naviculacea, valvis lanceolatis vel ovatis, nodulo centrali transversim dilatato, in utroque fine befido.

S. Lindigii Grun. S. valvis late ovalibus, linea media subsigmoidea, utrinque inter polos et nodulum centralem dilatata, nodulo centrali transversim dilatato, lineari in utroque fine bifurcato, ramis elongatis patentibus, recurvis (cum margine fere parallelis (striis transversis tenuissimus (36 in ·01 mm.). Longit. ·029 mm., latit. valvæ ·021 mm. Valva exsiccata hyalina ecolora. Tab. CXCV., Fig. 17. Very rare in the Honduras gathering.

S. Reichardtii Grun. S. valvis ovato lanceolatis polis parum productis, obtusiusculis, linea media recta lineari, fascia transversa utrinque befida, ramis arcuatis divergentibus, striis transversis subtiliter punctatis, subradiantibus 12 in ·01 mm. Longit. ·26–·036 mm., latit. valvæ ·16–·19 mm. Tab. CXCV., Fig. 18.

Adriatic Sea near Lussin piccolo (leg. Dr. Reichardt) on *Codium bursa* from Dalmatia (leg. Dr. Bartach). I have seen single specimens of two other species. *Cocconeis Wrightii*, O. Meara, 'Q. M. J.,' vol. vii., n. s., pl. vii., fig. 6, is without doubt another species of that genus.

Rhoicosigma Grunow.

Frustula plus minus spiraliter torta valvæ illis Pleurosigmatis similes.

This genus is perhaps not sufficiently distinct from Pleurosigma, but the species belonging to it are of a very peculiar habit, in front view resembling an Achnanthes.

Rhoicosigma Reichardtii Grun. Valvis late lineari lanceolatis obliquis convexis, linea media subrecta, striis transversis tenuibus (20–24 in ·01 mm.) longitudinalibus obsoletis. Longit. ·77–·18 mm., latit. valvæ ·14–·034 mm. Tab. CXCV., Fig. 19, *a*, *b*. Honduras (legit Lendig), Quarnero (legit Dr. Reichardt), Port Jackson (legit Cleve). The Quarnero specimens are larger than those from Honduras.

R. Reichardtii var. ? constrictum Grun. differs from the type form in the valves being more or less constricted in the centre, and the median line is more accurate. Honduras, Quarnero.

R. compactum (= *Pleurosigma compactum* Greville), very variable in outline, differs from *R. Reichardtii* by the very curved median line. Not rare. Honduras, Campeachy Bay, Corsica, Quarnero, Honolulu, Tahiti, Gallopagos, &c.

The other species of Rhoicosigma are—

R. arcticum Cleve, 'Bihang. till. Vetensk. Akad. Handl.,' Bd. I., No. 13, tab. iii., fig. 16. Arctic Sea, Finmark.

R. mediterraneum Cleve, MSS. Valve narrow, lanceolate; median line very much curved; striæ transverse; 17 in ·01 mm. Balearic Isles.

R. falcatum (Donkin) = *Pleurosigma falcatum* Donkin. 'Q. Mic. Jour.,' vol. i., n. s., pl. i., fig. 1. Cresswell and Boulmar Bay.

Two or three other species have been imperfectly observed. *Ceratoneis spiralis* Kg., 'Bacill.,' II. 31, may possibly be a species of Rhoicosigma, but I have never seen anything like Kützing's figure.

Isthmia.

I. Lindigiana, Grunow et Eulenstein. I. gracilis ecostata, valvis inequælibus, inferiore longiore, oblique conica obtusa, superiore breviore, oblique subtriangulari, margine superiore convexo, plus minus distincte bigibbo, valvarum margine inferiore serie annulare corpusculorum clavæformium (interdum etiam irregulariter in cetera valvæ parte interna distributorum) ornato, areolis in utriusque valvæ dorso sitis ceteris majoribus, irregularibus, reliquis membraneum connectivam versus in lineas longitudinales curvatas ordinatis, apicem versus minoribus hexagonis et irregulariter dispositis, membrana connectiva lata, areolis in lineas longitudinales ordinatis ornata, in media parte minoribus, valvas versus elongatis. Longit. frustul. ·023–·039 mm., latit. ·5–·10 mm. Tab. CXCVI., Fig. 1, *a*, *b*, *c*, *d*.

Common in the Honduras gathering.

This species is well characterized by the small club-shaped corpuscles in the interior of the valves. I have seen nothing analogous to these in any other diatom. The areolæ are covered with minute dots when seen under a higher power.

I. Lindigiana is very nearly related to an Isthmia inhabiting the southern seas, and seems there to represent the *I. enervis* of the northern seas. I name it *I.* (*enervis var.* ?) *capensis*. It is not rare at the Cape of Good Hope, and it also occurs on the coast of Australia and the Polynesian Islands. It is distinguished from *I. Lindigiana* by the absence of the peculiar club-shaped corpuscles, and from *I. enervis* by its narrower and longer valves.

[*I. capensis* is perhaps the *I. minima* of Harvey and Bailey.—F. K.]

Triceratium.

T. (*orbiculatum* Shadl. *var.*) *elongatum* Grun. T. frustulis cylindraceis concatenatis, membrana connectiva elongata lineis transversis (e divisione imperfecta ortes ?) plus minus numerosis in utroque dimidio opposite curvatis instructa, valvis exacte orbicularis, vel in tribus locis pluries undulatis, varius late ovalibus, cornibus tribus (rarissime quaternis) conicis obtusis aculeo unico instructes, nodulis suborbicularibus, marginatis ab margine aliquantulum remotes tenuissime punctatis. Areolæ hexagonæ parvæ in valva radiantes in membrana connectiva lineas longitudinales et obliquas efficientes. Diameter valvæ ·036–·102. Tab. CXCVI., Fig. 2, *a, b, c.*

Common in the Honduras gathering.

This Triceratium is distinguished by its orbicular valves and the slight undulation which I have not observed in other specimens of *T. orbiculatum.* It closely resembles the elongated form of *Auliscus pruinosus* as figured by Bailey, and also a peculiar Cerataulus which I shall presently describe.

Cerataulus.

I have in my collection a form of Cerataulus from China (legit Gaudichaud) which I consider to be a dubious variety of *C. lævis,* and have named it

C. (*lævis var. ?*) *Chinensis* Grun. It differs from *C. lævis* by its truly circular valves, the greater number of processes, and the arrangement of the minute dots which are irregularly scattered over the whole surface, and only form short striæ (13–14 in ·01 mm.) near the margin of the valve when seen from above. The connecting membrane is sometimes elongated (Pl. CXCVI., Fig. 3, *a, b*) like that of *Triceratium orbiculatum var. elongatum,* and shows similar divisions separated by curved lines, and which are always constant in the connecting membrane of Rhizosolenia.

I am unable to determine whether this elongation of the connecting membrane is connected with some at present unknown method of propagation, or only the result of certain abnormal conditions of life. The frustules of *Orthosira Roeseana* (Rabenhorst) (= *O. spinosa* Greville) often become elongated, and have then a very complicated connecting membrane. These abnormal forms of *O. Roeseana* seem to be produced in places where they are not always covered with water. Ehrenberg found them on the stems of trees, and named them *Liparogyra spiralis* and *L. dentroteres.* I have also found them on the thallus of a Marchantia from China, and sometimes in gatherings of *O. Roeseana,* but less developed.

In a preparation of Möller from Porto Rico I observed a still more interesting abnormity, viz. the multiplication of the valves within the frustule. Here the connecting membrane was very short, and the enclosed frustules (numbering 1, 2, 3 or more) became gradually smaller as they approached the centre like a nest of pill-boxes. Pl. CXCVI., Fig. 4, *b*. W. Smith has delineated a similar growth in *Orthosira Dickiei*, and I have observed a like abnormity in a small variety of *Orthosira distans*. Can this be a craticular state of the Melosireæ, similar to that of *Navicula cuspidata*, *N. Perrotettii Meridion circulare*, and *Odontidium mesodon*, and which Pfitzer, in his beautiful paper on the Bacillaria, compares to the resting spores in other algæ, and the thickening of the membrane for their protection from unfavourable influences? But in what manner do these abnormal frustules multiply and reproduce a new series of normal forms? Certainly not by conjugation or self-division.

The inner frustules of *Cerataulus lævis* are sometimes very small, and it is impossible to comprehend how these small frustules can reproduce by self-division frustules of the average size; the diminution of the frustule is always the result of self-division, and not the contrary. Much still remains to be done towards the interpretation of these and other facts connected with the reproduction of the Diatomaceæ.

I may here add that many genera of Biddulphieæ and Eupodisceæ are very doubtful. It is now generally admitted that Amphitetras and Amphipentas ought not to be separated from Triceratium, and it is even difficult to find a sufficient distinction between the latter genus and Biddulphia.

Triceratium striolatum Ehr. (= *T. membranaceum* Brightwell, *T. Biddulphia* Heiberg) is the triangular form of *B. rhombus*. (See Cleve, 'Bihang. till. k. Svenska Akad. Handlung,' Bd. I., tab. xiii., fig. 2.)

T. spinosum is a triangular form of *B. granulata* Roper. [*T. spinosum* is often quadrangular and *B. reticulata* sometimes three-sided.—F. K.]

Hydrosera triquetra Wallich, is also only a triangular variety of *T. compressa* Wallich. And *Cerataulus lævis* sometimes occurs, as we have just seen, with three processes.

[Cleve (*l. c.*, tab. iv., fig. 3, *a*, *b*) figures a frustule of *Biddulphia aurita* (which he considers sporangial), resembling our Fig. 4, *b*, inasmuch that a small frustule has been formed within it,* but in neither case can I imagine the larger frustules to be sporangial.

* In the August part of this Journal, p. 75, I suggested the probability that the endochrome may under certain conditions possess the power of producing (? by means of microspores) perfect frustules without conjugation. This would perhaps explain the abnormal conditions just described.

The peculiar structure of the connecting membrane in *Triceratium orbiculatum var. elongatum* and *Cerataulus lævis*, bears, in my opinion, only a superficial resemblance to Rhizosolenia. This genus resembles Rhabdonema and some allied genera in possessing a series of annuli (generally more or less wedge-shaped), and at a certain period of growth a smooth connecting membrane is formed, and shortly after two beaked ends (valves) are produced ; in some splendid specimens of *R. striata* from the Arafura Sea this has occurred three or four times before the frustules separated, thus forming a filament of considerable length.

It seems to me probable that Mr. Thwaites' explanation of the peculiar state in which *Orthosira Dickiei* is sometimes found is correct, and that it is a sporangial condition. In a very good gathering of this form I have seen it in every stage, from its commencement to the reproduction of the normal frustule ; the first indication is the formation of two conical valves, resembling two thimbles joined at their bases; within these are formed two fresh valves with the bases slightly broader; this is repeated until a large but normal frustule is formed, and self-division goes on until the

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EXPLANATION OF PLATES.

Plate CXCIII.

Fig. 1.—*Licmophora Remulus.* *a*, valve ; *b*, frustule × 400.
„ 2.—*Asterionella Bleakeleyi var.?* *a*, valve ; *b*, frustule × 400.
„ 3.—*Synedra lævigata* × 900.
„ 4.— „ „ *var. obtusiuscula* × 900.
„ 5*a*, *b*.— „ „ „ *? hyalina* × 900.
„ 6.— „ *provincialis* × 900.
„ 7.— „ „ *var. tortuosa* × 900.
„ 8.—*a*, „ *undosa* × 400; *b*, apex; *c*, centre × 900.
„ 9.—*a*, „ *cornigera* × 400; *b*, apex; *c*, centre × 900.
„ 10.—*a*, „ *Frauenfeldii* × 900; *b*, apex; *c*, centre × 1540.
„ 11.—*a*, „ *crystallina var.? insignis* × 200; *b*, apex; *c*, centre × 900.
„ 12.— „ „ *var. bacillaris.* *a*, valve × 450; *b*, apex; *c*, centre × 900.

Plate CXCIV.

Fig. 1.—*Synedra Baculus var. minor* × 900.
„ 2.— „ *capillaris* × 900.
„ 3.—*Sceptroneis cuneata* × 400; *b*, apex; *c*, centre; *d*, lower apex × 900.
„ 4.— „ *dubia* × 900.
„ 5.—*Striatella Lindigiana.* *a*, valve ; *b*, frustule × 400 ; *c*, areolation × 1500.
„ 6.—*Striatella intermedia.* *a*, valve ; *b*, frustule × 400.
„ 7.— „ *unipunctata.* *a*, valve × 900; *b*, portion of ditto × 1540.
„ 8.—*Plagiodiscus Martensianus* × 900.
„ 9*a*.— „ *nervatus* × 400.
„ 9*b*.— „ „ *forma minor* × 900.
„ 10.—*Nitzschia Kolaizeckii* × 900.
„ 11.—*Bacillaria paradoxa var. tropica* × 400.
„ 12.—*Mastogloia erythræa* × 900.
„ 13.— „ „ *var.* × 900.
„ 14.— „ „ „ × 900.
„ 15.— „ „ „ *biocellata* × 900.

[Plate CXCV.

formation of another sporangial frustule is requisite, either by reason of the power of dividing becoming exhausted or from the diminution of the size of the frustules.

In concluding these remarks, I beg to thank Herr Grunow for his kindness in permitting me to publish his valuable observations in this Journal, thus enabling the English diatomist to obtain a knowledge of what other countries are doing towards elucidating many of the mysteries connected with the life-history of the Diatomaceæ.—F. K.]

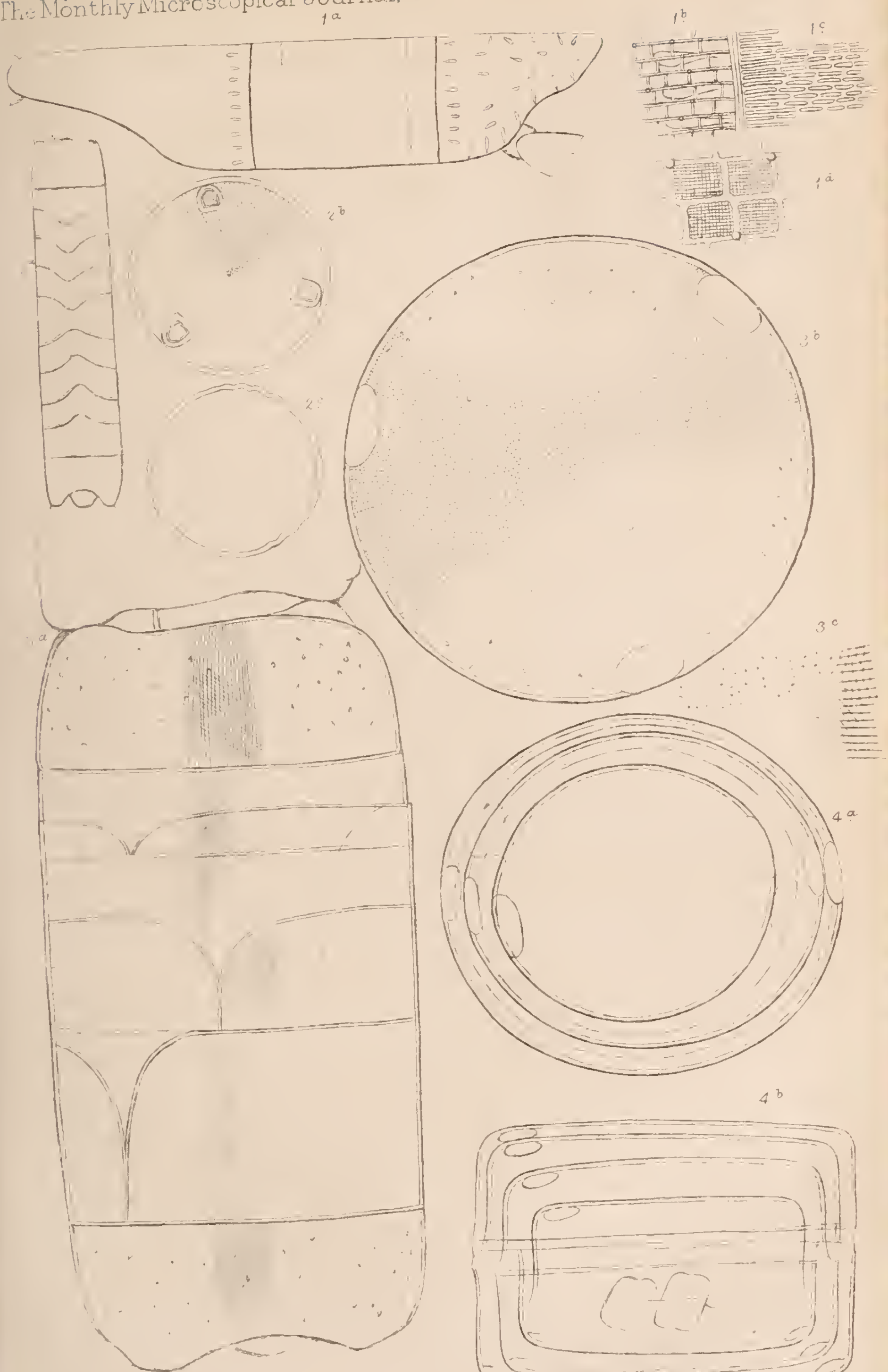
Plate CXCV.

Fig. 1.—*Mastogloia Jelineckii.*
,, 2.— ,, *rostellata.*
,, 3.— ,, *angulata var. pusilla.*
,, 4.— ,, *? reticulata* × 400.
,, 5.—*a*, ,, *undulata; b*, part of valve × 1500.
,, 6.— ,, *bisulcata.*
,, 7.— ,, *minuta.*
,, 8.—*a*, *Orthoneis crucicula; b*, forma minor.
,, 9.—*a*, *Amphora decussata* × 400; *b*, striæ, highly magnified.
,, 10.—*Navicula triundulata.*
,, 11.— ,, *fusiformis.* *a*, valve; *b*, frustule.
,, 12.— ,, ,, *var. ostrearia.* *a*, valve; *b*, frustule.
,, 13.—*Amphipleura Lindheimeri.*
,, 14.— ,, *Weissflogii*, original specimen with abnormal terminal nodules.
,, 15.—*Berkeleya micans.*
,, 16.— ,, *hospitans.* *a*, valves; *b*, ditto, with endochrome.
,, 17.—*Schizostauron Lindigii.*
,, 18.— ,, *Reichardtii.*
,, 19.—*Rhoicosigma* ,, *a*, frustule; *b*, valve.

All magnified 900 diameters, excepting Figs. 4, 5 *a*, 5 *b*, and 9 *a*, *b*.

Plate CXCVI.

Fig. 1.—*Isthmia Lindigiana.* *a*, frustule × 200; *b*, lower portion of valve; *c*, ditto connecting membrane, highly magnified; *d*, areolæ × 1000.
,, 2.—*Triceratium orbiculatum var. elongatum.* *a*, frustule × 200; *b*, *c*, valves × 400.
,, 3.—*Cerataulus lævis var. Chinensis.* *a*, frustule; *b*, valve × 900; *c*, striæ × 1540.
,, 4.—*Cerataulus lævis var.* × 900; *b*, frustules, showing abnormal self-division. Within the smallest of the larger frustules are two minute frustules.



Honduras Diatoms

II.—*Some additional Remarks on the Measurement of the Angle of Aperture of Object-glasses.* By F. H. Wenham.

A paper by myself on this subject was read before the Royal Microscopical Society at the November meeting in 1876, wherein I pointed out how in all previous methods of measurement serious errors had arisen from the admission of rays from oblique pencils which falsified the results by a considerable addition to the angle proper.

Angle of aperture simply means a pencil of rays starting from the axial centre of the focal plane, up to the diameter of transmission of the object-glass. The angle included represents the number of degrees of aperture, each ray of which gives an image of a near object, or a telescope view of a distant one in the same line of direction with a special eye-piece arrangement. But if another line be taken from the light boundary of the object-glass beyond the centre of the field plane, and to the opposite extreme of its margin, the direction of the ray is one of excessive obliquity; but still, notwithstanding its direction, it also gives an image of a near and distant object either without or with the special eye-piece for distance. In all methods of measurement for aperture hitherto employed, these very oblique pencils have been included in the amount, thus causing some object-glasses to show near double the number of degrees that the cone or pencil of rays should properly indicate; and so from the earliest history of the achromatic object-glass till now, one of the most astounding fallacies in science has been perpetuated, not much to the credit of those who have given attention to the subject.

The method described in my paper consists of placing an opaque screen, with a straight-edge set in focus in the centre, exactly bisecting the field of view so that a ray from the exterior or margin of transmission of the object-glass shall be confined to the centre only, by the edge of the screen. The direction of this ray, as indicated by a distant image, is marked as zero on a sector scale. The screen is then reversed, readjusted for focus and position, so as to cut off the other half, leaving the first open. A ray would thus pass from the opposite extremes of the circle of light transmission of the object-glass and through the centre of focus; the true angle is now indicated, as all the oblique rays deviating away on either side of the centre of focus are stopped off during the measurement. The *rationale* of this principle is so plain and comprehensible that no one has ventured forth to controvert its truth, notwithstanding that it must be extremely unwelcome to many, and may be left to posterity to recognize.

Several, who have been measuring their object-glasses for true aperture this way, have been puzzled by the different inversions, and have moved the sector the wrong way; this allows the oblique rays which should be cut off from the margin of the field to enter, and the effect of the screen will in consequence be *nil*. I have therefore applied a very simple remedy that will prevent mistakes. Above the concave examining lens (placed over the lowest eyepiece), I adapt a cap with a pin-hole stop, like that used in a Gregorian telescope. This greatly improves the distant telescopic vision, and increases the range, so that the screen can be seen on one side of the field. The cap is now removed, and the object is brought by the rotation on either side till the approach of the median edge causes it to vanish. I find it best to take the apertures by daylight sitting with the back to the window, and using for an object a vertical strip of white paper an inch broad, set a foot or so away.

Colonel Dr. Woodward maintains that immersion angles greater than 90° are now obtained, and tells us that this "was several years since demonstrated in the 'Monthly Microscopical Journal' both by Professor Keith and himself" (?).* In the last Journal he gives another demonstration, with a figure, by which arrangement a parallel beam of light is so restricted that it cannot enter within that angle, but passes straight on without refraction to the top of the slide or cover of an object in balsam, where of course it must be totally reflected; but if water is introduced between the cover and a high-angled object-glass, light will enter, and the field become luminous; but this proves nothing more than that the oblique rays I have specified, as including the extreme of the field of view, find entrance, and in this consists Colonel Woodward's mistake. There is no need of any such special contrivances, which tend to complicate and confuse the question. If an object-glass is duly adjusted on an object in balsam, it is quite clear, and follows as an *absolute optical condition* that if the rays emerge beyond at any degree *less* than parallel with the slide, the balsam angle *within* it must be under the critical angle, or below 82°. Now, if my opaque screen, formed as a slide, is substituted, the adjustment duly performed, and the oblique pencils cut off according to directions, the angle from out of the slide will always denote the angle within it. I have not yet met with any object-glass that possesses an angle of 150°—in fact, angles as high as 100° are rare, and what advantage is to be expected beyond 150°? In my last paper I gave a table of the percentage of value for apertures. The value of the ray-collecting

* In the 'Quarterly Journal of Microscopical Science,' No. xii., July 1855, page 303, I described how I first obtained the full aperture on objects in balsam by means of an additional front lens to the existing combination.

I mention this because the question has been argued as if I was ignorant of the principle, and denied that *in any case* an immersed angle beyond 82° was possible.

properties of angles is in proportion to the sines, or more comprehensively as the chord of the arc; the difference of value between 170° and 150° is only about three per cent., and the importance of the first is lessened by the distortion due to increased obliquity. With Colonel Woodward, I have no wish "to provoke ill-tempered discussion on the merits of individual makers." Microscopists have seen enough of this. If we are to come to what I believe to be rational, or more correct apertures, all alike must be reconciled to the reduction. I have known common sense in simple wonderment ask, What object can be properly seen at incidences claiming to near an aperture of 180°?—with every part foreshortened and distorted, even on the thinnest subjects, such as scales and diatoms —try and read a line of this page, at an incidence of five or ten degrees, and see what a confused muddle it appears to be. I think that microscopists should be glad if it could be proved that such an enormity does not exist.

A tiresome paper war, on doubtful apertures, has so far ended in nothing, that the whole might as well be consigned to the waste-paper basket. The question now is, whether the ultra rays belonging to the oblique pencils are to be measured in addition to the central cone or true aperture, in order to garnish up the now diminished substance, and to serve as lateral props against a case of would-be unstable equilibrium, and for the support of apertures that have not been reached.

Though Colonel Woodward and myself hold a difference of opinion, I do not at all wish to insinuate that he has any prejudice or bias in the question. The liberality of his contributions to the science of microscopy must place him far above any such suspicion.

NEW BOOKS, WITH SHORT NOTICES.

Pollen. By M. Packenham Edgeworth, F.L.S., F.A.S. Illustrated with 446 Figures. 8vo. London: Hardwicke and Bogue. 1877. —In this age of compilations, manuals, rudiments, students' text-books, and the rabble of such things, it is quite refreshing to meet with a volume of original observations on a special botanical subject, and, while admiring the zeal and talents of the author, to note the liberal enterprise of his publishers. The present book is indeed highly creditable to Mr. Edgeworth and Messrs. Hardwicke and Bogue, and is very welcome in the present sorry state of microscopic phytotomy in England. We have of late years had a surfeit of microscopical researches in the fossil flora, so that these seem to have diverted our attention from the intimate structure of the living plants which everywhere surround us, and to have blinded systematic botanists to the value of microscopic diagnostics. Should any person doubt this, let him give a glance at the descriptions in the current floras of this country and of the world. In them microscopic structure is generally discarded, though it would often afford valuable characters, and precise knowledge in the place of verbal vagueness. Were this instrument used, even superficially, in drawing up descriptions of plants, we should no longer be offended by such jargon as "plant mealy," "leaves rough with callous points," and many other equally obscure expressions; for the microscope shows that the "mealiness" of Chenopods is due to the effect on the light of peculiar utricular hairs, and that the "asperities" on the leaves of the Red Bryony are simply studs of calcareous granules. Indeed, a long and useful essay might be written on the employment by systematists of this kind of slipslop, which they might displace by accuracy with the aid of the microscope. In short, no full and true description of any plant can be drawn up without microscopic examination. In the species, genera, and orders, the characters should be given of the epidermis and its appendages, and of other cells or modifications of cells, including their contents, such as oil, resin, or crystals; nor should the properties of the peculiar and often very characteristic juices of many plants be neglected. This might be done briefly and effectually, especially if confined chiefly to diagnostics, and would be an instructive novelty in descriptive botany.

For all these reasons we cordially hail the advent of Mr. Edgeworth's book, which is likely to become valuable for reference to adepts, and still more extensively interesting to amateurs. Pollen is at once so beautiful and significant, that it cannot fail to maintain its popularity among microscopic curiosities. And in either way Mr. Edgeworth is an admirable guide, a careful and judicious observer, who has carried out a series of elaborate researches without the hope of any other reward than the gratification of a worthy love of the subject. To give an abstract of his extensive observations is beyond our power. Besides his collections from other writers, he has given us such a mass of his own investigations as must excite our admiration. We have now a compact and convenient book, with twenty-four plates, all from drawings by the author, which will afford us materials for forming some judgment of the taxonomic importance of pollen. Botanists have of late rated this as not worth much. At first they thought too highly of it. Finding certain forms of it common in certain orders, it was supposed to be generally of ordinal value; but exceptions became so numerous that this view had to be modified. Still the facts remain that pollen often has this high classificatory significance; that whatever exceptions occur ought to be duly noted and registered; and that sometimes it may be only of generic or even specific value. For example, *Ranunculus arvensis* is known at once from its nearest allies by its large and muricated pollen-grains, as they were originally described and figured, by Professor Gulliver, in 'Seemann's Journal of Botany,' September 1866; and Mr. Edgeworth confirms the truth of this curious observation, though it does not appear that he knew how old it is.

But all such irregularities are perhaps puzzling chiefly from the want of more investigations. The truth is that our knowledge is so imperfect that nature often revolts from and refuses conformity to even the best systematic classifications. Thus we have the acotyledonous *Cuscuta* in the midst of Dicotyledons, and odd differences of form in the embryo of Solanaceæ; the exogenous *Dracæna* among the Endogens; anomalies in the placenta of Mesembryaceæ, and in the albumen of Nelumbiaceæ, Rutaceæ, and Orontiaceæ; the strange insertion of the stamens in certain Plumbaginaceæ. These, and many other like perplexities, well known to botanists, might well have given them some patience for the vagaries of the pollen. But, after all, it cannot be denied that it often affords valuable characters, and that these are a part of the great whole which composes the cell-biography of plants, and which must be learned before we can acquire a faithful knowledge of their true nature; and to this end surely microscopic investigations cannot be dispensed with, as they have long injuriously been and still are by systematists. But all this must be reformed if we expect to arrive at a true description and interpretation of the vegetable kingdom.

And the present author contributes his contingent thereto. His eight introductory pages contain a summary account of the pollen, immediately followed by sixty more pages, in which we have a list of the plants of which the pollen has been described, those marked by an asterisk being such as he himself has examined and measured. The whole are classified according to the so-called natural system; and so too are the concluding twenty pages, these containing double columns and explanations of the plates.

Incidentally the author makes such observations on raphides as seem to indicate that he is alive to their taxonomic importance, and to this extent in advance of the systematists. And thus far he is rather in accord with the views of Professor Gulliver, as given in the remarks appended to his "list of plants which afford raphides," &c., published in the last September number of this Journal. Mr. Edgeworth finds these interesting crystals in the anthers of Smilaceæ, Nyctaginaceæ, Onagraceæ, Balsaminaceæ, and *Hydrangea;* and all these plants have long since been described as raphis-bearers by Professor Gulliver, except the last, in which we believe this character was originally discovered by Mr. Edgeworth. It is remarkable, because the Saxifrages, under which *Hydrangea* is commonly placed, are devoid of raphides; but Lindley had already separated it from that order, and as now appears not without another fact in proof of its want of affinity or identity therewith. Another osculant or aberrant genus, *Trapa*, usually included under Onagraceæ, Mr. Edgeworth finds destitute of raphides, and therefore agrees with Lindley that it belongs rather to the ex-raphidian group of Halagoreæ, and the more so as the pollen of *Trapa* is quite different from that of the true Onagraceæ.

Of a work so meritorious and full of valuable facts, all too depicted to a scale, so that he who runs may read, it might seem invidious to hint at faults. But we cannot help expressing some disappointment at the want of instructions as to the best means of examining the structure of the pollen, and especially of promoting the extrusion of the pollen-tubes. Recently the nectar of flowers has been recommended for this purpose, and the author's experience on this point might have been useful, especially if extended to other fluids, such as glycerine and saline solutions. The references to the figures and letters on the plates are too often incorrect and perplexing; and in a science of which the terms are so multifarious and oppressive, we have a right to expect, in one book at least, uniformity in their orthography. At the head of the list, p. 9, we have "Exogens," although the plants there are Endogens. In the measurements the numerator is constantly varied, while the denominator is fixed arbitrarily at 6000, which is by no means so simple a method of expressing vulgar fractions as the more common use of unity as an invariable numerator. But these, excepting the gross and inconceivable blunders in the explanations of the last and a few of the other plates, are small matters, scarcely affecting the high value of a work which is very creditable to its author and British botany.

PROGRESS OF MICROSCOPICAL SCIENCE.

Rate of Coral Growth.—The means of ascertaining this has been lately supplied both in Australia and Europe. In the latter it has been shown in a paper which Dr. Duncan has issued in a recent number of the 'Proceedings of the Royal Society' (No. 180). But it has also been observed in New Holland, as the following quotation from a Melbourne paper will show. A remarkable piece of coral, taken off the submarine cable near Port Darwin, is spoken of by the 'Cocktown Herald.' It is of the ordinary species, about 5 inches in height, 6 inches in diameter at the top, and about 2 inches at the base. It is perfectly formed, and the base bears the distinct impression of the cable, and a few fibres of the coir rope used as a sheath for the telegraphic wire still adhering to it. As the cable has been laid only four years, it is evident that this specimen must have grown to its present height in that time, which seems to prove that the growth of coral is much more rapid than has been supposed.

Remarks on the Rhizopod Genus Nebela.—In the ‘Proceedings of the Academy of Natural Sciences of Philadelphia,’ it says that at a late meeting Professor Leidy stated that in order to facilitate a ready reference to ordinary forms of rhizopods, he was disposed with some other observers to restrict the genus Difflugia to those rhizopods with lobose pseudopods, which ordinarily possess a covering or test composed of extraneous bodies, such as particles of quartzose sand, and diatom cases. In the genus Nebela, which he had viewed as distinct from Difflugia, the test is composed of discoid plates and minute rods, apparently siliceous and intrinsic to the structure of the animal. To the genus Nebela probably belong the species named by Ehrenberg, *Difflugia collaris*, *D. cancellata*, *D. carpio*, *D. binodis*, *D. annulata*, and *D. laxa.* Likewise the *Difflugia peltigeracca* of Carter, most of the forms described by Wallich under the name of *Difflugia pyriformis*, var. *symmetrica*, and also the *Difflugia carinata* of Archer. Formerly Professor Leidy had indicated several species under the names of *Nebela ansata*, *N. equi-calceus*, *N. sphagni*, *N. numata*, *N. barbata*, and *N. flabellulum.* ‘Pr. A. N .S.,’ 1874, 156. Most of the above-named species of Ehrenberg had been referred by the same author to a group with the names of Reticella and Allodictya, headed with a species named *Difflugia asterophora*, which, so far as could be judged from the description and figure, did not coincide with the characters of Nebela. Of the forms referred to *Difflugia symmetrica* by Dr. Wallich, the first one described has recently, by Schultze, been viewed separately from the others as characteristic of a new genus with the name of *Quadrula symmetrica.* The test of this is composed of quadrate plates, arranged in rows, like bricks in a wall. In all the species referred to Nebela, which have been observed by Professor Leidy, in all instances the test is compressed pyriform. Wallich remarks in reference to the tests of *Difflugia symmetrica*, that they “are sometimes so compressed as to give the aperture the undulating appearance represented in figs. 27, 29 and 30, but more frequently the tests are not compressed, and the aperture presents the ordinary circular or nearly circular outline.” The species *Nebela numata*, probably synonymous with *D. collaris*, is an exceedingly abundant form, in much variety in our sphagnum swamps, and illustrates well the character of the genus, and also exemplifies the extraordinary variation in the structure of the test, which appears to be common also in the other species of Nebela. In some individuals of *Nebela numata*, the test is composed of or invested with comparatively large circular disks of uniform size. In other individuals the disks are of the same character, but oval. In other individuals again the test is invested with circular or oval disks as in the former, but separated, uniformly scattered, and with the intervals filled with small circular disks. In other instances large circular or oval disks occupy the fundus of the test, and small ones extend from one-half of the body to the mouth, sometimes mingled with a few of the larger disks. In some instances the test is composed of minute circular disks, alone, or with a few large oval or larger circular ones scattered here and there. Generally the disks of the tests are sharply defined, closely placed, and touching at their contiguous edges. Sometimes they are crowded, and assume in a certain focus a more or less polygonal outline. Sometimes they appear to overlap the edges. Usually very distinct; they are sometimes more or less indistinct. The large disks in a certain focus appear centrally shaded, and exhibit a striking resemblance to ordinary blood-corpuscles. Not unfrequently the test is mainly or almost entirely composed of minute rods, placed in alternating oblique patches, with a few minute round disks. In other tests the disks predominate. In some tests large and small disks and rods are intermingled. In other tests larger, and fusiform rods, probably diatoms, are mingled with disks. Between the structural forms of the tests indicated, all sorts of intermediate forms are found. Occasionally, mingled with the more intrinsic elements of the tests, there are undoubted diatom cases, and rarely distinct and comparatively larger particles of siliceous sand. Professor Leidy looked upon the disks and rods of the tests of Nebela as intrinsic structural elements. They appear to be siliceous, as they undergo no change in heated sulphuric acid. No similar elements could be detected among the ordinary materials among which the animals lived. Dr. Wallich regards the disks and rods, of the forms he has called *Difflugia pyriformis* var. *symmetrica*, as being derived through the metamorphosis of diatom cases, through the combination of these with the basal substance of the test. In the reference to his figures 27 to 33, 'An. and Mag. Nat. Hist.,' 1864, he says that they "represent the series of forms exhibiting the transition from the ordinary mineral and chitinoid elements of the test to the evolution of the colloid disks." Professor Leidy remarked that notwithstanding he had examined multitudes of Nebela, he was not prepared to confirm this view, though he had too much respect for Dr. Wallich's accuracy of observation to doubt its correctness. The author then describes the various forms, and refers to adjoining figures of them.

Development of the Nerves in the Chick.—Mr. A. Milnes Marshall has communicated an important paper to the 'Proceedings of the Royal Society' (No. 179) on the development of the animal nerves. He says that in the investigation he undertook, embryos of ages from thirty-six hours to four days were employed. These were, for the most part, hardened by immersion in picric acid, prepared after Kleinenberg's method, for three to five hours, and then in alcohol of gradually increasing strength. It is to the use of picric acid as a hardening agent that the results obtained are believed to be in large measure due. All the more important results have, however, been confirmed by specimens hardened in chromic acid in the usual manner, though such specimens have almost invariably proved inferior in distinctness to those prepared with picric acid. Good results have also been obtained from duck-embryos hardened in picric acid.

Owing to the less compact character of the mesoblast of the head and to the absence of protovertebræ, the development of the cranial nerves is easier to study than that of the spinal, and will therefore be considered first.

Transverse sections through the hind brain of a forty-three hours' chick show that the cells along the median dorsal line are more spherical in shape and slightly smaller than those composing the rest of the brain; also that these spherical cells grow upwards, so as to form a conspicuous longitudinal ridge running along the upper surface of the hind brain immediately beneath the external epiblast.

The ridge is traceable along the whole length of the hind brain, but is much more prominent posteriorly than it is in front, where it gradually disappears. At intervals the ridge becomes more prominent, and grows out laterally into paired processes. These processes are the rudiments of the cranial nerves; the cells composing them are, like those of the ridge itself, small and spherical, and differ markedly from both the elongated cells of the external epiblast, and the large, loosely arranged, branching and irregularly shaped mesoblast cells.

At forty-three hours the first pair of these processes arises from the anterior part of the hind brain; it subsequently develops into the fifth nerve.

Immediately in front of the auditory involution (which at this period is a wide and very shallow pit) a large outgrowth arises on either side, from which the facial and auditory nerves are derived.

A large outgrowth from the median ridge commences on either side a short distance behind the auditory pit, and is of considerable longitudinal extent, reaching as far back as the middle of the first protovertebra. From this outgrowth are developed the glossopharyngeal nerve and the several branches of the vagus.

The outgrowth of spherical cells from the summit of the neural canal, forming the longitudinal ridge above alluded to, is not confined to the hind brain, but is continued backwards without any break some distance down the spinal cord. In the spinal cord, as in the brain, the ridge gives off at intervals paired lateral processes, which extend outwards just beneath the superficial epiblast. These processes correspond in number to the protovertebræ, and are the rudiments of the posterior roots of the spinal nerves. Each process has a longitudinal extension equal to about half a protovertebra, opposite the posterior part of which it is situated. In the case of the first few spinal nerves the processes are somewhat larger, and extend back so as to overlap the anterior parts of the succeeding protovertebræ.

This description, it is believed, differs from any previously published account of the development of the nerves in the chick, but agrees remarkably closely with Balfour's* account of the development of the nerves, both cranial and spinal, of Elasmobranchs, and is in

* 'Phil. Trans.,' vol. 166, pt. 1.

accordance with Hensen's * observations on the development of the posterior roots of the spinal nerves in the rabbit.

Opposite the centre of each protovertebra the external epiblast grows downwards as a small conical process on either side of the spinal cord and in close contact with it. These processes were mistaken by His † for the commencements of the spinal nerves, but are clearly seen to have no connection whatever with the nerve-rudiments. His is the only previous observer who assigns an epiblastic, instead of a mesoblastic, origin to the nerves in the chick; he, however, derives them directly from the external epiblast, while, according to the description just given, they really arise from the involuted epiblast of the neural canal.

From their mode of origin the cranial and the anterior spinal nerves will be seen to be all connected together at first by a longitudinal commissure of spherical cells, while the two nerves of each pair, whether cranial or spinal, are also connected together across the top of the neural canal.

The attachment of the nerve, whether cranial or spinal, is at first to the extreme summit of the neural canal. Shortly after their appearance the attachments shift slightly outwards, and in the case of the spinal nerve, become much more slender. The shifting is believed to be apparent rather than real, and to be caused, as first suggested by Balfour, by rapid growth of the cells at the summit of the canal, which has the effect of separating the roots of the two sides from one another and forcing them apart.

Though the proximal part of the nerve-root becomes thus more slender in the spinal nerves, the distal part enlarges considerably, and grows down as an oval mass (the spinal ganglion) between the spinal cord and the protovertebræ. At this period the most prominent part is situated opposite the interval between two protovertebræ.

During the third day a great change occurs in the point of attachment, which is now considerably lower down, in the position occupied by the root in the adult. The nerve is now attached, not by its apex, but by a small process growing out from its side, and projects considerably above the point of attachment. Owing to the surrounding mesoblast this stage is very difficult to investigate; but the appearance strongly suggests that the original attachment of the nerve to the summit of the card is lost, and a new one acquired lower down, and that the projection of the nerve above the point of attachment, which becomes inconspicuous very shortly afterwards, is a remnant of the original attachment.

The anterior roots of the spinal nerves arise later than the posterior, and have not been observed earlier than the latter part of the third day. They appear as small outgrowths from the lower part of the sides of the spinal cord, and from the first occupy the position held by them in the adult. This position is indicated before the actual appearance of the roots by a slight convergence of the cells at the outer part of the cord. The anterior roots are very slender, and

* 'Zeitschrift f. Anatomie u. Entwickelungsgeschichte,' 1876, Bd. i.

† 'Die erste Anlage des Wirbelthierleibes.'

consist of much elongated cells, contrasting strongly with the spherical or oval cells of the posterior roots.

Early on the fourth day each anterior root consists of a number of such processes placed one behind the other, and lying opposite the anterior half of a protovertebra. The total length of attachment of an anterior root on the fourth day is equal to about half a protovertebra.

The anterior roots grow outwards, and early in the fourth day join with the posterior roots to constitute the spinal nerves.

In the cranial nerves no anterior roots have been observed; but as the observations have not been carried beyond the fourth day, and certain of the cranial nerves have not been observed at all, no conclusion as to their non-existence is to be drawn from this fact, which can only be considered a doubtful confirmation of Balfour's failure to discover anterior cranial roots in Elasmobranchs.

The facial and auditory nerves have been seen to arise as a single outgrowth just in front of the ear; this speedily divides into an anterior part, which runs downwards in front of the auditory vesicle and becomes the facial nerve, and a posterior part, which is closely applied to the anterior wall of the auditory vesicle and becomes the auditory nerve.

The fifth nerve arises as a single outgrowth on either side, the position of which is very constant. The so-called "hind brain" consists at forty-three hours of an apparently variable number of dilatations separated by slight constrictions, and gradually decreasing in size from before backwards. These dilatations are well known, but appear to possess more constancy than is usually ascribed to them; the most anterior of them is but little smaller than the mid brain. From it the fifth nerve arises in all the specimens examined.

The third, fourth, and sixth nerves have not been observed; but a slight outgrowth from the summit of the mid brain, noticed in two specimens only, may prove to be the commencement of the third or fourth.

The olfactory nerves arise towards the end of the third day as solid outgrowths from the anterior end of the fore brain, close to the median dorsal line, and exactly correspond in mode of development and in appearance with the other cranial nerves and with the posterior roots of the spinal nerves. They arise at a time when a section through the anterior part of the fore brain transverse to its longitudinal axis, and passing through the olfactory pits and nerves, is almost perfectly circular in outline, and must therefore be described as arising from the fore brain itself, and not from the cerebral hemispheres, with which they have no connection at first, and which are not nearly such prominent objects at the end of the third day as they are often described to be. There is no trace of an "olfactory vesicle" in the early stages.

This mode of development of the olfactory nerve in the chick would seem to be of considerable morphological importance, since, if confirmed, any arguments concerning the composition of the skull, based on the distribution of the cranial nerves, would have in future to take the olfactory nerves into consideration.

Protoplasmic Filaments of the Teasel.—Mr. F. Darwin, M.B., has read a valuable paper before the Royal Society,* on this subject. The structures described are, he says, connected with the glandular hairs or trichomes found on both surfaces of the leaf of the common teasel (*Dipsacus sylvestris*). The trichomes are of two kinds, differing in a marked manner in shape. The gland consists of a multicellular pear-shaped head, supported on a cylindrical unicellular stalk which rests on a projecting epidermic cell. The whole structure projects about $\frac{1}{10}$ of a millimeter ($\frac{1}{250}$ inch) above the surface of the leaf.

The filaments issue from inside the gland-cells, reaching the surrounding medium by passing through the external cell-wall of the gland. The point where protrusion takes place is on the summit of the gland, and usually at the point of junction of several radiating cells at the centre of its dome-like surface. The act of protrusion is rapidly effected; a previously naked gland may be seen to send forth a minute thread of trembling protoplasm, projecting from its summit freely into the surrounding water. The filament grows by clearly visible increments, and may ultimately attain the length of nearly one millimeter. The filaments appear to pass throughout the substance of the external cell-wall of the glands, as no apertures to allow of their passage have been observed.

Under normal circumstances the filament presents the appearance of a delicate and elongated thread slightly clubbed at its free end, and animated by the perpetual tremble of Brownian movement. The distal end of the filament is often attached to the gland, thus forming a loop. Extremely delicate filaments of great length are often seen entangled in elaborate and complex knots, or several filaments may be seen issuing from a single gland. The substance of which the filaments are composed is gelatinous, transparent, highly refracting, and devoid of granules. It is in a great measure soluble in alcohol, is stained by tincture of alkanet, and not blackened by osmic acid, and is coloured yellow by iodine. These reactions, when combined with results of various physiological tests, show that the filaments contain resinous matter in some way suspended in protoplasm.

The most remarkable point in the behaviour of the filaments is their power of violently contracting. The act of contraction commences by the filament becoming shorter and thicker at a number of nearly equidistant points, situated close together near the free end of the filament. The curious beading thus produced spreads rapidly down the filament, which ultimately runs violently together into a ball seated on the top of the gland. In other cases contraction takes place without any previous appearance of beading.

Filaments frequently break loose but retain their vitality, and are still capable of contraction although separated from their parent glands; and this observation is of importance, as proving that the movements of the filaments are not governed by forces residing within

* 'Proceedings of the Roy. Soc.,' No. 179.

the glands, but that the filaments are composed of an essentially contractile substance.

The contraction of the filaments is produced by the following causes:

Dilute acids (from 1 to $\frac{1}{5}$ per cent.) — Sulphuric, hydrochloric, acetic, citric, and osmic acids.

Dilute alkaline solutions ($\frac{1}{4}$ to $\frac{1}{2}$ per cent.)—Carbonates of ammonia, sodium, potassium.

Solutions of gold-chloride $\frac{1}{2}$ per cent., silver nitrate $\frac{1}{4}$ per cent., sulphate of quinine $\frac{1}{10}$ per cent., citrate of strychnia (about) $\frac{3}{4}$ per cent., camphor $\frac{1}{10}$ per cent., the poison of the cobra (about) $\frac{1}{4}$ per cent., iodine $\frac{1}{4}$ per cent.

Glycerine.

Methylated spirits.

Vapour of chloroform.

Heat.—The temperature at which the filaments contract are rather variable, but are all below 57° C.

Electricity.—The induced current causes contraction.

Mechanical stimulation.—The filaments contract when pressure is made on the cover-glass.

The evidence derived from the experiments, of which the results are here briefly summarized, appears to be strongly in favour of the view that the filaments contain true living protoplasm, and that the sudden movement above described is a true act of contraction; for if the latter hypothesis is rejected, the only remaining view is that the filaments are so constituted as to be capable of undergoing coagulation, by which contractility is mechanically simulated. But it seems inconceivable that reagents of widely different natures, such as dilute solutions of acetic acid, of camphor, and of gold-chloride, should produce identical chemical effects. Osmic acid is well known to kill protoplasmic structures without making them contract. This characteristic reaction holds good with the filaments of the teasel when treated with sufficiently powerful solutions of osmic acid (e. g. 1 per cent.). When killed in an extended position, they cannot be made to contract with strong acetic acid. This observation is of importance in another way; for it proves that the violent movements caused by dilute acetic acid are of a "vital," and not simply of a chemical nature. Moreover, the general character of the reagents and other causes (such as heat, &c.) by which contraction is produced is quite consistent with the belief that the filaments are protoplasmic in nature.

An important series of phenomena are produced by the following fluids: dilute solutions ($\frac{1}{2}$ or $\frac{1}{4}$ per cent.) of carbonates of ammonia, potassium, and sodium, and infusion of raw meat. If a filament under the microscope is treated with a drop of $\frac{1}{4}$ per cent. solution of carbonate of ammonia, the following changes occur. The filament contracts, but almost instantly recovers itself, and is once more protruded. The filament, however, does not regain its original form or general appearance: instead of consisting of thin elongated ropes of a highly refracting substance, it is converted into balloon-like or sausage-shaped masses of very transparent, lowly refracting matter. These transparent masses are remarkable for the spontaneous changes of form and other quasi-amœboid movements which occur among them.

Dilute infusions of meat cause a similar effect, astonishing quantities of transparent matter being produced.

It has been shown that the filaments are protoplasmic bodies, containing a large quantity of resinous matter. The question next arises, with what process in plant-physiology is the protrusion of filaments homologous?

The leaf-glands of the teasel are similar in general structure to many glandular hairs which produce resinous and slimy secretions, and, like these glands, they contain bright drops of secreted resin lying in the centres of the gland-cells; they also resemble many glandular hairs in being often capped with accumulations of secreted matter. Now these accumulations stain red with alkanet, yellow with iodine, and are largely soluble in alcohol; that is to say, they consist of substances which have the same reactions as the filaments. There is, in fact, no doubt that the caps of resinous matter on the teasel-glands are produced by the accumulation of dead filaments. According to this view, the act of protrusion is essentially a process of secretion: the resin issues from the gland-cells, mingled with a certain amount of true protoplasm; and it is only from the death of the living or protoplasmic part of the filaments that the resinous accumulation results. This view of the act of protrusion corresponds with the theory of secretion held by some physiologists, viz. that secreted matter is produced by the dissolution or death of protoplasm—that, for instance, the oil in a fat-cell is the result of the disintegration of a plastid or individualized mass of protoplasm formed in the cell by endogenous cell-formation.

The protrusion of protoplasmic filaments from the glands of the teasel appears to bear an obscure relationship to the phenomena of "aggregation" in *Drosera* and several other plants. In both processes we have homogeneous, highly refracting protoplasmic masses, which undergo amœboid movements, and are in some unknown way connected with the absorption of nitrogenous matter. In *Drosera* the protoplasmic masses remain within certain cells; in *Dipsacus* they are protruded through the cell-wall.

When we begin to inquire as to the function of the filaments, the answer seems at first to be sufficiently plain; but this is very far from being the case. The connate leaves of the teasel form cup-like cavities, which become full of rain and dew in which many drowned insects accumulate. The glands at the base of the leaves are thus exposed to a highly nitrogenous fluid. And since such fluids are known to produce a remarkable effect on the filaments exposed to them, it seems probable that the filaments are in some way connected with the assimilation of food material. It seems probable that, either with or without the assistance of their filaments, the glands do absorb some nitrogenous matter; for changes of their cell-contents occasionally occur which can only thus be interpreted. But on account of the rarity and uncertainty of these aggregation changes *within the glands*, but little weight must be allowed to the phenomena as a proof of the absorbing capacity of the glands. Some other points in the structure of the plant render it almost certain that the connate leaves are specially adapted to serve some useful purpose. Kerner is probably right in believing that the "cups" of the teasel are of use to the plant in keeping off nectar-stealing ants and other wingless insects; but unless this is their only function, it seems probable that the connate leaves have been to a certain extent adapted for the capture of insects whose decaying remains are absorbed by the plant. The leaves are smooth and steeply inclined, and form a pair of treacherous slides leading down to a pool of water.

It is worthy of note that the leaves of the first year's growth, which do not form cups, are not smooth, but bristle with long sharp hairs; moreover, in *Dipsacus pilosus* the leaves (of the second year's growth) are not sufficiently connate to form cups, and they also are rough with hairs. These facts seem to show that the smoothness of the second-year leaves in *D. sylvestris* is a specially acquired quality. Another special point of structure in *D. sylvestris* may be noted. The stems are everywhere armed with sharp prickles, except where they are covered by the water in the "cups"; and here they are quite smooth, so that no ladder of escape is afforded to the drowning victims. Even if we grant from the above considerations that the filaments protruded from the glands are in some way connected with the absorption of nitrogenous matter from the putrid fluid in the cups, we are far from understanding the whole of the problem; for precisely similar *filament-protruding* glands are found on the seedling leaves of *D. sylvestris* and on the second year's leaves of *D. pilosus*; and as no "cups" are formed in either of these cases, the filaments cannot be connected with absorption of the products of decay. The only view which suggests itself is that the filaments absorb ammonia from the dew and rain. Recent researches have shown that certain leaves have the power of absorbing an appreciable quantity of ammonia; and this fact lends some probability to the view above advanced.

To recapitulate. Protoplasmic filaments are protruded from the leaf-glands of the teasel; and the only theory which seems at all capable of connecting the observed facts is the following:—That the glands on the teasel were aboriginally (i. e. in the ancestors of the Dipsacaceæ) mere resin-excreting organs; that the protoplasm which comes forth was originally a necessary concomitant of the secreted matters, but that, from coming in contact with nitrogenous fluids, it became gradually adapted to retain its vitality and to take on itself an absorptive function; and that this power, originally developed in relation to the ammonia in rain and dew, was further developed in relation to the decaying fluid accumulating within the connate leaves of the plant.

Is the Amœba a Cannibal?—Professor Leidy has asserted that the Amœba is a cannibal. However, Mr. J. Michels points out, in a letter to the 'American Journal of Microscopy' (July), that it is most probable that the supposed cannibalism of the Amœba that Professor Leidy has noticed, is nothing more nor less than a process of reproduction. In proof of this he gives a number of figures—copies of Mr. Dallinger's plates in this Journal—and cites the following quotation from one of the many papers which the Rev. Mr. Dallinger and Dr. Drysdale have communicated to our columns:—"Two of the monads, in no way distinguishable from one another, at times met and touched at their anterior ends, swimming freely together. The normal flagella rapidly disappeared, *and the bodies melted into each other*, and the whole assumed a granular condition." Subsequently, Mr. Michels remarks:—"Now, sir, there appears to me to be so close an analogy between the *blending* of the bodies of the Amœbæ, as seen by Dr. Leidy, and the *melting* into each other of the monads observed by Messrs. Dallinger and Drysdale, that I cannot resist the conclusion that they had reference to one and the same act. I beg to make this as a mere suggestion, with no desire to disparage Dr. Leidy's interesting observations, but rather to offer a rational solution to what he himself considered an abnormal act." It occurs to us that Mr. Michels is probably right with regard to his explanation.

Where Diatoms may be found.—The following observations from Professor Smith's translation of Kützing's work in the 'American Journal of Microscopy' (July), may not be uninteresting to our readers. He says that diatoms are found in almost all waters, or in wet or damp places. But those who suppose that these organisms occur in every drop of water are mistaken. In pure river or spring water they are rarely found, but near the banks of the rivers, and in the places where springs flow out, in water tables, and in damp places, around water pumps, and on the stones and plants which are under the water. The fine-threaded marine and fresh-water algæ are often very richly covered with them—sometimes so completely that the algæ cannot be recognized. Frequently, also, in summer, they are to be found in the little pools of drying ditches, or in the rain-pools, where, on the slippery ground, they form a more or less slimy skin, generally tender, but sometimes compact, and which is frequently characterized by a brown colour. On warm, sunny summer days, bubbles of oxygen are developed in these masses, buoying them up, and bringing them to the surface, where they then appear floating either as a thin and tender brown skin, or as larger, thicker, very slimy and compact, skinny or lumpy masses, from which a notable quantity of oxygen gas can be collected. The microscope shows that in these fine skins, very different forms are associated, usually Naviculæ, Cymbellæ, Surirellæ or free Synedræ, with a more or less lively motion. The larger slimy masses consist principally of one species, and if others are found among them, they must be considered as accidental mixtures. The thread-like forms of Melosira stick to plants, stones, wood, &c., in standing or flowing ditches, forming tender, brownish, thread-like masses. Others, e. g. Fragilariæ, are usually found on rotting tree or other leaves. Also among Confervæ, mixed with Cymbellæ, Synedræ, and other forms. It seldom happens that one species is found quite isolated from others. The adherent forms are generally found on the fine-threaded marine or fresh-water algæ, the former yielding the complex larger attached forms; the latter, especially, the small, isolated, free movable forms. The brackish waters in the vicinity of sea-coasts, or where the sea-water during high tide flows into the fresh-water ditches, or mouths of rivers, are particularly rich in forms of different genera. The tide washes these microscopic bodies loose from the ground, and the water collected near the bank contains them in great abundance. Filtering large quantities of such water, leaves them on the filter, and they can be gathered; a method of procuring them mentioned first by Ehrenberg. I have also practised the following methods: I have taken off the brown skin or slime, with a knife, or spatula, pressed the water out, wrapped the remnant in paper, and thus carried it off. In the same way I treated the other forms, which either as foam, or slime skins, appear swimming on the water. The species found on Confervæ, or other algæ, I gathered with these, pressed the algæ, and thus transported them. The separate packages I emptied into as many vials, at home, and poured water on the masses, then subjected them to the microscope, and afterwards preserved them, either in vials with alcohol, or spread out and dried on plates of mica; in the lack of mica plates, one can use little slips of glass for the same purpose of spreading and drying. In this way, all the forms found in one region can be preserved for an indefinite time. The larger, complex forms of the sea, e. g. Schizonemæ, Micromegæ, which are found attached to algæ, stones, and other objects, may be preserved either in alcohol, or dried like the algæ, on paper or mica plates. In the examination of these, as with all forms, they must first be wetted and softened by water. The dead individuals sink to the bottom of the water, and since their siliceous shells resist solution, as well as decomposition, they can be found therein even after thousands of years. And thus it may happen that these siliceous shells may get into the fertile humus, and form a part of it, but their presence therein is, generally, purely accidental, and only common in such places as are frequently flooded, or have in former times been the bottom of a swamp, or standing water, e. g. most peat-layers, in which, in addition to the diatom frustules, remnants of different water and swamp plants, and also snail and mussel shells are found. No diatom shells are found in the soil of dry regions.

Laticiferous Vessels in Plants.—'Nature,' of August 9, states, that a very interesting Russian paper, by M. Schmahlhausen, has just appeared, "Researches on the Vessels of Plants." The author shows that the growth of the vessels goes on in the same manner as that of the mycelium of parasitic fungi in the tissue of plants, and thus refutes the often expressed opinion that vessels in plants are analogous to the blood-vessels in animals.

Parasitic Infusoria. — Professor Leidy, who recently (June 12) read a paper on this subject before the Academy of Sciences of Philadelphia, stated that most of the known parasitic infusoria possessed a mouth like those which lived on ordinary water. Such is the case with the species of *Balantidium* found in the intestinal canal of man, the hog, and various batrachians; of *Nyctotherus*, found in the intestine of frogs, several insects and myriapods; and the *Conchophthirus anodontæ*, often found abundantly on the branchiæ and palpi of our *Anodon fluviatilis.* Other parasitic infusoria are not only devoid of an intestinal canal as characteristic of their class, but have no mouth, and, like the tapeworms and Echinorhynchi, absorb nourishment through the exterior surface of the body. Such is the case with the genus *Anoplophrya* of Stein, typified by the *Anoplophrya lumbrici*, found in the intestine of our common earth-worms, as well as in those of Europe. Professor Leidy had also detected the same species in the little wood-worm, *Enchytræus socialis*, and had found two other species, formerly described by him under the names of *Leucophrys clavata* and *Leucophrys cochleariformis*, in the intestine of *Lumbriculus limosus* and *L. tenuis.* Recently in dissecting the fresh-water snail, *Paludina decisa*, while examining the branchiæ he observed several individuals of an *Anoplophrya* moving actively, as if in antagonism with the ciliary motion of the branchial plates. Seeking the source of the little creatures he found that they came from the rectum of the *Paludina.* In examining other individuals of this snail he observed that some were free, others were infested with few, and some with multitudes of the infusorian. In several instances the *Anoplophryæ* were so abundant as to resemble in their crowded condition a mass of writhing worms, actually distending the portion of the intestine they occupied. The species appears to be an undescribed one, and is interesting from its comparatively large size. It was named and described as follows:—*Anoplophrya vermicularis.* Body cylindrical, slightly tapering posteriorly, rounded at the extremities, or subacute behind; flattened at the anterior extremity; translucent white, finely striated longitudinally, uniformly clothed with short cilia; internally finely granular, with a longitudinal cylindrical nucleus occupying nearly the length of the axis, and with from twenty to thirty contractile vesicles, mostly arranged in one, but often in two longitudinal series. Length from two-fifths to one-half a millimeter; breadth in front ·044 to ·048 mm., behind ·032 to ·04 mm. Besides the movements of progression induced by the cilia, the animal wriggles in a sigmoid manner and even doubles on itself. The contractile vesicles may contract more or less successively to mere points, but apparently at no time entirely disappear, and they may enlarge to double their usual size. The axial nucleus is at first barely susceptible, but becomes very obvious as the animal approaches dissolution. Incidentally Professor Leidy also stated that *Aspidogaster conchicola*, so common in the pericardium of Anodonta and Unio, he had also found in one instance in the oviduct of *Paludina decisa.*

Recent Researches on the Entomophthoreæ.—A recent essay on this subject, which appeared in the 'Botanische Zeitung' for April, and was followed by a second in the number for June, have been abstracted—as alone a botanist interested in the question could abstract them—by Mr. S. Moore in the 'Journal of Botany' for August. The two papers are entitled "Ueber die Entomophthoreen und ihre Verwandten," Von Dr. Oscar Brefeld; and "Die copulation bei einigen Entomophthoreen," Von Dr. Leon Nowakowsky; and Mr. Moore comments on them as follows:—The question as to the sexuality or asexuality of some groups of fungi is, in these two memoirs, shifted from tho *Basidio-* and *Ascomycetes*, to which it has recently been confined, to a group much lower in the scale. The first-named author, who, as is well known, has given considerable attention to the study of *Entomophthora* (better known in this country as *Empusa*), has come to the legitimate conclusion that, as all observation has failed to discover the resting spores of *E. muscæ* in the bodies of flies, those spores must be developed in some other host. His paper, however, does not fill up the gap in the life-history of the above-named fungus, but deals mainly with its congener *E. radicans* found on the cabbage caterpillar in autumn. Nearly two years ago the resting spores of (as was supposed) this species were found in small quantity inside the caterpillars, but these spores did not germinate in the following spring. Last autumn the fungus was found in great abundance; and as germination in the spring did not succeed, another method, that of inoculation, was followed in order to show if the resting spores were indeed genetically connected with the mycelium and ordinary spores of the caterpillar pest. For each series of inoculations 120 caterpillars were chosen; of these 100 were inoculated with fresh ordinary spores, while the rest were placed aside for a control experiment. Of the first 100 inoculated, 81 showed the disease, and 19 were rendered useless either by their passing into the pupa state, or by their being attacked by animal parasites; 62 of the above 81 showed normal eruption of the fungus, and 19 only slight signs of its presence. The dry shrivelled bodies were found filled with resting spores. In the second experiment, the caterpillars here being inoculated with spores from the first series, 50 were attacked (as evinced by eruption), and 28 dried up. Of the third series, inoculated with spores from the preceding, 39 showed eruption of the fungus, and 38 dried up; 54 of the fourth series became shrivelled and 29 had the eruption. Of the fifth series only 14 showed eruption; and in the sixth all dried up. All the uninoculated caterpillars remained sound. Dr. Brefeld holds that these resting spores arise asexually; by means of them, of course, the fungus passes through the winter. He refers to the resting state of *E. radicans* Fresenius' *E. sphærosperma*; moreover, the genus *Tarichium* of Cohn must disappear altogether; indeed, he thinks it possible that *Tarichium megaspermum*, Cohn, may be the resting-spore-bearing state of *Empusa muscæ*. In addition, a further conclusion is stated which must eventually either stand or fall with the accepted asexuality or sexuality of the higher Fungi. It is this; that in all essentials the structure and development of the *Entomophthoreæ* correspond to the same of the lower *Basidiomycetes*, such as *Exobasidium* and *Tremellineæ*, except that the Entomophthoreous basidium is one-spored; but we certainly think it unwarrantable to adduce the occurrence of these presumed asexually-produced resting spores as an additional proof of asexuality of *Basidiomycetes*. Indeed Nowakowsky's conclusion is a directly opposite one, for he asserts that he has seen zygospores not only in *E. radicans*, but also in two new species (*E. curvispora* and *E. ovispora*). These zygospores are produced in the manner that Brefeld himself discovered in the case of *Piptocephalis*, viz. as an excrescence from one of the lateral outgrowths of two conjugating cells. Nowakowsky, moreover, arranges the *Entomophthoreæ* as a special group of *Zygomycetes* near *Piptocephalideæ*. Nothing daunted, however, Brefeld holds to his original opinion, and considers that what Nowakowsky takes for conjugation is a simple fusion of hypha-threads, and has nothing to do with formation of resting spores. Assuming, therefore, that all *Basidiomycetes* (in the Brefeldian sense) are reproduced asexually, we see starting from *Entomophthoreæ* gradual elimination of the resting-spore element accompanied by complication of the ordinary fruit. The *Ustilagineæ* also come into the series, only here instead of the resting spores being merely *one* form of reproductive organ, they are *the main* form, since reproduction by gonidia and by ordinary spores occurs only on germination of the resting spores. With regard to the *Uredineæ*, the *Æcidium* fruit is held to be the analogue of the resting spores of *Entomophthoreæ* and *Ustilagineæ*, the spermogonia corresponding to the gonidia of the former, and to the club-shaped sexual cells of *Tremellineæ*, while the teleutospore fruit is a true basidiomycetous fruit, the teleutospore being merely the expression of adaptation to external conditions and producing true basidiospores as the result of its germination. Dr. Brefeld agrees with Sachs in considering that the *Zygomycetes* and *Oosporeæ* have been derived from Algæ. For them he adopts the old word *Phycomycetes*. The rest of the Fungi are divided into two groups, *Myxomycetes* and *Mycomycetes*, the latter containing *Basidiomycetes*, *Ustilagineæ*, *Æcidiomycetes*, and *Ascomycetes*.

CORRESPONDENCE.

Dr. Edmunds' Paper on a Paraboloid Illuminator.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—I fully endorse the remarks of Dr. Edmunds, in favour of the effects of the above illuminator. The idea is, however, by no means a "new" one, and has long been published and figured in the Transactions of the Microscopical Society. At the meeting on March 20, 1856, I read a paper on illumination, and described a small truncated parabola of crown glass used beneath the stage, on the flat top of which slides were to be laid with an intermedium of high refractive power. Animalcules, or objects in water, or other fluid were placed directly on the flat top, and covered with thin glass. Beyond making two of different sizes for my own use, and exhibiting the effects on that occasion, I made no further stir in the matter, and it has since been twice reinvented. My reason for devising this was on account of a difficulty in obtaining a perfectly black field under large angles of aperture by means of the ordinary paraboloid. In this I was then successful. I remarked in my paper of the truncated or "immersion" paraboloid that "the light may be obtained of any required degree of intensity and the field perfectly black with objectives of the most extreme aperture."

Dr. Edmunds remarks in his paper (page 84) that from "a paraboloid the illumination of an object may be made to reach the point where it could be taken up from above the stage by a fine parabolic Leiberkuhn, or other reflecting appendage to the objective." This idea I also carried out many years ago: it is figured and described in the 'Quart. Journal of Microscopical Science,' No. 7, April 1854. I have no desire to make undue claims, but merely refer to them as matters of history.

My original paraboloid was brought before the Microscopical Society early in the year 1850. A new generation of microscopists has sprung up since that time. Of the original members, whose genial monthly greetings I still so well remember, but few are now alive.

I am, Sir, your obedient servant,

F. H. Wenham.

PROCEEDINGS OF SOCIETIES.

San Francisco Microscopical Society.*

The regular meeting of the Society was held on Thursday evening, August 2.

Mr. Hanks donated a bottle of Beale's carmine injecting fluid prepared by him, and Mr. Langstroth presented a slide, mounted by him, with a Sertularian from Monterey Bay.

Regarding the luminous larva spoken of by Mr. Kinne at the last meeting, Mr. Henry Edwards stated that it was that of the *Ellychina Californicus*, a beetle of the family *Lampyridæ*, and that he had raised the perfect insect from similar forms found near crystal springs.

Mr. Kinne stated regarding the acarus found in the decomposing kernel of the coffee-berry presented by Mr. Wickson at the last meeting, that a somewhat critical examination of its minute parts had confirmed his opinion of its alliance to the sugar insect; the terminal and other joints of the legs, the mouth parts and disposition of hairy bristles being almost if not quite identical with the true *Acarus sacchari.* He alluded to the fact that about 15 per cent. of the coffee-bean is sugar, dextrine, &c., and was led to say in this connection that the opportunity which fortunately had been given him to examine many specimens has caused him to believe that most of its kind depended on saccharine matter for food, and should be classed as varieties and not species. The lemon-tree acarus, described by him recently, the colony found in the centre of a sugar-cured ham, the barley acarus found in the debris of a mass of that grain, which had been slightly moistened and fermenting, and others met with at various times with varying habitats, only were possessed of such slight variations from that of the true sugar-insect, that the evidence was of a convincing character enough to warrant the assumption that they were varieties of that acarus, modified by their environment, and should not be relegated to species.

Mr. X. Y. Clark favoured the members with some remarks on the Crustacea, in the way of explaining and exhibiting the organ of hearing in our local lobster, or crawfish, properly speaking, which is one of an entirely different genus (Astacus) from that of the lobster (Homarus). He stated generally the characteristics of the several special senses in

* These reports reach us in printed form, but are very incorrectly set up. We cannot of course be responsible for errata.—Ed. 'M. M. J.'

this crustacean, in which he had been interesting himself in study recently, and alluded to the probable development in the way of organs of seeing, smelling, and especially hearing. The eyes were, no doubt, once but simple feelers, and by a process of evolution had developed into appendages. The organs of smelling were the larger of the remaining pair of feelers—antenna—while those of hearing were located in the smaller pair, or antennules. The parts of the latter were easily dissected out with a pair of scissors, and the lobster's ear, in the shape of an auditory sac, handed about on a needle for examination. Placing a prepared fragment immersed in glycerine, on a slide, the sensitory hairs were beautifully shown, standing out from a telephonic floor, so to speak; and the previous explanations, by means of diagrams on the black-board, were rendered still more plain, and the method in which the little hairs would receive sensations from vibrations in the fluid in the sac made theoretically clear. Mr. Clark also exhibited several slides showing colonies of bryozoans and beautiful little calcareous helices of serpula, on some fronds of a fucus.

Dr. Gustav Eisen, Professor of Zoology, Upsala, Sweden, a corresponding member, called attention to some minute worms of the Oligochæta, of the family *Tabificidæ*, and exhibited some fine plates of beautiful drawings made by his skilful hand, representing their anatomy. The worms were all found in California, near San Francisco, in the Sierra Nevadas, or in the red-wood forests along the northern coast, all inhabiting ponds, lakes, or even clear running streams. Of said family, only five genera are known, viz. : Tabifes, Psamorychtes, Phreatotrix, Limnodrilus, and Thelmatodrilus. Of those, all except Phreatotrix were found in California, and one, the Thelmatodrilus, was endemic to the waters of the higher Sierra Nevada. The Doctor called attention to some points in their anatomy, and pointed out some characters by which species and genera could easily be distinguished, as in the Oligochæta generally no external characters are found, and the species must be arranged according to the shape of their interior organs. As a generic characteristic, the supracœsophageal ganglion is of great value, but as to specific characters the generative organs were undoubtedly the best. The organs represented on the drawings were principally the nervous system, the ovaries, the testes, the efferent ducts and the segmental organs, all exhibiting characteristic forms in the different species. The species described were *Limnodrilus crinis medusæ*, *Limnodrilus rejdoorkyi*, *Limnodrilus corallinus*, *Tabifes mirabilis*, *Thelmatodrilus alpestris and Psamorycles Californicas.* Besides these, many new forms had lately been found, but many more yet were likely to occur in our stagnant ponds or rivers. The Doctor expressed his hope that the members of the Society, during their excursions, would capture and preserve all such worms found, and any contributions, however small, should be most thankfully appreciated. Nearly every large body of water contains one or several new forms, and a perfect collection could only be brought up by a diligent search in different parts of the country.

THE MONTHLY MICROSCOPICAL JOURNAL.

NOVEMBER AND DECEMBER, 1877.

NOTICE TO SUBSCRIBERS.

The publication of the 'Monthly Microscopical Journal' ceases with the present issue.

Subscribers wishing to complete their sets may obtain any of the back numbers, but as very few copies of some of these remain unsold, early application should be made.

HARDWICKE AND BOGUE.

ROYAL MICROSCOPICAL SOCIETY.

Messrs. Hardwicke and Bogue having decided to discontinue publishing the 'Monthly Microscopical Journal,' the Royal Microscopical Society will for the future publish their own Transactions. All communications for the Society should be sent to Mr. W. W. Reeves, King's College, London.

WALTER W. REEVES,
Assist.-Secretary.

The President and Council of the Royal Microscopical Society take this opportunity of expressing the regret with which they heard of the death of Dr. Lawson, which took place at Cork on the 4th of October. Dr. Lawson edited this Journal from its commencement, and also held the appointment of Assistant-Physician and Lecturer on Physiology at St. Mary's Hospital. He had been in failing health for several years, and left London for his autumn holiday with little hope of return. He died at the early age of 37 years.

THE

MONTHLY MICROSCOPICAL JOURNAL.

NOVEMBER AND DECEMBER, 1877.

I.—*On a New Arrangement for Distinguishing the Axes of Doubly Refracting Substances.*

By H. C. Sorby, F.R.S., President R.M.S.

(*Read before the* Royal Microscopical Society, *October* 3, 1877.)

In studying with the microscope thin portions of doubly refracting crystals, seen detached or in sections of rocks, very little attention has hitherto been paid to the direction of the positive and negative axes, although a knowledge of this may afford most valuable information, as I have already shown in some of my former published papers. I must say that I am not at all surprised, since, though fully impressed with its importance, I have often neglected to make use of the form of apparatus hitherto employed, on account of the practical difficulties of the method and the uncertainty of the results. I have for a long time been anxious to devise some such modification of the necessary apparatus as would enable me with ease and certainty to ascertain which is the positive and which is the negative axis of any crystal, and have at length contrived a plan which appears to me in every respect satisfactory.

In order that the method may be more clearly understood, it will be desirable to briefly describe a few well-known facts. If a thin section of a doubly refracting crystal cut obliquely or parallel to an optic axis be examined with polarized light and a crossed analyzer, it will in certain positions give colours by interference, the exact tints of which depend upon the thickness of the section and the intensity of its double refraction. If another section thus giving the same tint of the same order be placed over the other, the tints due to the combination depend on the manner in which they are placed in relation to one another. If their positive axes are parallel, the effect is the same as if the thickness were double, and the tints are raised; whereas, if the positive axes are at right angles, and thus the positive axis of one parallel to the negative axis of the other, the doubly refracting power is, as it were, neutralized, and with crossed Nicols the field remains dark and the crystal looks black. If the crystal under examination vary somewhat in thickness so as to give by itself various colours, then only those parts which give the right tint appear black when the two plates are properly combined. In other parts the tints are raised or lowered, as the case may be, and it may be so difficult to distinguish between these higher and lower orders of colours that the determination may be very doubtful.

In applying this method to the microscope, thin flat plates of selenite of various thickness have usually been employed, either under the object on the stage, or under the analyzer over the eye-piece. The chief practical difficulty was to select a plate of selenite of such a thickness that its tint with polarized light was so nearly the same as that of the crystal under examination, that there could be no kind of doubt when the tints were raised and when depressed. If the apparatus contains many plates of selenite, much time is consumed in finding the right one; and if it contains but few, none may give such a decided result that the direction of the positive and negative axes can be seen at once, and no consideration be required.

Now the method which I have lately adopted combines all the advantages of a very large number of plates of selenite with the practical convenience of a single plate, and also enables us at once to determine the true order of the tint given by any crystal under examination. I have a wedge-shaped plate of quartz, cut parallel to the principal axis, $1\frac{1}{4}$ inch long, and $\frac{1}{2}$ inch wide. At its thickest ends it is $\frac{1}{20}$th of an inch thick, and thins off to the sharpest possible edge. This is fixed on a glass plate so as to leave a space of glass $\frac{4}{10}$ths of an inch long by $\frac{1}{2}$ inch broad, beyond this thin end of the quartz. The combined plates are fixed in a brass frame, like that for a micrometer, which slides into the eye-piece. On using polarized light with a crossed analyzer over the eye-piece, and arranging the plate so that the part with only glass is in front, we see the object in its normal state, and the rest of the field black, and on pushing forwards the quartz wedge we see the field of the microscope crossed with coloured bands, gradually rising from the bluish white of the first order, through all the brighter orders of colours to the faint reds and greens, and upwards to what cannot be distinguished by the unaided eye from white light. If some crystal giving any tint be on the stage of the microscope, we can usually see at once whether the tints are raised or depressed, by the manner in which it alters the colour of the bands; and by pushing the quartz wedge backwards or forwards there may be no difficulty in finding the exact place where the plate of quartz so exactly neutralizes the action of the crystal that it appears black. If this does not occur in any place, and, on the contrary, the tints appear to be raised, the eye-piece and the plate must be rotated through an angle of 90°, and the requisite place can then be easily found. The plate of quartz being so cut that its longer axis is parallel to the principal axis of the crystal, we know that this longer axis is positive, and thus also at once know which is the positive and which the negative axis of the crystal under examination. We can also at once see what is the true order of colour which it gives, since we can readily count it up from the bands due to the quartz alone, seen crossing the field of the microscope. We are also by no means limited to visible tints. The crystal may have such a powerful double refraction or be so thick as to give apparently white light, and yet by using the thicker end of the quartz wedge the tints may be reduced down to those easily distinguished.

It will thus be seen that by using this simple arrangement we secure all the advantages of a most unmanageably large number of plates of selenite, and can make all the necessary observations with ease and expedition. It now remains in conclusion to point out its practical use.

In examining thin sections of rocks or loose material, crystals of elongated prismatic form are very often seen. The optical axes may or may not be parallel to the geometrical axis, and this is a character of considerable importance. Now, by means of the apparatus I have just described, we can at once ascertain whether it is the positive or negative axis which is more or less nearly parallel to the geometrical axis. This might serve to easily distinguish two minerals. One might have its negative axis parallel to the prism, and thus might appear black when the quartz plate was parallel to it; whereas in the case of the other mineral, the positive axis might be parallel to the prism, and it might appear black when the quartz plate was at right angles to the axis of the prism. Of course in making these observations we must be careful to arrange so that the plane of polarization of the light is at 45° to one of the axes of the crystal, and the axis of the quartz plate either parallel or at right angles to that axis as the case may require.

Though I have hitherto specially alluded to crystals, the use of this method is by no means confined to true minerals. It may be employed with equal advantage in studying shells and other organic bodies which possess double refraction. We can thus at once see that in the shells of Pinna the negative axis is parallel to the axis of the prisms, as in the case of true crystals of calcite deposited on the wall of a vein or other surface of deposition, and in the case of some other shells may see that the negative axis of the aragonite is also perpendicular to the surface of their growth, as it also is when that mineral is deposited quite independent of any organic matter.

II.—*On the Measurement of the Angle of Aperture of Microscope Object-glasses.* By F. H. Wenham, F.R.M.S.

(*Read before the* Royal Microscopical Society, *October* 3, 1877.)

In a communication to this Society, read November 1876, I stated that angle of aperture is strictly the angle of a cone or pencil of rays starting from the axial centre of the focal plane, up to the diameter of transmission of the object-glass, and that all lateral rays from pencils of greater obliquity, extending to the margin of the field of view, have been hitherto included in measurements by the usual methods, thus indicating erroneous results far in excess of the true angle. In that paper I described the construction and use of an opaque screen, with a straight-edge set in focus, which edge was to be brought up to the axis or centre of the field alternately, during the measurement, so as to cut off all lateral rays, and confine the light to an absolute line or point in the focus.

As great difficulty was afterwards experienced in adjusting and using this screen, and mistakes were liable to occur from taking the readings in the wrong direction, I afterwards proposed, in the 'Monthly Microscopical Journal,' to use a pin-hole stop, set over the "examining lens" (which is used above the lowest eye-piece for obtaining a distant telescopic image), in order to confine the eye to the axial directing the instrument; but the plan was subsequently shown to be objectionable, as in conjunction with the half-screen set at the same time in the focus of the object-glass, the aperture of this was found to vary with the size of the stop at the eye end; and the plan was altogether so troublesome, that the preference has been given to a method of greater simplicity.

In order to obtain a correct indication of angle of aperture the exterior rays, including the angle of field, must be cut off. This can be effected with greater facility at the eye-piece, for every oblique ray, including the field of view at the object-glass, is reproduced as field of view at the eye-piece; therefore a small stop or aperture placed here will also exclude lateral pencils, at the final emergence, corresponding with those at the focus, without diminishing the aperture or axial angle of the object-glass: the result is more certain and accurate on account of the increased magnitude of the pencils.

The arrangement that I now make use of, consists of an "examining lens" placed over the lowest eye-piece. This lens is a plano-convex achromatic of near four-tenths of an inch focus, contained in a tube sliding in an outer one, fitting firmly on to the eye-piece nozzle; at a distance of one and a half inch behind the lens there is a removable cap, containing a thin plate with a central stop of one-fiftieth of an inch in diameter. The small size of this stop and the distance that it is placed from the lens, ensures the fixed direction of the eye in the axis, and prevents any rays except those of the central pencil from entering. By means of the draw-tube a lamp-flame or other object, taken for an index, is focussed for distinct vision without the stop. Replace this and take the angle of the objective, either by rotating on a sector, in the usual way, or by measuring the angle between two objects set the requisite distances asunder, the apex being at the focal point of the object-glass. A stop as small as one-fiftieth of an inch may be used without inconvenience, as the speck of light from the flame can be plainly seen, and the error in excess of true aperture will not be worth allowing for Of course a large stop will give inaccurate results, by admitting oblique pencils into the eye.

In order to show the distinction between angle of aperture and angle of field, I quote the following experiment, which also illustrates the fallacy of the usual mode of measurement. A $1\frac{1}{2}$-inch object-glass was taken, consisting of two superposed achromatics. The aperture by the usual method was 12°. The exact distance of the focus from the front face of lens was one inch and three-tenths. A thin metal stop was then fitted close on to the front lens, having a central aperture of ·046 in. Now from this dimension to the focus the pencil of rays must be absolutely limited to an angle of two degrees; yet when measured by the usual sector method, with this stop in place, the angle of aperture indicated was more than double this, or five degrees. The difference in excess belonged to angle of field instead of angle of aperture.

Some object-glasses, said to have an aperture of near 180°, are reduced by correct measurement to near one-half: an axial pencil having an angle of 100° is rarely to be met with. If a finely embossed or corrugated plane is viewed at various degrees of inclination, there is a certain angle of sight that gives the maximum of distinctness. It is about 45° or 50°. Beyond this, as the eye approaches nearer to the level of the plane, the vision becomes more confused and indistinct, till, at a few degrees, the structure is quite obscured. This observation only applies to the degrees of vision. For illumination, light may be thrown on the object at the utmost obliquity of incidence with advantage, in order to obtain the contrast between light and shadow, in prominences and depressions.

III.—*The Building Apparatus of Melicerta ringens.**

By Francis Alfred Bedwell, M.A., F.R.M.S.

(*Read before the* Royal Microscopical Society, *November* 7, 1877.)

Plates CXCVII. and CXCVIII.

The long-continued absence of Mr. Cubitt's interesting papers on this subject, has induced me to group together the following particulars, which are the results of observations made by me in the years 1861–62.

The building apparatus in *M. ringens* consists of a combination of very various parts, in which combination the pellet organ is but one item. It is requisite that the pellet should be specific in shape when made, and in situation and in attitude when laid; the materials have to be specifically selected, their safe arrival at

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DESCRIPTION OF PLATES.

Plate CXCVII.

A.—An attempt to represent *M. ringens* in a natural attitude; the fourth lobe is hidden from view. The increase in the diameter of the case is due to the growth of the animal, which simply makes larger pellets as it grows older.

B.—Diagrammatic figure exhibiting progress of material collected by *M. ringens* from the moment of its reaching the lobes, and showing its division into "eatable," "mural," and "waste" streams; its passage down the secondary lips past the first tasting organs (represented by two triangles) to the reflecting cushion (represented by the cubical figure), and thence to the mastax on the one hand, and the side chins and pellet organ on the other, giving also the tasting organs immediately above the mastax (represented by two triangles) and the pellet organs with pellet, together with the setæ armed pimple that decides the position of the pellet and the movable projection below the pellet organ, which with the main chin pinches and actually deposits the pellets. The hooks or spines and the long antennæ are omitted.

Plate CXCVIII.

Figs. 1, 2, and 3.—Mechanical illustrations of collecting apparatus of Rotifers, exhibiting the transition from forms like Melicerta to Conochilus (see text).

Fig. 4.—*a*, *b*, *c*, *d*, and *e* are five successive diagrammatic transverse sections showing sectional limits of sinus as seen by an eye looking directly over the main chin into the pellet organ and focussing upwards, bringing out the curled or bent edge of the sinus projecting over the ditch of cilia leading by side chins to pellet organ (see text).

Fig. 5.—Diagram illustrating extraordinary method in which pellet is sometimes constructed. The arrow denotes the side chin along which the accession of mural particles is *not* stopped (see text).

Fig. 6.—Outline view of *M. ringens* ascending from tube, and showing pimple of setæ.

Fig. 7.—Outline view of *Limnias ceratophylli*; (*a*, *b*) is the line of the shield-like organ.

Fig. 8.—Front view of shield of *L. ceratophylli*; (*a*, *b*) as in previous figure.

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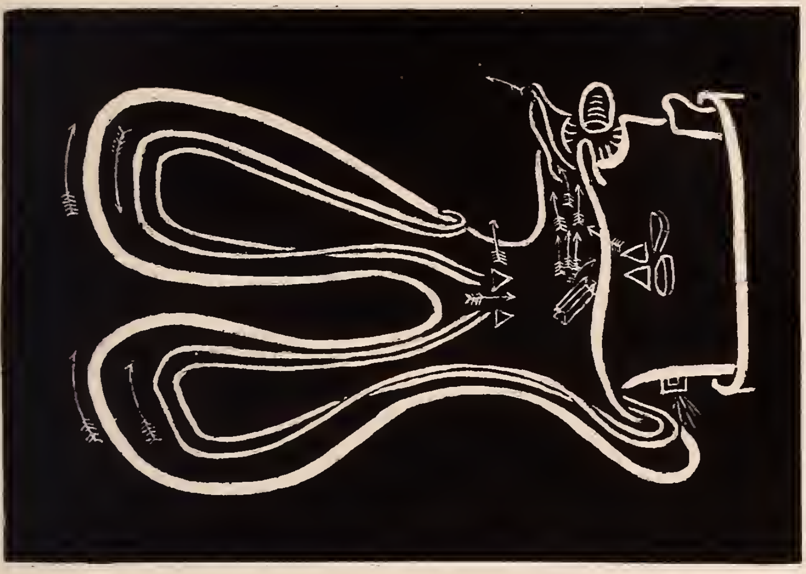
* The papers referred to are the following:—Mr. Cubitt's, 'M. M. J.,' vol. iii. p. 240; 'M. M. J.,' vol. v. pp. 168 and 205; 'M. M. J.,' vol. vi. p. 165; 'M. M. J.,' vol. viii. p. 5. Dr. C. T. Hudson, 'M. M. J.,' vol. xiv. pp. 225 and 267. Mr. Henry Davis, 'M. M. J.,' vol. xvi. p. 1.



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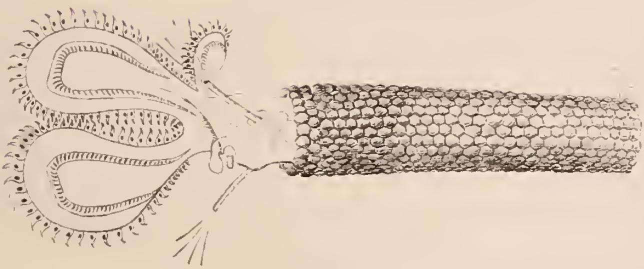


A

Melicerta Ringens.

W. West & Co. sc.

F.A.B. del.

the pellet organ specifically ensured, and all in the presence of very considerable opposing risks; to understand how these results are arrived at is one of the exquisite enjoyments of microscopic research.

My views differ somewhat from those of Mr. Cubitt, and will be found exhibited (but diagrammatically only) in Pl. CXCVII., B. The first two features that call for attention exist in every wheel-bearing rotifer, and are the secondary lips with their respective streams of cilia working in opposite directions, and as a clear view of these is very useful in assisting us to appreciate a large portion of the Rotifera as a group, I shall venture to offer the following as a mechanical illustration. Conceive a cog-wheel, Fig. 1, working from left to right, with great rapidity; on it, lay two smaller cog-wheels, working the left-hand one from left to right, and the other from right to left; set the apparatus upright in a fluid full of small particles, and suppose each wheel to have independent motion round a fixed centre, then, if the large wheel had the power of drawing from the farther side particles into its teeth and jerking them over to the smaller wheels, on this side these particles would, if carried by the small wheels, have a tendency to meet at the point where the small wheels approach each other, and if the small wheels could be made to deliver them at that point, the two streams would unite and pass on in a straight path down to a receptacle suitably placed for the purpose. Now, if for the small wheels we substitute lip-like ditches standing out from the main wheel with a V-shaped transverse section, and for the cogs of the larger wheel substitute a rich fringe of vibratile cilia, we have the gathering apparatus of *M. ringens* and of the cognate forms, and if we then fill the V-shaped secondary lips or ditches with cilia, those on our left moving to the right, and those on our right moving to the left, we obtain the apparatus which ensures the progress to the receptacle of the particles so gathered in by the main fringe of cilia. The receptacle into which the particles are discharged can be well described by likening it to the "hopper" of a flour-mill, or to a truncated pyramidal figure with its base uppermost, and if we proceed to connect such a facial wheel or gathering apparatus to such a receptacle as in Fig. 2, then by suitable alterations in the outline and attitude of the facial wheel and the smaller wheels, we can obtain the various forms of Melicerta, Limnias, &c.; but further and besides this, if we cut out a triangular piece from the facial wheel at the lower portion, and tip the wheel away from the eye as on a hinge, and make the two smaller circles coalesce and go round the "hopper," we obtain, as in Fig. 3, the arrangement seen in *Conochilus*, and have as in Conochilus the sinus or entrance to the receptacle in the centre of the facial circle with the principal antennæ standing out from its surface, and by help of these two conventional forms we can pass from one to the other of the groups referred to and distinguished in this particular by Mr. Cubitt * and Mr. Davis.†

Returning now to *M. ringens* and its building apparatus, I agree with Mr. Cubitt that the united stream brought down by the two V-shaped ditches is subjected to a process of investigation at the point where the two tides meet, and that the edge of each V-shaped collecting ditch or secondary lip concludes with a blunt organ like a knotty protuberance set symmetrically one against the other; two janitors, in fact, to watch the stream, and which only allow those particles to pass that are fit either for "eatable" or "mural" purposes, and which stop all the rest, sending them off at a tangent as "waste" over the main chin (see diagram, Pl. CXCVII., B) where these organs are represented by two triangles with the apices downwards; but below these blunt protuberances I place another organ, for the stream which passes the blunt protuberances bounces down with great force on to a "cushion" of hemispherical shape placed at an angle on that side of the sinus or "hopper" which is opposite to the main chin, and as I cannot represent the natural appearance of this cushion by any effort of the pencil, I have shown its position in the diagram by a cubical figure placed at a suitable angle. From this cushion I make out certainly three, and sometimes four deflected streams: one glances off and shoots down as "food" to the *mastax;* a second sometimes goes off at a perpendicular over the main chin, that is "waste"; and the third and fourth go off at slight angles to the last, one on one side of it, and the other on the other, and these two last are the "mural" streams passing over the side chins and going to the pellet organ. Now, the action of this cushion is most striking, for if I am right, it is highly sensitive, and by altering its facial configuration with startling rapidity. it distinguishes between all these four streams respectively, and drives suitable particles in appropriate directions.

If now we follow the two currents that go from this cushion to the side chins, we must try and carry with us in imagination the size of the animal, and the space at our disposal, and we must remember that close over head, so to speak, is a roaring rush of "waste" particles tearing away from the blunt protuberances and threatening to sweep away the delicate fragments required for the pellet organ, and then consider how the safe passage of those fragments to that organ is to be ensured. And here I introduce a further arrangement; along each side of the sinus or "hopper," as I have called it, and running at an angle from each side of the cushion to each side chin, is a ditch (or chase as Mr. Cubitt calls it) of cilia, along which the pellet fragments travel, this anyone can

* 'M. M. J.,' vol. viii. p. 5. † Ibid., vol. xvi. p. 1.

see; but over each of these side rows of cilia I make the wall of the sinus "curl" so as to represent the edge of an ordinary flat sponge bath when turned inwards, and thus when once a particle sets off to a side chin, this overhanging "eave" acts as a covered way and prevents it flying upwards and joining the stream above it, and protects it from the effects of the rush of that stream; for this is most noticeable, and a point easily verified—namely, that the passage of each set of mural fragments to its own side chin is comparatively slow and regular relatively to the rush of waste above, and that the contrast between the rate of each stream is marked and distinct, and has to be accounted for.

I have not attempted in the diagram to give the effect here referred to, it would tend to confuse the parts, but the ocular impressions from which I deduce the existence of the last-mentioned arrangement, are as follows:—If the animal is standing sideways, then as we focus downwards the moment we arrive at the nearest mural stream, made visible by carmine, and get it in "true view," we shall find just over it the edge of the corresponding protecting and projecting "eave": focussing onward we shall pass through the central stream of "waste" and reach the other mural stream, and just before we reach it and above it is the edge of the accompanying eave; on the other hand, if we take the animal transversely, and suppose that we are looking over the main chin and right into the pellet organ, now as we focus down we meet the particles as they bounce up from the cushion to the side chins and to waste, and then focussing on we shall get a successive series of outlines in "true focus," forming repeated transverse sections of the sinus, and if I am right they will appear as in Fig. 4, where Fig. *e* is the section nearest the eye, and represents the end of the main chin with the side ditches to the pellet organ, while Fig. *a* is the section farthest from the eye and close to the cushion. Now all these particulars I have seen—and I had once the privilege of seeing and studying *M. ringens* with its lobes turned flat towards me, so that I could look right over the main chin and into the pellet organ—and Fig. 4, *a*, *b*, *c*, *d*, *e*, represent the actual effects produced on the eye in focussing from above and downwards on that occasion.*

Returning to the cushion, we must follow for a moment (and before we go on to the pellet organ itself) the stream that goes to the

* Mr. Cubitt has used words which lead me to conjecture that he has seen the effects here insisted on, for at p. 209, vol. v. of the 'M. M. J.,' he says, speaking of the mural streams, that he has seen them "course along the *chases* beneath the lateral margin of the dorsal lobe." The word "beneath" here exactly expresses what I describe. I am bound to add, however, that I have never been able to persuade my friend Dr. C. T. Hudson that my observations are correct, and as long as such an observer differs from me I cannot but feel somewhat anxious as to the accuracy of my conclusions.

œsophagus: that stream is further scrutinized by the two lovely little lip-like organs situate just over the *mastax*, which touch each particle so lightly and rapidly and admit or reject it as they approve or disapprove of it; it is astonishing to see how the little quick jerk which they give tosses an objectionable morsel up into the central stream of waste and drives it away, thereby actually making a sixth separate and distinct stream in this minute space. These two organs are represented conventionally in the diagram by two triangles, while the *mastax* (also represented conventionally), lies just below them. Now it sometimes happens that the two janitors above and the cushion overhead have not done their duty, and that in spite of their vigilance an unwelcome and unsuitable intruder of unusual magnitude has reached the more delicate tasting organs below; the jerk that was sufficient for an ordinary sized particle has no effect upon this one, it is sent up only to return, and this happens over and over again until the sinus gets clogged up with matter—the little lips are so occupied in jerking up that they let nothing pass down, and the result is a stoppage of all food. Now there is but one thing to be done, and that is to stop the stream from above, for as long as it goes pouring on, the downflow will beat the upthrow, and the objectionable particle will not leave the sinus; but in order to stop the stream from above, the main wheel itself must stop—and so it does, the row of cilia round the edge of the lobes stops dead, the downflow stops, the *mastax* joins the little lips in the jerk up, as if determined to have no more trifling, and throws the particle out, and thereupon everything goes on again as before. It is curious to observe here that when the main wheel stops it "holds its attitude," the cogs are there, but motionless. All the cilia remain *in statu quo*, and you have the same effect as that so beautifully represented by Mr. Cubitt in his drawings of Stephanoceros,* showing, if anything were wanted to prove it, that the motion of the cilia is exactly the same as that of the stalks of corn in a field under a passing breeze, where each separate stalk moves in succession and rhythmically, but each stalk is a little after its neighbour on one side and before its neighbour on the other.

The construction of the pellet in the pellet organ itself is the next point that calls for our attention: this organ is so well known that it is sufficient to describe it as of a cup shape, situate under the main chin, and full of cilia, the mouth of the cup being placed perpendicularly, so that when the animal is upright the medial axis of the cup is horizontal; here I agree with Mr. Cubitt that the "normal" shape of the pellet when made is that of a Minié rifle bullet, as in Fig. 5. It is to this fact that I think Mr. Slack refers in 'Pond Life,' p. 93,

* 'M. M. J.,' vol. iii. p. 248.

and again in the 'M. M. J.,' vol. xiv. p. 267, when he speaks of "conical" pellets. In captivity and when hurried by the unnatural surroundings of a small glass receptacle, the animal makes imperfect pellets and deposits them half made, sometimes even throwing the pellet away in the bashful retreatings that it makes into its case, but when quite complete they are generally as drawn in the diagram, Pl. CXCVII., B, and the advantage of such a shape over a spherical form in such a building is sufficiently obvious. There are two methods by which this ultimate and complete form is obtained, one the ordinary method, and the other an extraordinary method, and both are so exquisitely simple that it is impossible to regard them without great wonder and admiration. The process in either case consists of two parts, and we will take the ordinary process first. In the first part of this process the small particles from the side chins which trickle into the pellet organ by the two little chinks or clefts, one on one side of the main chin, and the other on the other, are by cilia kept rolling over and over in the pellet cup in the glutinous secretion, there exuded, and the motion is kept up around an axis, the angular attitude of which is constantly changing, just as a boy makes a round ball of clay out of a rough mass by rolling it between the palms of his hands in every possible direction; when this sphere of particles is sufficiently hard and large the second part of the process begins, and the sphere is then pushed forward into the mouth of the pellet organ (Pl. CXCVII., B), and there it protrudes a little out of the organ, but the motion now *changes* to a uniform revolving motion round an unalterable axis, that axis being *perpendicular to the plane of the cup's mouth, and being coincident with the medial axis of the cup;* by this simple change the following results are arrived at: the part of the sphere which protrudes from the pellet organ receives no more accretions, but the part of the sphere which is inside the organ does, and these additions as affixed to the hind part of the sphere are by the revolving motion round one axis arranged in the form of a cylinder, just as a boy converts his ball of clay into a cylindrical form by continuous rolling round an invariable axis between the hands.

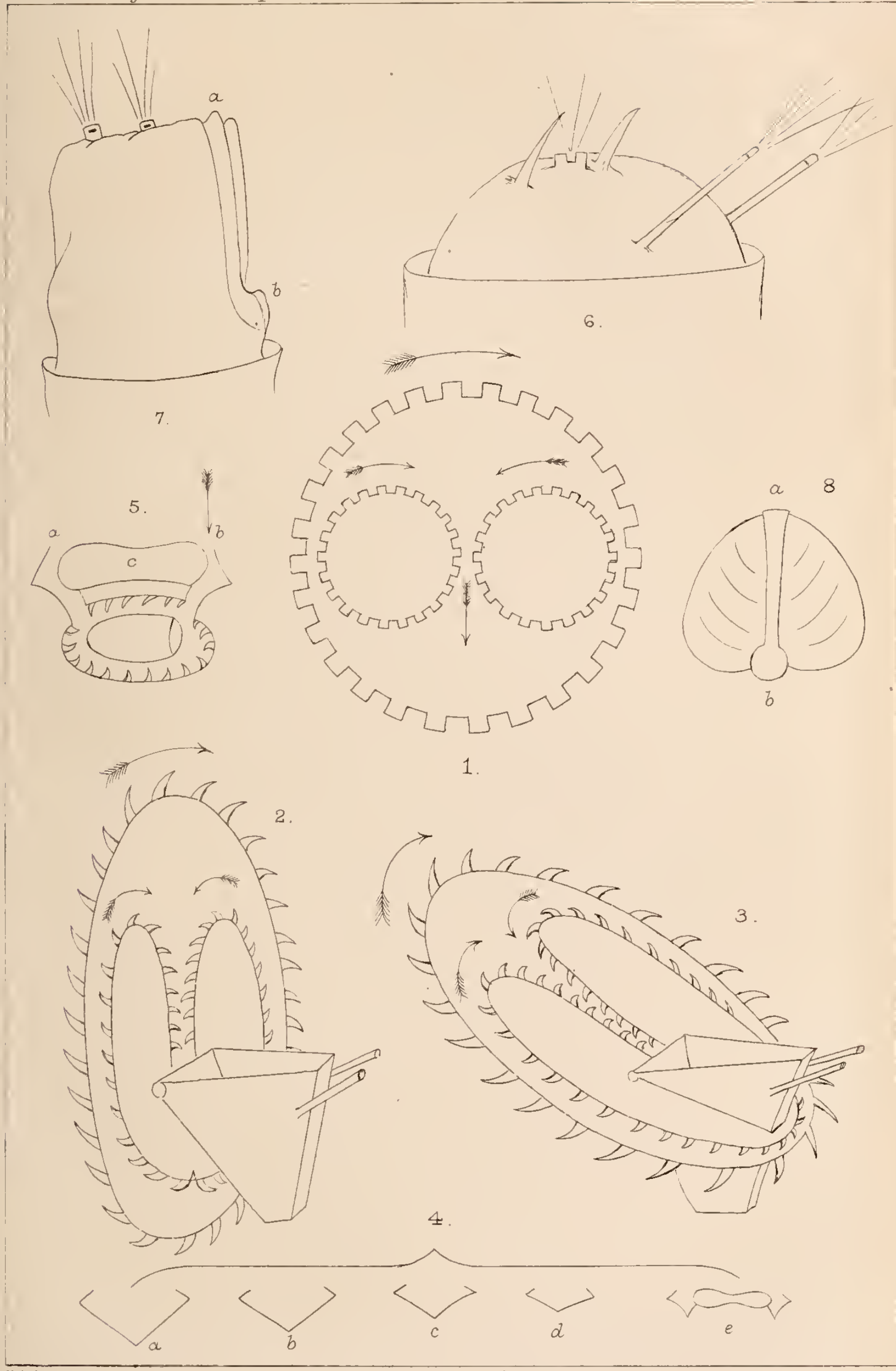
But the same result is sometimes produced by another, which I have called an extraordinary method, and which is still more remarkable: it will be seen from Mr. Cubitt's figures * that the pellet sometimes lies transversely in the pellet organ (see my Fig. 5). Now I have seen it constructed in that attitude as thus: after the sphere is completely made the animal actually stops the supply over one of the side chins; it then sets up the uniform revolving motion as before, but this time round a horizontal axis, which is exactly perpendicular to that which it

* 'M. M. J.,' vol. iii. p. 240.

adopts in the ordinary method—perpendicular, that is to say, to the line of vision as you look straight into the pellet organ; the result is that the sphere which is pushed over in the cup to the side where there is *no* additional supply coming in, is increased by addition only on the other side to which accretions *do* arrive, and thus, while one part remains unaltered and spherical, the other part, as before, becomes cylindrical, and the same result is finally arrived at!

When we pass on to the act of depositing the pellet on the wall of the building we find the machinery equally specific and definite. The obvious remark will occur to the reader that whenever the pellet is made in the attitude last described, and transversely to the mouth of the pellet organ, it has to be turned half round before it can be deposited, while it must be borne in mind also that there are two ways of doing this, and that one way is right and the other wrong; for the spherical outline of the bullet is always laid on the outside of the case, and the flat end of the bullet is always laid to the inside. In the process of depositing it the pellet is pinched or nipped between the main chin above the pellet organ and a nob or protuberance like an inverted nose or second chin underneath that organ (see the diagram); between this protuberance and the main chin there is a certain amount of play, for they can draw towards each other so as to hold the pellet when extruded from the pellet organ. But then there comes this question: how does the animal know where to lay a new pellet? On this point I cannot agree with those writers who say that the pellets are laid irregularly; on the contrary, as a rule I found them laid with great regularity, and one row is seldom or ever begun until the previous row is finished, and it is the exception arising from confusion in confinement when the pellets are placed irregularly. Every little youthful housekeeper begins her domestic life by surrounding herself with a girdle of pellets, all laid on the top or edge of her transparent case, and she always finishes the first row before she begins the second, and Mr. Cubitt, in his admirable drawing,* has in no way exaggerated the exquisite regularity of the tube when completed. Now I agree with that gentleman that the organs which he calls the "lips," but which I should call "hooks," or spines, and which with the two long antennæ, or setæ-bearing tubes, form such prominent objects as the animal rises from its case, Fig. 6, do play some part in connection with the laying of the bricks, but as to what that part is seems very uncertain. But there is another organ which he does not mention, and which in my opinion plays a much more definite part in settling the important question of where the bricks shall be laid. That organ is a small pimple-like protuberance armed with

* 'M. M. J.,' vol. v. p. 209.



F.A.B. del.

W West & Co lith.

Melicerta Ringens.

setæ, as shown in Fig. 6, and which lies between the two hooks and a little above them. Still, however, we have the striking fact that all these three organs are, when the animal is feeding and making the pellet (see diagram), situated on the *opposite* side of the animal to that in which the pellet organ is placed. But this is what happens: When the pellet is ready the animal turns round and deposits it at the spot with which this pimple of setæ was in contact at the moment before the animal began to turn. It does it so quickly that before you have got over the agitation and surprise which its unexpected and rapid change of position causes you, the act, like a conjuring trick, is over, and the animal is in its old position again, with an empty pellet organ hard at work at a new brick. It is not always easy to give the animal under a high power sufficient room to be quite at its ease, and failing that ease it is apt to lay the pellet anywhere, but when quite comfortable and at home in its trough, the above results will, I believe, be obtained; and it will be found, as a rule, usually to *make* its pellet on the opposite side of the case to the point at which it *deposits* it. We have thus traced the progress of the pellet from its inception to its ultimate deposit, and I will now venture to call attention to some points of interest arising out of the above observations when considered in connection with other forms of Rotifera.

Mr. Cubitt's recognition of *Limnias annulatus* is most interesting and valuable. The enpimpled shield with which it gauges and regulates the beautiful case that it builds is at once the analogue of the spines and pimple of setæ in *M. ringens;* but I would call attention to this fact, that *L. ceratophylli* has also its shield-like instrument and in a corresponding position. Whenever that form is seen retiring into its case, its favourite attitude will be found to be as in Fig. 7; the hard line from *a* to *b* in that figure is always undeviating in form, and it arises from the presence there of the hard shield in question. The shield is seen again in a front aspect at Fig. 8, and it acts in two capacities, for when the animal retreats, it fills up the mouth of the tube, and serves for an *operculum,* while when the animal is expanded it helps to mould the case. The main chin in *L. ceratophylli,* and over which the "waste" passes, answers to that in *M. ringens,* and has a rough receptacle underneath in the place where *M. ringens* has the pellet organ. Here it secretes fluid and rough particles which trickle over the main chin, and with these it "rough casts" its tube on the outside, and "stuccoes" it smoothly on the inside; to do the former operation it leans over in the attitude which Punch's victims assume at the final slaughter in that eventful history, and then roughly rubs on the outside the secreted fluid and coarser particles; but to do the latter it adds the same substance on the inside of the tube, and then smooths it down with the shield in question, much as the bricklayer smooths over his stucco with his flat trowel; and I have very little doubt that *L. annulatus* does much the same with its remarkable instrument. *M. ringens* has nothing like an operculum, but its analogous organs, namely the hooks and the pimple of setæ, also in my opinion serve a double purpose, and are used for defence and building; for the two hooks are formidable weapons at close quarters when the animal finds a disagreeable opponent intruding into its case. The recognition by Dr. Hudson of the striking form *Melicerta tyro*, is also most acceptable. The presence of the third pimple of setæ in that form, the absence of the hooks, and of the pellet organ, and the presence of the long antennæ is certainly very instructive. As to the so-called *M. pilula*, I am sorry Mr. Cubitt did not alter that name when he was altering that of *L. annulatus*, and bring the animal down to a Limnias. *M. pilula*, so far as its building habits go, starts off in a widely divergent line of its own; for it makes its pellets in its stomach, and builds a house of ejectamenta; and as Dr. Hudson says of *M. tyro*, it is another delightful instance of how Nature seems to utterly baffle us when we attempt to generalize—for while it comes close up to Limnias in its form (except that it wants the shield-like addition), and while it has the two antennæ of a Melicerta, yet it makes its case in a new and wholly unexpected manner, and differently from either of them. The pimple of setæ which *M. ringens* carries between the hooks, and to which I have drawn attention above, will at once remind the observer of the so-called siphon of Cephalosiphon which springs from the same spot, as also of the antennæ of Philodina and *Rotifer vulgaris*.

I may be unduly prejudiced in favour of my subject, but the apparatus of *M. ringens* always fills me with wonder and delight; it stands in my judgment so completely and instructively *per se*, it is so complicated yet so accurate in its performance, the apparent intelligence of this " speck of life " is so extraordinary, the results are so unexpected, so many points too of the animal's economy have to be considered in estimating the final result; and although true it is that we have, even from Stentor upwards, a series of rough building processes going on, which result in more or less workmanlike habitations, yet the leap from the very best of them (Limnias) up to *M. ringens* is to my mind a vast, a giant stride, and just as great as the step from a lath-and-plaster cottage up to a house built of patent stone, made by the aggregation of sifted sand forced together in a mould and deposited by the action of highly complicated machinery. To start from Limnias and reach by development an animal which in the size of the tenth of an inch shall make 1000 separate bricks, each brick shaped like a rifle bullet, convert a sphere into a complicated figure, turn the brick round, lay it in its right place and attitude, make another, lay that next it, throw away its waste material, choose its material, keep up five, nay six separate and distinct currents, all necessary to its object, never let them get confused, though there is not the one-hundredth part of an inch between either of them, and go on eating all the time, I confess utterly seems to me to confound the power of the imagination; you want not merely a pellet organ, that is nothing, you want a set of setæ at the back of the head, and a pair of hooks on each side of them, a movable nose to pinch the brick against the chin and lay it on the wall, the cushion to direct, and an apparatus to guide the materials, a cleft in each side of the pellet organ to conduct them, and the intelligence (or say improved "vital force") to use all the apparatus when you have got it, and make it work as one machine. Even with Limnias to help me, still the last form of apparatus I should have dreamt of reaching would have been such a one as that before us. As to whether it can be reached by degradation I know not, but I confess myself unable to see how it is possible to evolve it out of anything less advanced in organization than itself, at any rate by any process which does not end in first creating and then dropping out a score of intermediate non-existent forms just at the very point where we most want their presence and have a right to expect their existence, and where the actual survival of so many, and the extremely favourable and established conditions under which the development has been going on fully entitle us to require the non-existence of the others to be strictly accounted for.*

* I have added in Pl. CXCVII., A, a portrait of this beautiful animal; those by Mr. Gosse, Mr. Slack and others, and even that by Mr. Cubitt, by no means exhibit it in its best attitude.

IV.—*An Introduction towards the Application of the Micro-spectroscope to the Study of Evergreens.*

By Thos. Palmer, B.Sc., F.R.M.S.

(*Read before the* Royal Microscopical Society, *November* 7, 1877.)

Plate CXCIX.

The few remarks to which I beg to call your attention are not as yet so much connected with the science of the micro-spectroscope as I should almost wish they were; but, for this very reason, I will endeavour to show how useful a knowledge of that instrument connected with botanical inquiry is. By its application, some of the great worker's experiments are made clearer to us; not that I wish to imply for a moment that we do not understand them, but they are so frequently lost sight of that our memories require rubbing up occasionally, or we are very apt, in these days of quick advancement, to forget some of those valuable discoveries which must have caused our ancestors so much anxiety and thought when first they conceived them. Well, then, the subject which I now wish to bring before you must be regarded simply as an introduction towards the application of the micro-spectroscope to the study of evergreens.

That due justice may be done to the subject, perhaps you will allow me to enter upon a few old facts which tend greatly to substantiate what I wish to say.

When many of these authors wrote, spectroscopes were not dreamed of, and what apparatus they possessed was of the most imperfect character as compared with that used by present observers; still great, undisputed laws were established, many of which puzzle us now to imagine how they assumed so much. Nevertheless there they are.

As plants, then, are living beings endued with especial powers

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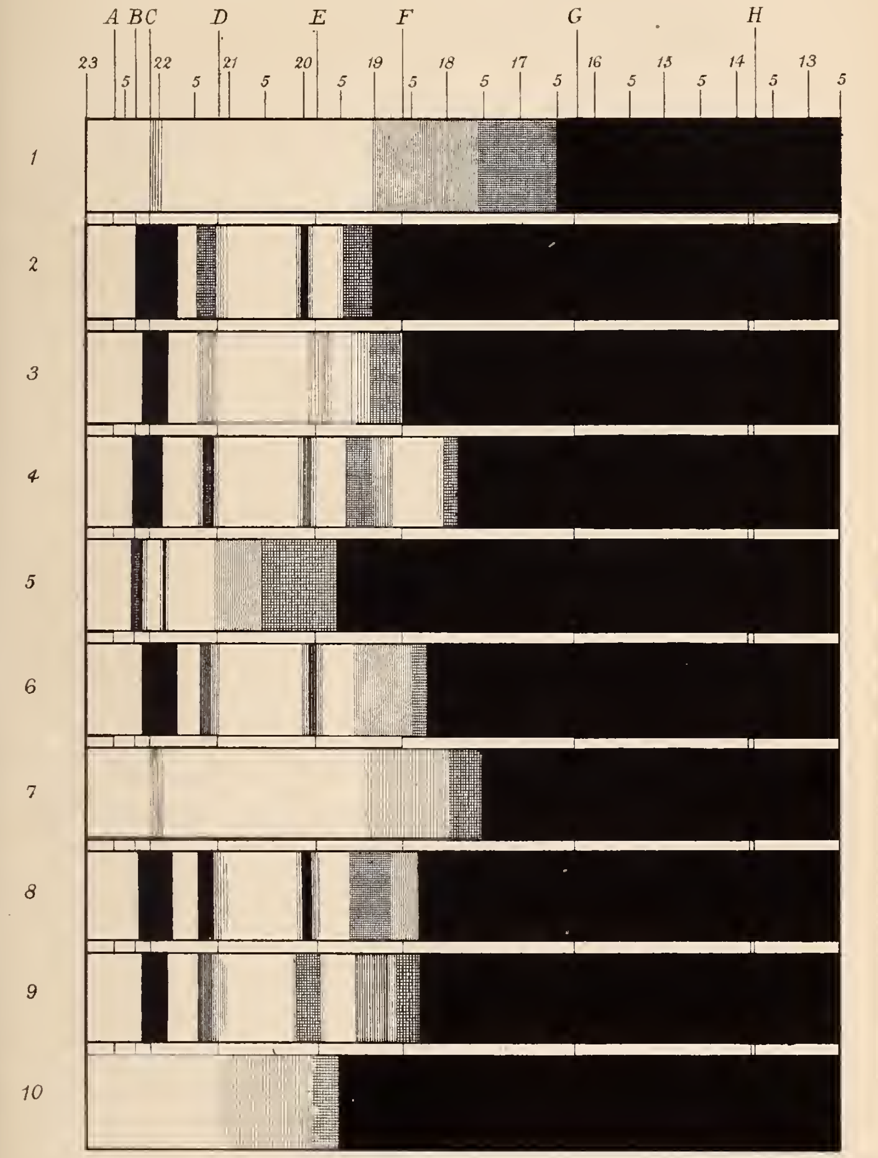
EXPLANATION OF PLATE.

Fig. 1.—Young	leaves	of laurel.		
" 2.—Mature	"	"	Alcohol.	
" 3.—	"	"	"	Ether.
" 4.—	"	"	"	Wax precipitated.
" 5.—Solution from		"		
" 6.—Mature	leaves	of holly.		
" 7.—Young	"	"	(variegated).	
" 8.—Mature	"	arbutus.		
" 9.—Young	"	"		
" 10.—Red	"	"		

Note.

Class 1 is a symmetrical band.
" 2 is an unsymmetrical band.



Spectra of evergreens

T Palmer del.

W. West & Co. lith.

of respiration, &c., the first questions which naturally arise are, how do they live, and what do they breathe? This is all answered by the text-books of botany, but the internal portion of their existence, and that of which we know so little at present, viz. the formation, production, and the carrying out of a perfect system in themselves, is still a mystery, and consequently need workers. But to begin with the way in which plants live, respire, and grow, or rather how the internal machinery is set up, kept in motion, for a distinct purpose, and thoroughly and most efficiently carried out, inevitably craves our first attention.

From the experiments of De Saussure, we learn that the quantity of carbonic acid absorbed and decomposed by plants varies greatly in different species even when placed in the same circumstances. *Lythrum salicaria* was found to absorb seven to eight times its bulk of this gas in a day; while the *Cactus opuntia*, and other fleshy-leaved plants, did not absorb above a fifth of that quantity. The proportion absorbed, according to this author, depends upon the surface of the plant; and therefore thin-leaved plants must absorb more than those that have fleshy ones. The whole of the oxygen contained in the carbonic acid is not absorbed, but is emitted again by the plant. This has been clearly shown to be the case by the same author's experiments, one of which, I thought, might not prove out of place here.

Carbonic acid was mixed with common air in such a proportion that it occupied 7·5 hundredths of the total mass. Jars stood over mercury, covered with a thin film of water, were filled with this mixture; and plants of *Vinca minor*, growing in a small vessel of water, were introduced into each. These plants, thus placed, were exposed for six successive days to the sun, from five to eleven in the morning, while the temperature was at 70°, during the whole of which time they vegetated with great vigour. The bulk of the air in the jars was not altered, neither could any carbonic acid be detected in it, though the proportion of oxygen was $24\frac{1}{2}$ per cent. The whole of the carbonic acid, amounting to 21·75 inches, was therefore absorbed, while the oxygen emitted was only 14·72 inches, whereas the whole of the oxygen contained in the carbonic acid would have amounted to 21·75 inches. The difference of about 7 inches was found to be composed principally of azote, which was given out by the plants in combination with the oxygen. The whole will be clearly seen on referring to the annexed table:

	When put in.	When taken out.
Azote	211·92	218·95
Oxygen	56·33	71·05
Carbonic acid	21·75	—
	290·00	290·00

From this experiment we deduce that, when exposed to the light, or those rays of the spectrum which have the greatest effect in promoting the decomposition of carbonic acid, plants absorb carbonic acid, decompose it, and emit the greatest part of the oxygen, mixed, it would seem, with a certain quantity of azote. It is, I suppose, now-a-days quite an established fact that plants by this process of respiration, if I may so term it, acquire the greatest part of the carbonaceous matter which they contain; for as I previously showed in my paper on the various changes caused on the spectrum by different vegetable colouring matters,* if we compare the quantity of carbon contained in plants vegetating in darkness—where this process does not go on—with the quantity which those plants contain which vegetate in the usual manner, we are bound at least to admit that the difference is most conspicuous. Chaptal, in his 'Elements of Chemistry,' published in the year 1791, gives an instance of a *Byssus* which, when vegetating in the dark, produced but the $\frac{1}{89}$th part of its weight of carbonaceous matter; whereas the same plant, after being made to vegetate for thirty days exposed to the sun, gave the $\frac{1}{24}$th. Hassenfratz says, "plants which grow in the dark contain much more water, and less carbon and hydrogen than those exposed to light," while Sennebier speaks of similar results having answered to his analysis, and shows that plants growing in darkness yield less hydrogen and oil, while their resinous matter is to that of plants growing in the light as 2 is to 5·5, and their moisture as 13 is to 6.

That leaves and plants absorb oxygen has been shown to be the case by many observers. It is, however, not separated from them by submitting them to the exhausted receiver of an air-pump; by that means a little air is given off, but it is always much less than the oxygen absorbed, and it is moreover of precisely the same character as the atmosphere in which they were confined. Neither does it appear that the oxygen is extracted when leaves are exposed to sufficient heat so as not to prove destructive to them.

There is, then, every reason to assume that the oxygen absorbed is converted into carbonic acid within the plant, but this only occurs when the plant is saturated with this substance, and when the surrounding oxygen is partly converted into carbonic acid by combining with the carbonaceous matter of the plant.

When leaves are exposed to the light, carbonic acid is decomposed and oxygen thrown off, which is usually greater than that absorbed. But the oxygen given out in daylight, when plants grow in atmospheres destitute of carbonic acid, is always proportional to that inspired during the night, being always greatest when the plant has absorbed the largest quantity of oxygen.

As with carbonic acid, so with oxygen; plants differ very much

* 'Royal Microscopical Transactions,' vol. xvii. p. 225.

from each other in the quantity which their leaves absorb during the night. Fleshy-leaved plants absorb the least, probably because, as has been previously shown, they emit no carbonic acid gas. Hence they can vegetate in high situations, where the surrounding atmosphere is more or less rarefied. In the case also of those plants, such as evergreens, of which we have principally to deal, though the oxygen absorbed is greater than in the case of fleshy-leaved plants, still it is much less than those which fall in winter.

That all plants of every species and order absorb the moisture which is contained in the atmosphere in which they grow is too well known to require anything but simple mention. Bonnet showed in his researches concerning the use of leaves, that they continue to live for weeks if one of their surfaces be applied to water, and that they not only vegetate themselves, but imbibe enough water to support the vegetation of a whole branch and the leaves belonging to it; though, according to Duchartre, plants such as Hortensia, *Helianthus annuus*, which wither in the evening in consequence of the dryness of the earth in the pot, did not recover or become turgid if copiously moistened by dew during a whole night, the pots, and therefore the roots being covered. It is, moreover, well known that Epidendral Orchids, Tillandsias, &c., behave in the same way in this respect; they also absorb neither water nor aqueous vapour through their leaves, nor even in any considerable quantity through the roots. The water which they require for their transpiration and growth must be conveyed to them in the form of rain, or dew, which moistens the root envelope or wounded surfaces.

It would seem, therefore, in the case of land plants, which wither on a hot day and revive again in the evening, that it is the result of diminished transpiration with the decrease of heat and crease of the moisture in the air, the activity of the roots continuing, and not of any absorption of aqueous vapour or dew through the leaves. Rain again revives withered plants, not by penetrating the leaves, but by moistening them, and thus hindering further transpiration and conveying water to the roots, which they then conduct to the leaves.

After all that has been said with regard to the functions of leaves, light is, without doubt, the most essential element, as the entire life of the plant depends upon its action on the cells that contain chlorophyll, this being the essential condition under which new organic compounds are formed out of the elements of carbon dioxide and water. The amount of oxygen evolved in this process is nearly the same as that required for the combustion of the substance of the plant, and the amount of work equivalent to the heat produced by this combustion gives a measure for the amount of work performed by light in the chlorophyll-containing cells of the plant. It is very remarkable to observe the number of curious facts presented to us in relation to this subject, for we find light acting, 1st, as a constructive, and 2nd, as a destructive agent; at the same time, who knows, says Mr. Sorby, but that these metamorphoses are not of the most vital importance to the life of a plant, I mean the decomposing action on the colouring matter of leaves? The red substances formed from chlorophyll by the action of light are hereafter decomposed by it; and if we suppose that both chlorophyll and other colouring matters, such as the yellow, red, blue, and brown products of its decomposition are, besides the independent colours, in some way formed by the action of light, from other constituents of the plant, and are hereafter decomposed by the same agency, we can far more easily explain many remarkable facts, such as the various changes in shade for instance, from the earliest forms to the deeper or lighter colours, either of their mature or decaying state.

Thus we gather from these observers, experiments how leaves gradually become less and less fit for this process of transpiration. Sennebier found that when all other things are equal, the transpiration is much greater in May than in September, hence the reason surely that some leaves are renewed annually. Their organs, moreover, become gradually unfit for performing those especial functions that are so necessary to them, and therefore, as a matter of fact, it is advisable that they should be renewed. Those trees which retain their leaves during winter months, have been shown to transpire less than others; it consequently takes a longer period for them to carry out those several functions which nature has allotted to them. It is, however, well known that evergreen plants do also renew their leaves. The delicate shades of yellow, rather than green, which characterise the young newly-developed leaves of the laurel tribe are very beautiful, and the spectrum produced by a solution in alcohol tends to show how much the constructive energy of light and other acting agents do to them ere they become the dark forms which adorn our garden hedges. A waxy substance pervades to a considerable extent the leaves of all evergreen plants. It exists both as an external coating to the epidermis, and so doubtlessly protects the leaves from the action of wet, and other changes in the weather, as well as pervading the whole structure. It is curious also to note how it protects the chlorophyll from the action of solvents, those such as ether taking hardly any effect, while alcohol extracts it all in a remarkably short space of time; our spectrum in Fig. 2 is from a solution of these leaves prepared in alcohol, while Fig. 3 is from one made up in ether. The difference is too striking to require any comment; suffice it to say that those macerated in alcohol were reduced to the yellow state which is so often seen in the case of natural decadence. It seems to me as though this waxy compound was in some way or another produced by the decomposition of chlorophyll itself through the direct action of light and heat, for the spectrum produced by the remaining solution after the wax has been fully precipitated has become, as will be noticed in Fig. 3, lighter, while the bands, though very nearly all constant, are more or less shaded at the extremities; there is, moreover, another band produced from what was previously but part of the general absorption.

Fig. 1.—Newly formed Leaves on Young Shoots of Laurel in Alcohol.

	M.		λ	Observations.
1	23·97	Centre	651·0	Class 1. Very shaded; size ·145.
2	19·0 17·0	Commencement	498·0 445·0	Very shaded at first, then gradually dark till quite black.

Fig. 2.—Mature Leaves of Laurel prepared in Alcohol.

	M.		λ	Observations.
1	22·035	Centre	645·0	Class 1. Very black; size ·565.
2	22·742 21·0	Centre .. .. End	595·0 582·0	„ 2. Shaded; size ·365.
3	20·065	Centre	532·0	„ 1. Shaded, centre dark; size ·270.
4	20·535	Commencement	514·5	General absorption.

Fig. 3.—Mature Leaves of Laurel prepared in Ether.

	M.		λ	Observations.
1	22·037	Centre	645·0	Class 1. Very black; size ·415.
2	22·700	„	598·5	„ 1. Very shaded; size ·200.
3	20·200	„	526·9	„ 1. Very shaded; size ·200.
4	20·700	Commencement	509·0	General absorption.

Fig. 4.—Mature Leaves of Laurel, the Wax of which has been Precipitated.

	M.		λ	Observations.
1	23·957	Centre	652·0	Class 1. Very black; size ·475.
2	22·75	„	595·0	„ 1. Centre dark, ends shaded, size ·3.
3	20·135	„	529·41	„ 1. Centre dark, ends shaded, size ·35.
4	20·985	„	500·42	„ 1. Shaded, size ·63.
5	18·00	Commencement	468·50	General absorption.

The wax, if required for testing, may be extracted in the following manner:

Digest the bruised leaves first in water, and then in alcohol, till every part which is soluble in these liquids is extracted. Then mix the residuum with six times its weight of a solution of pure ammonia, and after sufficient maceration, decant off the solution, filter it, and drop into it while it is incessantly stirred, diluted sulphuric acid, till more be added than is sufficient to saturate the alkali.* The wax is then precipitated in the form of a yellow

* This point may be most accurately determined by using the method I have previously described, see my paper (vol. xvii. of our Journal, p. 232), where all the necessary points to be observed are clearly set forth.

powder, which is easily soluble in warmed alcohol. The simplest way, however, that I find to treat the leaves, is either to make several solutions from the first one, and thereby reduce the quantity of wax in each, or else to allow the solutions to stand for a few hours in test tubes; a precipitate is then formed, and the clear portion can be drawn off for examination by means of a glass siphon, when a few more drops of alcohol, which has been previously warmed, should be added to that drawn off, so as to prevent any further precipitation from taking place. This latter method is, of course, unavailable for any definite form of analysis, as much wax, starch and gum, &c., are held in solution; by its means, however, the xanthophyll bands in the blue are more resolved, from what, as in Fig. 2, was but a general absorption; the spectrum also, as is seen on referring to Fig. 4, is much lighter in the spaces, and the bands are intensified and more defined.

Among the other carbonaceous compounds that exist in the leaves of laurel, besides all evergreens to a more or less extent, is oil. It is of a brownish tint, has an aromatic smell, and is obtained from the berries by distillation. I have, however, procured it from the leaves by the following method:

Into a test tube containing an alcoholic tincture prepared from laurel leaves, I dropped clarified castor oil, which at once formed a copious thick green precipitate. Oil was added in each case, till no further precipitation took place, when the whole was tested with another solution in alcohol, to see that no excess of castor oil had been added; it was then allowed to stand for a few hours. The top solution was then carefully siphoned off, care being taken to exclude any of the precipitate. That drawn off was of the colour of very dark sherry, and was very oily. After being allowed to stand for twelve hours, a weak solution of sulphuric acid was added; this caused a precipitate of a greenish tint. I allowed this to settle entirely, and then holding the tube in a vessel of hot water, I added more acid till no further precipitation took place; the whole was then allowed to simmer gently for a few minutes, when it was removed from the tube by means of a siphon as before, and carefully examined by the micro-spectroscope, the measurement and spectrum of which I have given in Fig. 5.

Fig. 5.

	M.		λ	Observations.
1	23·7 23·8	Commencement End	676·75 666·75	Class 2. Very black, shaded to end; size ·1.
2	22·05	Centre	644·50	,, 1. Centre dark, ends shaded; size ·1.
3	22·8 20·5	Commencement	592·25 515·50	Very shaded. ,, black. } General absorption.

Perhaps the best example of a change in colour existing in the evergreen shrubs of our gardens and hedges, is holly (*Ilex aquifolium*), the leaves of which plant have been found to be extraordinarily sensitive to light, the quantities of chlorophyll and orange xanthophylls varying as much as 40 to 50 per cent. from those in the interior of the plant, and so shaded from the direct action of the sun, and those which are always exposed to a southern aspect. The spectrum, which is not unlike that of Figs. 3 and 4, laurels in alcohol, &c., is given in Fig. 6, though in the case of laurel the general absorption is nearer the red, and the bands are all more or less darker and broader. Doubtless many of you have noticed that in the variegated species of this plant, the young leaves, when first developed, are of a pinkish tint, especially around the edges, which, when they become mature, are quite white, or rather a whitish yellow hue. This, without doubt, is another of the many changes effected by the action of light, for, when growing in an aspect protected from the direct action of the sun's rays, these leaves take a considerably longer period to become like others that are exposed, even though they may be part of the same shrub. But such a cause as this is easily understood, when we recollect and consider that the production of chlorophyll itself is entirely due to the action of light, and we all must admit that Mr. Sorby has quite established that point in his admirable paper on comparative vegetable chromatology, which has been so often before referred to, and which all who desire to thoroughly master this subject would do well to read most intently.

Mr. Sorby there shows that leaves of *Acuba japonica* produced 50 per cent. more chlorophyll, and 25 per cent. less xanthophyll when shaded, than those exposed, in the short period of three weeks. This, moreover, was performed on a leaf of nearly a year old, and it must not therefore be overlooked, that whereas the xanthophyll had diminished, the yellow substances soluble in water had increased 100 per cent. After such a valuable addition to our knowledge of such matters, has been made by so able a worker as our worthy President, it is quite needless for me to say that I have arrived at precisely the same results with laurel, holly and other plants of the same species. I therefore can but form a similar conclusion, viz. that this difference should take place seems to prove, either that the action of shade is favourable to the development of chlorophyll, which would entirely disagree with all the hitherto well-known facts; or else, that the increase in its amount does, in some measure, indicate the quantity formed also in the other, but decomposed in the same interval by exposure to the sun. At all events, the facts presented to us seem to prove that the equilibrium between the different constituents of leaves can soon be changed by altered conditions. It must, however, be especially remembered, that by thus shading a plant is quite another thing from so smothering it up as to cause it to become sickly and fade, or to prevent the development of young leaves by keeping them in the dark. In the instance above alluded to, the glare or heating properties of the solar spectrum were simply arrested from falling directly upon the leaves intended for analysis, by pieces of black cloth and small squares of very dark blue glass.

Thus we see the effect of the constructive energy of light, which, simply speaking, means a greater percentage of chlorophyll, and an increase in the vitality of the plant. Reverse the experiment, and the opposite effect is most marked. That is to say, expose plants to the action of the red, yellow, or green rays of the solar spectrum, and they soon wither up, in consequence of the decomposition of the carbonaceous compounds through the destructive action of light. Thus in ordinary daylight we have these two conflicting and contradictory agents combined, while we cannot fail to see in every-day life, how they affect the whole course of nature. It is, moreover, very curious how plants resist, as it were, this decomposing influence, and no doubt it is in this case greatly due to their colours not being in solution, though I do not wish to infer that it is so with all plants, for according to Kraus, it follows from his experiments that the green colouring matter is distributed in such a manner in the colourless matrix of the chlorophyll grains that it must be considered in a state of solution; they are therefore brought to a standard of equilibrium, which when reached, and having no more essential work to perform towards the process of their own development, or towards the economy of the plant to which they belong, excepting that of course of bearing, or helping to produce seed, are more quickly acted upon, so that we find the analysis reduces itself to a loss of 38 per cent. for chlorophylls, 14 per cent. for orange xanthophylls, and 6 per cent. for mixed xanthophylls, &c. By comparing the figures in the subjoined table the whole subject will be seen at once.

	Exposed. Gain per cent.	Shaded. Loss per cent.
Chlorophylls	50	69
Xanthophylls	25	10
Soluble in water	100	—
	175	79

These experiments were all made with leaves from *Acuba japonica*, and their natural state was severally estimated as equalling 100.

About the month of July, there was a most interesting article in 'Nature,' "On the Source of the Carbon in Plants," which no doubt many of you read at the time, and perhaps remember that it gave an account of some most elaborate experiments which were performed by Dr. Moll. The question at stake was, "Can leaves decompose the carbon dioxide which is at the disposition of the root?" He argues that one part of the plant—the leaf—taking up and decomposing carbon dioxide, is no proof that it is not taken up in another part—the root. Space will not admit of even a *résumé* of his experiments, one of which, however, I must take, as it so especially corroborates what has been previously said in relation to the action of light. Leaves of bulrush and bur-reeds were etiolated, and then separated from the plants; the upper end of the leaf was inserted in a glass shade without carbon dioxide, the lower in an atmosphere containing 5 per cent. of this gas, whilst the space between was left free to the open air, though it was obscured by tinfoil, so that no starch could be formed in it, at the expense of any carbon dioxide passing through the tissues from the lower shade. The experiments lasted one day and uniformly gave the same result; starch was formed abundantly, where carbon dioxide was at disposal in the air, while the excess of it in the lower shade had no effect upon the portion of the leaf in the upper one, which remained entirely free from starch. The apparatus was, moreover, always placed in a light window shaded by gauze blinds, if the sun was too hot; and throughout all the experiments it was an interesting circumstance to note that in the lower portions of these rather thick leaves more starch was formed on the side next to the window. This variation in the starch formation according to the amount of light showed that that portion of leaf had not always used all the carbon dioxide at its disposal, and that consequently there was an excess which might have passed upwards through the tissues.

Fig. 6.—Holly in Ether.

	M.		λ.	Observations.
1	22·08	Centre	645·0	Class 1. Very black; size ·48.
2	22·73	"	596·0	" 2. Shaded; size ·335.
3	20·15	"	528·57	" 1. Very shaded; size ·285.
4	{ 20·8 19·8 }	Commencement	{ 504·75 473·50 }	Very shaded, ultimately quite black; general absorption.

Fig. 7.—Holly (Variegated) Young Leaves in Alcohol.

1	22·0	Centre	649·0	Class 1. Very shaded; size ·2. Same as in Fig. 1.
2	{ 19·0 18·5 }	Commencement	{ 498·0 455·75 }	Shaded, ultimately quite black; general absorption. Same as Fig. 1.

Another highly interesting point in relation to this subject, and which is also of some importance, is the production of red leaves from those which in the period of their maturity are green. This change is often noticed in the commoner sorts of plants in almost every stage, though in the case of evergreens it is more or less confined to a few. Take one instance of it, the arbutus, where the leaves undergo several distinct changes of colour from the time that they are newly developed upon the young shoots, till they become either dying or dead.

Looking cursorily or rather without the eye of a micro-spectroscopist at the young newly-formed leaves of arbutus, the difference in shade as to colour, &c., is so very slight to those which are older and more mature, that one might be almost inclined to doubt whether or not the selection of this example was not rather in opposition to the views lately laid down. However, look at Figs. 8 and 9 where the difference mainly and only due to the action of light and temperature, &c., is clearly seen: thus we find that these young leaves do to a certain extent contain a quantity of those essential elements which constitute their life in the shape of a highly wax-like or other secretion, for it is particularly noticeable how they are, as it seems, coated or rather thoroughly impregnated with this greasy material, which, as the accumulative action both of light and temperature takes place, forms both a varnish for the sake of protection and acts probably also as the chief substance from which the other parts are hereafter formed. They moreover seem to need the action of light to a much greater extent than laurel and holly, as those leaves which grow within the shrub, and are therefore more or less shaded, wither quicker than those which are exposed.

The peculiarity, however, which I more especially wish to call your attention to is that these deep green leaves, when their functions with regard to the plant have been thoroughly carried out, that is to say, when an equilibrium of their mature state has been established, and they have arrived at the stage of the third order, or the period of descension, they gradually, and indeed somewhat quickly, assume a pink-red hue, which is evidently only another product formed by the action of light; for when at the commencement of this state they are shaded as before described, the green tint is preserved till they have gone too far for subsequent recovery when they will be found to have withered up entirely, whereas while allowed to be exposed, the pink colour which will be seen on turning the leaf over to be only on the surface, is but one step in the ladder reached, for we find the red resolving into yellow, and the yellow to total death, which is evinced by the appearance of dark brown spots on the epidermis, which eventually impregnate the whole leaf. If, therefore, we deduce that the red and yellow substances are formed by the direct action of light, and are therefore due to some direct change having taken place in the previously existing chlorophyll, I do not think we shall err much from the path of truthful inquiry.

A natural question arises however; is not the chlorophyll in such instances as these actually dependent on the red colouring matter? Or, more simply speaking, is it not actually in existence when the leaf is still green? So far as my experience goes, I certainly should answer these questions in the affirmative, for I have known these red leaves to turn green again as summer has approached; still there is a difference in the red which denotes the declining scale to that which is the effect of a season, and I therefore cannot help thinking but that it is in some measure due to temperature; when that falls, the equilibrium between the constructive and destructive agencies is so much modified by the reduction of vital activity exerted on the part of the plant itself that the amount of chlorophyll formed is considerably less in proportion to that of the red substance which exists as a rounded hyaline strongly refractive mass in the upper part of the palisade cells, and appears sometimes as red, sometimes as yellow, and consists mainly of tannin, while the chlorophyll grains intact and of a beautiful green are all crowded together in the inner end of these cells, whereas in the more seasonable weather of spring and summer the reverse is occasioned, and consequently the leaves assume their natural colour—green.

The fact that other plants of the evergreen order do not turn red appears to me to be analogous to the state in which the chlorophyll exists in them. Laurel and holly, for example, do not turn red in winter; still there is very little doubt but that their leaves become darker as the temperature falls, and this I am rather disposed to attribute to the action of a blue or brown compound which acts in exactly the same way, though it is not so noticeable as in the case last enumerated.

The spectra which I have recorded are taken first, as in Fig. 8, from the leaves in a mature state; second, as in Fig. 9, from the young ones; and third, as in Fig. 10, from those which have assumed a red hue.

Fig. 8.—Mature Leaves of Arbutus.

	M.		λ.	Observations.
1	22·00	Centre	649·0	Class 1. Very black; size ·4.
2	22·76	„	594·5	„ 2. „ dark; size ·27.
3	20·05	„	532·5	„ 1. Shaded, centre dark; size ·30.
4	19·00	„	498·0	„ 1. Shaded, centre dark; size ·6.
	19·5	Commencement	482·5	General absorption; black.

Fig. 9.—Young Leaves of Same.

	M.		λ.	Observations.
1	23·97	Centre	651·0	Class 1. Very black; size ·37.
2	22·7	„	598·5	„ 2. „ dark at one end, other shaded; size ·2.
3	20·07	„	531·5	„ 1. Dark; size ·35.
4	19·00	„	498·0	„ 1. Shaded; size ·6.
5	19·50	Commencement	482·5	General absorption.

Fig. 10.—Red Leaves of Same.

	M.		λ.	Observations.
	21·0 20·5	Commencement	582·0 515·5	General absorption; very shaded at first till quite black; no trace of any ordinary bands.

The action of the rise and fall in temperature, besides the beautiful way in which it is disseminated throughout the whole spectrum, has without doubt great influence in the production of both plant life and decay. All who take any interest, however small, in the plot of garden which, notwithstanding the advance in population about the district in which they happen to be located, is still reserved to them, must know how useful an acquisition the cool corner is; all things seem to vegetate so much better there, besides acquiring that amount of strength which is often wanting in the same species not thus suitably situated.

With all this, however, the leaves of laurel, holly, and arbutus, when in a dying state assume a more or less yellow tint, which seems indeed the most universal form of colour for all plants whether of the evergreen species or not. This yellow substance, of which the partially dead leaves are composed, is acted upon by temperature to a great extent. They soon, as is far too common a metamorphosis to require any allusion, become a dull dead appearance, besides being very brittle and breaking off from the stem with the merest touch. Thus we are led to see in conclusion how that the combined action of both light and heat has done its last duty, and what remains is only so much carbonized matter.

This, then, closes my few remarks upon what seems, at least to me, a most extensive subject, and I suppose it is needless for me to add how much I wish to see others taking up this branch of inquiry.

The further question of solvents with regard to the species of plants of which we have treated is a most important one, and I can only hope that on some future occasion I shall be enabled to bring before you some researches in connection with the micro-spectroscope, that during the working out of this paper have naturally presented themselves.

V.—*On the Microscopical Examination of Water.*

By Wentworth Lascelles Scott, Public Analyst to the County of Glamorgan and the Borough of Hanley; late Analyst and Microscopist to the Hon. East India Company, &c.

(*Taken as read before the* Royal Microscopical Society, *Nov.* 7, 1877.)

In spite of the number of books and treatises bearing upon the subject of this brief note, which have been published from time to time, the results of the microscopical examination of waters from a hygienic point of view are generally so vague and unsatisfactory, that little, if any, importance is attached to them in the majority of instances, whilst by more than one high official authority, and by fully two-thirds of the private analysts in practice, the systematic application of the microscope in water analyses appears to be practically ignored.

I am quite aware that a vast amount of useful work has been performed—especially by Fellows of this Society—in relation to hydro-microscopy, and that hardly a manual or treatise 'On the Microscope' exists which does not include some instructions for the collection and observation of the organisms present in water from various sources, but, on the other hand, I can discover but little attempt to reduce such instructions to any uniform and practical rule, or to gather together results in such a manner as to render them at all comparative. Hence if, as is very frequently the case, the *chemical* results of a water oblige the analyst to pronounce a somewhat doubtful judgment thereon, the microscope *properly applied* should yield an absolute and an unmistakable verdict which should be *identical*, whether the instrument was applied by any one or more skilled observers. At present this is *not* the case, and I have now before me the opinions of three experts upon the quality, as shown by the microscope, of one and the same specimen of water, these three opinions being utterly at variance with each other from first to last.

A case of a somewhat similar character occurred not long ago in my ordinary practice. A sample of well-water was sent to me by the Local Board of Health of Wednesfield for analysis. I found the water to be chemically passable, but microscopically bad, and condemned it accordingly. A local chemist having reported the water to be good and wholesome, the owner of the property and the Local Board agreed to obtain a third opinion. By the merest accident the gentleman selected was one who is in the habit of attaching some importance to microscopic results, and these induced him at once to designate the water as "unfit for drinking"; my opinion, therefore, was confirmed and acted upon, but, as a matter more of chance than of fact, as will be readily admitted.

Much of this incertitude, if not, in time, the whole of it might, in my opinion, be removed, if hydro-microscopists could agree in the adoption of one uniform plan to which every sample of water examined by them for health purposes were submitted, a certain elasticity in detail being, of course, admissible. As some slight contribution towards the end I have in view (and which I hope to be permitted to touch upon more fully hereafter), I venture now to submit to your criticism a brief outline of the method adopted in my laboratory for all hydro-microscopical inquiries.

In addition to the usual appliances, the following simple pieces of apparatus, &c., are required; the first four articles may advantageously be in duplicate.

1 Filter-stand, with 2 rings.
1 Glass beaker, about 25 ounces.
2 ,, pear-shaped decigallon flask.
1 Centigallon bottle.
2 or more funnels (without necks).
2 Small pipettes.
Filter-papers.
Collodion (special).
Ozo-vaseline.
2 Zinc or boxwood circular stencils.

The water intended for examination is first subjected to prolonged (but not too violent) agitation, which is continued whilst, either by pouring, or with the aid of a siphon, the pear-shaped decigallon flask is filled up to the mark on the neck. This flask is furnished either with a lateral aperture of about ·2 of an inch near the mouth, or with an external tube of about the same bore, extending nearly from the mouth to the bottom, where it communicates with the interior; the beaker being placed upon the stand, and a funnel, with a special filter therein, arranged above it in one of the rings, a little of the water is poured into the filter from the pear-shaped flask, which is quickly inverted therein in such a manner that the lateral aperture before mentioned is just below the surface of the liquid when the filter is about two-thirds full.

Under these conditions, as will be readily seen, filtration will proceed quietly and continuously until the flask is emptied, for as soon as the level of the liquid in the filter sinks below the little aperture (or tube), air is thereby admitted to the flask, the filter is again filled up to the original level, and the operation proceeds as before.

The filters employed, however, are of a particular kind, the centre of each circular paper having been rendered impervious to fluid by means of some neutral fatty composition, for which purpose I prefer a mixture which may conveniently be called "Ozo-vaseline"; of

Vaseline	35 parts.
Ozokerite	65 „
	100

of which a small sample is before you. With the aid of some zinc-plate or boxwood stencils, ozo-vaseline in the fluid state may be so applied to the filter-disks that they present the appearance of those herewith.

Using filters of this description, it is evident that the whole of the suspended matter, living and dead, mineral and organic, present in a given quantity of water, say 7000 grains (or any convenient multiple thereof), can be, as it were. concentrated or condensed into $\frac{1}{100}$th of its normal bulk, or even less if needed, without wasting the major portion of the water itself, and without injuring or altering the characters of the various organisms finally contained in the small and impervious cone forming the bottom of the filter. Larger or smaller quantities of water can, of course, be operated upon, as may be found expedient, provided always that the *principle* involved be rigidly adhered to, viz. that some definite measure be used throughout, by preference referable to the imperial gallon; so to afford a means of comparing one sample of water with another, both as regards *varieties* and the *number* of the organisms present therein.

The filter-paper ordinarily met with will, without doubt, afford a free passage to many of the smaller organisms present in many waters; it becomes necessary, therefore, to adopt some means of stopping their egress. For this purpose I find a very thin structureless collodion exceedingly useful; filter-paper dipped herein, and allowed to dry, may thus be rendered of any required *degree* of porosity. In practice I find it convenient to keep ready two or three varieties of paper thus treated.

It is obvious that by this fractional filtration process it is possible to collect together in a rapid manner, and in the compass of a few drops of liquid, all the organisms previously diffused throughout a large quantity of water without the doubtful labour of the ordinary "fishing" processes, and without the great loss of time attendant upon the "settling" and "decantation" plans generally recommended.

Again, in the examination of adulterated milk, it frequently becomes a question of material importance whether pure or contaminated water has been employed to dilute the natural secretion of the cow. By following the plan I have endeavoured in general terms to indicate, the innocent or more or less dangerous nature of the adulterated water can be ascertained, and, in case of need, demonstrated in a court of law. Not long ago, amongst a number of *milk* samples delivered to me for analysis by one of the Glamorganshire Food Inspectors, one was found to be not merely much adulterated with water, but the water employed for this admixture sold as "new milk" I ascertained to have been of a frightfully impure character, inasmuch as besides decomposing animal and vegetable matters, no less than eighty-seven living animalculæ were counted in half a pint of this "milk" treated according to the plan here indicated. I certified the sample to be "injurious to health," and a fine of *3l.* and costs has effectually remedied this obvious danger to public health in the neighbourhood of Penarth. Since the conviction I have ascertained the source whence this foul and polluted water was obtained, wherewith the dealer was in the habit of "improving" the product of his cows.

Upon a future occasion I hope to say a few words upon the method proposed by me for the critical examination of the organisms collected in the space of a few drops of water, but representing an infinitely larger bulk; as also upon the comparison and tabulation of the results. For the moment, if I succeed in obtaining some expression of opinion upon the necessity which exists at present for a *system* of hydro-microscopy capable of yielding something like comparative results, my object will have been fully accomplished.

1

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C. Stewart del.

W. West & Co. lith.

Lachrymal gland of Turtle.

VI.—*On the Lachrymal Gland of the Common Turtle.*

By C. Stewart, F.L.S., Hon. Sec. R.M.S.

(*Taken as read before the* Royal Microscopical Society, *Nov.* 7, 1877.)

Plate CC.

In dissecting the head of the common turtle (*Chelone midas*) one cannot but be struck by the great relative and absolute size of the lachrymal gland. The large size of this organ is the more remarkable, as in water-dwelling animals it is frequently either absent or but slightly developed, the surrounding water answering all the purpose of its secretion in protecting the eye from dust, drying and loss of transparency of conjunctiva and cornea. The necessity for at least an occasional abundant lachrymal secretion in these animals is perhaps found in the fact that at certain times, especially during the breeding season, they have to leave the water and remain for some time on the hot sandy banks in which their eggs are laid.

In the turtle the lachrymal gland lies in the posterior part of the orbit, that is, in the place which in human anatomy would be spoken of as its outer portion. It is covered and protected by the post frontal bone which contributes so largely to the formation of the false roof of the cranium found in this genus and in Chelydra. The gland is about three times the size of the globe of the eye; it is composed of numerous closely-packed lobules of an irregularly flattened cleft and indented conical form, the apices of the lobules all converging to the central duct. Each lobule is exceedingly firm in texture, and on examining a thin section under the microscope it is seen to consist of a central core of dense connective tissue in which lie the larger branches of the duct, blood-vessels, &c. The duct is lined by columnar epithelium lying on a layer of superposed smaller cells. From the duct proceeds, directly outwards, tubular acini, which repeatedly branch and become reduced in size as they pass to the surface of the lobules. These acini are lined by a single layer of a most remarkable variety of columnar epithelium, the cells being in no place in contact with one another, but separated by a clear space, each cell having also deep grooves running along its sides, and at its fixed end being attached by numerous delicate root-like processes. A section that grazes the surface of an acinus will accordingly show a number of dots corresponding with the transverse sections of these root-like processes; if it be a little deeper each cell will appear like a minute star; whereas if the centre of the acinus be cut through, a true side view of the cells will be obtained, the entire section presenting an appearance of great beauty.

It seems possible that this channelled condition of the epithelium may serve the purpose of increasing the surface from which the secretion may be poured out.

PROGRESS OF MICROSCOPICAL SCIENCE.

Double Staining with a Single Fluid.—In the 'American Journal of the Medical Sciences' for January last, there is a long and interesting article by F. Merbel on the double staining of tissues by a single fluid. Many similar fluids have been tried before, but have not realized the hopes that were entertained regarding them, that in a complex tissue the various constituents should show a marked selection for the different colours or tints, which should be constant, and might serve to afford some additional evidence as to their structure. That such a stain has not yet been discovered may be asserted, nor does the author in his paper claim to have arrived at this result, but he appears to consider that by some modification of his process, the uncertainty and failure may be eliminated and a successful result be always obtained. The stain consists of two fluids which are mixed before using. One consists of half a drachm of carmine, two drachms of borax, and four ounces of distilled water; the other, of two drachms of indigo-carmine, two drachms of borax, and four ounces of distilled water. The ingredients should be very carefully rubbed in a mortar, and after standing for some time the supernatant fluid must be poured off, filtered, and kept in a stoppered bottle. They are to be mixed in equal proportions. The sections or tissue to be stained should be as thin as possible, and if they have been hardened in chromic acid or chromates, all traces should be removed by careful washing, they may then be plunged for a few minutes in alcohol, from which they are transferred to the staining fluid; after remaining in this for a quarter of an hour or twenty minutes they are removed to a saturated solution of oxalic acid for a rather shorter period, and are then washed in distilled water till no trace of the acid remains. They may then be treated in the ordinary way and mounted in Canada balsam, glycerine, jelly, &c. Indigo-carmine is the commercial name for the sulphindigotate of potassium or sodium, and as this is very soluble in water the oxalic acid is used with the object of fixing it; unfortunately this acid precipitates carmine, and this is, without doubt, the weak point in the combination, nevertheless some very good results have been obtained, and a successful preparation is a most beautiful object. There is not only the blue of the indigo and the red of the carmine, but different shades of purple, violet, &c., and in a structure that has been decalcified in chromic acid, a phalanx for instance, if some trace of the acid remains a series of greens make their appearance. In a section of ecchymosed skin the extravasated blood-disks presented a brilliant apple-green tint; indeed at first sight so varied is the colour that one would more readily believe it was due to polarized light than to the action of a single staining fluid. Whether a fixing agent other than oxalic acid, and which shall not act deleteriously on the carmine, can be substituted, must be the result of future investigation and experiment.

The Minute Structure of Red Blood-corpuscles.—In the 'Archiv. für Mic. Anat.,' Bd. 14, Professor Boettcher gives the results of some continued researches on the structure of the red blood-corpuscle.

He believes the facts brought forward support him in the views he has long held, though antagonistic to those generally received, and which were first introduced by Rollet. Formerly he made use of alcohol for hardening the corpuscles, and then clearing them with acetic acid, demonstrated that they contained a nucleus; but frequently the distention caused by the latter counteracted the beneficial action of the former reagent. He has now been led to make use of a saturated solution of corrosive sublimate in 96 p.c. alcohol, and into about 50 volumes of this solution one of blood is to be rapidly diffused. The effect of this is that the corpuscles are deprived of the hæmatine which colours them, and thus their internal structure is rendered clear; their preservation and bleaching take place at the same time. The action of the fluid is assisted by frequent agitation, and in about a day the red corpuscles have lost all colour, and when allowed to subside are more or less pale, whilst the superincumbent fluid is clear and of a dark brownish colour. This is then poured off and pure alcohol substituted, which is to be frequently agitated to ensure thorough washing of the corpuscles. In twenty-four hours or more the alcohol is poured off, and the process repeated with distilled water. When the corpuscles are again allowed to subside, they form a nearly white layer at the bottom of the vessel, and are no longer liable to be acted on by water. In this state Professor Boettcher claims to be able to find the structure to which he draws attention, but it is rendered more clear by a process of staining, and for this purpose he has made use of eosin, hæmatoxylin, picric acid, and carmine, giving the preference to the last, the gradations of tint rendering the various components more ready of recognition. The three classes of red blood-corpuscles which the Professor describes, contain one, two, and three elements respectively. The first appears to be homogeneous, and shiny throughout; the second, added to a homogeneous shiny cortical layer, has a granular mass in the interior which takes the staining fluid readily; the third has the same cortical layer and protoplasm, but enclosed in the latter is a clear nucleus containing a nucleolus. In the same paper an account is given of the examination of the blood of a man who had poisoned himself with an alcoholic solution of corrosive sublimate; here the red corpuscles were found to be exceedingly pale, and in many of them a nucleus could be seen, which was surrounded more or less with protoplasm. The paper, if heterodox according to generally received views, is yet well worthy of attention.

*A New Parasitic Chlorochytrium.**—Professor E. Perceval Wright describes in vol. xxvi. of the 'Transactions of the Royal Irish Academy' "a new species of parasitic green Alga belonging to the genus *Chlorochytrium* of Cohn." In it we have another occurrence of the remarkable and extremely rare phenomenon of a chlorophyll-containing thallophyte leading a parasitic life. Professor Cohn, of Breslau, discovered in 1872 the first chlorophyllaceous endophyte living in the intercellular spaces of the parenchyme of *Lemna trisulca*, and on this plant the genus *Chlorochytrium* was founded. Professor Wright,

* From the 'Academy,' Nov. 17, 1877.

of Dublin, has now discovered what he supposes to be another species of this genus as yet undescribed living in the substance of *Schizonema* fronds, and in the paper above quoted details the results of his investigations into its life-history. It may first be observed that the patience and labour bestowed on this investigation are to be valued apart from the result. Nothing however can be clearer, on Professor Wright's own showing, than that the plant he describes is no *chlorochytrium* according to Cohn's diagnosis. We do not for one moment doubt the accuracy of Professor Wright's observations so far as they go: but when his plant, as he himself plainly states, is distinguished from Cohn's by a "totally different process of the formation of the zoospores, and the occurrence of *large* and *small* zoospores" (the italics are ours), surely something more than a specific difference is present. As to this matter of large and small zoospores, "the true significance of this fact" Professor Wright is "at present unable to determine." Many things are, of course, possible, and we have neither desire nor space to speculate on the probability of their conjugating besides fulfilling the function of vegetative reproduction. We will mention only one suggestive instance, that of *Ulothrix zonata*, which produces macrozoospores and microzoospores, the latter of which conjugate among themselves, but the former never, nor the one kind with the other, while both under favourable circumstances are capable of the asexual reproduction of the mother plant. Now, in this case of *Chlorochytrium* may not some of these forms of conjugation take place? This important point was not cleared up. It would be fortunate if Professor Wright himself discovered the true solution of this question. At present the value which the paper appears to have is as a partial description of the life-history of what seems to be a yet undescribed plant.

The Influence of Light upon the Development of Bacteria.—Mr. A. Downes and Mr. T. P. Blunt sent the following note to 'Nature' (July 12), on this subject:

We have been engaged during the last few months on an investigation into the effect of light upon the development of Bacteria in certain of those solutions in which they are usually produced.

We reserve the details for a paper which we hope to submit to the Royal Society in the course of their next session, but wish to state, in the meanwhile, that the first portion of our inquiry has led us to the following conclusions:

1. That light is inimical to the development of Bacteria.

2. That under favourable conditions it may prevent their development.

3. That under less favourable it may not prevent but only retard.

4. That for the full effect of light to be produced direct insolation is necessary.

5. That those conditions which tend to neutralize the action of light are the same which are known to favour processes of fermentation and putrefaction.

6. That the fitness of the solution to serve as a nidus is not destroyed by insolation.

7. That, so far as our investigation has yet gone, it would appear that the germs originally present in the solution are destroyed by direct insolation.

We are still pursuing the inquiry, and have devoted much time to investigating the influence of the refrangibility of the ray, but regret that at present we are not in a position to give any definite conclusions on this point.

We are endeavouring also to trace an analogy between facts which we have observed and certain vital and chemical processes, in which light is known to play a part, and are extending our observations to other phenomena of fermentation and to microscopic fungi.

That light is not essential for the development of Bacteria has been long known, but that it is absolutely inimical to their production has not, so far as we are able to ascertain, been previously shown.

The Lymphatics of the Skin.—Dr. Mrs. Hoggan and Mr. Hoggan, M.B., have lately sent a paper on the above subject to the Royal Society (June 14), of which they have been so good as to forward to us the following abstract, in which they state that, by means of certain modifications in known methods of histological research, a full description of which they offer, they have been enabled to show the minute structure and relationships of the lymphatics of the skin in mammals. For the purpose of anatomical description they divide these lymphatics into three categories, named, from their position, the subhypodermic, the dermic, and the subepidermic. Only the first and third can be described as layers; the second consists of horizontal and vertical sets of vessels, extending through the whole thickness of the dermis, and connecting the other two distinct layers together. All the lymphatics of the hypodermis, and most of those of the dermis, are valved efferent vessels without any collecting channels that would entitle them to claim any absorbing function in these portions of the skin, through which they merely pass. The subepidermic lymphatics are narrow parallel collecting channels, destitute of valves, lying, as their name implies, immediately under the epidermic cells in young animals, although separated from them, as adult life is reached, by bundles of gelatinous tissue. These are the only radicles of the lymphatics of the skin. Upon the subepidermic lymphatics they find a rich plexus, formed by multipolar nerve-cells and non-medullated nerve-fibres, the distribution of which to the epidermis has been made evident by the same process. As no acknowledged contractile elements enter into the walls of these lymphatics, the function of the nerves found upon them cannot be affirmed by the authors. Neither sweat-glands, sebaceous glands, hair-muscles, fat-cells, or nerve-bundles, possess any lymphatics, and the papillæ in the human skin are equally destitute of them. Functionally, the lymphatics of the skin are to be considered as forming two classes—the valved efferent vessels with independent walls formed only of crenated endothelium cells, and the valveless collecting channels of the subepidermis lined by those crenated cells. Upon the facts accumulated in this and their former paper the authors are led entirely to reject the theory of vasa serosa or radicles of the lymphatics, formed by chains of connective-tissue cells, or the cavities in which they lie. In the human skin especially, these cells of the connective tissue are numerous and in intimate relationship with the superficial blood-vessels, but prominently absent from the collecting lymphatic channels lying alongside of these vessels, thus supporting the hypothesis they formerly emitted, that these cells were merely links in a nutritive chain, not radicles of the lymphatics, even when, as in tendon, the cornea, &c., they are connected with the lymphatics. The paper is illustrated by about a dozen and a half of camera-lucida drawings of microscopical specimens in their possession.

The Imaginal Disks of Insects.—A most important work on the metamorphoses of insects has recently been published at Warsaw, by Professor M. Ganin. This work has been reviewed at considerable length in the 'American Naturalist' (July), doubtless by Mr. A. S. Packard, jun., the highest American authority on the subject. From this notice we take the following quotation of the words of M. Ganin with respect to the imaginal disks of insects:—"I deem it proper to examine here the question of the morphological importance of the imaginal disks of insects in general. The data respecting their embryology and comparative anatomy render it very probable that the thoracic imaginal disks, hidden in the body of *Muscidæ*, the thoracic imaginal disks placed immediately on the skin of *Corethra*, *Miastor*, and the Hymenoptera, and the thoracic legs of the larvæ of Lepidoptera and Coleoptera, are homological formations, replacing each other in all those groups. In other words, and more explicitly, I believe that the thoracic imaginal disks of the Hymenoptera, *Muscidæ*, *Corethra*, and *Miastor* are nothing but reduced ambulatory legs, which in other insects (Lepidoptera and beetles) are used as organs of progression, but in the above-mentioned groups (*Muscidæ*, &c.) have lost their physiological value, and have preserved in the history of their development a mere record of that value. This view may be sustained by the following scientifically pregnant facts: 1. All insects, the larvæ of which possess, in their thoracic segments, the so-called imaginal disks, do not have any rudiments of legs on the same segments during the period of their embryonal development; in other words, the imaginal disks take the place of the legs, which, in other insects, appear much earlier, in the same places, during the period of the embryonal development. 2. In insects, the larvæ of which possess thoracic legs, these latter are transformed into the legs of the imago, in such a manner that the final segmentation of the joints of the leg of the imago appears more or less sudden and simultaneous, in consequence of the segmentation of the corresponding leg of the larva, which has been very much drawn out in length. On the contrary, those insects, the larvæ of which, instead of thoracic, ambulatory legs, have imaginal disks, show, before the appearance of the final segmentation of the leg of the imago, a stage of a *provisional* segmentation of the leg in the developing imago. Thus the segments of the leg of the imago of *Muscidæ*, Hymenoptera, &c., do not all appear simultaneously, but gradually, first one, then two, three, &c. This provisional segmentation of the leg, growing out of the imaginal disk, must be considered, probably, as the expression of the ultimate segmentation of the leg which it formerly possessed; or, in other words, the provisional segments of the leg, developing from the imaginal disk, remind us of the permanent segments of the larval legs of Lepidoptera, beetles, &c., which, in these latter, are used as temporary, provisional, locomotive organs. 3. I believe that great morphological importance must be attached to the fact that during the development of the imaginal disk of the *Muscidæ*, the Hymenoptera. *Corethra*, and *Miastor*, the provisional cavity in the disk, which has no ultimate meaning, appears first of all. The scientific meaning of this provisional cavity, as well as of its outward tegument, can be explained, I think, as follows: The fact that imaginal disks, formations homologous to ambulatory legs, are situated in the cavity of the larval body, in connection with the tracheæ and nerves, must undoubtedly be understood as a consequence of the compound process of the displacement of the imaginal disk from the surface towards the inner cavity along the tracheal tube or nerve. The larvæ of *Corethra*, *Miastor*, *Chironomus*, have the imaginal disks more on the surface of the skin than those of the ant (*Myrmica*). In the former larvæ, these formations are walled in by a comparatively less developed fold of the skin. In the larvæ of *Myrmica*, this deep fold is transformed into a well-developed bag, which, together with the leg of the imago, developing within it, is placed during a certain time within the cavity of the larval body, below its muscular, subcutaneous stratum. In these insects, after the leg is stretched outside, the bag enclosing it is atrophied, and has no ulterior meaning. If we represent to ourselves that the outside aperture, leading into the provisional bag, with the incipient leg of the ant, is closed, we obtain all the homological parts of the disk of an ant as compared to the disk of *Muscidæ* in the corresponding stage of development. That is, the part of the disk of the *Muscidæ* which I described as its outside tegument, becomes the homologue of the closed fold of the skin in the disk of the ant; the provisional cavity of the disk of *Muscidæ*, between its outer and inner tegument, is homologous to the cavity of the bag in the disk of the ant; the inner tegument of the disk of the *Muscidæ* and the thickening of the anterior half of the disk of the ant represent the beginnings of the leg of the imago, and are homologous formations. The phase of development of the imaginal disk of the ant, before it begins to project externally, when the extremity consists only of three provisional segments, and the corresponding phase in the disk of *Muscidæ*, entirely concealed within the cavity of the body, are remarkably alike anatomically, if we do not pay attention to the external opening in the disk of the ant. It seems very probable that, when the post-embryonal development of different insects is better investigated, embryological facts will be found, which will favour the view, explained above, of the imaginal disk of *Muscidæ* being comparable to the disk of the ant (*Myrmica*). I mean to say, that an intermediate stage of the imaginal disk will be found, during which it occupies in the full-grown larva a position similar to its position in the larvæ of *Muscidæ*, and has at the same time its outer integument and provisional cavity similar to those of the ant."

Microscopy of the Blood in Infants.—M. Hayem (May 21) read a paper on this subject before the French Academy. He draws the following conclusions:—1. When the blood of the new-born infant leaves the capillaries it is black, almost as much so as the venous blood. 2. The red corpuscles are much more unequal in size than in the adult; the largest exceed the largest corpuscles in the adult; and in the same way, the smallest are smaller than in the latter. 3. The red corpuscles of the child seem to differ but very slightly from those of the adult in intimate composition; in fact, they allow endosmose, and lose shape more rapidly at the contact of reagents and of moisture; the small corpuscles especially easily become spherical. 4. The number of red corpuscles contained in a cubic millimeter is almost as high at the moment of birth as in the most vigorous adult, and consequently always notably superior to that of the corpuscles of the mother's blood. The average number per millimeter in seventeen infants was 5,368,000. The highest figure was 6,262,000, and the lowest 4,340,000. The result furnished by these calculations appears to be influenced by the manner in which the cord is tied. In six children who had the cord tied immediately, the average figure was 5,087,000. In eight children where the cord was tied only after the cessation of the pulsations of the umbilical artery, the medium was 5,576,000, making a difference of 489,000 in favour of the latter. 5. The colouring power of infants' blood, that is to say, the proportion of hæmoglobin determined by the aid of the chromometric process employed by M. Hayem is, on the average, as strong as that of the adult. 6. At the moment of birth, the same varieties of white corpuscles are found as in the adult. However, these elements are a little smaller, and the small variety named globulines are relatively more abundant. During the first two or three days of life, the number of white corpuscles is three or four times greater than in the adult. The average for the forty-eight first hours was 18,000 white corpuscles per cubic millimeter, whilst in the adult the average of white corpuscles is about 5000. 7. After birth, the blood of the child undergoes important modifications. In a first period corresponding to the diminution of the weight of the new-born infant, the number of corpuscles, both red and white, remains stationary, or slightly increases; when it reaches its minimum weight, that is to say usually on the third day, there is at the same time a sudden and considerable decrease in the number of white corpuscles, which fall from 18,000 to 6000, or even 4000, and an increase in the number of red, which generally reach their maximum. The rise in the number of the red corpuscles is very variable, from 100,000 to 600,000, and not constant. 8. From the time when the child begins to gain weight, the number of white corpuscles rises a little, it presents greater oscillations than in the adult, and remains generally higher than in the latter up to a yet undetermined epoch. At that time there is an average of from 7000 to 9000. The number of red corpuscles remains definitely smaller, and in the course of the second week, a decrease of about half a million on the actual amount is found. 9. The fluctuations in the anatomical composition of the blood, as much in relation to the variety of corpuscles as to their number, are very evident from one day to another, and this is one of the most striking characteristics of the blood of infants. The modifications in the proportion of the corpuscles of different diameters bring on corresponding fluctuations in the colouring power of the blood. 10. It is therefore seen that the blood of the new-born child shows characteristics specially belonging to it, and sufficiently important to allow it the designation of fœtal blood.

Vertebrates Developed without any previous Fecundation.—This is asserted to have occurred among some pickerel in possession of W. E. L. Sturtevant, who has written the following letter, dated July 8th, to the Smithsonian Institution, U.S.A. He says that "on March 5th, 1875, the boys brought in some brook pickerel. One was swollen with spawn, weight of fish 521 grains; of spawn freed from membrane, 127 grains. 117 spawn weighed 5 grains. Therefore whole number about 2972. This spawn was amber coloured, and the eggs were in general translucent Occasionally an egg could be seen which was slightly smaller than the rest, and clouded, and some few were opaque. These eggs, thus marked, presented different appearances under the microscope. I have mislaid the notes and drawings that I took at the time, but can furnish the following facts from memory. The clouded eggs showed a different development from the others, there being a greater difference in size of the cells, and occasionally the cells arranged in lines. Some of the opaque eggs had evidently developed in the line of the fecundated egg, as the cells were arranged in the form of a curled fish, the line of the back being well defined, the line of the belly and sac poorly or not at all defined, while there was a concentration of cells about the locality of the eye. I cannot say that I saw a young fish, for I did not, but I saw what I considered sufficient to interpret as development to a certain degree, without fecundation. I was so much surprised, that for a time I doubted my own eyesight, and called my brother to look. He saw what he called a young fish in the egg, and so I was convinced, but I had not the courage to send my observations to men of science. This next spring I will try and procure some fresh specimens, and if my observations can be verified, as I doubt not but that they can be, I will send them to you."

The Ascidian Origin of Vertebrates.—This subject has, of course, been referred to in the address of the President to the British Association. Dr. Thomson said, in referring to the notochord that it is a continuous median column or thread of cellular structure, running nearly the whole length of the rudimentary body of the embryo, and lying immediately below the cerebro-spinal canal. It occupies in fact the centre of the future bodies of the vertebræ. It exists as a primordial structure in the embryo of all vertebrates, including man himself. and extending down to the amphioxus, and, according to the remarkable discovery of Kowalevsky in 1866, it is to be found among the invertebrates in the larva of the ascidia.* In amphioxus and the

* 'Mem. de l'Acad. de St. Petersbourg,' vol. x.

cyclostomatous fishes the notochord, growing with the rest of the body into a highly developed form, acts as a substitute for the pillar of the bodies of the vertebræ, no vertebral bodies being developed; but in cartilagiuous aud osseous fishes various gradations of cartilaginous and osseous structures come to surround the notochord and give rise to the simpler forms of vertebral bodies, which undergo more and more distinct development in the higher vertebrates. In all instances the substance forming the vertebral bodies is deposited on the surface of or outside the notochord and its sheath, so that this body remains for a time as a vestigial structure within the vertebral bodies of the higher animals. The observations of Kowalevsky with respect to the existence of a notochord in the ascidia, which have been confirmed by Kupfer and others, have produced a change little short of revolutionary in embryological and zoological views, leading as they do to the support of the hypothesis that the ascidia is an earlier stage in the phylogenetic history of the mammal and other vertebrates. The analogy between the amphioxus and ascidian larva is certainly most curious and striking as regards the relation of the notochord to other parts, and it is not difficult to conceive such a change in the form and position of the organs in their passage from the embryonic to the adult state as is not inconsistent with the supposition that the vertebrates and the ascidia may have had a common ancestral form. Kowalevsky's discovery opens up at least an entirely new path of inquiry; and we must be prepared to modify our views as to the entire separation of the vertebrates from the other groups of animals, if we do not at once adopt the hypothesis that through the ascidian and other forms the origin of the vertebrates may be traced downwards in the series to the lower grades of animal organization.

The Development of Batrachians without Metamorphosis.—This fact, which was lately alleged to occur by a writer in a London journal, has produced a statement of some interest in the 'American Naturalist,' August, 1877. The statement is made as follows by Mr. B. G. Wilder:—"In 'Nature' for April 5, 1877, is an interesting article, author not stated, upon 'The Development of Batrachians without Metamorphosis.' On page 492 occurs the following passage: 'The young of *Pipa Americana* (the Surinam toad) come forth from the eggs laid in the cells on their mother's back, tailless and perfectly developed. In them, likewise, no one has yet detected branchiæ.' Two points here made are not in accordance with the observations of the late Professor Jeffries Wyman, as recorded in the 'American Journal of Science and Arts,' 1854, 2nd series, vol. xvii. pp. 369–374. Wyman states that the eggs are transferred by the male to the back of the female, which presents 'a uniform surface throughout;' 'their presence excites increased activity in the skin, it thickens, and is gradually built up around each egg, which it at length encloses in a well-defined pouch.' On pages 370 and 371 he figures and describes the earlier embryos as having 'three branchial appendages on each side of the head. In a later stage the external branchiæ had disappeared, but a small branchial fissure was detected on each side of the neck, and within this on each side a series of fringed branchial arches.' Wyman's figures are evidently enlarged, and he gives no measurements of the embryos. But his figures and descriptions are explicit, and I am not aware that any statement by him has ever been found to be incorrect. In view, however, of the passage above quoted from 'Nature,' I have endeavoured to obtain confirmation of Wyman's statement. On examining two embryos from cells upon a Pipa presented to me by Dr. J. B. S. Jackson, I found them very ill preserved. They measured 14 mm. from tip to tip, and I could find no trace of branchiæ internal or external. I then suggested to Dr. Jackson an examination of some better preserved examples in the Warren Anatomical Museum of the Medical College of Harvard University. The examination was made by Mr. C. S. Minot, who reports as follows: 'I have examined two eggs from the back of the Pipa, and found the embryos a little more advanced than that figured by Professor Wyman; they are between 12 and 13 mm. in length. The gills were partly absorbed, but a single slit with the gills still projecting could be readily seen on each side at the back of the head. I could not make a more detailed examination, as the eggs were not well enough preserved.' We may conclude, then, pending the extended examination of a series of perfectly preserved embryos, that the Pipa does possess external branchiæ at a certain period before hatching."

The more simple Sarcode Organisms.—The anniversary address of the President of the Linnean Society (Dr. Allman) has been recently issued in printed form, although it was delivered as long ago as May, 1876. Still it is one of the most valuable memoirs that the microscopic world of England has seen for a long while; and we believe that the difficulty of engraving the blocks was the chief cause of the delay in publication. It is a *résumé* of all continental and English work which has been done of late years on the subject of amœba-like organisms. It extends over fifty pages, and is illustrated by nineteen very capital woodcuts. It opens up quite a new field of work for the English microscopist. One of the most interesting forms described in the address is one which was discovered on the Algæ which cover the piles of the harbour of Odessa, by Cienkowski. It is exceedingly well figured, but there is this objection that the draughtsman has given us no idea of the magnification employed. However, the relation of the peculiar fusiform bodies to the filamentine network is well shown. But with regard to the Russian's view of the relation of the plexus to the spindle, Dr. Allman evidently is more disposed to agree with the distinguished Irish naturalist, Archer, than with Cienkowski.

E. Gundlach's New Periscopic Eye-piece.—E. Gundlach describes his new eye-piece in the 'American Naturalist.' He says, "My new periscopic eye-piece consists of a triple eye-lens, (two positive crown-glass lenses and one negative flint-glass) a double-convex field-lens, the latter being situated within the focal distance of the former, and a diaphragm located in the focus of the equivalents of both lenses. The field of the new eye-piece is considerably larger and flatter than that of Kellner's, and the image is sharply defined to the extreme edge."

NOTES AND MEMORANDA.

Death of a Diatomist.—The 'Journal of Botany' (August) states that the death is announced of Dr. Gustav Waldemar Focke at Bremen, on June 1, in his sixty-eighth year. He was well known for his researches in *Desmideæ* and diatoms.

Dry-mounting of Crystals.—Mr. R. S. Peet, in the 'Cincinnati Medical Journal' for August, says:—"My attention was particularly called to crystals, separate from plants, by a discovery made by me last December. In experimenting for the best oblique illumination, I was one night startled by finding the field (of diatoms) suddenly filled with gems such as only polarized light can yield, while at the same time the ground was perfectly black. On looking at the mirror, I saw that I had unconsciously carried it quite to the left (the lamp side) of the axis of the objective. Noting the position of things, I was the following night able to reproduce the effect. I diligently followed the thing up, until I reached what I will now describe: I place the kerosene lamp without a screen, about fifteen inches to the left of the stand, the latter being at right angles to the former. A slide of Nottingham earth is placed on the stage, and focussed by direct light. The mirror is then slowly carried to the left until the field is nearly dark. Afterwards the mirror is very carefully moved away from or toward the observer, as it were feeling with the utmost minuteness for the angle. When the angle is hit, it will be manifest by the diatoms appearing illuminated with polarized light, those best formed for polarization showing as the most exquisite gems conceivable—indeed passing conception. That the light is really polarized is, I think, proved by the fact that by a slight shifting of the mirror the complementary colours are shown in the same object. By a horizontal arrangement I have adapted my bull's-eye to the use of a condenser. By careful adjustment I get rid of all decomposed light, obtaining a perfectly achromatic result, and very greatly increasing the intensity of light. When the right angle is secured without the condenser, the latter is placed close under the diaphragm, concave side up. The faint spot of light on the cover is made to present itself just to the right of the objective. I then adjust with my eye upon the tube, if the effect is not reached, the condensed light is caused to come directly under the objective, the mirror being afterwards carried a little farther to the left, and adjusted as before. Diatoms and polycystines are the objects most easily exhibited, then crystals. Salicine (in balsam) gives a brilliant gold colour with silver points. Salicylic acid from alcohol (dry mounted) shows gold and green, with shades of purple and silver points. Santonin from chloroform (dry) shows gold and green, sometimes so blended as to have a truly supernal effect. Iodoform has always three colours, red, gold, green, and often violet, purple, and dark gold. Chromic acid from absolute alcohol (dry) is the most brilliant of all. This crystal first takes the form of a double layer, the upper layer soon begins to cleave with every possible variety of line, often producing groups, the exquisite symmetry of which is indescribable. The surfaces of these lines seem to act as analyzers, and we have green, orange, and red presented in a brilliantly beautiful form. Crystals in plants, when they are in the same plane, can be well shown by this light; pollens also, and stellate hairs in glycerine jelly. Very thin transverse sections of bamboo, rushes, and the like, make fine pictures. Anything thin enough to be illuminated without change of focus is not only beautiful, but the minute parts are more precisely defined than in any other light. The most suitable powers are half, fourth, or fifth inch. Precise measurements would aid but little, as stands and stages differ so much. Only the above general directions can be given. The observer must find out the exact thing by his wits, helped by steady nerves. The manner of forming and mounting such crystals as are most interesting, may now be briefly stated. Salicine is formed and mounted as Mr. Davies directs. Salicylic acid should be mounted dry, it is crystallized from common alcohol on a slide slightly warmed. A few seconds of sharp heat, after the drop has spread, and before the crystallization has proceeded farther than the edge, improves the forms. As soon as cool, a balsam ring is drawn around it; and after a few hours, another upon the first. After three or four days, the cover may be put on, first slightly warming the latter over a lamp. In a day or two a thin coating of balsam is put on the edge of the cover. After a day this is repeated. At the end of a week the slide may be finished with cement, &c. Mounted in this way are all the others, except iodoform, which disappears in a short time. Santonin is very permanent: also chromic acid. Santonin makes altogether the finest appearance from chloroform, equal weight. Crystallized without heat, the effects are so peculiar, that there should be a slide of it prepared in that way; heat to 200°, or higher, after the crystallization has gone on for a few minutes on a cool slide, gives a finer variety of form. Chromic acid should be allowed to form on a slide warmed to 90° or 100°; then heat to 130° or 150°. The acid should be dissolved while red, and in absolute alcohol, being allowed to stand half an hour or so."

Death of Dr. Beatty.—Our readers will be sorry to hear of the death of Dr. Beatty, of Baltimore, well known in connection with the staining of vegetable tissues. Dr. Beatty was only in his fortieth year, but had achieved a high reputation as a successful physician and microscopist.

Professor J. Edwards Smith.—Professor J. Edwards Smith has removed from Ashtabula to Cleveland, where he has been appointed to the chair of Microscopy and Physiology in tho Homœopathic Hospital College.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *October* 3, 1877.

H. C. Sorby, F.R.S., Esq., President, in the chair.

The minutes of tho preceding meeting were read and confirmed.

A list of donations to the Society since June 6 was read, and the thanks of the meeting were returned to the donors.

The President informed the Fellows that efforts had been made to arrange for a scientific evening, to be held on Wednesday, October 31, and although they were not sufficiently completed to enable him definitely to announce the meeting, no doubt the necessary permission would be obtained, in which case due notice would be given in the usual way.*

The President then gave a *résumé* of his paper "On an Improved Method for Distinguishing the Axes of Doubly Refracting Substances." Numerous diagrams were drawn upon the black-board in illustration of his remarks, and a slide containing the wedge-shaped section of quartz which he employed was exhibited in tho room.

Mr. M. H. Johnson asked if Mr. Sorby would kindly explain which way the quartz was cut with regard to the crystallographic axis?

The President said it was cut parallel to tho positive axis.

The thanks of tho meeting were unanimously voted to the President for his communication. (The paper will be found at p. 209.)

A paper by Mr. F. H. Wenham, "On the Aperture of Object-glasses," was read by the Secretary. It described an improved method of ascertaining the true angle of aperture as distinguished from angle of field. (The paper will be found at p. 212.)

A vote of thanks to Mr. Wenham for his paper was unanimously passed.

At the request of the President, who expressed his regret that Mr. Wenham was not present, Mr. Ingpen made some remarks upon

* Permission has since been obtained.

Mr. Wenham's paper, showing its connection with that which appeared in the November number of the 'M. M. J.,' and explaining the difference between Mr. Wenham's methods of measuring angular aperture, and those usually advocated. He also drew attention to the bearing of the subject upon illumination generally, the advisability of ascertaining, by means similar to those employed by Mr. Wenham, the exact optical conditions under which objects were examined, and the necessity for excluding all stray light, and for controlling the angle and direction of the illuminating pencils, in order to obtain fine definition. He further observed that the conditions of illumination suggested by Mr. Wenham's papers as essential to good definition were in a great measure fulfilled in the case of a minute globule of mercury placed in the centre of the field of view and illuminated by reflected light. There was then no stray light from the rest of the field, and, whilst all the illuminating rays proceeded from the focal point, every part of the objective was in use that was capable of transmitting "image-forming rays."

The President said the whole question was a very important one, because it was really of very little use to examine minute objects unless they were sure whether they were seeing real things or not.

Mr. H. J. Slack said it seemed clear that any rays which reached the eye without passing through the focal point did not help to form an accurate image. He was not prepared to pronounce any decided opinion upon the whole subject, but he knew from experience that objectives which had a low angular aperture were capable of showing minute objects usually supposed to require large angles. One corollary from the doctrine of the paper was very extraordinary, none of their high-angled objectives being nearly what they professed to be, if Mr. Wenham was right. In one case one of 170° turned out, by his measurement, to be only 100°; and if he was correct, nobody had ever seen an object properly with any of the enormous angles supposed to operate.

Mr. Charles Brooke confessed that without further consideration, and tracing all the rays through their courses, he could not clearly trace the exact justice of Mr. Wenham's method; but it was quite clear to him that the ordinary method of measuring the angle of an objective was fallacious. He then drew upon the black-board a diagram showing the common method of ascertaining the angle by means of a candle flame, and pointed out that, although a distinct image could be formed at a wide angle on either side, if the object viewed was at some distance from the objective, it did not at all follow that at a nearer point on the same axis of vision for the distant object, they would also get the same distinct image of a near object. How far the method now proposed by Mr. Wenham counteracted that error, he was hardly prepared to say without further examination.

The President said he had listened to the paper and to Mr. Ingpen's explanation with great interest, but he quite felt with Mr. Brooke that to give a definite opinion upon it would require a great deal of attention. He could not help thinking that there was a great deal more yet to be done with respect to object-glasses.

Mr. Slack said he should like to ask Mr. Brooke what would be the effect of rays entering the object-glass which had not passed through the focal point. Could they be reliable?

Mr. Brooke thought that the only effect they could produce would be a sort of confusion of light commonly known as "milkiness" in the field.

Mr. H. J. Slack said that a few days ago he happened to be looking at some objects in the water from a spring, and found amongst them a species of *diglena*—he believed it to be *lacustris. Diglena* was a very difficult genus to draw, because its parts were extremely mobile. It was capable of protruding its jaws and moving the margin of the mouth aperture to such a degree as to entirely alter its appearance. In the instance to which he drew attention the *diglena* was swimming about, and in the course of its movements it happened to get a flip from the tail of another creature, an *anguillula.* It immediately turned sharp round, like an angry dog, went after the anguillula and seized it near the middle, and gave it a number of bites, worrying it much in the same way as a terrier would a larger animal that it was unable to overcome. Once it got hold of the tail and partially swallowed it, but not being able to make much of that, it let go, and the fight went on for about ten minutes, at the end of which time the anguillula was bitten nearly through, and the diglena then went its way. There did not seem to be any desire to eat the anguillula, but merely to worry and punish it. Mr. Gosse pointed out that rotifers of the genus diglena were amongst those which could protrude their jaws, and he said in his paper in the 'Philosophical Transactions': "In diglena and its allies the manducatory apparatus approaches most nearly to that of a predaceous insect." He thought it worth mentioning because he had not noticed such conduct before, and he did not remember anything having been noted on the subject of angry rotifers.

The thanks of the meeting having been voted to Mr. Slack for his communication,

The President announced that the next ordinary meeting of the Society would be held on November 7, when a paper will be read by the Rev. W. H. Dallinger, and one by Mr. Thomas Palmer, "An Introduction to the Study of Evergreens by the Micro-spectroscope."

Scientific Evening, October 31, 1877.

This meeting was well attended by the Fellows, and, as will be seen from the subjoined list, the objects and apparatus exhibited were of great interest. The thanks of the Society are due to Mr. Baker and Messrs. How and Co. for the loan of excellent lamps. Tea and coffee were served in the course of the evening, and there was much friendly conversation on the objects displayed.

Exhibitors and Objects.

The President, H. C. Sorby, Esq., F.R.S: A microscope fitted with his new arrangement for distinguishing the axes of doubly refracting substances.

Mr. J. Browning: Spiculæ of *Labaria hemispherica*, prepared by Mr. Cole.

Mr. W. H. Beeby: *Plumatella coralloides* alive.

Mr. Chas. Baker: Lord S. G. Osborne's diatom exhibitor; Rev. J. Bramhall's oblique illuminator; and Mr. Hailes' new section machine.

Mr. J. W. Bailey: New folding microscope.

Mr. W. Brindley: Sections of boulder clay from Chester.

Mr. Thos. Curties: Specimens of desmids, &c., mounted in a reliable preserving medium by H. Duncker, of Berlin.

Mr. Henry Crouch: Fossil polyzoa from Suffolk Crag.

Lieut. R. B. Croft, R.N.: Croft's field microscope. This instrument was designed for use on shipboard, for exploring expeditions, and in situations where a microscope on a stand could not be used.

Mr. Chas. G. Dunning: Larva of *Acilius sulcatus* and gill of herring.

Dr. Edmunds: Podura scale markings shown as featherlets with immersion paraboloid and immersion $\frac{1}{8}$th.*

Mr. F. Enock: Insects mounted without pressure showing internal organs.

Mr. F. Fitch: Illustrations of the anatomy of the harvest spider.

Mr. Chas. J. Fox: Polariscope for convergent light, and mica and selenite combinations.

Mr. W. H. Gilburt: Leaf of *Erythroxyton coca*, showing so-called absorbents of Mr. Herbert Spencer, and other leaves.

Mr. H. F. Hailes: Sections of various Foraminiferæ.

Messrs. How and Company: Chara stems in sections of flint from Lulworth, Dorset; section of granite with vein of felsite from Leicestershire.

Mr. J. H. Howard: Head and jaws of ant lion.

Mr. J. E. Ingpen: Spiders, &c., from Ceylon, mounted by Mr. Staniforth Green.

Mr. W. Ladd: Table polariscope, showing the action of monochromatic light on sections of crystals, producing effects which are invisiblo with white light.

Dr. Millar: *Eurete farreopsis* and other sponge sections and Parkeriæ showing sponge structure.

Dr. Matthews: Crystals of gold from amalgam from the bed of an Australian quartz mill.

Dr. A. H. Newth: Sections of spinal cord (human).

Mr. Thos. Palmer: Micro-spectroscope with alkanet root, showing

* See p. 78.

the action of an acid on vegetable spectra, with scale for measuring attached.

Mr. B. W. Priest: Section of sponge, *Farrea spinulata.*

Mr. Walter W. Reeves: Some insects found on moss in Scotland.

Mr. Chas. Stewart: Ganglia and nerves of Pterotrachea.

Mr. J. H. Stuard: *Myrmeleon formicarius* from Sweden.

Mr. J. W. Stephenson: Podura scale with a $\frac{1}{25}$th by Zeiss under one of his erecting binocular microscopes, and A, B, and C eye-pieces.

Mr. A. Topping: Sections of beard of turkey, showing the peculiar folds in the skin from which the hairs grow.

Mr. F. H. Ward: *Surirella gemma* with an $\frac{1}{18}$th immersion glass of Merz and quartz eye-piece.

The Royal Microscopical Society: A binocular eye-piece made and presented to the Society by Mr. Ahrens.

Donations to the Library, &c., since June 6, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum	*Ditto.*
Society of Arts Journal	*Society.*
Bulletin de la Société Botanique de France. 3 parts	*Ditto.*
Bulletin de la Société Botanique de Belgique. June, 1877	*Ditto.*
Erupcion Oftica del Ayuntamiento de Molledo. Por Don F. Q. Rodriguez	*Author.*
Journal of the Quekett Club. No. 34	*Club.*
Quarterly Journal of the Geological Society. No. 131	*Society*
Popular Science Review. July, 1877	*Publisher.*
Mineralogical Magazine. 2 parts	*Society.*
Report and Proceedings of the Croydon Microscopical Club. 1875	*Club.*
Papers of the Eastbourne Natural History Society. 1876–77	*Society.*
Report to the Surgeon-General U.S.A. on the Transport of Sick and Wounded by Pack Animals	*Surgeon-General.*
Transactions of the American Medical Association. 2 vols. 1876	*Association.*
Catalogue of American Palæozoic Fossils. By S. A. Miller. 1877	*Fredk. Habirshaw, Esq.*
Journals of the Linnean Society	*Society.*
The American Journal of Microscopy. 4 parts	*Editor.*
Osservazioni e Note ad Elucidazione Dello Sviluppo Delle Diatomee. Del Sig. Conte F. Castracane	*Author.*
A Binocular Eye-piece	— *Ahrens, Esq.*

WALTER W. REEVES,
Assist.-Secretary.

KING'S COLLEGE, *November* 7, 1877.

H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society was read by the Secretary, and the thanks of the meeting were voted to the donors.

Four gentlemen were proposed for membership, and the certificates in their favour were ordered to be suspended in the usual manner.

Mr. Thomas Palmer, B.Sc., read a paper, entitled "An Introduction to the Study of Evergreens, by means of the Micro-spectroscope" (which will be found printed at p. 224). The subject was illustrated by drawings, and by solutions of the various colouring matters and products referred to in the paper, exhibited under the micro-spectroscope.

The President, in conveying the thanks of the meeting to Mr. Palmer for his paper, expressed the pleasure which he felt at finding that the results of the experiments detailed so fully confirmed his own, which were made some time ago, and which turned out to be so different from what he had previously expected. The association of wax or oil with the chlorophyll was of great interest, and he considered it doubtful if anyone had ever seen chlorophyll in its pure condition; what they called the colouring matter of leaves was, he believed, a mixture of wax or oil with a substance which had never yet been isolated. He was inclined to differ from Krauss as to the chlorophyll being dissolved, and he thought it of much importance to notice that the band which they got from the fluid was in a different position from that which was seen when it was evaporated to dryness. There was perhaps hardly any subject more difficult to deal with, and he was very glad indeed to find that it was beginning to receive more attention.

Mr. Palmer expressed his entire concurrence with the observations of the President, and hoped that others might be induced to take up the study—where they wanted most workers was in the case of young leaves. He had on one occasion made a solution of arbutus leaves when quite young, and found it most difficult to fill the tubes owing to the excessive quantity of wax which he found to exist in decreasing proportions as the leaves increased in age, and as the quantity of wax decreased there was a decrease also in the nature of the colouring matter.

A paper by Mr. F. A. Bedwell, "On the Building Apparatus of *Melicerta ringens*," was read by the Secretary. It was illustrated by some excellent drawings, two of which were enlarged upon the blackboard by Mr. C. Stewart.

The President moved a vote of thanks to the author of the paper, which he felt sure must have been highly interesting to all who took an interest in these remarkable organisms. The process of discriminating between what was and what was not proper material, which had been so well described in the paper, reminded him very much of the arrangement for sorting out the heavy and light sovereigns by the machine at the Mint.

Mr. Slack, in reply to a question from the President, said it was impossible to do justice to such a paper without reading it very carefully through, and collecting fresh specimens for examination.

Mr. Ingpen said that the shape of the pellets varied very much. In specimens which he used to get at Barnes Common they were made of a perfectly Minié-bullet shape. In confinement the pellets were generally made flatter, but by supplying the creatures with exactly the proper quantity of material, they would make them the same shape as when they were free, and if they were supplied with too much the shape became irregular. The rotation of the pellet in the cup was the most complicated part of the whole performance. He had watched it many times, under various powers up to $\frac{1}{8}$ inch, but could never be perfectly satisfied as to whether it really did rotate or only appeared to do so.

The President said it appeared to be a very remarkable and complicated arrangement.

Mr. Slack thought that the pellet must rotate in order to obtain the shape.

The proceedings were then adjourned to December.

Donations to the Library since October 3, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
Linnean Society's Journal	*Ditto.*
American Journal of Microscopy	*Editor.*
Lecture on the Antiquity of Man. By T. Rupert Jones, F.R.S.	*Croydon Microscopical Club.*
Mémoire sur la Structure et la Composition Minéralogique du Coticule, &c. Par A. Renard, S. J.	*Author.*
General Catalogue of Books, 1875 to 1877. By Bernard Quaritch	*Publisher.*
Royal Society's Catalogue of Scientific Papers. Vol. VII. ..	*Royal Society.*

The following gentlemen were elected Fellows of the Society:—Griffin William Vyse, Esq., F.G.S., &c., and W. H. Jones, Esq.

Walter W. Reeves,
Assist.-Secretary.

Quekett Microscopical Club.

November 23, 1877.—Henry Lee, Esq., President, in the chair.

Six new members were elected, and four gentlemen were proposed for membership. A large number of donations were announced, amongst which may be specially mentioned a $\frac{1}{5}$-inch objective from Mr. Wray; fifteen slides of anatomical preparations from Mr. Cole; twelve slides of vegetable tissues from Mr. Gilbert; and twenty-four of physiological preparations from Mr. J. J. Hunter; for which the thanks of the meeting were unanimously voted.

The President intimated that the subject of elementary instruction upon subjects connected with the microscope, which had often been urged upon their attention, had been submitted to the careful consideration of a sub-committee appointed for the purpose, and that upon the recommendation of these gentlemen it had been decided to make the experiment. On the next gossip night, therefore, it had been arranged that Mr. Ingpen should occupy one of the "bays" in the room in which they met, and give to any who felt disposed to attend, a short description of the microscope and its construction. It was hoped that a series of such explanations might prove of much use to many of the younger members of the club, and that they might be given without in any way interfering with the freedom of the general body of members during the evening.

Mr. Ingpen called the attention of the meeting to the method of mounting test-objects by Dr. Edmunds, and exhibited by him at the previous meeting. The slide was made of cedar, and had a round hole cut through the centre. The diatom or scale was placed upon a piece of the thinnest microscopical glass attached by gum to a diaphragm of thin bank-post paper, and covered by another piece of thin glass; the paper was then gummed to the wood slide. The advantage of this was that the thinness of the paper enabled the object to be readily examined with a high power from either side, whilst the elasticity given was sufficient to secure both object and objective from the danger of fracture.

Mr. M'Intire made a short communication descriptive of the larvæ of the cat flea, which he exhibited in the room.

Mr. J. G. Waller read a paper "On a new British Sponge, of the genus *Microcyona*," for which he proposed the name of *M. Bihamigera*. The specimens—which had been found in a deep cleft in the red sandstone rock in Torbay—were minutely described, and their specific differences from known species were pointed out, and illustrated by diagrams and by a portion of the sponge itself.

Mr. Charles Stewart, at the request of the President, gave an interesting *résumé* of the general characteristics of the Spongidæ, fully illustrating his remarks by drawings upon the black-board.

The President said, that on looking at the drawing of the new species described by Mr. Waller it seemed to be familiar to him, but he could not clearly recollect whether or not he had seen it at Dr. Bowerbank's, or whether it was figured in the fourth volume of his 'British Spongidæ,' the plates for which were prepared before the author's death. He hoped that some of the members of the club would be induced to give their attention to the subject of sponges; the field for research was a very wide one, and at present it had few, if any, British investigators.

The thanks of the meeting were then unanimously voted to Mr. Waller and Mr. Stewart, and after a few observations from the Secretary, in further explanation of the proposed "elementary gossips" to be held at their intermediate meetings, the proceedings terminated with a conversazione, at which a number of interesting objects were exhibited.

The New Cross Microscopical and Natural History Society.

President's Address.

The annual meeting of the above Society was held in the Lecture-room, New Cross Public Hall, on the evening of the 8th of November, J. Taylor, Esq., President, in the chair. An interesting report was read of the proceedings of the Society for the last, and officers elected for the ensuing year; after which the President proceeded to deliver the following address:

It affords me, I can assure you, the greatest pleasure to address you this evening as your President. Since I joined this Society in 1872, shortly after it had been formed, I have witnessed its development with the liveliest satisfaction. We formerly met in a small room at Brockley, and on many occasions no greater number of members were present at our meetings than four or five, including our President, Mr. Jenner Weir. A tribute to his administration cannot be out of place here, for it was mainly due to his untiring zeal and constant attendance that we were kept together at that time. Ominous threatenings of dissolution were somehow quelled, and good feeling and hope restored by his patience and forbearance. Since that time our members have gradually, but surely, increased. Starting with fifteen or twenty, we now number sixty-six. Many important alterations have been made in our constitution, notably the admission of ladies to some of our meetings, and the introduction of soirées, which, if not always purely scientific in their result, yet make a most charming break in the session, and afford a really intellectual and social evening to our members and our friends. The tone of our papers has become more practical, I fancy; and this I am pleased to see, for we are as yet too young in nature's mysteries to theorize much; and theory should be as far as possible deprecated until we are more practised. Our present position with respect to the admission of ladies, although a step in the right direction, appears to me, nevertheless, somewhat incongruous, for, in these days of medical women, and while so many are striving for the advancement and better education of women as a class, I see no reason why they should be denied admission to many of the learned societies. We admitted them on what are termed "special evenings"—as it were on sufferance—but reserved to ourselves the right to exclude them on certain other evenings. This is so far right, possibly, because they are not members. But why restrict them from becoming members if they so desire it? I am committing no breach of confidence, I trust, if I say that on more than one occasion in this room I have heard that desire expressed. That women are able to work well with the microscope, can grasp scientific facts, are careful manipulators, and in every way fitted for the study of botany and natural history, will not, I am sure, be denied. There are a few other matters to which I wish to direct your attention this evening, and first and foremost amongst these is the formation of a library for the use of members. Without books the student in natural history can do very little; he is apt to drift into a mere collector, or may fall into another extreme, and, fancying many things he collects are new and undescribed, will trouble himself little or nothing about the habits or peculiarities of species, merely collecting for the love of collecting. There have been two or three suggestions made with regard to a library. One—and a very good one—is, that members should lend books to the Society for a term; that the books should be kept in a box at the Society's room;

and that members should have access to them at the monthly meetings. Another suggestion is, that we should pay a yearly subscription to a scientific library; but this, of course, must depend greatly upon our funds, which at present, I fear, will hardly meet such a strain. I would now, gentlemen, direct your attention to the objects of the Society, viz. the study of natural history. Some of the means by which this is to be accomplished have received very little attention beyond the notice in our report, viz. "The formation of cabinets illustrating geology, entomology, and mineralogy (and, I presume, we might add conchology), also a cabinet and herbarium for the use of botanical members." Now, this desirable end might, I venture to think, be easily attained by making more use of our field excursions than we do. Let every gentleman attending these excursions collect for the Society as well as for himself, and we should by this means engender a little honest rivalry, which would act as an incentive, and, I am quite sure, we should be possessed of a nucleus of a museum. It would be well if our excursions were better attended, and if we can make them more attractive possibly they will be. From a health point of view alone they are important, especially to those of us who

> "Long in the noisy town have been immur'd,
> Respir'd its smoke, and all its cares endured,"

for there is scarcely a greater pleasure than a ramble in the country, especially if one has an object in view. Collecting specimens is, however, of very little value merely as specimens. They must be properly named and properly kept. Here is a difficulty, and, I fear, rather a great one. The room here is, I am afraid, too damp to keep such tender things as botanical and entomological specimens, either in cabinets or in cases. But supposing some gentleman in the neighbourhood would undertake the office of curator, the cases of specimens collected could be kept under his charge. They might be exhibited at annual meetings in order that we might really see what work we are doing; and they would besides add an interesting feature to those meetings by an exhibition of the fauna and flora of the neighbourhood of New Cross. The object of the Society, I take it, gentlemen, may be summed up in an endeavour to mutually improve ourselves, and perhaps our conversational evenings carry out this object as well as anything else we do, for at these meetings we can compare notes, learn each other's difficulties, and pick up "wrinkles" not mentioned in papers, or asked for in discussions. While we number among our members some of acknowledged scientific attainment, practical students, and lovers of nature, still many of us are but beginners in nature's primer. I would say to these—Be not cast down at difficulties, but be sure at the turn of every page in Nature's Library so much the more happiness will be gained, so many apparent incongruities cleared up, that this of itself should be an incentive to future action. And if we cannot all reach fame, still we have the knowledge that much valuable work has been done by the plodding student, which has often been the means of enabling the thinkers to arrive at greater ends. We are searching after the truth, and while we are each doing so according to our lights, we can take with the poet the consolation that "Some are and must be greater than the rest." The report of work done during the past year under the able presidency of Dr. Francis Taylor, which our Honorary Secretary has just read, is, I am sure, a sufficient guarantee of our zeal. It would be invidious to specialize papers where so many able ones have been given, so I will conclude, gentlemen, with the wish that the closing of this session may give us as goodly a list.

Bristol Microscopical Society.*

The 359th meeting of the Society was held on Wednesday, November 21, at the Bristol Museum and Library, Mr. W. J. Fedden, President, in the chair.

The Hon. Secretary, the Rev. P. Sleeman, submitted a statement of the financial condition of the Society; after which a paper was read by Mr. W. W. Stoddart, F.G.S., &c., upon the "Fossil Microzoa of Clifton and the neighbourhood."

The writer directed the attention of the members of the Society to the exceeding richness of the strata in the neighbourhood of Bristol in various microscopic forms of animal life. He pointed out the different localities which, from personal experience, he had found well suited for careful examination; referring especially to the cuttings on the Avonmouth Railway, Aust, Horfield, Portishead, &c. He exhibited a large collection of interesting objects obtained and mounted by himself, which abundantly illustrated the wealth of the carboniferous and other strata in the districts to which he referred. Several of the species shown have been recently described by Mr. H. Brady, of Newcastle-on-Tyne, in the Memoirs of the Palæontographical Society. The writer also remarked upon the importance of a thorough and systematic search of the lias deposits around Bristol and Clifton, and the desirability of classifying and arranging the microscopic organisms found therein; calling attention to the fact that minute and insignificant as the specimens discovered may appear, yet that these will often afford as reliable and valuable an index to the previous history of the different formations as do the fauna and flora of larger size. Mr. Stoddart concluded by mentioning his discovery of what seemed to be an entirely new species of insectivorous mammal in the post-pliocene deposits in veins at Holwell, Mendip; in the further study of which he was engaged.

The meeting was largely attended, and Mr. Stoddart's paper was listened to with much interest.

Mr. T. J. Culverwell was elected a member of the Society.

* From the Hon. Secretary.

San Francisco Microscopical Society.*

A regular meeting of the San Francisco Microscopical Society was held on Thursday evening, October 4, with Vice-President H. C. Hyde in the chair. After reading the minutes, Mr. X. Y. Clark was elected a resident member of the Society.

In consequence of the absence from the city of many members of the Society, no meeting was held at the stated time, on September 20, and the Secretary had to announce the acquisitions of both dates, which were as follows, viz.: 'American Naturalist,' 'Monthly Microscopical Journal,' 'Cincinnati Medical News,' and 'American Journal of Microscopy' for August and September; the 'Popular Science Monthly,' with supplement, for September and October; 'Nature' for July and August; 'Journal Quekett Microscopical Club' for July; Part 2, vol. ii., 'Bulletin Bussey Institution,' and 'Journal de Micrographie,' Pelletan—all by subscription.

By purchase there were added 'Manual Botanic Terms,' Cooke; 'Elements of Embryology,' Foster and Balfour; and 'Walker's Statistical Atlas of the United States,' while Mr. Kinne donated No. X. of 'Proceedings of the Belgian Microscopical Society.'

Dr. S. M. Mouser donated to the cabinet a slide mounted by him with a stained section of frog's stomach, showing the *villi* and cell structure, and Mr. J. R. Scupham handed in samples of siliceous and micaceous earths from Gold Hill, Nevada. Quite an extensive series of diatomaceous earths were presented by the California State Geological Society, obtained by that young but energetic scientific organization from Monterey, Santa Barbara, Ventura, near Virginia City, ten miles north of Petaluma, and Nottingham, Maryland. Most of these fossil deposits have never been unearthed before, and consequently the members were desirous to know of the characteristic diatoms to be found in them, to which end the Corresponding Secretary was instructed to request Dr. A. M. Edwards, one of their members, to examine the samples and report as soon as practicable, trusting some of them might prove as fruitful as the Santa Monica deposit.

From Mr. J. W. Deems, a corresponding member, residing in New York City, was received three specimens of supposed coral, found by oystermen at Long Island Sound.

The second instalment, being Century II. of Professor H. L. Smith's reliable series of typical diatoms, had come to hand, and was warmly welcomed by all present, particularly those who love to study and become familiar with the correct nomenclature of the siliceous shelled little beauties. The mode of arranging them in book-like rack boxes is a great improvement over the former method adopted by Professor Smith, and yet a late letter to Mr. Kinne contains the information of

* Note.—It will afford us great pleasure to publish notes of the transactions of any of our microscopical societies. The limited space at our command precludes the insertion of lengthened accounts of mere business details.

something better still in this direction, as well as the discovery of a new method of mounting dry preparations so that they will not spoil (as unfortunately all those with asphalte rings are liable to do), nor the covers become dislodged by any blows or falling.

A very interesting letter was received through the hands of Dr. C. L. Anderson, a corresponding member, residing at Santa Cruz, in consequence of the interest the mineral he mentions seems to be attracting in scientific and other quarters. A slide, received from Mr. Allen Y. Moore, of Coldwater, Mich., of the coorongite, was handed to Mr. Hanks at a former meeting, but no report has been received from him as yet. Mr. Kinne stated that he understood the mineral to be named from the district of Coorong, where it is found. With a small quantity of the mineral, Dr. Anderson also sent a small piece of what he regarded as a paraffin shale, also from Australia. He stated it to be rich in carburetted hydrogen, and presumed it to be abundant, from the fact that it can be obtained at about $25 per ton in San Francisco. The origin and extent of the deposit must be a subject of interest not only to science but to commerce. The slide sent in by Dr. Anderson, with the samples, was one mounted by Mr. Morris, from the coorongite, and was found to contain varieties of fresh-water diatoms.

Mr. H. F. Attwood, of Chicago, sent the members of the Society, through Mr. Kinne, several slides of diatoms obtained from the water supply of his city, and which he stated have recently been receiving considerable attention from a Professor Piper there, who, like many others, seems to mistake notoriety for fame, and proceeds to fright the soul of the average Chicagoan who takes his water straight, by badly executed drawings of diatoms and other fresh-water microscopic plants. Some of the Professor's terrible monsters of the deep were at once recognized as *Diatoma vulgare*, *Stephanodiscus Niagara*, *Cyclotella operculata*, *Asterionella formosa*, Fragilaria, &c., species which are as particular about their water supply as any one need be.

Indicative of the interest that the microscope is attracting, a letter was read to the members from a lady resident of the city who was desirous of learning of some one proficient in microscopical studies, who would form a class or give private instructions.

The Secretary of the American Postal Micro-Cabinet Club notified the members that the boxes of two of their circuits had come to grief in the riots East or been stolen; at least the use of the highest powers he could obtain was unable to resolve them into anything tangible. As Mr. Hervey in his letter suggested that "lightning hardly strikes twice in the same place," the members decided to send on some more slides.

Dunkirk Microscopical Society.

The regular meeting was held on Friday evening, October 12, 1877, the President, Dr. Geo. E. Blackham, in the chair. There was a large attendance of members and visitors. This being the first regular meeting since the summer vacation, a good deal of routine business was transacted in the business session.

At the scientific session, Lieutenant W. L. Carpenter, U.S.A., late of the Hayden and Wheeler Surveys of the Territories, gave a brief but interesting lecture "On the use of Curare in the study of Biology." His remarks were illustrated by the injection of a few drops of the dilute solution of this poison beneath the skin of a male frog, producing complete paralysis of the voluntary muscles. By a careful dissection, the intestine was drawn out, and the circulation of the blood in the small vessels of the mesentery was well shown on the President's large Tolles' stand, with his Tolles' 1-inch objective, and the B (1-inch) Huyghenian, and the $\frac{1}{2}$-inch and $\frac{1}{4}$-inch solid eye-pieces, the powers being respectively 100, 200, and 400 diameters. Under the latter power the individual corpuscles were beautifully defined.

Lieutenant Carpenter exhibited one of Zentmayer's new Histological Microscope stands. This is a most compact, convenient, and beautifully finished little stand, having several new points of excellence. The mirror bar is pivoted in plane of the object, and carries a sub-stage or accessory carrier, the distance of which from the object can be varied to focus a condenser. The mirror and sub-stage can be swung above the stage, and used for the illumination of opaque objects.

The President exhibited a Tolles' large microscope stand, "B," with 1-inch Huyghenian, and $\frac{1}{2}$ and $\frac{1}{4}$-inch solid eye-pieces, and Wenham reflex illuminator. The firmness, solidity, convenience, and perfect workmanship of this splendid stand were much admired. The President also exhibited a cheap $\frac{1}{5}$th dry objective, by Tolles, price $15, which resolves clearly *P. angulatum* by central light.

The additions to the library and cabinet were, 'Science Observer' for August and September; ten pamphlets relative to the display made by the U.S.A. Medical Department at the Centennial Exhibition; 'Journal de Micrographie,' Paris, France; Report on the Rocky Mountain Locust and other Insects injurious to Vegetation, by Dr. Packard; the 'Cincinnati Medical News' for July, August, and September; a series of drawings of typical forms of diatoms, from Rev. J. W. Armstrong, D.D.; foraminiferous earth, from Rev. M. Adams; a number of specimens of the imago and the empty larva cases of the so-called seventeen-year locust (*Cicada Septemdecem*), from Mr. and Mrs. H. L. Hinman.

After a time spent in the examination of objects, and discussion of Lieutenant Carpenter's remarks, the Society adjourned.

Tyndall Association of Science.

At a stated meeting of the section of Microscopy of this Association, held at Columbus, Ohio, October 13, 1877, Professor T. C. Mendenhall in the chair, papers were read by Rev. I. F. Stidham on the "Oscillaria;" by Mr. C. C. Howard on "Blood," and exhibiting the amœboid movements of the white corpuscles; and by Professor Albert H. Tuttle on "Sub-stage Illuminators for Immersion Objectives." There were on exhibition and tested, Wales' Students' $\frac{2}{3}$rd, $\frac{1}{5}$th, and $\frac{1}{10}$th immersion, and Spencer's $\frac{1}{4}$th Students' dry and corrected. Considering the cheapness of the above, they did most remarkable work. The following officers were elected for the year 1877–8: President, Rev. I. F. Stidham; Secretary and Treasurer, Curtis C. Howard; Curator, Professor Thos. C. Mendenhall. P. O. address of officers, "Columbus, Ohio."

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