THE
NORTHERN MICROSCOPIST
AND
MICROSCOPICAL NEWS.

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MICROSCOPICAL NEWS.

An Illustrated Journal of Practical Microscopy.

EDITED BY

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ETC., ETC.

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PREFACE.

ANOTHER year has drawn to a close, and the December of 1882 brings with it the completing number of our second volume. We are glad to find that the circulation of the Journal has considerably increased during the past twelve months, but at the same time we are well aware that many a working microscopist has not been reached by it, and until this can be said no longer, our desire will exceed its fulfilment.

We have spared no endeavours to make the Northern Microscopist as interesting as possible to the largest number of our readers, and our efforts, we venture to think, have met with a very fair amount of success. We have certainly aided in the dissemination of much useful microscopical knowledge by the publication of many papers which might otherwise have remained in obscurity. Many congratulatory letters have reached us, both from this country and from America—where the sale of our Journal is steadily progressing—and we hope to be able in the future to give as much satisfaction as in the past.

No expense has been spared in the direction of the illustration of the Journal, and we now hope to meet our readers' wishes still further in this respect, by giving our correspondents such instructions as shall enable us to give illustrations wherever they may be desirable. In the present volume will be found papers from the pens of the Rev. W. H. Dallinger, F.R.S., and Dr. H. C. Sorby, F.R.S., while Mr. Stanley's "Notes on Mosses," Mr. Blackburn's "Theory of Aperture," and numerous other communications also require no testimony from us as to their value.

Our 1883 Volume will bear a title which, we think, more fitly describes the nature and character of the object of the Journal. The fact that the bulk of our subscribers are to be found in the Midlands and South of England will explain the addition of "Microscopical News," though our adherence to the lines upon which we started will be marked by the retention of the "Northern Microscopist."

We cannot close this Preface without thanking all those who have aided in securing the efficiency of our Journal, and hoping that the same kindly feeling will be manifested and the same helping hand extended in the future as heretofore, we wish our readers, one and all,

THE COMPLIMENTS OF THE SEASON.

LIST OF ILLUSTRATIONS.

THE NORTHERN MICROSCOPIST.

No. 1. *JANUARY.* 1882.

THE EPHEMERIDÆ, OR MAY-FLIES.

By W. Blackburn.

Concluded from page 290.

THE circulation of the blood and pulsation of the dorsal vessel are very well seen in these larvæ, on account of their transparence. The dorsal vessel extends nearly the whole length of the body, and is furnished at regular intervals with valves, dividing it into chambers, one chamber to each segment of the body, through which the blood moves towards the head. At the posterior extremity of each chamber, a central valve allows the blood to enter from the adjoining chamber, while external openings receive the blood from the interspaces of the surrounding tissues. The dorsal vessel divides in the head into two branches, through which the blood flows into the open cavities of the body. The corpuscles of the blood, by which this motion is observed, are oblong, somewhat "oat-shaped," when viewed in one direction, but approaching more to the circular form when seen in another direction.

Sir John Lubbock traced the life-history of a Cloëon from the egg to the imago, and we learn much concerning the growth and development of the Ephemeridæ from his instructive record. Cloëon is a small British genus, very common in still water, that makes its appearance as an imago from May to October. Fig. 61. When it escapes from the egg, it is about $\frac{1}{40}$ of an inch in length. Its antennæ are $\frac{1}{70}$ of an inch in length, and consist of thirteen segments. It has two tails of nineteen segments each. It has neither gills, spiracles, nor tracheæ. Respiration must, therefore, be effected through the integument. It is provided from the first with six legs, in which the tibiæ and tarsi are firmly united. The tarsi are jointless, and terminate in a single claw, the same as in the other genera. There are five eye spots visible, all similar to each other. Swimming is effected by jerks of the abdomen upwards and downwards. In this motion the tails assist. When any small creature comes in contact with Cloëon, the tails are immediately advanced in front, as if for the purposes of defence or sensation. The larger larvæ, such as Ephemera, never advance the tails in this manner.

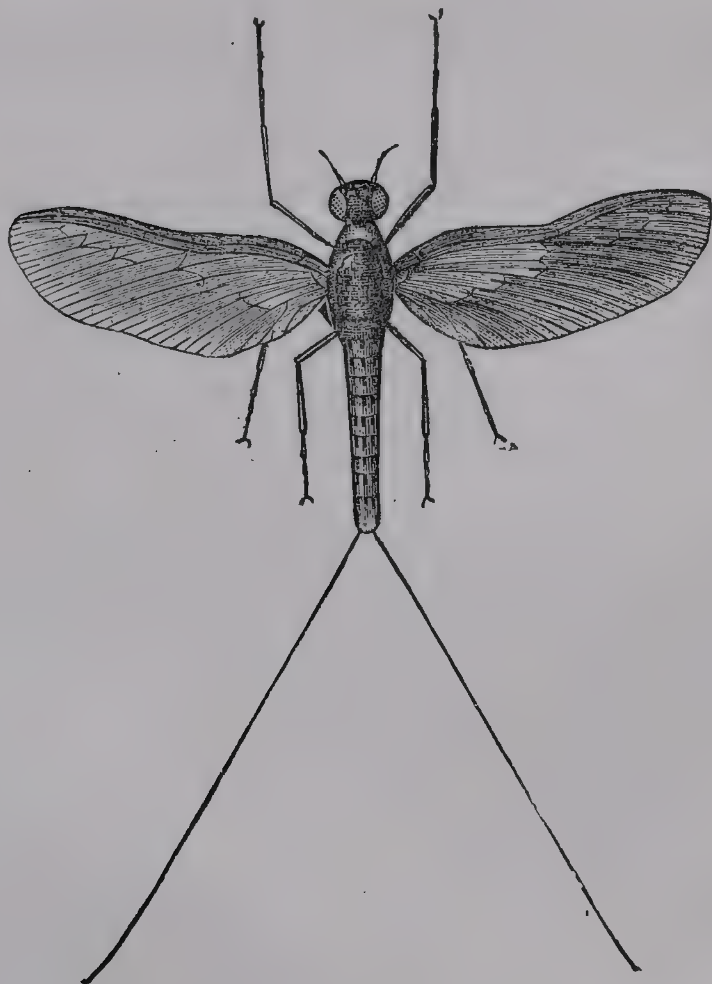

Fig. 1. Female Imago. × 2½.

In from two to three days Cloëon casts its first skin. In so doing, it does not, as is usually the case with these larvæ, split the skin of the thorax, but extricates itself through the top of the head. The orifice is very small, and the skin left is very perfect. After moulting, the length of the body is found to be $\frac{1}{10}$th longer than at birth. The antennæ and tails are also slightly longer. The antennæ possess the same number of joints as before, and the tails one more joint, the extra length being principally found in the first segment of the tails, and the third segment of the antennæ. The posterior angles of the second to the sixth abdominal segments are slightly produced, indicative of the position of the subsequent gills. A minute knob appears between the two tails, the rudiment of the middle tail.

In a few days the second moult takes place. The antennæ are now found to have increased in length, and to consist of two more segments, viz.: fifteen. The tails are also longer, and consist of four more segments, viz.: twenty-four. The eyes have become differentiated, the posterior pair being larger than the rest, so that the distinction between the oculi and ocelli is now observed. The oculi, however, have not yet any facets. The posterior angles of the second to the sixth abdominal segments are less produced than before, but each has a small oval appendage at its extremity, the first appearance of branchiæ. The middle ones are the most developed. The other gill-bearing segments now have their posterior angles elongated, in preparation for the remaining gills, which make their appearance after the next moult. No tracheæ have yet made their appearance.

In two or three days the larva casts its third skin, when the tails and antennæ are found to be longer, and to consist of more segments than before. In this state, the five intermediate pairs of gills begin to vibrate. Tracheæ are now seen in these gills, and communicate with two longitudinal trunks in the body. After the next moult the first pair of gills begin to vibrate. The seventh pair never vibrate in this genus. After the fifth moult, the antennæ were found to contain two segments less in number than in the preceding state, two fresh ones having been produced, and four others having coalesced. The posterior eyes now consist of dark spots on a pale ground.

After the sixth moult, the larger gills have small lobes attached to them, which eventually form double gills. The seventh pair remain single in this genus. The two lateral tails now consist of thirty-two segments, and the central knob has expanded into a tail of six segments. The antennæ consist of two more segments, the third segment having divided into three. After the next moult, the middle tail consists of twelve segments, and after another moult of eighteen segments. The third segment of the antennæ has again divided into four parts, and the posterior dorsal angles of the meso and meta-thorax are slightly produced in preparation for the wing-cases of the nymph.

Some of the larvæ arrived at the tenth state in September, about twenty-five days after leaving the egg; they then took about a week before re-moulting. This period, however, much depends upon the temperature, as the larva moults much more seldom in winter, and there is then less difference in the growth between the moults. Sir John Lubbock found that in January, February, and March, Cloëon took from fourteen to thirty days before re-moulting.

After the thirteenth moult, a secondary lobe appears on the first pair of gills. In the fifteenth state, the rudimentary wing-cases cover the metathorax. In the seventeenth state, the secondary lobes of the anterior gills are almost as large as the primary; the tails consist of more than sixty segments, and are covered with a fringe of hair. In the eighteenth state, the wing-cases cover the first abdominal segment, and the body is one-third of an inch long. In this state the sexes can be distinguished. Between the large compound eyes of the male, may be seen, on the top of the head, a series of dots, the rudiments of the facets of the large pillared eyes. Rudimentary forceps may also be seen, and in the female small ovaries. In the twentieth and last state of the nymph, the wing-cases extend to the third abdominal segment. The small antennæ of the subimago can be seen within the larger antennæ of the nymph, lying loosely in their sheath, the soft tissue having become absorbed around them; whilst beyond the new antennæ, the old ones retain their usual consistence. The two lateral tails of the nymph now appear darker than the middle one, the subimago tails being visible inside them, whereas the contents of the middle tail have been absorbed. The four-jointed tarsus of the subimago can also be seen within the single joint of the nymph. The ovaries of the female now occupy nearly the whole length of the abdomen, and consist of two cylindrical bodies, each of which consists of a great number of minute egg-tubes. Each of these egg-tubes is divided into two chambers; the upper one long and narrow, contains vitellogenous cells, the lower, oval in form, contains oil globules. The mouth consists of a pair of mandibles with saw-like projections on the upper edge, prolonged internally into a molary plate; a pair of maxillæ, with two-jointed palpi; a labium, with three-jointed palpi, and a bi-lobed labrum.

The insect now quits the water, and becomes a subimago, and in doing so, it sheds, for the first time, the inner membrane of the tracheal trunks, which is usually cast by other larvæ at each moult. It drops its abdominal gills, and breathes through spiracles. After a short time, it extricates itself from its additional skin, which it leaves very perfect behind it, the wing-cases being in a state of collapse at the sides of the thorax. It is now an imago, and appears brighter, lighter, and more adapted for a denizen of the air. Sir John Lubbock names his species "*Chloëon dimidiatum.*" The male has four large compound eyes, the upper pair being raised on broad columns, pushing the lateral pair low down at the sides of the head. In front of these, the three simple eyes are placed triangularly on the forehead, the upper two being elevated on short pedicels. The mouth is without any external opening. Curtis dissected the mouth of an *Ephemera danica*, and was able to discover the rudiments of maxillæ, labrum, and two sets of palpi.

Nearly two hundred species of these insects, British and foreign, are already known. The British, however, are restricted to ten genera, containing thirty-seven species, according to the following classification of Mr. Eaton.

British Ephemeridæ.

Genus.	*Species.*	
EPHEMERA	3	4 wings and 3 tails.
LEPTOPHLEBIA	4	
POTAMANTHUS	1	
EPHEMERELLA	1	
BAETIS	9	4 wings and 2 tails.
HEPTAGENIA	8	
CENTROPTILUM	2	
SIPHLURUS	2	
CÆNIS	4	2 wings and 3 tails.
CLOEON	3	2 wings and 2 tails.
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In ascertaining the genus to which any specimen belongs, note the following peculiarities: the presence or absence of hind wings and middle tail, (the female may have the middle tail when it is absent in the male); the nature of the neuration of the large wings, whether the longitudinal nervures are many and complex, or few and simple; whether the transverse nervures are numerous or not, especially in the costal and sub-costal areas; whether the interneural veinlets of the terminal margin, if present, are continuous with the longitudinal or with the transverse nervures, or are separate from both, and, if separate, are they single or in pairs? The general character of the neuration only need be considered, not particular details. The wings of Ephemera and Cloëon illustrate some of these peculiarities. The hind wings may be small, as in Ephemera, or mere rudiments, as in Baetis and Centroptilum. Next examine the tarsi, to ascertain whether there is a fifth joint, and the relative proportions of the joints, and the form of the claws. Note the comparative length of the tarsi, tibiæ, and femora in both sexes; in what respect the compound eyes of the male differ from those of the female; the form and number of joints of the male forceps, usually three or four, but in some genera only two, and in Cænis jointless.

Another item of importance is the attitude assumed by the subimago during repose. The forelegs may be elevated or on the ground, held together or separated; the tails may be nearly parallel or spread out; the wings may be elevated or depressed. The subimago state may last for some hours, or be quitted immediately, or be the permanent state of the female.

The characteristics of the nymph must be considered. The head may be armed, to enable it to form burrows in the mud, like Ephemera and Cænis. It may swim actively like Cloëon and Baetis; or creep, like Leptophlebia and Ephemerella. The form and position of the gills must be noted; and also the mouth, with the number of joints on the palpi, and the form of the legs, antennæ, and tails.

The species are determined by slight modifications of structure, combined with variations in colour and markings. The three species of Ephemera, viz: *E. danica*, *vulgata*, and *lineata*, may be readily recognised by the difference in the marks on the abdomen.

Most authors on Entomology have described a few species of the Ephemeridæ, and have mixed up their names in almost hopeless confusion. The best works for the student are F. J. Pictet's "Histoire Naturelle des Insectes Néuroptères: famille des Ephémérines," which has not been translated into English; and the Rev. A. E. Eaton's "Monograph on the Ephemeridæ," published by the Entomological Society, in which the descriptions of the genera and species are in Latin. The latter is the best work for classification, the principles and nomenclature of which I have adopted in this paper.

Specimens of the Ephemeridæ found in museums are often dried up beyond recognition, their soft bodies becoming changed in form as well as colour. In the British Museum they are kept in a cabinet, which contains about two hundred specimens, British and foreign; they have been arranged by Mr. Eaton. To preserve the imago, he recommends it to be dipped in dilute spirits, and then transferred to a tube partly filled with water, to which a drop or two of glycerine should be added each day until the tube be full. A drop of acetic acid will prevent fungoid growth. A few of the specimens in the national collection, contributed by Mr. Eaton, are preserved in this way.

The microscopist will find this family of insects one of absorbing interest, many of them being of exquisite beauty.

W. BLACKBURN.

"THE NORTHERN MICROSCOPIST" VERIFICATION DEPARTMENT.

EXPLANATIONS.—Columns *a* and *b* give the denomination of the objective as issued by the maker. Columns *c* and *d* show the results of measurements made at a distance of TEN INCHES from the front lens of the objective, to the plane surface of the eye-lens of the ocular. The column *d* shows the actual distance between the upper surface of the covering glass and the front of the objective, when used over a slide of *Amphipleura pellucida*, the frustules being mounted dry, on a cover suitable for observation with a one-twenty-fifth dry objective. The column *e* gives the actual focal length of the objective determined by Cross' formula $\frac{n\,l}{(n+1)^2}$ where l = the distance between the two micrometers and n = the amplification at this distance.

The eyepiece used is a Ross A, with a diaphragm aperture of 0·75 inch, and yielding approximately an amplification of 5 diameters.

Column *f* contains the results of the aperture measurements by Professor Abbe's Apertometer; they are the mean of several, but the individual measurements scarcely differ from each other. Column *g* is calculated from the numbers in column *f*.

REGISTER NUMBER.	SOLD AS		AT TEN INCHES.			REAL APERTURE.		REMARKS.
	a Inch.	*b* Air-angle or Aperture.	*c* Amplifying Power. Diameters.	*d* Working Distance. Inches.	*e* $\frac{n\,l}{(n+1)^2}$	*f* Numerical.	*g* Air-angle.	
Number 34......	1/15	170°	466	.015	.078	.91	132°	Open.
	... ...	... ...	570	.02	.062	.878	123°	Closed.
" 35......	½	70°	94	.13	... ...	.48	58°	
" 36......	¼	110°	200	.01	... ...	.766	100°	
" 37......	1/5	80°	195	.01	.20	.63	78°	
" 38......	1"	27°	44	.38	.78	.225	26°	
" 39......	¼	140°	190	.01	.21	.93	137°	
" 40......	¼	90°	186	.04	.22	.675	85°	
" 41......	1"	16°	40	.76	... ...	.122	14°	

AN INTRODUCTION TO THE STUDY OF FUNGI.

By the Rev. J. E. Vize, M.A.

Concluded from page 281.

THIS resting spore even under the level of the ground knows, in common with all vegetable life, the right time to grow. In June and July it is ready to mature, and if it gets sufficient moisture it is full of life, and if it touch a tuber, at once its mycelium penetrates it, extends up the haulms and goes to the leaves, proving its presence by the growth of itself there, and by the absorption and destruction of the vital properties of the leaf, thus turning it to the brown color we see on it. Possibly some of you may like to know some of the wonders the microscope reveals at this brown spot. To make it clear to you, it will be well to remember that the leaves of all plants which do not live in water are not what they appear to be, namely, green things with a thin film or coating on each side to keep it together. The films, or more properly speaking cuticles, are beautifully arranged so as to admit and consume moisture and air. These are called stomata, stomates, breathing pores or mouths. It is estimated that in every separate leaf of the potatoe plant there are 100,000 of these mouths. The fungus of the potatoe when on the leaf always grows in these mouths, and not elsewhere on the leaf, as some of its allies do. The growth then is made, and we get the leaf full of mycelium or thread-like roots. But there are not only growths inside; if you notice the leaf even with the naked eye, but especially under the microscope, you will observe a grey tint or bloom upon it. This tint consists of a tree-like growth, upon which are borne two kinds of spores or seeds, both of which are capable of growth during the moist summer weather when they find the right place to develope, but neither of which will exist in winter; they must die. One kind of spore we call the conidia, or dust spore. It grows at the end of the branch, and when ripe will drop or be wafted by the wind to another leaf or the stem of the potatoe where it will grow again; it will even start into existence on many a damp place, but will quickly die unless it can find a mouth of the potatoe leaf or stem, or some very closely related leaf of the family to which it belongs, on which it grows. When it has found its habitat, the moisture in due time causes the corrosive matter of which the spore is composed to expand, and with it vegetation gets to work, and increases the potatoe disease.

But we were saying there is another kind of spore, on the branches. This we call the "zoospore." Its structure is very different to the one about which we were just speaking. It is capable of division into a number—say about 8—of atoms. The atoms have a lash-like tail, and they have the power of propelling themselves by means of these appendages for hours or even days together. When their travelling ceases, their corrosive particles work similarly to the dust-like spores. Still these lash-like things are more able to extend the disease than the others, because their wonderful power of locomotion is so great. Hence a warm wet day or night is very favorable indeed to the propagation of the disease.

These two kinds of spores, it has been said, cannot exist through the winter. The question then naturally comes, If two kinds of seeds do their destructive work only in summer and die, how is the disease propagated? This is just the puzzle which has harassed the minds of the ablest men of the day, and which has gained for my friend Mr. Worthington G. Smith his gold medal for the discovery. In addition to the two spores named above, the third has been found by Mr. Smith, which exists all the winter and spring in a dormant state, but in June and July is only waiting to find a tuber so that it may produce the disease and continue its existence. The way in which Mr. Smith found it was simply this. He collected together a great number of brown spotted leaves such as those we have been considering. These he kept moist during the whole of the winter at the cost of a good deal of labour and trouble. Mr. Broome did the same. The consequence was that these moist leaves produced a quantity of mycelium threads, including the long looked for and missing link which is called the oospore or resting spore. If it could be destroyed we should be free from the potatoe disease. But this spore lives through the winter. Every diseased potatoe you leave to be buried in the ground deposits vast numbers of these resting spores; every haulm you put to the manure heap to rot for future use only increases the disease. This spore too undergoes a beautiful process in order to become fruitful. It has its mate, for vegetable life is like animal life,—it needs its partner. There is the resting spore. It is pierced by a beak like projection—a change takes place almost at once. The beak like thing has completed its mission, and the spore which has been pierced awaits its time and opportunity to grow, which of itself it could not have done. Thus we find that the two divisions of Phanerogamic Botany and Cryptogamic Botany are merely man's invention through his not having been acquainted with the wonders God has revealed through the microscope, and thus we find too that the divisions can exist no more in reality, although for convenience the terms may be used. These resting spores for all we know may live for years without growing unless they find a suitable start into life for themselves. Such is the case with many Fungi, they will in hybernation undergo excessive variations of wet and dry, of heat and cold, without being destroyed. This will account for the sudden appearance of fungi after the interval of many years since the time they were last seen. Many of these plants form themselves into a hard substance called sclerotia. They may often be found, and are found too on all sorts of substances. They are a mass of cells destitute of fruit. Many of the mushroom tribe are at certain periods of their existence constantly connected with the sclerotia, in which dormant state they await their time of development. It must be very interesting to obtain these plants, and to induce them to grow; one point of course being of great assistance in their development, viz., that they should be kept as nearly as possible in their original state. If they grow on sticks, take the stick and never let it appreciate the fact that it has been moved. The same exactly with all the sclerotia. By adopting this plan some very beautiful Fungi have been obtained and added to the list as new species.

Reverting, however, to the resting spore of the potatoe disease, as yet there has not appeared anything to destroy it, and certainly the difficulty in its destruction must be enormous. Wet places are vastly more likely to produce it than dry ones. Wet seasons encourage its growth more than the reverse. The same ground should not be used for years together for the growth of the potatoe. Every haulm should be burned, and every root or rootlet. It should never go near decaying substances used for manure. Those varieties of potatoe which are the least affected by the disease, such as the very earliest sorts, should be encouraged, so should the red kinds of winter potatoes rather than the white. My own idea is that as a special intervention of God brought the disease here, so a special withdrawal of it by the Almighty will exterminate it. It is not as though the common potatoe were only attacked. The potatoe belongs to the family Solanum. Eleven of the Solana are recorded as having developed the disease, so has *Arthoceris viscosa.*

Time passes. I must begin to close this paper. Some of you doubtless will be very disappointed that I have not said a great deal about the poisonous Fungi and contrasted them with those that may be eaten, laying down royal roads whereby the youngest student may be able to say whether he is going to be poisoned or not, if during the next season he is spared health and strength. To be candid, I know scarcely anything at all about the Fungi to which the edible and poisonous ones belong, nor is it my intention for a long time, if ever, to study them; they are a section of themselves, and are in very good hands indeed. My work has been almost exclusively amongst the fungi which must be studied with a microscope, particularly those which are parasitic on leaves. To take up the whole field of Fungi is more than I could do in justice to myself and still more to my parochial work. My belief is that no royal road will be made whereby you can tell a dangerous from a safe fungus. Nay more, you may eat to-day without any ill-effects resulting, what in a few days hence may greatly injure you, and for these reasons your bodily organs may be well now but weak then; also, although the fungus may be the same, there may be the mycelium of some mould growing on it which would injure you. Hence, amongst your rules never touch an old specimen: again, carefully avoid all highly coloured ones, also those which are sharp or acrid to the taste. Besides this, learn for yourself by experience what is good and what will be bad, just as your ancestors have found out that a cabbage is good for food, whilst aconite would kill you—that hemlock is to be avoided but parsley may safely be taken.

Let me now give you some idea as to the division of the Fungi, and here I must use a few hard words. I have hitherto most carefully tried to avoid them, having been requested not to write a difficult paper, a process which has made the paper more troublesome a good deal to prepare. The Fungi are arranged under two divisions: first, the sporifera in which the spores are naked; secondly, the sporidiifera in which spores are in sacs or asci.

The first division is subdivided into four families; the second is subdivided into two families. In all these families "the name is derived from the predominance of the organ which is the distinguishing feature in each.

Thus Hymenomycetes from *Humen* (Greek) a membrane and *Mukés* (Greek) a mushroom. The fruit being formed on a membrane which is either naked from the first, or soon becomes so if originally inclosed in a volva.

Gasteromycetes from *Gaster* (Greek) a belly where the fruit is produced in a closed receptacle.

Coniomycetes from *Konis* (Greek) dust, the dust-like spores forming the chief character.

Hyphomycetes from *Huphê* (Greek) a woven mass of threads.

Physomycetes from *Phuskê* (Greek) a vesicle or bladder where the fruit arises from the tip of a thread, penetrating into the vesicle, which forms a covering for the fruit.

Ascomycetes from *Askos* (Greek) a sac where the fruit is formed within asci."

For the above definitions I am indebted word for word to my friend Mr. Broome; they are in his paper on "The Fungi of Wilts."

These families are subdivided into thirty-one orders.

The orders into 368 genera up to the publication of Dr. Cooke's Handbook of British Fungi, and the species up to that time (1871) amounted to 2809. But then so good has been the work the last few years that a great number of species are constantly being recorded as new to Great Britain—the number 2809 does not represent by hundreds the Fungi that are known as British. The very certainty of this may induce students to begin Fungology, not doubting at all, but that they will soon add some new species to the list.

And now, considering the time that you have been listening to me, and that by now you will have heard enough for one night, I should be sorry for you to leave here and think the subject is exhausted. Not a word has been said to you about certain properties and characters certain Fungi have when compared with others, luminosity for instance,—very little has been said about their ubiquity, and the advantage gained from studying them inasmuch as they are to be found every day in the year as compared with flowering plants which you know are only to be had at a limited season. Not a word has been said about the geographical distribution, how some countries have been marked—others remain untouched, nor have the names of those friends of the science been given who in distant lands have proved their love of botany. Indeed the paper has left foreign lands and kept us pretty well to Great Britain. More might have been said about the hybernation, about the modes of fructification, about the tools necessary for collecting specimens and about the herbarium. A calculation we have been given as to the effect of heat and cold, of light and darknesss upon the Fungi. Each section might have been illustrated with drawings, and the magnified parts thereof examined. Still a good deal has been brought before your notice, and gladly too.

If any of you intend to study this branch of the Almighty's work, or are now pursuing any branch of His wonders in Creation, never rest satisfied with merely the examination of the specimens themselves. His works are grand and magnificent. Study them as so many assistances given to help on your spiritual life. The person who looks at a plant and sees no more in it than a plant misses his mark fearfully; he stops just where he ought to begin; he looks at the sign post which is to direct him on his way, and he refuses to be guided by it. He gets not the sweetness and the richness which might be extracted. There is, by coupling true religion and true science together, an incalculable blessing in prosecuting their study. The one eases the path of the other. On the other hand, if you divorce from each other these two, you may see a pretty thing with the seeing of the eye, but you stop there. The right way is to make them go hand and glove together, to let soul and spirit apply to the work, and thus get ourselves in training for a really happy eternity.

THE LIMITING DIAPHRAGM, OR APERTURE SHUTTER.

FOR many years past we have heard declamations against the practical value of wide aperture objectives, principally however, upon the ground that they do not possess *penetration*, though all seem agreed that they do define much better than those of small or medium angle. Even Dr. Carpenter, the champion of medium angles, in the last edition of his work, p. 732, seems at last to prefer wide apertures, for in the only instance in which he has expressed an opinion upon the structure of insect scales *from his own study* he writes, "The author has fully satisfied himself by "his own study under an oil immersion 1-25th of Messrs. Powell "and Lealand of a *Podura* scale illuminated by the 'immersion "paraboloid,'" etc., etc.

It is well-known that the wider the aperture of the objective, the less the working distance may be, though this does not depend upon the aperture alone. A reference to pp. 257, 282, and 283 of this Journal will show this clearly, if columns *a*, *d*, and *g* are compared; we do not, however, wish to enter into this question at present, but will endeavour to show how penetration may be given to wide angle lenses.

It seems upon inquiry that some of our opticians have for some time past produced a half-inch objective for use with the binocular, by placing a diaphragm of smaller aperture than usual behind the back lens of the objective. The half-inch of 60° is thus easily reduced to 40°, and the penetration consequent upon such reduction is by this means obtained.

For some time past we had been using stops of blackened cardboard, and as these were not very convenient in use, we had a conversation with Mr. J. B. Dancer of Manchester, as to the utility of making an "iris" diaphragm for the purpose, when he produced a graduating diaphragm made ten years ago, but as to the best of our knowledge, our idea has never been published, we give a sketch of the instrument as made for us by Messrs. Ross & Co.

Fig. 2 shows the instrument as a nose-piece screwing into the lower end of the microscope tube, while fig. 3 exhibits the iris diaphragm placed immediately above the objective, the lever which actuates it being shown in both figures. It is plainly a very simple piece of apparatus, but to be perfect, the aperture in the diaphragm should be capable of accurate centering.

It will be seen that this form of aperture shutter enables the operator to adjust his objective to any aperture he wishes, and this cannot be effected upon any older plan without having a large set of stops on hand. The closing of the shutter does not contract the absolute size of the field, but only the brightness of it, and the true value of *penetration* can easily be observed without moving the eye from the tube.

The value of wide apertures for good definition may also be seen

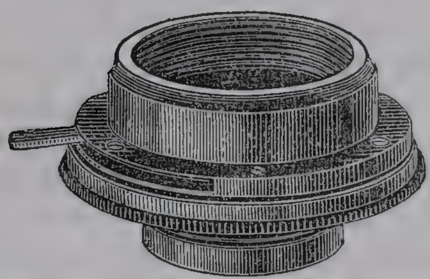

Fig. 2.

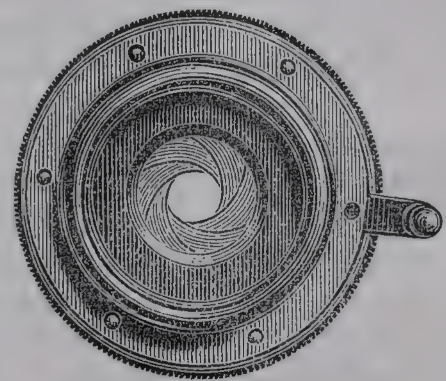

Fig. 3.

when using this "shutter." If Topping's admirable preparation of the proboscis of the blow-fly be observed with an inch objective having an air angle of 30°, the view is superb, the *pseudo-tracheal* markings come out well-defined and sharp; but close the shutter until an angle of 14° or less is obtained, and examine again, when it will be found that the definition is not nearly so good, while there is more penetration, the whole of the pseudo-tracheal tube being observed under one focussing. While in this condition, the eye being still applied to the tube, open the shutter to its full extent, and the effect of wide aperture will demonstrate itself.

Perhaps the best object to show the amount of *penetration* possessed by objectives of low angle, may be found in the micro-fungus *Myxotrichum deeflxum*, or *M. chartarum* observed under the one-inch objective. The former object consists of little patches of grey downy balls, from which arise a number of radiating threads furnished with a few opposite and deflexed branches. Under an inch objective of 30° air angle but few of these branches can be seen under one focussing, the remainder being enveloped in a haze of light; but if a central layer be focussed, the simple closing of the shutter will suffice to bring the superior and inferior layers into view, though of course the image is not so bright or well-defined as before.

The objection to wide angles, that they do not possess penetration may now be fairly said to have broken down; its other phase, that of working distance, we will treat of in a future number.

MICRO-FUNGI: WHEN AND WHERE TO FIND THEM.

IF there be any one branch of botanical study more likely than another to attract the special attention of the student of microscopy, it is the study of the minute fungi. Wherever his home may be, they come around him from month to month on all sorts of decaying or dead organisms, animal and vegetable. They float in the ponds and ditches, and their invisible spores are carried through the atmosphere in every possible direction, even along our streets and into our dwellings, especially our cellars. Most of these decompose for want of the required nidus, but countless thousands are developed into active vitality, and bring into existence most beautiful organisms. Now, in this dead time of winter, we have them in all damp places around our homes—often on the bread we eat and in the water we drink—on our cheese; and if we eat the tinned meats our cousins send us from Australia, we may find the fungus there in the shape of a hateful white patch. If we scan with careful eye our window panes, we may find house flies who have sought out quiet corners where they might die, and there upon their dead remains we find a mass of minute white threads, which are the filaments of a well-known and interesting fungus. Amongst what may be called the domestic fungi, we have that still worse family pest the ring-worm—no worm, or any other animal, but a *bona fide* plant, well known and identified. A scientific friend of mine suffered some years ago from the infection of this so-called worm in his beard. He caught and tested the structure of the unwelcome visitor, and sent me specimens of its organism, including the spores. My friend Mr. Tozer, the head of the fire department of our Manchester Corporation, a year or two ago sent me specimens of the ring-worm, which had got upon many of his horses, and was breaking up the hairs into strange fractions of diverging fibres. Doubtless many of the diseases we suffer from have their origin in fungoid life, as yet only suspected, but may some day be known and eradicated. Already has science done much in this direction, but a wide field still remains to be investigated. The *Sarcina ventriculi*, a so-called fungus when I began microscopic study, but now looked upon as a Confervoid Alga, has played sad havoc with the human stomach. It is but recently that this little vegetable monster has been known, and even now it is a difficulty and a puzzle to the medical student. So during all the centuries of man's existence it has been doing its deadly work in the dark, disordering his vital functions and doubtless abbreviating his span of life.

I remember a certain shoemaker in Sheffield, who some thirty years ago was a sufferer from this pest unknowingly for a considerable period, and who was greatly reduced from being a very stout man to pitiful thinness, when a microscopist, and a personal friend, examined the fluid the shoemaker vomited, in which he at once detected the Sarcina, and he told the sufferer that he had got the *Sarcina ventriculi* in his stomach. The poor fellow was horrified, thinking that it must be some huge monster. Explanation followed, and the proper medicine soon destroyed the unwelcome guest. From what I have said it will be seen that the study of the minute fungi is not only a pleasant occupation and a matter of general scientific interest, but it is in a certain sense a duty we are bound to fulfil in our own interest, and for our own personal protection and the public good. Before leaving this department of study let me refer to the Ergot of Rye, a minute fungus of the genus Claviceps. This, taken in household bread, has been known to produce the most fearful results, upon the details of which it is not desirable that I should dwell. It is not for the medical student, but rather for what may be called the botanical student that I write, that I may aid him in those studies which will be to him a pleasure rather than a profession. About this time of the year, with the prospect of spring before him, the student will be thinking of the leaf fungi, which are not yet nor can they come for some two or three months; but numerous others are to be found in woods and meadows, and elsewhere in places innumerable. I hope to have an opportunity next month of calling the attention of the student to some of these. In the meantime, I may not inappropriately conclude by quoting the well-known inscription on the tomb of Sir Christopher Wren, in St. Paul's Cathedral, London—"*Si monumentum requiris circumspice*, for truly monuments of nature's handywork are all around him.

In concluding this paper for January, it may be well to allude more specifically to some of the domestic pests which are referred to above. The too-common one on bread is known as *Ascophora mucedo*, and will be familiar to every student of microscopy. This is the only species we have of that genus. Then we have the Mucors, of which many species are well known. *Mucor mucedo* on fruit, preserves, etc.; *M. clavatus* on decayed fruit, as also *Mucor amethysteus*, which is the especial fungus of rotting pears. Then we have *Mucor caninus* on the ejectamenta of cats and dogs, and numerous others, which I must leave to another occasion, the space at my command being fully occupied.

THOMAS BRITTAIN.

NOTICES OF MEETINGS.

CARLISLE MICROSCOPICAL SOCIETY.—This Society held a meeting on Wednesday evening, November 23rd, to hear the inaugural address from the President, the Rev. Canon Carr, F.R.M.S., vicar of Dalston. There was a very large attendance.

Canon Carr, who was received with applause, first congratulated the members on having associated themselves in a society having for its object the promotion of microscopical research. His only regret was that a more able member had not been selected to fill the position of its first President. However, he would do his best to promote the interests of the Society, and he trusted that as time went on we should find their organisation would result in practical benefit to all. Standing side by side with that popular and useful Society, the Carlisle Scientific Society and Field Naturalist's Club, they had work of a somewhat similar character to do. Of that Society the general purpose is to promote observation and to increase our knowledge of the larger objects in nature, chiefly those connected with geology and botany. The object of the Carlisle Microscopical Society is to pursue research where the other stops—to examine into the minute structure of objects which are either invisible to the unassisted eye, or which, though visible, have details too small to be investigated without optical appliances. (Applause.) In those researches they had great advantage over those who had preceded them. The microscope had of late years been brought to marvellous perfection, and it was still improving as an instrument of precision. All that our ancestors had to use in the examination of minute objects was practically the simple lens, followed in time by Wollaston's doublet. He then proceeded to describe the various instruments which had been introduced in recent years, his remarks, of course, being of a technical nature and more particularly intended for the members. The simple microscope, with one or more achromatic objectives, and one or two Huyghenian eye-pieces, mounted on a stand and furnished with a mirror underneath to reflect the light on the object, is all that is really essential for simple observation. Many improvements had been made in the stand itself, and many ingenious accessories introduced to facilitate the use and to increase the capabilities of the instrument. He then described in detail the binocular arrangement of Mr. Wenham, the concentrically rotating stage, and the swinging substage. Although the accomplished and experienced microscopist could by the accommodating power of the eye, and by successively focussing on different planes of the object, obtain even with the monocular instrument a very correct idea of its solid form, yet it was certain that the stereoscopic binocular microscope gave to the ordinary observer a much more accurate idea of the solidity of the object than the monocular instrument could give him, provided no optical sources of error come in to disturb the correctness of the image. Though some of the accessories to the microscope were expensive luxuries, it might be a satisfaction to them to know that save for some exceptional purpose, the most skilful microscopists make very little use of them. A story was told of an experienced physician who, when asked what remedies he employed, replied that as a young man he had perhaps a dozen remedies for every disease, but that now he had more nearly one remedy for a dozen diseases. Similarly the accomplished microscopist cares little, as a rule, for ingenious and costly appliances. True, with many of them fine results could be obtained, but it was equally true that by the skilful use of the simplest apparatus almost if not quite as much may be done. (Applause.) When they considered that the great researches and discoveries of Ehrenberg and others were made with glasses which would scarcely rank with the most mediocre of those now used, they would see how very much might be done without incurring the cost of elaborate accessories or of the finest high power objectives. He touched on the pleasure which microscopists experienced in following out their investigations, warned them that the management of the light was of the first importance, and dwelt at some length on the various objectives of more or less power. "I cannot conclude," said the President, "without alluding briefly to certain remarkable results which have followed from investigations made by means of the microscope into the producing cause of some intractable diseases. It has been long known that germs which produce disease of various character are continually floating in the air in inconceivable profusion, and that on falling on tissue in a suitable state to nourish them they grow and produce the disease in question. It has only been within the last few years, however, and in some cases within the last few months, that the germs of some of the most fatal diseases which attack animals and man have been detected by the microscope in tissue or in the blood, and not only detected but isolated, and not only isolated but cultivated, and not only cultivated but so attenuated and deprived of their virulence that inocculation with them could be safely resorted to, and the subject be thus practically rendered proof against the terrible disease in its most malignant form, even though exposed to its most baneful influence. I refer, of course, to the researches of M. Pasteur, Dr. Koch, Dr. Klein, M. Toussaint, and other distinguished physicians and veterinary surgeons. The experiments hitherto made by these observers have been chiefly but by no means exclusively confined to the diseases of animals. The first success was attained by M. Pasteur in his attempt to arrest the progress of the silk-worm disease. The germs of this disease were discovered. Infected insects or eggs were separated from those which were not infected, and such successful methods suggested for stamping out the disease that they were recognised both by his own and foreign governments. Afterwards his attention, and that of other workers in the same field, was turned to other diseases. The very fatal splenic fever of sheep and cattle, identified by continental writers with the murrain of Egypt, the pig-typhoid, the fowl-cholera, the cattle disease known as *la maladie de chaberd*, and even hydrophobia, have been the subject of careful experiment. In each of them a microscopic organism, a *bacterium* or a *bacillus*, less than the thousanth part of an inch in length, has been found in the blood, and discovered to be the cause of the disease. The organism has been separated, cultivated in chicken soup, made almost innocuous by long exposure to the oxygen of the atmosphere, and then used for inoculation purposes. After this it is found that though the constitutional disturbance set up has been very slight, the animals so inoculated are almost if not quite proof against the disease, even though the germs of it in their virulent form have been introduced into the blood. In the case of diseases of other kinds, which attack the human subject—such as ague, malarial fever, and that rapid and fatal form of it, yellow fever—similar organisms have been found in the blood, and the treatment of the diseases by the injection into the veins of phenic acid, which is known to destroy such germs, has been attended with success. That like causes may be traced, and some kindred treatment successfully adopted, in the case of other epidemic or contagious maladies, seems to be highly probable; and as the result of this new microscopic departure in regard to the theory and the treatment of disease, it is hoped that there may in due time be a large abatement in the death-roll attributable to such widespread and dangerous disorders as scarlet and typhus fever. Such investigations as these can, of course, only be carried out by those trained in medical science. But there is abundance of work for others to do in the examination of those most interesting animal and vegetable organisms with which our ponds and rivers and hedge banks teem. What we want is to enter into the matter with spirit, and with unflagging interest. We have already in our Society a fair number of members who wish to avail themselves of the advantages it affords. Most of them are workers in the field of microscopical investigation, and I should hope that none of those who belong to the Society will rest content without possessing a microscope of their own, that each one will do some real work so far as time and duties allow, that he will bring to the meetings anything of interest he may discover, and seek to give or to gain information. Teachers and students of physiology will find special aid in facilities for conducting those microscopical demonstrations which are essential to success in the line they follow, whilst those who are beginners in the use of the instrument will have assistance and advice from the more experienced members. It is our purpose to give our Society an educational and instructive character, as well as to make our meetings interesting. Courses of subjects relating to vegetable tissues, insect structure, and so forth, will occupy a portion of some of our meetings, the topics discussed being illustrated by slides obtained for the purpose or mounted by members. Such slides and others will gradually form a cabinet, which may be open to examination by members; whilst instruction in the art of mounting objects would probably excite much interest and do good service. Books of reference will be purchased for the use of members, and such magazines and periodicals taken in as may suit their wishes and requirements, and keep them acquainted with the most important current literature on the subject. First-rate instruments and apparatus may be too costly to purchase, the subscription to the Society being only ten shillings a year, but through the liberality of members even these may possibly in due time be had. Our object must be to make our Society a thoroughly practical and useful institution, and if we determine that no pains shall be wanting on our part to make it a success, I think we shall not fail. And then, as we search more and more deeply into the secrets of nature, and dive into those recesses which our instrument alone enables us to explore, we shall increasingly wonder at the power and goodness of Him who made all, who, whilst He studded space with suns and worlds, clothed also with exquisite beauty organisms too minute to be brought into view save with the highest powers of the microscope, and others, doubtless equally lovely, which elude our vision. (Loud applause.)

Mr. Allison moved a vote of thanks to Canon Carr, expressing a hope that the Microscopical Society, though separated from the Scientific Society, would not work in opposition to it, but that both would carry on their studies together. (Applause.)

Mr. Hallowes seconded the motion, which was carried amid applause.

The various instruments were then set in operation, and the proceedings were brought to a close about ten o'clock.

MANCHESTER CRYPTOGAMIC SOCIETY.—At a meeting of this Society, held on Monday, the 21st of November last, Capt. Cunliffe, F.R.M.S., who presided, said he had mnch pleasure in bringing before the notice of the members some specimens of *Weissia mucronata*, which he had very recently found growing near his own home at Handforth, Cheshire, and which was the more interesting on this account, insomuch that it had not hitherto been recorded as growing within the district of the Manchester Flora. Mr. Cunliffe also exhibited a few other rare mosses from the same county, and which had been collected during a recent excursion. *Tortula rigida* and *Sphærangium muticum* were amongst the microscopic slides, and were much admired as perfect specimens of microscopical manipulation.

Mr. Stanley also exhibited a good series of microscopical slides, chiefly Hepatics, shown not on account of their rarity or beautiful forms, but more as as specimens of the microscopical work which is necessary to display the characters of this class of Cryptogams.

Mr. Pearson read a few notes translated from G. Limpricht's recently published paper on the European Bog Mosses. The notes read had a more immediate reference to Limpricht's strictures upon C. Wornstoffs new classification of this particular group of mosses. The subject proved to be very interesting to the members present, was well discussed, and suggested several new openings for microscopical investigation.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

W. L. W. E. (Hants).—The fungi we have duly received and have forwarded them to an expert in such matters.

C. A. L. (Stafford).—You are correct, the alga is *Ploeamium coccineum* and you will see that after so long a period the color is well retained. The excrescences upon the oak leaf are not fungi. They are commonly called *oak spangles*, are really galls, each containing a single insect which retains its habitation till March.

J. A. C. (Hants).—We cannot test or verify oculars under any condition, at least at present.

A. A. (Windsor).—We have asked for a batch of objectives ($\frac{1}{8}$ths) to be sent us for selection; but they have not yet come to hand.

C. A. G. (London).—It is a mistake for you to assume that high powers are unnecessary for botanical work.

D. D. (London).—We did expect to get railed at for advocating the use of wide apertures; we wish however that you will keep a copy of your letter and reproduce it without alteration in ten years time.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free.* They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

Animal Parasites.—Have a large number of these in exchange for animal parasites, ixodes and acari, mounted or unmounted. W. A. Hyslop, 22, Palmerston-place, Edinburgh.

Cast Skins of larva of Cloëon *(Ephemeridæ)*, well mounted, in exchange for other objects of interest. W. Blackburn, Woodlands, Chorlton-cum-Hardy.

General Slides in exchange for others. C. D., Care of Editor.

SALE COLUMN FOR APPARATUS, BOOKS, Etc.

Advertisements in this column are inserted at the rate 4d. for each 12 words or portions of twelve.

Advertisers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied by a penny stamp for each letter, to cover postage.

All Advertisements intended for insertion in this column must reach us before the 14th of each month.

Micro-spectroscope by Browning, scarcely ever used. Quite equal to new, in Mahogany case, cost £9, price £7, or should be glad of offers. A. L., Care of Editor.

For Exchange.—A good one-fifteenth immersion objective by Dancer for sale or exchange. Wanted (1) Heliostat, (2) Swift's best lamp and goniometer eye-piece, (3) Ramsden's eye-piece Screw micrometer, or what offers. Address J., Care of Editor.

Microscope for sale or exchange. A good binocular microscope by Browning, nearly as good as new, in mahogany cabinet with box for apparatus. It has mechanical stage; stop to ditto to use Maltwood's finder; a pair of A eye-pieces; a pair of B and a single D, Selenite stage; Morris' rotating stage; Achromatic condenser, Polariscope, Camera Lucida and Bulls'-eye condenser. Price £14, or would exchange for a wide angle one-sixteenth, by Powell and Lealand, or a set of the Quarterly Journal of Microscopical Science. B., Care of Editor.

Polyzoa.—Named slides of British and Foreign Polyzoa at six shillings and eight shillings per dozen respectively, J. C. E., Care of the Editor.

THE NORTHERN MICROSCOPIST.

No. 14. *FEBRUARY.* 1882.

A VISIT TO AN OBJECTIVE FACTORY.

ON page 105 of Pritchard's Microscopical Cabinet we read, "Nearly all the naturalists who have distinguished themselves by their discoveries with the microscope have rejected the compound instrument with its luxurious field of view and attached themselves solely to the single instrument"; and again, "The great loss of light in the ordinary compounds, with the consequent absorption of all the delicate tints and colors of an object, makes it appear like a coarse engraving in black and white. This added to the great and sensible dispersion which envelopes every object seen through them in a false prismatic halo, and utterly obliterates all its delicate markings and structure, renders this instrument almost useless for investigation." Such seems to have been the general opinion many years ago, but when we look around us at the present moment, it would be difficult indeed to find anyone willing to endorse such views.

Microscopic Objectives are looked upon with a great deal of superstition by nearly all microscopists, most workers taking very special pains not to learn anything of the optical principles of the appliances with which the tubes are fitted, but we hope that the time will come when every possessor of a microscope will be familiar with the optics of his favourite study, and no longer look upon an objective as something too deep to be fathomed, and of which, therefore, the less said the better.

Objectives, as they are made now-a-days, are remarkably free from imperfections, that is if we consider the spherical and chromatic aberrations only, and there is in the market an abundance of really good lenses, at very moderate prices, and capable of doing an immense amount of work.

The beginner must, however, understand that the construction of a really first-rate objective, of wide aperture, is an expensive matter, so that one cannot be produced at the nominal price charged for some lenses, and as in the present diffusion of microscopical knowledge cheap lenses will always be enquired for, most opticians make two or three series of objectives, each differing in price and quality. A novice would be unable, perhaps, to discover any distinction between an inch objective of 18s. and one at £4, but an old hand would have no difficulty in detecting the difference, if any existed. We must confess, however, that the price paid for an objective is, alone, no criterion of its excellence, as the incident mentioned on page 256, Vol. I. of this Journal will show. A glass may be well corrected for a small angle, and should, therefore, be much cheaper than one of wide aperture, where the back lenses are larger and stops are inadmissible.

Both theoretically and practically there is now no doubt that wide apertures are to be preferred to smaller angles, but there are many of the old school of thought even yet, and the optician, of course, seeks to satisfy the idiosyncrasies of all his customers.

Medium or small apertures seem only to commend themselves when great working distance is a *sine qua non*, and even then they must be constructed on a plan for giving a large anterior focus, as it is not *all* low angle glasses which possess great working distance. We hope, however, to treat of this more fully in a future number.

With all the intricacies of a trade like this we can scarcely be familiar, but, by keeping his weather eye open, the observer may find much food for reflection, and he will often discover that many objectives, believed to be the product of much thought and knowledge on the part of different opticians, have all originally come from the same factory, if indeed they are not foreign lenses put into an English dress.

Being mixed up amongst thoughts correlative with all the foregoing, we gladly availed ourselves of an offer to visit an objective factory.

At Laurel House, North Hill, Highgate, a suburb of North London, lives Mr. W. Wray, from whose workshops a large number of low and medium power objectives of excellent quality are turned out.

In the garden adjoining his house these workshops are situate, so that all the operations may be under his immediate control, and this is further provided for by the active part taken in the production and correction of the lenses by his two sons. Mr. Wray caters for all classes of customers; wide and small apertures, expensive and cheap, all are produced in his factory.

In one room we saw the formation of large lenses, such as would be used in the construction of the ordinary two-inch ocular, and for small "bulls-eye" condensers. It was in this part of the building also that telescope lenses were being made.

Our interest in these large pieces of glass, however, was not equal to the curiosity we felt to see the manipulation of those fragments constituting the fronts of $\frac{1}{8}$ths, $\frac{1}{10}$ths, $\frac{1}{12}$ths, and $\frac{1}{15}$ths. In the next room this was going on, and at one of the benches we were in time to see the finishing touches given to the achromatic lens of a Webster Condenser, while at another bench some very minute lenses were being made.

Here we had a lens formed for us from the rough glass. A piece was examined as to freedom from flaws, and next cemented with best black sealing-wax to the chuck of the lathe. It was then turned to shape with a small, smooth-cut file moistened with oil of turpentine, used as a turning tool. When this stage was reached, the partly constructed lens was polished and finished by setting the polishing lap running in the lathe and working the lens upon it by hand—attached as it was to the chuck upon which it was fashioned.

This is the way in which most small lenses are made, and it will be seen that their manufacture calls for a large amount of manipulative skill on the part of the operator.

In another room we saw the brass work being executed, both for the objectives and their boxes. We also saw some of the mechanical arrangements for expediting the work, and one, especially, for cutting a spiral slot for the cover adjustment struck us as being very ingenious.

We now came to the mounting department where the lenses were tested and placed in their brass cells, and the exceedingly simple methods which practical opticians have of setting and centering these lenses greatly excited our admiration. The reflection of the window bars and the flame of the lamps over which the lenses and cell were warmed before mounting, were each pressed into service as an aid to centering. The lens by which Mr. Wray illustrated to us the mounting process was a low angle half-inch, for use with the binocular, composed of two pairs of lenses with a thick, solid front.

The brass work and lenses of the back pair being warmed, a drop of balsam was placed upon the anterior surface of the back lens. Both were then placed in the cell and screwed into the lathe chuck, being pressed together and manipulated with a pointed pencil of soft wood until the reflected image of the flame was quite steady upon the revolving glass. The middle combination was then treated similarly, the front screwed on, and finally the aberrations corrected by reducing the thickness of the front.

Before leaving we inspected several of Mr. Wray's glasses, one of which notably, a $\frac{4}{10}$, gave us really a splendid show of the Podura scale when used with a deep eyepiece.

Mr. Wray makes a separating lens in which the two systems are moved by a screw collar in a manner similar to that made by Zeiss of Jena, but we believe that Zentmayer was the first to produce objectives of this pattern.

Since visiting Mr. Wray's factory we have had many of his objectives under our notice, sent into our Verification department, and it is mainly on this account that the present article has been written, as we have been very much pleased with his productions.

Register Number.	Sold as		At Ten Inches.			Real Aperture.		Remarks.
	a Inch.	*b* Air-angle or Aperture.	*c* Amplifying Power. Diameters.	*d* Working Distance. Inches.	*e* $\frac{n\,l}{(n+1)^2}$	*f* Numerical.	*g* Air-angle.	
Number 42......	1/7	105°	290	.011	.126	.73	94°	
" 43......	1/6	95°	240	.02	.156	.63	78°	
" 44......	1″	16°	43	.81	.770	.14	16°	
" 45......	1/2	60°	90	.14	.405	.44	52°	
" 46......	1/4	95°	200	.03	.192	.70	90°	
" 47......	1/4	95°	190	.02	.196	.78	103°	
" 48......	1/8	110°	300	.015	.124	.83	112°	
" 49......	1/4	50°	140	.06	.270	.42	50°	
" 50......	1/4	50°	140	.10	.263	.35	41°	
" 51......	1/4	...	190	.015	.192	.80	108°	
" 52......	1/4	100°	190	.02	.200	.78	104°	
" 53......	1/4	95°	180	.01	.204	.58	72°	
" 54......	1/2	40°	70	.14	.670	.37	44°	
" 55......	1	23°	40	.53	.854	.20	24°	
" 56......	1	27°	43	.40	.764	.24	28°	
" 57......	1	...	43	.80	.813	.15	17°	
" 58......	1	27°	41	.49	.826	.23	27°	
" 59......	2	12°	20	1.71	1.530	.12	14°	
" 60......	2	16°	23	.91	1.320	.14	17°	
" 61......	1 1/2	14°	25	1.31	1.300	.12	14°	
" 62......	3/4	...	54	.25	.685	.26	30°	
" 63......	1	18°	38	.72	.900	.17	20°	

MICRO-CRYSTALLIZATION.

By E. Ward, F.R.M.S.

CRYSTALLIZATION, as a force, was known in primitive times, and in a decidely primitive manner. The word crystal, which is derived from a Greek word signifying ice or frozen water, expressed to the early observers what for a long time was considered the great cause of crystallization, for Albertus Magnus about the middle of the 13th century tells us that the cold in the lofty mountains makes the ice so dry that it congeals into crystals.

And, although in the 16th century Agricola *knew* but little more, he rejected extreme cold as the originator of crystals, and accepted something similar to Magnetic power. And, as well as indicating some simple forms of crystals, he noticed many things which in other hands were destined to bear much fruit.

When Linnæus, later on, brought his master mind to bear upon this, as upon so many other subjects, he evolved from the former chaos something like a classification of the forms, still but a very imperfect one; for he affirmed that *Salt* was the only known cause of crystallization, and that consequently the forms of the crystals of all other substances was determined by the Salt in union with them.

As well as the cause, the mode of formation of crystals was a favourite subject of speculation with the earlier writers on crystallography, and it still attracts numerous enquirers; but the scientific progress has not been as great or rapid as many could wish. Under our Microscopes, as under those of workers long ago, may still be seen crystals springing out of solutions and increasing in size; but the powers that be are still left much in the region of doubt and speculation, and these words of Brewster's still hold true:

> "In whatever way Crystallographers shall succeed in accounting for the various secondary forms of crystals, they are only on the threshold of the subject,—the real constitution would still be unknown; and though the examination of these bodies has been diligently pursued, we can at this moment form no adequate idea of the complex and beautiful organization of these apparently simple bodies."

Not being a student of crystallization as a science I have not to discourse on the classification or angles of crystals, but to describe in as simple a manner as possible how I have produced and how you may probably produce interesting, beautiful, and valuable Microscopical slides of some of these wonderful forms.

I have said advisedly, how you may *probably* produce these things, for it does not follow that if one worker has produced an interesting slide of crystal and accurately describes the process by which it was obtained, his hearers or readers will be able to produce, without many failures, a similar slide; but though failures when frequent are very discouraging they are ofttimes not utter loss, for those slides which do not shew the desired form of Micro-crystallization may, if examined carefully, exhibit other forms equally or possibly more interesting or beautiful.

Plant culture, which affords ample scope for enthusiasts, also illustrates well what I mean; for where one man aims to produce superior plants of a well-known species, another will devote himself to the production, by cross fertilization or different methods of cultivation, of other and newer forms and varieties. Upon the same principle, workers in the subject before us to-night aim—some to prepare superior slides of typical crystals, others by making solutions of different strengths and in various media, by working at higher or lower temperature, and by adding foreign substances—to obtain, like the plant grower, new varieties and beautiful forms which shall not only delight the sight, but exercise the mind of the observer.

In describing the mode of preparation of some of the Micro-crystals, those which are most readily prepared have been selected, —one of the easiest being Tartaric Acid; this, like many others of the "common objects of the Microscope," is very beautiful, and is thus prepared.

Make a strong solution in water of the Acid Crystals, and having warmed a slide, drop on the centre a little of the solution and evaporate by gentle heat, that is by holding the slide some four or five inches above the flame of the spirit lamp. If only a small drop of the solution has been used, the crystals will be thin, and will require a selenite to bring out their utmost beauty; but if the drop of solution is heaped up, as it were, on the slide, the crystallization will be stronger and will not need the selenite, but as the polarizer is rotated, the colour will be well shewn.

Immediately following this, may be mentioned Gallic Acid, of which a moderately strong solution is to be made in methylated spirit. Drop a little of this solution in centre of cold slide and allow to evaporate very slowly; if, however, smaller crystals are desired, as soon as the slightest appearance of crystallization is visible, slightly, very slightly warm the slide. A third and different form of crystal is obtained by adding together saturated solutions of the acid, both in water and methylated spirit; then placing a little of the mixture on centre of warm slide, and as soon as the crystals commence to form, pricking the centre with a cold needle.

The preparation of the slides from these two acids separately, naturally at this point leads me to notice a form of crystal obtainable by a mixture of the two as follows:

Make a strong solution of each in methylated spirits, and then mixing both together, place a drop upon a cold slide, gently warm until opal, oyster shell-like crystals begin to appear: instantly then remove from the warmth, and generally the appearance of the slide is improved if now it is cooled rapidly by placing it upon a cold surface; but this is a matter requiring more attention and experiment than has yet been given to it, and though I cannot always depend upon getting this precise form, when obtained, they are very interesting, shewing a combination of the broad crystallization of the tartaric, and the needle-like crystals of the gallic acid. This combination when produced needed a name, and upon recommendation of some chemical friends, it was designated Gallo-tartaric Acid.

Pyrogallic Acid, a substance at the present time well-known to Photographers and Photo-micrographers, next claims our attention, and will yield at least two good forms to the student of Crystallography. By making a cold saturated solution of this acid in water and placing a drop upon the slide, it will very quickly cover the spot with long needle-shaped crystals; but if a very minute shower of some insoluble foreign substance be allowed to fall upon the solution when on the slide, the effect is grand,—each minute speck forming a nucleus around which the needle crystals gather, forming, if examined with a selenite slide, so resplendent an object that no words of mine can adequately describe it.

Hippuric Acid will also be found worthy of all the attention that can be given to it, and upon experiment would probably yield many varied results. I will mention two I have produced, known respectively as Circular and Floral Crystals.

Circular, or as they are frequently called, Wheel Crystals, may be obtained by making a strong solution in pure alcohol; in this case methylated spirit not answering sufficiently well. Drop on a warm slide a little of this solution and immediately hold over a spirit lamp, removing the slide from warmth directly the crystals begin to form; but should the crystallization stop, it can be caused to recommence by again warming.

Floral Crystals may be obtained from the same solution, but it must be dropped upon a cold slide; and if the slide is gently waved about to evaporate the alcohol, the floral crystals will form; and the suggestion may be offered, though I have never put it to experiment, that if a rotary movement is given to the slide the crystals, as they form, will be a combination, possibly taking the character of circular florets.

As a conclusion to my selection of acid crystallizations, your attention must be directed for a moment to Citric Acid, which, although a most difficult form to produce, is so strikingly beautiful that it deserves the expenditure of all necessary time and trouble. The most successful plan with this acid is to make a very strong solution in cold water; place a drop on centre of slide and at once pour off all surplus fluid, leaving as it were only a film. Put the slide on one side for a short time, say half-an-hour, then warm very gently and but slightly, and allow to cool very gradually; repeat these operations until the rosette crystals are formed. This may occur at the first cooling, or it may take several applications; sometimes in fact it is found impossible to cause them to form at all, and as it is noticeable that when formed, too much heat will cause them to disappear, it may be that too great a warmth in one of the warmings is the cause of their non-appearance.

All the crystals yet described, except the last, should be mounted in pure Canada balsam; but this last preparation is best mounted in a solution of evaporated balsam in Benzole.

Passing now from the acids to the salts of some of the metals, I would direct your attention to Potassium and Sodium, which yield with little trouble many good forms of Micro-crystallization. These salts include the Arseniate, Carbonate, Chromate, and Bichromate, Bitartrate, Chlorate, Iodide, Nitrate, Oxalate, Ferricyanide, Ferrocyanide, Sulphate, Urate, &c. Of these I need only mention one or two which have been brought more particularly under my own observation and preparation.

As in the acids, I will refer first to one that offers but little difficulty to the amateur mounter—the Chlorate of Potash. The most typical form of this salt is that in which the crystals are each separate and distinct. To obtain these, it is necessary to make a strong solution in hot water, and to place a little of this solution upon a slide (previously breathing upon the slide, which causes the liquor to spread evenly). The slide must then be placed on one side, that the crystallization may proceed gradually, and if the solution has been made from pure chlorate, the crystals will be large and fine.

For the imperfect, or as they are generally known, the dendritic crystals, place a little of the same solution upon a slip and heat over spirit lamp. Immediately the crystals begin to form at any point, at once tilt the slide away from that point, so that all surplus liquor may run off, then continue the crystallization by gentle warmth.

Somewhat similar in outward appearance to the separate crystals of Potassium Chlorate, I may here mention those of Sodium Nitrate, which are, however, obtained in a slightly different manner, and offer a little more difficulty in the production.

A strong, nearly saturated solution, must be prepared in cold water, and a drop put upon a cold slide. In a very short time crystals will reveal themselves as small points rising from the surface of the liquor. At once all surplus mother liquor must be poured away, and the slide must be gently warmed over a spirit lamp; and at the same moment it will frequently be found advantageous to blow upon the surface of the slide. I cannot offer any reason for this why it does good, but it is often to be noticed that these little dodges improve materially the character of a slide.

Potassium Ferrocyanide, or Prussiate of Potash, can be made to assume very beautiful dendritic forms, but the plan found to answer best with this is to make a hot, nearly saturated, solution in water, and then placing a drop of the solution on warm slide, jerk off with a rapid movement of the hand all surplus liquor. The jerk, which leaves but a thin film upon the slide, also very quickly causes the cooling of the slide and the instant crystallization of the salt. It may be suggested that the same process may be sucessfully employed with many other salts. The Potassium Chlorate is said to be a success by this method, as also is Barium Chloride.

Biborate of Soda, or Borax, is not a difficult slide to produce, but when formed and mounted safely in Balsam and Benzole, it must be allowed to dry naturally, as the application of even very moderate heat will cause the utter destruction of every crystal. This I learned by sad experience, for some time since having mounted several dozens of this slide I at once placed them above my hob to harden the Balsam, and was annoyed to find all spoilt in one afternoon.

If this salt is allowed to crystallize gradually, from a cold saturated solution in water, the crystals will be large; but if a nearly saturated solution be made in pure alcohol, it will crystallize almost immediately it is placed upon the cold slide, but the crystals will be much smaller than those from the aqueous solution.

Turning now for a short time to the Salts of Ammonium, I will direct your attention to the Ammonium Chloride, known commercially as Sal Ammoniac. This requires only a moderately weak solution in cold water, of which a drop is to be placed upon the slide and then drained off, leaving but little upon the surface. This must then be gently warmed by holding over a spirit lamp, at the same time cooling from above by blowing upon the slide as described before.

Ammonium Bitartrate differs much from the last described both in appearance and in mode of production. It requires a very strong solution in hot water, of which solution a drop should be placed upon a warm slide, and if allowed to cool gradually small and distinct crystals will be formed, which when quite dry, which is absolutely necessary, are best mounted in balsam and benzole.

Ammonium Oxalate also forms a beautiful object, if an aqueous solution is evaporated upon a slide, and mounted in pure balsam; but more beautiful than this is the Ammonium Oxalurate, which is deservedly popular.

Of this latter salt make a hot saturated solution in water; place a little upon cold slip and warm very gently, when circles composed of numerous needle-shaped crystals will commence at the edge of the drop of fluid and extend gradually towards the centre; but the beauty of this micro-crystal is increased if a fine point of wood is held in the centre of the fluid, when the needle-shaped will radiate from this artificial centre.

If instead of this hot saturated solution we take a cold but not quite saturated solution in water, and evaporated still more slowly upon a cold slide, the crystals will assume more distinctly the circular or wheel character previously described, and they are so delicate that when mounted in pure balsam, they become almost undistinguishable unless examined by polarised light.

Before leaving this group I must refer to Ammonium Purpurate, frequently known as Murexide, a salt which is obtainable by the decomposition of Uric Acid, and is also found among urinary crystals in certain abnormal conditions of the secretive organs. A solution of this salt in water, upon evaporation, deposits the crystals in short and flattened four-sided prisms which show well by polarized light, and possess the analytic character referred to later.

Besides the salts of Ammonia described may be enumerated the Borate, Muriate, Phosphate, Sulphate, Urate, and Platino-cyanide; with these I have had but little experience. I may say, however, that of themselves, and in combination with other things, you will find them worthy objects of study or amusement.

Turning now to Magnesium, we find that at present there are not so large a number of its salts that are recognised as micro-crystals; but I must not omit from these the well-known Epsom Salts, or Magnesium Sulphate, which will produce, according to the mode of crystallization, very varying results. The most typical and one readily produced, is obtained from a saturated, or nearly saturated, aqueous solution, which, if allowed to crystalize very slowly on a slide, will result in much larger crystals than if the slide, with a drop of the solution, is very gently warmed. These crystals, if mounted in pure balsam, will, with selenite, form a brilliant slide.

Ammonia Phosphate of Magnesia, or as it is frequently called, Triple Phosphate, is like the Murexide referred to before, a production from urine, and occurs in many different forms, of which the one known as the prismatic form is the most frequent. This salt is not a commercial product, but it is said that the crystals may be obtained by allowing urine to decompose, or by diluting the secretion with water and adding in small quantities, dilute Ammonia solution.

One other salt of Magnesia, the Platino-cyanide, must be referred to, and as well as being one of the most beautiful, it is, of the Platino-cyanides, the most easy to prepare. Most of them, it will be found upon experiment, offer almost insuperable obstacles to any but a scientific chemist.

To obtain these micro-crystallizations, make a strong, but not quite saturated solution in pure alcohol, and place a drop on cold slide, which should be covered with a shade of some kind to prevent the too rapid evaporation of the alcohol. A watch glass will answer this purpose, which allows time for the gradual building up of the desired crystal, but if, as frequently happens, it is found that good crystals have not been produced, drop upon the same spot a little more of the solution, this will re-dissolve the crystals already formed. Again cover with a shade, and in due time new and probably better crystals will be formed. When the crystallization is satisfactory and is also thoroughly dry, the slide may be mounted in balsam and benzole.

Asparagine, another choice crystallization, must not be omitted. The finest results are obtained by making a hot saturated solution in water, of which solution a drop must be evaporated on the centre of the slide, by means of very gentle heat. The slide must be removed from the influence of heat, as soon as an amphorous film replaces the solution, and as the slide cools the crystals will appear. Another form approaching closely that of wheel or circular crystals, described earlier in my paper, may be obtained by having the solution of less strength.

It has probably been noticed that the crystals hitherto described have all been obtained from aqueous or alcoholic solutions, and it is a fact that in each case, although I have experimented with other solvents, as ether and chloroform, the best results have been obtained in the manner described; but I cannot leave this part of my subject without mentioning two crystallizations (those of Salicine and Santonine) of which the best *solution* can be obtained by methylated chloroform; but even in these two cases solutions do not give the best results, and it is noticeable that in all, or nearly all cases where a very volatile solvent is used, the results are not so good as when a slower process of crystallization can be employed.

In the case of Salicine and Santonine a solution does not give so good a result as the process of fusion, and this process may be adopted in at least two different ways: by fusion only on the surface of the slip, and fusion between the slip and cover glass. The best results I have obtained by placing a small portion of either salt on the centre of slide and heating until fusion takes place; and here I may warn you that a greater heat is required than in any other crystals mentioned, and although in other cases the slip may be held between the fingers, I would recommend that now a clip be used. One of those known as American clothes pegs answering admirably. When fusion has taken place, it is necessary to spread the fused mass with a hot needle over the desired surface, keeping the slide still heated until this is done. As the slide cools the crystals will be formed. I have been informed that for these slides castor oil is the best mounting medium, but have invariably mounted them in pure Canada balsam, and I think with good effect.

This process of fusion will be found to be of great advantage in many other cases; but fusion of the second kind mentioned may also in the case of Santonine be chosen with good results, as the process of fusion under the cover glass renders the film of extreme tenuity, and in this case produces a slide of wavy crystals extremely beautiful under a spot lens, and also very permanent.

Of another mode of producing interesting Micro-crystallizations, that of Sublimation, I can only indicate broadly the methods to be employed, as I have not experimented much in this direction; but it is a process which must not be passed over, yielding as it does good results in the case of Benzoic Acid, Anthràcene, Anthraquinone, Iodine, Naphthaline, and many others.

To obtain results by this process, it is really only necessary to place a little of the material in a small box,—a match box for instance, and cutting a hole in the lid of the size required, placing a slide with its well-cleaned surface downward over the hole. If this is placed in a warm place the material will sublime and condense again on the glass above. Of course, should great heat be required in the process, it will be necessary to use something better than the box described; and the material to be sublimed may be placed in a test tube, and the test tube being held by a clamp at the proper distance above a spirit lamp, the slide may rest with its central portion over the mouth of the tube, and will thus receive the sublimation.

Of the crystallization of fatty acids, which would of itself afford ample occupation for anyone wanting a subject, I can say nothing now.

And of the combination of two or more salts, which is a subject requiring, and which will reward any amount of investigation, I can only outline the matter by saying that fine slides *have* been produced of various salts of Copper and Magnesia, Copper and Ammonium, Copper and Potassium, Chromium and Potass, Chromium and Ammonium, and many others, and of which process of combination the Platino-cyanides are fine illustrations.

Some crystals possess a power known as Dichroism, or the presentation to the observer of two colours according to the direction of the light, and which is said to depend upon the absorption of some of the rays of light in the passage through the crystal. This power is possessed by Acetate of Copper, Chloride of

Palladium, and by the Oxalate of Chromium, and Potash and others. Other crystals possess a character which by some is termed Dichroism, but which is, I think, most properly designated Fluorescence, and is well shewn in the Platino-cyanides, more particularly those of Magnesium and Yttrium.

Another peculiarity of some crystals was in 1837 designated by Fox Talbot as Analytic, that is, they have the power of analysing polarized light like a Tourmaline, and when examined on the Microscope stage, do not need the analyser above the objective. This power is possessed by the Platino-cyanides, Boracic Acid, Murexide, Hippuric Acid, Nitrate of Potash, Iodo-sulphate of Quinine, and many others.

The scientific cause of these powers of Dichroism, Analysis, and Fluorescene, as well as Polarization, I pass entirely by, leaving them to be dealt with by others much more fitted for the work. And in concluding, I would ask any who are tempted to take up this subject either in a scientific or *dilettante* manner, to jot down for their own or others' benefit anything which arises from their experiment, as it is from such notes as those, made at my work-table, that I have ventured to prepare this paper.

NOTICES OF MEETINGS.

BOWDON LITERARY AND SCIENTIFIC CLUB.—The current meeting of this Club, held on Monday, December 19th, was devoted to Microscopy, Rev. A. Mackennal, B.A., F.R.M.S., in the chair. A short paper was read by Mr. G. J. Johnson on *Insectivorous Plants*. The chairman exhibited some highly interesting specimens of Deep Sea Dredgings, with sections of Chalk. The Rev. A. L. Watherston, M.A., F.R.A.S., showed crystallizations in process; Mr. Jesse Haworth some beautifully-mounted Peristomes of Moss, with five specimens of *Navicula, Isthmia nervosa*, &c.; Mr. G. H. Fryer illustrations of pure and adulterated foods; Mr. T. D. Hall, M.A., *Hydra viridis*, in process of germination, and *Volvox globator*. The protean changes of Hydra excited much interest. At one moment it appeared as if the completion and detachment of a new individual would be effected under the observer's eye: then again in an instant the ground apparently gained was lost, and things were once more *in statu quo*. This was the first microscopical meeting; but the interest excited, promises much for the future development of this section of the operations of the Club.

LIVERPOOL MICROSCOPICAL SOCIETY.—SOIREE OF ASSOCIATED SOCIETIES.—The Fifth Annual Associated *Soirée* of the Liverpool Literary, Scientific, and Art Societies was held in St. George's Hall on Wednesday evening, Dec. 21st, 1881, when, as on previous occasions, the whole of the magnificent suite of rooms, in addition to the large hall, were thrown open. Every part of the hall was crowded with a brilliant assemblage, and it was estimated that not less than 3,500 persons were present.

The *soirée* was formally opened at half-past six o'clock, in the Small Concert Room, by the Mayor of Liverpool. His Worship, who was warmly received by the assembled company, said there could be no doubt that it was by the aid of the learned societies of the city that a love of art and literature had increased amongst the inhabitants of the city. His predecessor in the high office which he had the honour of filling, congratulated his audience at the last *soirée* upon the completion of the endowment fund of University College ; and he now had the pleasure of congratulating them upon the completion of the College scheme and the first public appearance of the three of the first professors of the College —Principal Rendall, Professor Lodge, and Professor Herdman. (Applause.) It was just seventy years since the first of these societies—the Literary and Philosophical—was founded, and the remaining eighteen other societies were nearly all offshoots from it, This fact indicated a large amount of activity in the various branches of science amongst the commercial classes of Liverpool.

Amongst the lectures—in the Crown Court at 9 p.m., a Lecture, on "Interesting Characteristics in the Life-History of some Common Shell Fish," was delivered by Dr. Hicks, illustrated by the author's original drawings, shown by the Oxy-Hydrogen Light ; and in the Civil Court, at the same hour, a lecture on "Life at Great Depths in the Ocean," by Professor Herdman, D.Sc., F.L.S., which was rendered additionally interesting from the fact of his having been the secretary to the Challenger expedition committee.

The microscopical display was arranged in the following groups, which we give as being useful to other societies :—

ANIMAL KINGDOM.

Sub-Kingdom.	Class.
I.—PROTOZOA. The simplest of all animals, having neither body-cavity nor nervous system	Rhizopoda Infusoria
II.—POLYSTOMATA. (Sponges only) have an internal cavity, one outlet, and usually many inlets...........	... ...
III.—CŒLENTERATA. (Jelly Fishes, Sea-anemones, and Hydra) have a stomach-cavity, and a radiate symmetry........	Hydrozoa ...
IV.—ECHINODERMATA. (Star-fishes and Sea Urchins) have a body-cavity, stomach, nervous and water-vascular systems	Ophiurida ...
V.—VERMES. (Leeches, Worms, Rotifers, &c.) have a body-cavity, alimentary canal, nervous and vascular systems...............	Rotifera ...
VI.—MOLLUSCA. (Oysters, Snails, &c.) have a true heart and blood vascular system, alimentary canal, nervous system, and advanced respiratory organs...	Molluscoida Mollusca Gasteropoda
VII.—ARTHROPODA. (Crabs, Spiders, Insects, &c.) have jointed bodies and limbs, and an external skeleton in addition to the above........................	Arachnida ... Insecta ...

VEGETABLE KINGDOM.

SUB-KINGDOM.	CLASS.
I.—THALLOPHYTA. Simple plants, often unicellular, having neither stems, leaves, roots, nor fibro-vascular bundles. Reproduced by spores or by division of the cells.	Algæ ... Fungi ... Characeæ ...
II.—BRYOPHYTA. Spore-bearing plants, having stems and leaves, but no true roots or fibro-vascular bundles. Reproduced by spores.	Hepaticeæ ...
III.—PTERIDOPHYTA. Spore-bearing plants, having stems, leaves, and roots, all permeated by fibro-vascular bundles. Reproduced by spores.	Filicenæ ... Lycopodinæ
IV.—PHANEROGAMIA. Flowering plants, bearing true flowers and produced by seeds.	Angiosperms

MINERAL KINGDOM.

I.—SEDIMENTARY ROCKS.
Rocks formed by deposit of "Sediment."

II.—ORGANIC ROCKS.
Rocks formed from Plants or Animals.

III.—IGNEOUS ROCKS.
Rocks of Volcanic origin.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the December meeting of this Society (1881) Captain Cunliffe, Vice-President in the chair—

The Hon. Secretary, after reading the minutes of the last meeting, made a statement in reference to the record of *Weissia mucronata*, and through the kindness of Dr. J. B. Wood, of Broughton, was enabled to place before the members specimens of this *mucronate* moss which had been gathered at Parkside, April, 1847, by Mr. William Wilson, and near Mottram by Mr. J. Whitehead in 1868. The Society's herbarium specimen had been presented by the Todmorden Botanical Society from the extensive Nowellian collection in their possession, and had originally been gathered at Airth, in Scotland.

This meeting being the annual one, the following officers were elected:—Dr. B. Carrington, F.R.S.E., President; Captain Cunliffe, F.R.M.S., and Mr. Thomas Brittain, Vice-Presidents; Mr. Thomas Rogers, Hon. Secretary. A brief annual report was read, which showed that the work of the Society had both been satisfactory and interesting. Three new species of Hepaticæ had been discovered as new to the British Flora by members of the Society, two of which had been named by Herr Jack and Dr. Spruce, in honour of Dr. Carrington and Mr. Pearson, as *Radula Carringtonii* and *Lepidozia Pearsoni*.

When Dr. Carrington first determined the specific characters of the Radula, he provisionally named it in honour of his friend the late Dr. Moore, of Dublin, but the publication had been preceded by Herr Jack's name as *R. Carringtonii* (Jack).

The Secretary as Treasurer of the Society, stated that the financial condition of the Society was improving, and that the debt incurred for herbarium purposes would soon be paid off.

The thanks of the Society were accorded to the Royal Microscopical Society for copies of the proceedings and Journals of their Society, and to Miss Marian Ridley for a copy of a recent work she has had published as a "Pocket Guide to the British Ferns." Thanks were also accorded to Mr. J. Cash for two copies of his moss labels, and to Mr. W. E. A. Axon for a reprint of his paper on *Tricophyton tonsurans*.

The Secretary's reports having been adopted, Captain Cunliffe exhibited two old interesting books on Cryptogamic Botany; one by Hedwig (published 1782), the other by Dillenius (published in London, 1763). In this latter book it is interesting to note that one of the habitats given for a plant near Manchester was "On the breaking of Medlock river bank at *Easington Wood*, between Garrett and Knot Mill, about a mile from Manchester."

Mr. W. H. Pearson exhibited specimens of the new hepatics described by Dr. Spruce recently in the "Revue Bryologique," as *Marsupella Stableri* and *Marsupella divacea*, both collected by Mr. George Stabler; specimens of the former being presented to the Society's herbarium by the discoverer. Mr. Pearson also exhibited specimens of *Gymnomitrium adustum* Nees (*verum*) new to Britain, collected by himself last August in Wales.

The Hon. Secretary read a few Bryological notes from some correspondence which Dr. J. B. Wood had kindly placed at his disposal. One of the notes referred to specimens of *Campylopus paradoxus* of Wilson, which had been collected some few years ago in swampy ground on Cader Idris by one of the Society's members (Mr. Percival). Its claims to specific distinction has been much disputed, as the name implies; but Juratzka has recently decided that it can only be recognised as a variety of *Campylopus flexuosus*, to which he gives the varietal name "uliginosa." Another of the notes referred to the new classification of the *Harpidium* group of *Hypnums* by Renauld, as published in a recent article in the Revue Bryologique. Bryologists in this neighbourhood will be surprised to find that he places the well-known *Hypnum exannulatum* as *Hypnum fluitans* in his classification, and that he considers that certain monoicous species appear at times dioicous.

The following correction has been sent us.—[Ed.]

Sir,—In your last issue I see it is stated by Captain Cunliffe, who presided at the last meeting of the Manchester Cryptogamic Society, that he had found the rare *Weissia mucronata* near his house at Handforth. He also stated that the above moss was an addition to the district of the Manchester flora. As the latter statement is certainly erroneous, I think it ought not to pass uncorrected. In Buxton's Guide to the Plants round Manchester, published in 1859, I find the following record of its discovery in the district:—"*W. mucronata*, Fallowfields, Park side, W. Wilson, Esq." I also find the same locality repeated by the late lamented Mr. Hunt, in his List of mosses occurring in the neighbourhood of Manchester, in the report of the Manchester Field Naturalists' Society for 1863. On referring to my Herbarium I also find that I and Roger Scholefield found the same moss in Hattersley, near Mottram, Cheshire, April, 1868. It is interesting to notice that *Gymnostomum squarrosum*, another rare species, is associated with *W. mucronata* in the three localities mentioned above.

Brunswick-street, Dukinfield. John Whitehead.

MANCHESTER FIELD NATURALISTS' SOCIETY.—At the Dec. meeting of this Society a paper was read by Mr. W. Thomson, Analytical Chemist, of Princess-street, upon "Minute Forms of Vegetation." The reader brought before the notice of the members the fact that the sporules of the minute forms of vegetation of which he had to speak were to be found in the atmosphere, though they could only be discerned by the naked eye when a beam of sunshine entered into a room. The amount of work which those minute forms of vegetation were capable of doing, from year to year, was greater than all the armies and navies of the world could accomplish even if they were joined together. Their power of destruction was great, but they were of vast service to mankind when properly used, and we might take it that the greatest part of the income of the Government was derived from the cultivation of some of the minute fungi. After describing certain fungoid diseases peculiar to insects, the essayist said that certain species attacked the human subject. These might be divided into two classes, one which attacked the hair of the scalp, and the other the body. The first, which was known in Edinburgh as *Favus*, was a peculiar straw-coloured eruption on the hair of the scalp. It was exceedingly difficult to free a person from it. That fungus, which was known as *Achorion Schonleinii*, was sometimes found upon mice, and had been traced from the mouse to the human subject. The cat ate the mouse, the lady fondled the cat, and thereby got the fungus upon her skin. It had been clearly shown by investigation to be so in at least one instance, where that peculiar kind of fungus was transmitted to a whole family through the cat. Another fungus which affected the hair of the scalp was the ringworm (*Trichophyton tonsurans*). Another kind of fungus, the *Microsporon mentagrophytes*, attacked the hair, multiplied rapidly, and broke it up by the roots. Those kinds of fungi acted much more seriously on the human subject in India than they did in this country. One species of fungus produced baldness without causing irritation, though there were, of course, other causes of baldness besides the presence of a parasite. After referring to other forms of fungi, one of which manifests itself under the nails of the human subject, while another has been observed in India, where it attacks bones and sometimes necessitates amputation. Some minute forms of vegetation attacked wood, and produced what was popularly called "dry rot," while others formed the mildew that caused so much loss by damaging the grey cloth which Manchester merchants sent to India and other places. The fungus in question converted the cloth into tinder by a peculiar action, in which the whole fabric became a complete pulp by the simple interlacing of millions upon millions of minute sporules. If we were to take the grape and squeeze its juice into a vessel in such a way as to prevent it from coming in contact with the sporules which were continually flying about in the air, wine would not be produced. The sporules of the *mycoderma vini*, which helped to produce wine, stuck to the skin of the grape; therefore in making wine the grapes were first pressed and then the skins were thrown in among the juice, fermentation being caused thereby.

At the close of the paper, Mr. John Barrow, F.R.M.S., made a few remarks to the effect that having on a previous occasion had ample opportunity of studying *Trichophyton tonsurans*, he had to confess that his observations were entirely different from the diagrams Mr. Thomson had put before them. Had the reader ever seen the spores so plainly as shown in the diagrams? as he had never been able to do so.

Mr. Thomson, in his reply, said that if there was any error in the diagrams, it was not his fault, as he had carefully reproduced them from standard works upon the subject, but from his own way of thinking he regarded them as accurate. He had several slides illustrating the fungus in question, and should be happy to show them at the close of the evening. This was attempted, but the exhibition of the spores was not successful, owing, perhaps, in a great measure, to the sections being too thick.

MANCHESTER MICROSCOPICAL SOCIETY.—The following is an abstract of the paper read at the November meeting upon *Cysticercus cellulosæ*:

Mr. John Smith, M.R.C.S., commenced by premising for the information of any of the members not conversant with the subject that Cysticercus, as well as its mature relation Tænia, was pretty generally to be found amongst animals;

that each had its favourite host, and that it seemed to be a pretty constant law that both were seldom or never found to exist in the same animal.

The *Cysticercus cellulosæ* was the higher larval intermediate stage of growth of the *Tænia solium*, one of the tape-worms infesting the human body, and in this its encysted conditions was technically called a scolex, a name given when it was ignorantly supposed to be a distinct animal. *Cysticercus cellulosæ* was then described; its four projecting discs or suckers, conical rostellum, double circle of hooklets, calcareous particles, and water vascular system of vessels, being illustrated by slides and diagrams. Attention was drawn to the curious fact that Cysticercus in swine was alone distinguished from that of man by possessing only twenty-four to twenty-six hooklets, instead of thirty-four to thirty-six as occurs in the human subject. The body of a Cysticercus was entirely asexual, and terminated posteriorly in a bladder or cyst in which the animal was often found invaginated like the inverted finger of a glove. Although a misnomer, it was convenient to speak of the anterior extremity of a Cysticercus as the head, but there were no traces to be found of oral appendages or digestive organs, the animal appearing to be nourished by imbibition through the skin. Unlike its mature relation, Tænia, a Cysticercus was never found in any part of the body communicating with the external air, but nearly always encysted and inhabited the voluntary muscles, inter-muscular areolar tissue, liver, heart, lips, tongue, and other parts of the body, including the eye and brain. In open cavities it floated without any enveloping cyst. The cyst was developed at the expense of the tissue in which the animal was imbedded. It was commonly found in swine, less commonly in the ape, dog, and sheep, and, fortunately for us, very rarely in the human subject.

The life history of *Cysticercus cellulosæ* was then described. The mature joints or of *Tænia solium* being expelled from the body of the animal harbouring them were conveyed with excrementitious matter on to the land, or found their way into wells, ponds, or streams situated near human habitations. The ova being protected by an exceedingly tough chitinous shell retained their vitality for a great length of time, and, becoming attached to vegetable matter, were swallowed by different animals, such as pigs and sheep, eventually developing into Cysticercus in their bodies. In cases which had occurred in the human subject salads and other uncooked vegetables, also fallen fruit were the means of infection. The disposal of sewage on market gardens and farm lands was for this and other reasons not such an unmixed blessing as some people supposed. The ova being swallowed the contained embryo or pro-scolex (vesicular in form and only about 1-1250 of an inch in diameter), was set free either during mastication or digestion and resisting the action of the gastric secretion immediately commenced to migrate, passing through the intestinal wall by means of six boring spines which being approximated formed an exceedingly minute piercing instrument. Gaining access into an intestinal vein it was carried by the portal vein to the liver, or by a current of arterial blood was transported to distant parts of the body, and becoming encysted attained its intermediate stage of development as a Cysticercus.

The transition of the scolex into the Tænia was then described. The measle being swallowed, the vesicle or bladder disappeared, the cysticercus however resisting the action of digestive secretions retained its vitality, joints or strobila were developed by a process of budding and passing on to make room for those more recently formed, became eventually sexually mature, each joint being hermaphrodite and largely composed of reproductive organs. It has been computed that each sexually mature joint contained 30,000 ova, and the wonder was that measled meat was not more commonly found, but the majority of the eggs eventually decomposed and perished, or were consumed by animals whose organism was unfavourable to their development. The use of the suckers and hooklets was now apparent, the so-called head of *Tænia solium* being so firmly fixed to the intestinal wall that it was only rarely it could be found. The upper part of the Tænia still represented the cysticercus, indeed a Tænia was in reality a cysticercus plus the joints and minus the vesicle. Cobbold's account of Leuckart's experiments in tracing the development of the embryo were then epitomized. The meat measle had been known from time immemorial. The Mosaical injunction to abstain from eating swine's flesh being probably founded on a knowledge of the mischievous effects of Cysticercus and Trichina on man, and was one of the many wonderful rules of hygiene contained in the Levitical law. The pork measle had been alluded to in one of the Greek plays of Aristophanes, and was therefore known to the Greeks, who, with the Romans, called it the "hailstone" disorder, from the resemblance of the glistening measly cyst to a hailsone. It was long thought to be a distinct animal, and supposed to arise spontaneously, as there seemed to be no evidence of any process of generation such as existed in other animals, although the calcareous was supposed to be ova. Pallas, in 1766, affirmed that cysticerci would be found to be immature tapeworms. At length, in 1842, the discovery of the successive alternations of development of the *Cercariæ* gave the long-sought-for clue, and in 1851, Kuchenmeister and Von Seibold, by a series of feeding experiments on animals, proved the fact that the cystic were converted into the cestoid entozoa or tapeworms. Cysticerci were administered with the almost invariable result that Tæniæ were afterwards found, and the converse experiment of feeding the animals with the joints or ova of tapeworms resulted in the development of cysticerci in their bodies. As a preventive it had been proposed to submit to the action of fire excreta containing the strobilæ of tapeworms, but for obvious reasons this could not be carried out.

A learned physician had remarked that man had not inaptly been defined as the cooking animal, for amongst the innumerable animals found in creation, man alone cooked his food. In perfect cooking lay the true remedy, because if the measle were destroyed the perfect animal or Tænia would cease to exist, and it had been found that a temperature as low as 140° was sufficient to destroy the meat measle.

MANCHESTER MICROSCOPICAL SOCIETY.—At the ordinary monthly meeting of the Manchester Microscopical Society, held in the Mechanics' Institution, Dec. 1st, 1881, Mr. John Boyd, president, in the chair, Mr. George E. Davis exhibited a series of metal caps, devised by Enock in order to protect glycerine mounts. These caps are made to fit Pumphrey's vulcanite cells, and prevent the cover being pushed off.

The President described a new method of making cells of wax for mounting opaque and transparent objects; and urged for their adoption that, as it takes no more trouble to make a thick or deep cell than a thin or shallow one, it is a very expeditious method—no waiting for varnish to dry before you can apply another coat. Again, the cell is not soft enough to crush by ordinary accident, and the tenacity of wax will enable it to withstand any ordinary blow without removing the cover, which is a great advantage over the ordinary cement cell.

Mr. F. W. Lean read an interesting communication on the Larva of the Crane Fly. He illustrated his remarks by two coloured drawings which he had prepared for the purpose.

Mr. J. L. W. Miles called attention to a simple substitute for the paraboloid or spot-lens, for obtaining dark field illumination, by using the bull's-eye condenser under the stage of the microscope, the plane side being turned up, with a spot of black paper in the centre. Tube fittings under the stage of microscopes should be removed in order to get the condenser sufficiently close to the stage. Another useful contrivance in place of a revolving table was, in its simplest form, a piece of table oilcloth about fifteen inches square, the cloth side turned to polished tables and the oil side to painted tables. This would carry an instrument and lamp round ordinary tables very smoothly.

Mr. E. Ward said that at the suggestion of Mr. Miles he had used the oil-cloth carrier, and was much pleased with its simplicity and usefulness.

The President, Mr. Brittain, and others described various modifications of this plan.

The President announced his distribution of the eggs of the parasite of the partridge, and Mr. Fleming's distribution of a series of starches. Mr. Thomas Brittain, vice-president, having read a paper on the Structure and Modification of the Organ of Sight, the usual conversazione followed, but most of the members went upstairs to visit the exhibition of the Photographic Society, from whom a general invitation had been sent by the courteous secretary, Mr. Chadwick.

MANCHESTER MICROSCOPICAL SOCIETY MOUNTING CLASS.—The Mounting Class in connection with the Society has again got into full operation for the winter session. Numerically the class is a strong one, and also includes about a dozen gentlemen who were members last session, who continue to take great interest in the work done, which is always practically demonstrated by the presiding operator. At the last meeting (the third of the session) Mr. Miles officiated, and illustrated mounting in balsam, a transparent medium which permanently secures an object between the slide and the cover, and gives it the appearance of being beautifully embedded in glass. Mr. Miles further successfully demonstrated deep-cell ringing with white zinc varnish, an article very difficult to manage, but giving a very handsome finish to mounts, hardening with age. This latter operation was watched with much interest. Theoretically, the idea is to "build up" the varnish, but in practice Mr. Miles showed that the proper plan is to begin at the top of the ring and allow the varnish to gently fall down the sides by gravitation, assisted by the sable pencil. Of course, the best and most artistic results will only be obtained after considerable practice. Rich foraminiferous sand from Dog's Bay, Ireland, was distributed by Mr. J. A. Furnival, who kindly promised to officiate at the next meeting, taking glycerine jelly as the mounting medium.

MANCHESTER SCIENCE ASSOCIATION.—The third Soirée in connection with the Science Classes of the Manchester Mechanics' Institute was held on Saturday, December 17th, when in spite of the miserably wet evening a very numerous assemblage filled the different rooms to overflowing. A splendid collection of ancient and modern scientific instruments, art models, machinery, chemistry, and most branches of science, whether for amusement or purposes of trade, had been provided by the members of both Societies, generously aided by gentlemen from the Manchester Microscopical Society, Photographic Society, &c. The news and art rooms contained the principal part of the Exhibition, while the lecture hall was devoted to a laughter-evoking lecture by Mr. Thomas Harrison, entitled "The Science of Humour," illustrated by photographs from Punch, of 'John Leech's' caricatures, and Caldecott's 'Mad Dog,' which were shown upon the screen by Mr. Chadwick, the Hon. Sec. of the Photographic Society.

The following is a list of the Microscopical objects:

ANIMAL.

Limnæus stagnalis	Mr. Jas. Fleming.
Volvox globator *Lophopus crystallinus* Vorticella	Mr. Robt. Graham.
Daphnia pulex *Hydra fusca*	Mr. J. L. W. Miles.
Spirogyra quinina *Melicerta ringens*	Mr. E. W. Napper.

Fairy Shrimp Brittle Star Fish Tongue of Lance Fly	Mr. Alston.
Cheese Mites (alive) Gizzard of Beetle Palate of Snail Mandibles of Caterpillar Biliary vessels ,, Nerves ,, Barbed Hair ,,	Mr. H. Hall.
Trichina spiralis Ova *Œstrus equi* in situ Larva ,, ,, T. Sect. Stomach of Frog *Tænia cercumerina* } Head. ,, *marginata* } *Strongylus paradoxus* (Pig) ,, *tetracanthus* (Horse) *Trichodectes Equi* (Louse of ,,)	Mr. J. B. Wolstenholme, M.R.C.V.S.
Pediculus vestimenti (without pressure) *Pulex musculi* ,, ,, T. Sect. inject. Human Kidney ,, *Goniodes stylifer*	Mr. J. Percival Yates.

VEGETABLE.

Sect. of Mistletoe ,, Clematis ,, Dog-rose	Mr. Alston.
,, Black Pepper	Mr. E. B. Cook.
Sect. of *Rosa canina* (Polar)	Mr. A. J. Doherty.

MINERAL.

A collection of Minerals shown as Polariscope objects—Mr. Wm. Leach.

Sect. of Coal ,, Rocks Polycistina Ocean Ooze	Mr. Wm. Gee.

Micro-Photographs—Messrs. Gee, Napper, Ward, Yates.

Zoophytes Stained wood Sect.	Mr. Ed. Ward.

Botany and Natural History were chiefly represented by Mr. Henry Hyde, who exhibited two pictures—one of ferns and the other of autumn leaves, and a quantity of special objects, each mounted in a glass case for class demonstration.

NEWCASTLE-ON-TYNE LITERARY AND PHILOSOPHICAL SOCIETY.—A Musical and Microscopical Conversazione was held in the Rooms of this Society on Friday, Dec. 16, 1881. The members of the North of England Microscopical Society attended with their instruments, and notwithstanding the inclemency of the weather, the meeting was a most successful one. The microscopical display occupied the Museum of the Natural History Society. It included the following objects:—

Micro-fungi	John Arthur.
Section of Meteorite	T. P. Barkas.
Section of Echinus Spines	John Brown.

Various objects under Polarized Light ...	...John Brown, jun.
Blood Corpuscles (human)	Joseph Craggs.
Crystals in New Skin, &c., of Prawn; also, Piercing Apparatus of Flea	J. G. Dickinson.
Preparations illustrating the comparative Anatomy of the Ear	Dr. Ellis.
Feet of Insects	Henry French.
Euglena viridis	George Harkus.
Sections of Marble and Carboniferous Limestone ...	R. A. Lewis.
Section of Human Lung in Health and Disease; also Sections of Hairy Scalp and Skin, showing Sweat Glands, &c.	... Dr. May.
Process of Crystallization under Polarized Light ...	John Ridsdale.
Halo Slides; Microspores of Truffle; also Fused Iron	Frederick Robson.
Circulation of Blood in Isopod; also Cyclosis in Nitella	M. H. Robson.
Plant Hairs and Eggs of Insects	T. H. Swallow.
Various	Alfred Thompson.
Foraminifera, &c.	Mason Watson.
Spicula of Sponge, &c.	Joseph Wright.
Eggs of Moths and Exuviæ of Museum Beetle ...	J. B. Young.
British Mosses	Alfred Hume.
Insects, whole and in parts, with dark ground illumination	William Gillespie.

NORTH OF ENGLAND MICROSCOPICAL SOCIETY.—The monthly meeting of this society was held on Wednesday evening, December 14, 1881, in the Patents Room of the Literary and Philosophical Society. Dr. Ellis occupied the chair. There was a good attendance of members. Two auditors, Messrs. Gillespie and Harkus, were appointed, and one new member elected. Dr. May read a paper on "Bone under various aspects," showing the beginning (so far as has been ascertained) from embryonic stage, to maturity and ultimate destruction, of which the following is an abstract:—He said—I have culled a few facts from the anatomical works of Erasmus Wilson, Gray, and the Physiological writing of Dr. Kirkes, at present edited by W. Morrant Baker. Some facts also that have come under my own observation I have ventured to mix up with the well-attested and world-known writings of those eminent men which I have collected from these sources, and with the few specimens of old and young bones I hope I shall not be tedious. The subject matter is very important and very voluminous, too much so for one evening's reading, nevertheless I shall venture to ask your kind indulgence, and hope it may induce other members to come forward with papers and make our meetings more useful and instructive. Bone is composed of one-third animal matter, which is almost completely reducible to gelatine by boiling, and two-thirds of earthy and alkaline substances. In these proportions:

Cartilage	32.17	parts.
Blood vessels	1.13	,,
Phosphate of Lime	51.04	,,
Carbonate of Lime	11.30	,,
Fluoride of Calcium	2.00	,,
Phosphate of Magnesia	1.16	,,
Chloride of Sodium	1.20	,,
	100.00	

It strikes one as an essential that the framework on which is built the human form divine, should be sufficiently strong with a certain amount of elasticity to support and give attatchment to the muscular portion of our economy, and to enclose our vital parts with a firm and protective strength to shield our lungs, brain, digestive, and other important organs from external violence. Fresh bone is white externally, and deep red within. On examination, it has two kinds of tissue, one the *external dense* and ivory like, the *internal* consisting of slender fibres and lamella, which join to form a reticular structure. This is the cancellous, from its resemblance to lattice work. The relative quantities of these two tissues vary in different bones, and in different parts of the same bone, as strength or lightness is required. Minute examination of the ivory like external crust shows it is very porous, so that the difference in structure between it and the internal cancellous structure depends merely upon the different amount of solid matter, and the size and number of spaces in each, the cavities being small in the compact tissue, and the solid matter between them abundant, whilst in the cancellous structure the spaces are large, and the solid matter diminished in quantity. By steeping bone in diluted nitric acid, or muriatic acid, we chemically remove the earthy portion of bone, leaving a tough semi-transparent substance, which retains its original shape. This is often called cartilage, but in fact it only requires to be boiled under pressure, when it will be seen to be nearly all gelatine. To get rid of the organic matter we have only to subject the bone to good clear fire, and we obtain the earthy portion of the bone. Both constituents retain the singular property of remaining unaltered in chemical composition after a lapse of centuries. Bones of the head contain more earthy matter than the bones of the trunk, and so also have the long bones of the extremities; as we grow older the earthy matter preponderates. Hence old people's bones are easily broken. Children's bones often bend, and may be straightened without a fracture, or may be fractured but not separated, like a green wood,—hence, called *greenwood fracture.* In children, where the animal matter preponderates, it is often found the long bones often bend, either from the action of the muscles or from violence. Some of the diseases to which bones are subject depend on the disproportion of the organic or animal matter to the earthy. Thus in rickets, the bones become bent and curved, either through the weight of the superincumbent body or action of muscles; this is from defect of nutrition not supplying the necessary earthy matter. In the skeleton of a rickety subject the animal or soft tissue has been found to be as high as 79-75, while the earthy proportion has only been 20-25. As to the form of bone, nature has made no mistake, but has afforded the architect many examples of strength and beauty, as exemplified in the arch of the foot and cranium. The long bones are hollow cylinders, in which is found medullary matter, commonly called marrow, forming a soft envelope for the blood vessels, and which is contained in an inner lining similar to the external periosteum. On examining the surface of most bones, there will be found little eminences or processes, tuberosities, tubercles, spines, ridges or lines; there are also various depressions, such as fossa grooves, furrows, fissures and notches. These all give attatchments to the various muscles, or go to form the various articulations or joints; if a fine section of long bone, transverse, is seen under a low power, a number of apertures are seen surrounded by concentric rings, with small dark spots, grouped around, also in a concentric form the apertures, which are dark looking, are the *Haversian Canals*, called after the discoverer (Clopton Havers): the concentric rings are sections of the *lamellæ*, which are developed round the Haversian Canals; the little dark spots are called *lacunæ*. The canals afford a passage to the minute blood vessels which go to nourish the bone; they are lined by a delicate membrane continuous with the periosteum. The *periosteum* is the fine skin covering all bones, and supports a dense network of fine blood vessels, which give nourishment to the dense external tissue of bones; the cancellous internal structure is supplied by blood from vessels which perforate the external dense structure through foramens. Bones are well supplied with blood vessels, and sometimes bleed very freely when wounded—in amputations are sometimes plugged, to stop the flow. When bones are deprived of their periosteum, they frequently exfoliate or throw off plates of diseased bone, or may become necrosed or dead. The medullary canals of adult long bones contain marrow as well as the cancellous tissue, likewise the Haversian canals in young bones; it is a transparent reddish fluid, in the long bones of adults it is yellow and fatty.

Bone is developed at a very early period ; the spine and cranial bones are first developed. At first, the parts destined to become bone consist of a congeries of cells connected together by an amorphous blastema, which constitutes the simplest form of cartilage ; this assumes a complete miniature of the form of bone it is destined to lay the foundation for, in fact *is* a temporary cartilage, which in due time becomes converted into bone, and as ossification is a slow process and not completed until adult life, it grows in size by interstisitical development of new cells. The ossification of this temporary cartilage commences at certain points or centres from which the process extends into the surrounding substance. In the fifth to seventh week the bones commence growing in the embryo ; first, in the clavicle or lower jaw, then the vertebra humerus femur ribs and cartilaginous portion of occipital bone. I think it scarcely necessary to go through the whole of the skeleton. I have brought to your notice the fact that bone begins to develope at this period of uterine life. I should have liked to have shown the new formed bone, but from various causes I have not been able to do so. For a long period after birth a thin layer of unossified cartilage remains between the extreme articular end of long bones and their shafts, until their growth is fully completed, their function taking place either at the period of puberty or towards the end of the period of growth. It is important that surgeons should know when the epiphysis become joined to the shaft, as it aids in diagnosing many injuries to which joints are subject, for it not unfrequently happens that on application of severe force to a joint, the epiphysis may be separated from the shaft, and such injury might be mistaken for fracture.

GROWTH OF BONE.—Increase in length, by development of new bone in the cartilage at either end, and in thickening by the deposition of soft ossifying blastema in successive layers upon the inner surface of the periosteum.

There are 200 distinct bones in the human skeleton :

Vertebral Column, including Sacrum and Coccyx	26
Cranium	8
Face	14
Os Hyoides, Sternum and Ribs	26
Upper extremities	64
Lower do.	62
	200

There are sometimes a few very small loose bones called the Wonnian bones found in the sutures between the bones of the head. The bones of the ear are three, and occasionally some seed-shaped bones are found. The teeth are not included. There are twelve ribs on each side of the body; the first seven are connected with the sternum or breast bone by cartilages, this allows the chest walls to enlarge when we inhale the air, they rising up to increase the size of the chest. The first seven ribs, called sternal or true. The remaining five are asternal, or false ribs, and the last two, shorter than the rest, floating ribs. The ribs articulate with the spinal column and the sterum.

NOTE. There is an opinion, I believe I might say a popular one, that in amputating a limb the greatest pain is felt when the marrow is cut through. This, I need scarcely say, is an error.

NOTE. Shaft, Diaphysis. Ends, Epiphysis.

The Chairman complimented Dr. May upon his very concise and accurate summary of the subject, and a vote of thanks with acclamation was passed to the doctor, for his very able contribution. Mr. T. H. Swallow exhibited a longitudinal section of the jaw of a mole, with teeth in situ; Mr. H. French, longitudinal and transverse sections of bovine bones; Mr. M. H. Robson, fossil bones (carboniferous); and Dr. May, various sections and examples of human and other bones in health and disease, with explanatory remarks forming an addendum to the paper previously read.

NOTES AND QUERIES.

OBITUARY.—The death is announced from New York of Dr. John William Draper, the eminent author of several scientific and philosophical works, and whose name has already been mentioned in these columns, with regard to early photo-micrography.

SALMON DISEASE.—The fungoid disease has extended so much among the salmon of the Tweed that a few days ago in a single pool no less than 75 dead salmon trout and grilse were counted, the heads, backs, and bellies of which were affected with the fungus. During the past few weeks anglers on the river have landed and also detected large numbers of sea trout similarly affected. It is considered that fully one-half of the fish are diseased, and many are lying dead about the river. Some have been taken out with parts of the nose eaten away, and when cut up they emit a most offensive smell. The fish appear to have come into the river with the fungus upon them, as new run fish have been taken in a diseased condition, and many of them are so enfeebled by it as to be unable to ascend the weirs, and consequently congregate in pools and die. It is feared that, in addition to the incalculable havoc which the Norwegian trout commit in the river in the devouring of fresh-water trout, they have also infected the latter with the disease.

LINACRE PROFESSORSHIP.—The long-delayed appointment to the Linacre Professorship of Physiology at Oxford, vacant by the death of the late Professor Rolleston, was settled a short time ago at a meeting of the electors held at Lambeth Palace, when Mr. H. N. Moseley, M.D., was selected. Mr. Moseley is well known in London as a lecturer on scientific subjects at Philosophic and Literary Institutes.

METROPOLITAN SCIENTIFIC ASSOCIATION.—At a meeting of the Metropolitan Scientific Association, held at Bloomfield Street, Finsbury Circus, E.C., on Tuesday, Nov. 8th, 1881, the President,

W. H. Davies, Esq., in the chair, a paper was read by Mr. H. T. Vivian, F.R.A.S., one of the vice-presidents, on "The Principles which Guide Opticians in the Construction of Achromatic Combinations of Lenses," in which Mr. Vivian explained the difficulties which had to be overcome from the imperfection of the images formed by single lenses, and the mode of ascertaining whether in any combination the imperfections had been removed. Mr. Vivian exhibited a microscope, having an objective which he had himself constructed, in which he had given the lenses that form which he considered would best remove the imperfections, and which showed objects with great distinctness of outline and freedom from colour.

The Vertical Illuminator.—At a meeting of the Royal Microscopical Society, held early last year, Mr. T. Powell begged to call attention to his exhibit of *A. pellucida* dry on the undersurface of the cover-glass and without base-slide, illuminated by the Vertical Illuminator, and viewed by his new 1-12 oil immersion of 142° balsam angle. It will be remembered that at the Scientific Evening a similar exhibit had been made, and it had been suggested that the illumination was really reflected upwards from the surfaces of the base-slide. In order to meet that explanation of the illumination the object was now completely exposed on its underside —there was no glass surface beneath to reflect light.

Mr. Crisp said that Mr. Powell's exhibition touched upon a curious optical phenomenon, namely, whether or not this was strictly "opaque" illumination. Mr. Stephenson had suggested to him that *A. pellucida* was not itself sufficiently *opaque* to scatter by ordinary reflection so bright a light as was seen in the microscope, and that inasmuch as the image was only seen by using an immersion objective of numerical aperture greater than 1.0, it may be illuminated by a part of the zone of rays transmitted by the objective of greater inclination than the "critical" angle—the diatom, being in intimate contact with the underside of the cover-glass, allowed these rays to pass into itself, and they could not wholly emerge at the under-surface of the diatom by reason of portions of the surface acting as total reflecting surfaces, and thus reflecting back through the diatom these *extra* oblique rays which the large aperture of the objective transmitted to the eye of the observer as a remarkably fine resolution of the dry diatom. In fact, he regarded the diatom thus mounted to be "immersed" (to a considerable extent) on its upper side, whilst its under-side was exposed to air.

In this view the explanation of the illumination appeared to him rational: the "immersed" side of the diatom *cancelled* the total reflection, which could be seen to take place in the adjacent parts of the field (the image of the lamp-flame being plainly discernible), but the underside of the diatom being in air (a less refracting medium) a portion only of the light escaped, owing probably to minute undulations of the surface, the greater portion being totally reflected upwards.

In recent discussions in America, the illumination with the vertical illuminator had been assumed to be "opaque" as a matter of course, and many microscopists had allowed the assumption to pass without a critical examination. He thought, however, that Mr. Stephenson had completely explained the illumination to be *not* "opaque."

Mr. Powell said he did not by any means insist that the illumination shown was strictly that known as "opaque"; but he might mention that with an opaque object like a diamond-beetle's wing, the illumination by the vertical illuminator was strictly "opaque"—that is, the object was viewed by means of the light which it reflected.

Mr. Crisp, on removing the eyepiece of the microscope in Mr. Powell's exhibit, said the portions of the bright ring of light that could be seen, really represented the zone of aperture that was effective in the new objective *beyond* the equivalent of 180° in air; in fact, the central portion of the aperture exactly corresponding to 180° in air (*i.e.*, 82°, twice the critical angle in the body of the front lens) was practically inoperative in the illumination, the whole of that portion of the pencil was transmitted by the base of the cover-glass—producing practically no visible effect on the diatom—and was thus lost to the eye.

Mr. Stephenson asked if Mr. Powell had been able to resolve the diatom using the vertical illuminator with an objective of less aperture than 82° measured in crown glass? If the object were opaque enough to be viewed by reflected light it should then be seen. In his experience, however, under these conditions little or nothing but the mere outline of the valve could be seen, and nothing whatever of the resolution as now exhibited by Mr. Powell. He could not regard it as a case of "opaque" illumination. The diatom adhering to the cover-glass allowed the light beyond the "critical" angle to enter, but the under side of the diatom totally reflected back a great portion of the light—acting, indeed, to a great extent as a total reflecting surface. As he had previously pointed out, this method of illumination was a practical demonstration of the excess of aperture of wide-angled immersion objectives beyond the equivalent of 180° in air,—not only of the existence of such aperture, but of its utilisation in obtaining resolution of difficult objects.

Mr. Powell said that with an objective of less than 82° angle in glass the diatom was practically invisible, and, of course, the bright ring of totally reflected light was not then seen. This ring was only shown by immersion objectives having more than 82° angle in glass.

Improvements in Photo-micrography.—I have great pleasure in sending enclosed sketch of a piece of apparatus (Fig. 4) which I

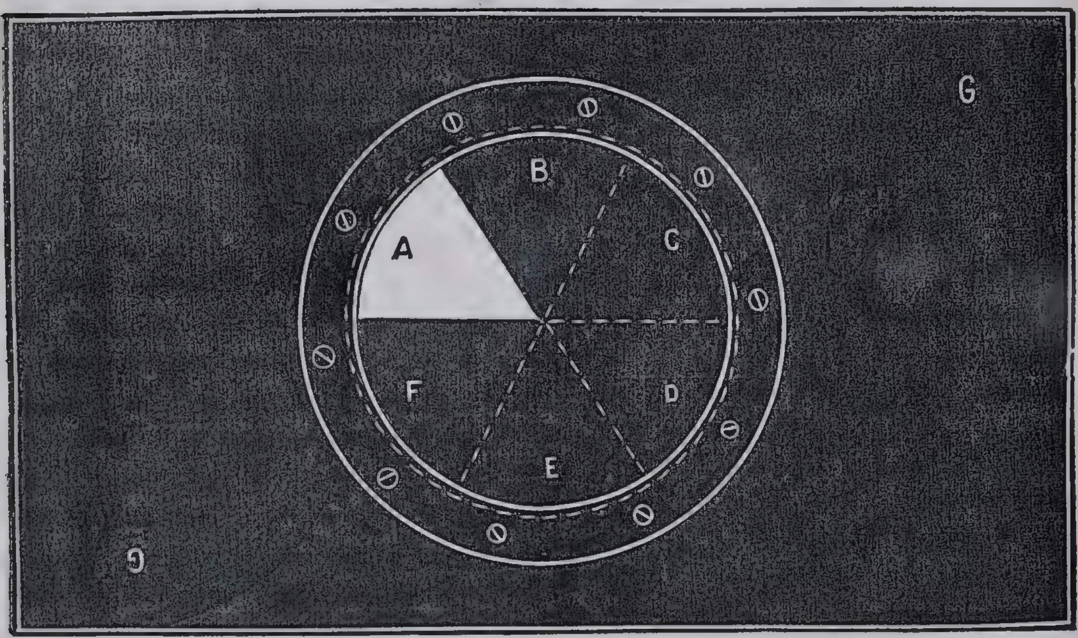

Fig. 4.

have no doubt will facilitate one of the most difficult operations in Photo-micrography, viz., that of rapidly finding the difference between the chemical and visual foci which micro objectives possess, more or less (especially the lower powers). You will see that it is a revolving shutter (Fig. 5) with a diagonal opening (H) to be fixed just in front of

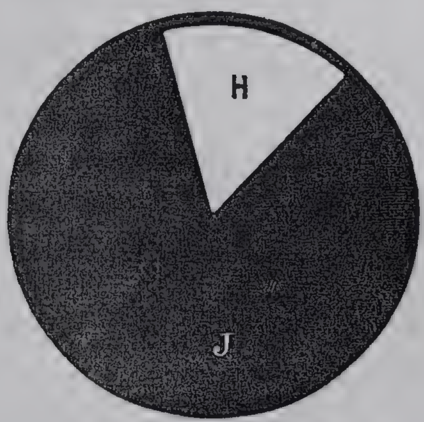

Fig. 5.

the dark slide. Six different exposures may be made on one plate, each with a slightly different amount of adjustment of fine screw, thus on one plate the different amount found necessary to give the sharpest possible focus may be found. It will be quite clear also that you secure a record of the depth of focus and flatness of field of objective under examination—a transverse section of lime will be as good as any. You first focus the object as usual on focussing screen, which should be rubbed over with a little oil. Now put in position revolving shutter, with diagonal opening at A, and give first exposure. Shut off the light, close the dark slide, then turn revolving shutter to F; make slight alteration with fine adjustment screw, give second exposure, and so on through six different exposures. On development you will possess a most valuable record.—*W. Shipperbottom.*

HABITAT OF FORAMINIFERA.—Up to a comparatively recent period it was thought that the *Foraminifera*, under ordinary circumstances at any rate, lived on the sea-bottom; in several isolated instances, however, specimens were taken on the surface, and the extensive series of gatherings made by Major Owen showed, beyond the possibility of doubt, that several species of *Globigerina*, *Orbulina*, and *Pulvinulina* are pelagic; that they live and multiply at the surface, and that, when dead, their skeletons fall to the bottom, and form the well-known globigerina-ooze, of which a large part of the sea-bottom is composed.

It then became a question whether the calcareous *Foraminifera* were exclusively pelagic, or whether some forms might not have their regular habitat on the sea-bottom, even at great depths, the latter opinion being supported by several observers who found the sarcode or protoplasm still contained in the shells of dredged specimens.

The facts brought forward by Mr. Brady seem to show very clearly that this is actually the case. A tolerably weighty piece of negative evidence is afforded by the fact that, after all the extensive series of observations which have been made on the surface fauna, only a very few out of the numerous species of *Foraminifera* have been taken out in a tow-net; all the others have been obtained exclusively by dredging, that is, from considerable depths.

DEATH OF MR. E. W. BINNEY.—The President of the Manchester Literary and Philosophical Society and one of the most eminent of local geologists, Mr. Edward William Binney, F.R.S., died at his house in Cheetham on Monday, Dec. 19th, 1881. Some ten days before he had left his Isle of Man residence, situated close to the Fort Anne Hotel, in Douglas, for Manchester, and whilst on the way he was stricken with paralysis. He remained unconscious to the time of his death. Mr. Binney was a native of Morton, in Nottinghamshire, and came to Manchester in 1836, when he was in his twenty-fourth year. He practised here as a solicitor, but the bulk of his fortune was made in connection with the paraffin oil business, and in partnership with Dr. James Young, F.R.S., and Mr. Edward Meldrum. Mr. Binney pursued the study of geology with intense enthusiasm, and he was perhaps the leading authority on the subject of the northern coal measures. He was elected a Fellow of the Geological Society in 1853, and of the Royal Society in 1856. He was honorary member of the Geological Societies of Edinburgh and Liverpool. For the Palæontographical Society, of which he was a vice president, he wrote a monograph on the "Structure of Fossil Plants found in the Carboniferous Strata."

WHAT IS DIPHTHERIA?—An investigation of the nature of diphtheria was lately undertaken by Professor Wood and Dr. Formad, at the instance of the United States National Board of Health. An infected town, on Lake Michigan, was visited, where one-third of all the children in a marshy district died of the epidemic. The authors affirm that a minute plant fastens on the white corpuscles, and multiplies until, with the interior destroyed, they burst, and the liberated cells go off individually to continue their work on other corpuscles. Thus increased, they poison the blood, choke the vessels, and are found in myriads in the spleen, and other organs rich in blood. The false membrane, supposed to invariably indicate diphtheria, may, according to Prof. Wood, be caused by ammonia, Spanish-fly, or any other irritating influence in the throat, as well as by the parasitical plant of diphtheria. This plant is exactly the same as found on the coated tongue. When Prof. Wood put plants such as are found on a healthy tongue in sterilized matter they failed to grow, whereas plants from the throat or blood of a person under diphtheria multiplied rapidly. The possibility of prevention by vaccination was suggested.

PRESENTATION.—Mr. John Ellor Taylor, F.L.S., the editor of *Science Gossip*, was recently presented with a clock, watch, and purse of £600, in recognition of his services as curator of the Ipswich Museum. Sir Richard Wallace, Bart., M.P., presided at the presentation. Mr. J. E. Taylor was born at Levenshulme, and in youth and early manhood worked as a mechanic at the Gorton Tank railway works, Longsight. His first printed work was a treatise on the geology of Manchester and its neighbourhood.

THE VACCINATION OF ANIMALS.—Statistics brought up to Oct. 1 show that the inoculations of splenic fever, according to Pasteur's method, was performed on 160 flocks, comprising 68,900 sheep, of which 33,576 were vaccinated and 21,938 left uninoculated, so as to judge of the results of the difference of treatment. Before vaccination, the losses caused by splenic fever amounted in the whole of the flocks to 2,986 animals. During vaccination, and until its effects were perfected, 260 sheep out of the whole number of 33,576 perished. During the same period, the mortality rose to 366 out of the group of 21,938 which were not vaccinated. When the effects of vaccination were complete in the first group the mortality from splenic fever fell to five. This rate has persisted up to the present time; and the next statistical account will give, it is expected, the same satisfactory results as regards the groups of animals vaccinated and left unvaccinated.

A COMPRESSOR FOR EIGHTEENPENCE.—Mr. H. E. Forrest has devised a Compressorium, which consists of a strong glass plate, 3in. by 1¼in., with ground edges. A small brass screw passes through this plate, the point projecting upwards through it about ¾in. A brass arm, bent so as to form a spring, rotates upon the screw as on a pivot, and carries at one end a brass ring holding a thin cover-glass, 1in. in diameter, which covers the centre of the plate when in use. A milled nut works upon the screw above the arm, and when screwed down brings the cover-glass in contact with the glass plate. The spring acts upwards and raises the cover, if the nut is unscrewed, so that the two glasses can be fixed at any degree of proximity required.

This accessory may be obtained from Mr. Bolton, of Birmingham, at the price above named.

NATURALIST'S STUDIO ON THE WEST COAST.—Mr. E. Wade Wilton, of Leeds, has issued a circular in which he states that the desirability of establishing a Microscopist's and Naturalist's Studio, devoted largely or entirely to marine organisms, has been shown to him; he has recently been asked to open such an establishment on the South or West Coasts. He states that during the last two years he has received much encouragement in his business as Dealer in Living Objects for the Microscope and hopes for a hearty response to his appeal.

The situation chosen is Clovelly on the West Coast, and within easy distance of the best collecting grounds both on the West and South Coasts.

The "HYDROID ZOOPHYTES AND POLYZOA" of these coasts are very plentiful and interesting, but owing to the difficulty experienced by students in inland places, they have been neglected to a great extent; special attention will be paid to them in their season, viz.: Spring and Autumn.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

J. C. T.—Proceedings too late for this issue.

W. R.—The account of last meeting crowded out.

J. R.—You do not give date of last meeting.

S. S.—The fungus is *Aspergillus glaucus;* it is very common.

W. L. E.—It would not be possible to start another department such as you suggest. Our time is already fully occupied.

A. A.—The Ross-Zentmayer stand is perfectly steady. If too expensive for you, why not try their "Brewer's Stand"?

D. H. B.—Cobbold's *Entozoa;* Schneider's *Nematoden*, with 22 plates and 130 figures in text; and Wagener's *Cestoden*, with 22 plates, would suit you. There are several American Microscopical Journals. You should apply to Mr. W. P. Collins, whose address may be found in our advertising columns.

H. H. C.—There is only one way of getting the information you require—Study.

B. B.—It would be now too late to attempt to found a Society this season. Reserve your efforts till August or September, and commence then. We shall have an article upon the subject about that time.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

SEA-WATER.—I shall be glad to supply my subscribers gratis with materials for making sea-water for keeping Marine objects.—E. WADE WILTON, Northfield Villas, Leeds.

WANTED, Diatom material, mounted or unmounted parasites, for Anatomical and Pathological Slides, Sections or materials.—D. H. BARLEY, 10, Cambridge Street, Newcastle-on-Tyne.

SECTIONS OF LIME tree or Cedar of Lebanon, double stained, well mounted, in exchange for general slides. Botanical preferred.—244, Waterloo Street, Bolton.

DIATOMS.—Remarkably pure gathering *Gomphonema geminatum*. Sample tube sent for three good slides, or exchange for good material.—M. MITCHELL, Mansfield Place, Edinburgh.

SALE COLUMN FOR APPARATUS, BOOKS, ETC.

Advertisements in this column are inserted at the rate 4d. for each 12 words or portions of twelve.

Advertisers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied by a penny stamp for each letter, to cover postage.

All Advertisements intended for insertion in this column must reach us before the 14th of each month.

LIVING OBJECTS for the Microscope. I shall be glad to arrange with collectors for supplies of good objects.—E. W. WILTON, Northfield Villas, Leeds.

HELIOSTAT.—Beautifully finished, all brass, new and unused, ten inches square, double adjustments, mirror 6 × 15, weight 12 lbs. Worth £5, for 40s., or exchange Scientific Apparatus.—J. LILLIE MITCHELL, 6, Mansfield Place, Edinburgh.

WANTED, 12 Nos. of the Northern Microscopist and Postage, for 12 out-of-print numbers of the English Mechanic. Enclosed addressed post card for reply.—WHITMARSH, Wilton.

THE NORTHERN MICROSCOPIST.

No. 15. *MARCH.* 1882.

A NYMPH OF THE GENUS CÆNIS.
(FAMILY EPHEMERIDÆ.*)

BY W. BLACKBURN, F.R.M.S.

THE name "Cænis" was derived from the mythology of ancient Greece, and applied to this genus of insects. Cænis was a woman beloved by Poseidon, and changed by him into an invulnerable man, who engaged in the wars between the Lapithæ and Centaurs. As they were unable to kill him, the Centaurs buried him alive, when he became changed into a bird, and afterwards into a woman again, whom Æneas is described by Virgil as meeting in Hades, in the "fields of mourning" set apart for the solitary wanderings of the shades of unhappy lovers. (Æneid vi., 448). The supposed resemblance between the entomological Cænis and its mythological prototype I leave to be explained by those who delight in efforts of the imagination.

Other generic names have been given by various authors to specimens of this genus, amongst which I may mention *Ephemera* by Linné and Fabricius, *Brachycercus* by Curtis, *Oxycypha* by Burmeister, *Macrocercus* by Westwood, and *Cloë* or *Cloëon* by others. The Entomological Society have, however, given their approval of the name *Cænis*, by which the genus is at present known.

The imago is easily recognized, as it is the only two-winged British genus that has three caudal setæ or tails; the other two-winged genus, Cloëon, having only two tails. It may also be known by the comparative shortness and great breadth of its wing, the longitudinal nervures of which are simple, with few transverse nervures, and, in the typical species at least, without interneural veinlets arising from the terminal margin, which is ciliated in this genus; by the abdomen being little longer than the thorax and scarcely extending beyond the posterior margin of the wing; and by the size and width of the thorax and head, which proportionately exceed those of Cloëon. The compound eyes of the male consist of a single pair, the large pillared eyes of the male Cloëon being absent. The tarsi have five joints, the fifth joint being sometimes

*A paper read before the Manchester Microscopical Society on 2nd Feb.

absent on the intermediate pair. The setæ are nearly equal in length; these appendages, as well as the segments of which they are composed, being usually much longer in the male than in the female. The male forceps are either jointless, two-jointed, or tipped with a minute sharp process. The type of the genus is Cænis macrura, which makes its appearance as an imago between May and September; in summer the early morning and the cool evening being preferred by the insect for its final ecdysis. The Rev. A. E. Eaton, our greatest authority upon this family, has found the subimagines of this genus waiting at half-past five in the morning in June for the sun to dry the dew upon their wings before attempting their last moult. Spiders' webs and newly-painted wood in the neighbourhood of gentle streams and quiet lakes and ponds should be examined for specimens when they are not found in flight. Although not so common in the British Isles as the genus Cloëon, Cænis is sometimes found flying in swarms at the beginning and end of summer. Dr. Hagen describes the English species as appearing in such numbers in Prussia that objects near the water have been covered by them to the depth of an inch, which, considering the small size of these insects, would necessitate many layers placed one above another; whilst, in the "*Curische Nehrung*," the pigs are sometimes fattened upon them. The length of the body of the mature female seldom exceeds one-fourth of an inch, the male being usually much smaller.

The typical attitude that the subimago assumes during repose is with the wings widely expanded, the fore-legs on the ground, and the caudal setæ nearly parallel.

The winged Cænis lives an exceptionally short time for even this short-lived family. Its eggs are soon deposited, and the object of its aërial life being accomplished, exhausted it expires. The chief characteristic of an Ephemeridous egg is, that the germinal matter is segregated in one part, the remaining portion containing some kind of formative material, serving, no doubt, as a store for the further development of the embryo until it becomes capable of leading an independent life. In the eggs of some of the genera there is a constriction between these two portions, more effectually separating them. This is the case in the eggs of Cloëon and Ephemerella. In other cases the germinal portion assumes the form of a crescentic protuberance from the rest, and this appears to be its character in the genus Cænis. The eggs having been laid in a cluster on the surface of the water, they sink to the bottom, where they may either be eaten by some hungry trout or other fish, or lie in unobserved security for a few weeks until they become hatched. In the struggle for existence these insects often have a hard time, for no sooner does the larva issue from the egg than other larvæ, of a larger growth, are waiting to attack it; and if, in spite of its aquatic foes, it succeed in arriving at maturity, the dragon-fly and other predaceous insects and numberless small birds are on the watch for the dainty morsel; so that if it were not for the great number of eggs that are laid, the Ephemeridæ would soon become extinct.

When the larva of this genus has escaped from the egg, its attempts at swimming, which are somewhat clumsy, are made in a wriggling manner, the abdomen being moved rapidly from side to side, in order to propel the body slowly forward. This being the usual mode of motion in swimming, it is occasionally varied by the adoption of a vertical motion, still performed in a wriggling fashion, and giving the larva the appearance of having some difficulty in making its way through the water. The same motions are observed when the larva has become a nymph by being sufficiently matured to have acquired rudimentary wing-cases. As all the characteristics of the insect, in its aquatic state, do not appear until the elements of the wings are present, it is more convenient to describe the nymph than the less developed larva.

The nymphs of this genus burrow in the mud or hide under the stones of the water they frequent, for which reason they are rather difficult to find. They are either unarmed, in which case they are provided with the usual ocelli, three in number, on the forehead; or, in place of the ocelli, they are furnished with three short conical horns, which occupy the same position on the forehead that the ocelli do in the unarmed species. The unarmed nymphs are represented by the type of the genus, *Cænis macrura (Stephens)*, in which the legs have the femora broad and strong, the tibiæ have their tips produced obliquely inwards and terminated by a bristle, and the claws are long and formidable. The armed nymphs are represented by the species *Cænis luctuosa (Pictet)*, in which the femora are more slender, and the tibiæ and tarsi are more ciliated. All the English species have the lateral edges of the posterior abdominal segments considerably produced and terminated in the form of a bristle; of the ten segments of the abdomen, the seventh and eighth are longer than the rest. The mandibles are well defined. The inner edge is extended into a molary plate, the outer anterior edge is furnished with two stout spinous processes, well adapted for prehension. Both the maxillary and labial palpi are three-jointed; of the former the second joint is the shortest, the first and third being nearly equal in length; of the latter the first joint is much the largest. The segments of the antennæ and tails are rather long in this genus, and are furnished at the joinings with a few short hairs. The second segment of the antenna is much longer than the first. The tails are comparatively short in the nymph and subimago, and this character is generally preserved in the female imago, but in the male imago these appendages appear to undergo a rapid elongation after the last moult, until in many cases they are from three to six times their previous length. In one English species, however, according to Pictet's measurements, the female has tails nearly three times the length of the body. In the nymph and subimago they are usually shorter than the body.

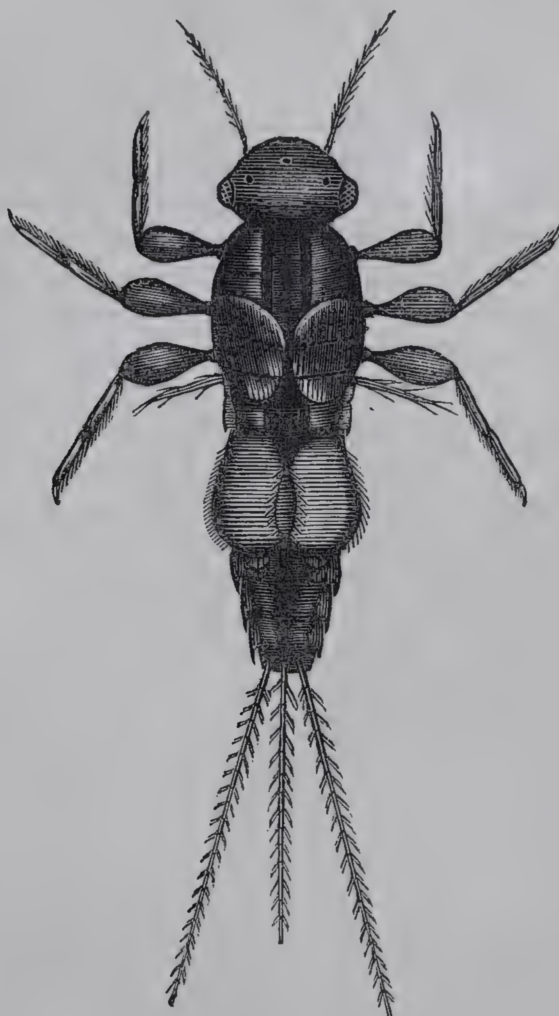

Fig. 6.

The drawing represents an unarmed nymph, not quite arrived at maturity, and about one-tenth of an inch in length. The thorax is large, the head somewhat hammer-shaped, with two compound eyes and three ocelli, the femora compressed, the wing cases considerably developed, and the central caudal filament somewhat shorter than the other two. The shape of its limbs indicates its digging propensities. It is furnished with six pairs of external abdominal branchiæ, consisting of single plates, which are supplied with branches of the tracheal system for the aëration of the blood. The first pair have their origin in the antero-lateral portion of the first abdominal segment, near its junction with the metathorax.

They are small and narrow, somewhat lance-shaped, and are fringed with a few long filaments, each of which receives a small branch of the tracheal vessel that runs through the length of the plate. A slight constriction near the middle of each plate appears to divide it into two parts, but it can scarcely be called an articulation. These plates are held nearly at right angles to the sides of the segment on which they are placed, and they do not vibrate during respiration. The second abdominal segment is without branchial appendages. The second pair of plates arise from the junction of the second and third abdominal segments, fitting underneath the dorsal projection of the second segment, against which the plates are raised and kept rigid during respiration. They are very large and thick, obtusely oval, somewhat conical anteriorly, ciliated on the margin, and in the full-grown nymph they cover the remaining posterior gills during repose, the left plate slightly overlapping the right. In the specimen represented in the drawing the length of these plates was about $\frac{1}{40}$ of an inch. On the under surface of each of these plates a trachea runs in a longitudinal direction, giving off branches at each side. The remaining gills, of which there are four pairs, are situated on the dorsal surface of the fourth, fifth, sixth, and seventh abdominal segments. They are thin and delicate, somewhat ovoid in form, and are fringed with long filaments on the margins. The trachea divides near the base of each plate into several branches, the sub-divisions of which are continued into the marginal filaments, *i.e.*, each filament receives a single branch. The plates on the fourth segment are about half the length of the large protecting plates, those on the posterior segments gradually diminishing in size from the fourth to the seventh segments, the last being about $\frac{1}{160}$ of an inch in length. In the full-grown nymph each of these plates covers to some extent the posterior plate contiguous to it, and their terminal filaments are intermingled when the insect is not engaged in the visible act of respiration. This provision prevents the introduction of foreign matter between the plates, a protection which appears to be necessary on account of their delicacy and the burrowing propensity of the nymph.

When the nymph respires, the large plates on the third segment are raised and fixed against the edges of the second segment at an angle of about 50° above the dorsal surface. They never vibrate. The four posterior pairs of membranous gills also are raised, and are kept in rapid vibration until they are lowered again. The first pair are held nearly parallel to the protecting pair, whilst vibrating through a small angle. The second pair are more depressed, the third still more so, the last pair being raised not more than 20° or 25° above the dorsum. The number of vibrations which I counted during one observation amounted to about 250 per minute. The sight of this phenomenon through the microscope is one of considerable interest. The protecting plates are first raised, when the four pairs underneath are immediately seen in their proper positions in rapid and rhythmical motion, the long fringes lashing the water and creating currents that send the floating particles of matter eddying in the most tortuous courses; when, after continuing in action for a minute or two, the protecting plates suddenly descend upon the rest, and, instantly pressing them out of sight, leave nothing visible but the upper surfaces of the large plates in perfect repose. Those who delight in witnessing such sights as the circulation of the blood, as seen in the vascular plexus of the frog's web, or the beautiful contortions of the tentaculated crowns of the polyzoa, may perhaps find a new sensation in witnessing the branchial performance of the nymph of the genus Cænis.

An interesting discovery in relation to the circulation of the blood in the Ephemeridæ has comparatively recently been made by Herr O. Zimmermann, and recorded in the *Zeitschrift für wissenschaftliche Zoologie*, for 1880. A note alluding to this discovery will be found in the Journal of the Royal Microscopical Society for last year. It had been long known that the valves which separate the dorsal vessel into chambers open in an anterior direction, the contractions of each chamber propelling the blood forward towards the head; but how this fluid not only entered the long caudal appendages, but was also maintained in active circulation through the greater portion of their length, was a problem which entomologists had not satisfactorily solved. The German investigator has found in some of the smaller larvæ, such as Cloëon and Cænis, a provision for this purpose. In the last chamber the valve, instead of opening forwards, opens backwards, so that when that chamber contracts the blood is forced backwards into the central vessel of each seta, from which it finds its way through a long oval aperture into the peri-vascular cavity, and is then propelled forwards again by what physiologists call the *vis a tergo* of the current. The walls of these appendages being very thin, allowing the return current of the blood to come very close to the surface, it is supposed that the circulation here has a respiratory function as well as a nutritive one.

There is still much to be learned with regard to the aquatic forms of this family of insects. Some of the nymphs are imperfectly known, especially in the early stages of their growth; and any scientific microscopist who will trace the life-history of some of the rarer species from the egg to the imago, will not only throw some light upon the development of the Ephemeridæ, but may possibly be a contributor of important facts to the domain of entomological physiology.

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„ 72......	¼″	...	190.0	.04	.200	.57	70°	
„ 73......	No. 8	...	357.0	.01	.105	.93	137°	
„ 74......	1″	...	38.0	.80	.925	.20	23°	
„ 75......	2″	...	19.0	1.82	1.53	.08	10°	
„ 76......	½″	...	97.0	.12	.37	.33	39°	
„ 77......	¼″	...	200.0	.03	.208	.68	86°	
„ 78......	J $\frac{1}{15}$″	108°W	540.0	.009	.704	1.10	110° W	
„ 79......	½″	35°	100.0	.110	.356	.32	37°	
„ 80......	$\frac{1}{10}$″	150°	330.0	.03	.113	.87	122°	
„ 81......	$\frac{1}{10}$″	150°	350.0	.03	.108	.88	124°	
„ 82......	⅛″	140°	400.0	.01	.101	.91	132°	
„ 83......	⅛″	140°	350.0	.005	.111	.866	120°	
„ 84......	⅛″	140°	420.0	.025	.089	.83	112°	
„ 85......	⅛″	140°	360.0	.015	.108	.88	124°	

THE MYXOGASTERS.

THE Myxogasters or Mycetozoa, of all fungi can claim only the most distant relationship to ordinary members of the vegetable world, and on this account several eminent naturalists have been inclined to place them in the animal kingdom, under the designation of Mycetozoa. I think, however, with Berkeley and Brogniart, that they should form a separate family—Peridininæ.

Being destitute of thecæ or basidiæ, they first appear in the form of a pulp or soft, milky mucus, white as a rule, though sometimes coloured, and which sticks to the fingers when touched, like cream. This amorphous pulp or rudimentary mycelium is converted by rapid transformations into isolated peridia in groups or adnate, of variable form or colour. These peridia are filled with diffluent matter, at first opaline, but soon coloured, and eventually become flocculose or pulverulent by the formation of capillitia, or elaters and spores.

A Myxogaster is usually an agglomeration or colony of individuals living in company, separate or communal, but in one common nest (Hypothallus, Plasmodium or simply Mycelium) consisting of a very frail membraniferous bed, silky or glazed, opaque or pellucid, generally like a soft couch of albumen or gum, or else of branching anastomosed or reticulated threads.

As the substratum gains consistency the conceptacles may be seen forming in the amorphous substance after the following manner:—(1) In some species a single membranous peridium is formed enveloped in a furfuraceous covering *(Lycogala, Didymium)*. 2. In composite species a thick glazed crust grows over the whole mass holding in solution a large quantity of salts of lime, after which the interior divides into cells, which are so many connate or united peridia. (3) In free species, or those not connected with each other, save by a peculiar mycelium *(Trichia)*, ramified *(Physarum)* or reticulated *(Diachœa)*, each individual of the group possesses a peridium of its own.

The peridium is composed of a membranous wall papyraceous or scarious, often very thin, delicate, fragile, and fugacious, appearing to be the result of the concretion of the substratum. It is sessile or stipitate, spherical or ovoid, closed or open. It is bare or enveloped with a crustaceous covering, which is either furfuraceous or pruinose. Its elegant form gives the appearance of so many pearls, eggs of insects, or berries; it is generally coloured and brilliant, but when it arrives at maturity it takes an iridescent tint and shines with a metallic lustre quite peculiar to this group of fungi.

The dehiscence and dissemination of the spores also present many curious phenomena, and take place in various ways with the different species. The peridium when mature opens, (1) by an irregular orifice *(Lycogala)*; (2) by a rupture with noise *(Physarum)*; (3) by an operculum or lid, which soon falls off *(Craterium)*; (4) by the fall of the upper half, the base remaining in the form of a cup *(Arcyria)*; (5) when it falls entirely, or at the slightest touch splits into minute fragments *(Stemonitis)*. While the peridium is growing the fluid contents are also being transformed, and the spores with the capillitia or elaters (which are their sporophores) make their appearance. The capillitia or flocci are tubulous cellules, very attenuated, diaphanous, simple, ramose, reticulated or anastomosed, and by their expansion the spores are dispersed. The elaters, analagous to those of the Hepatics, are tubulous filaments forming elegant spiral threads destined to disperse the spores.

The existence of another organ in its axis is often manifest in the peridium, the Columella or Stylidium. This organ is the continuation of the stipe penetrating more or less into the conceptacle and sometimes traversing the whole of its length. It is often found in the rudimentary state, and serves to attach the capillitia to the peridium.

The spores which are spherical or oval take very varied forms. They are simple, glabrous, papillose, or tuberculose, and furnished with a true hilum or spot where it is borne by the capillitia and nourished. The epispore is coloured and ocellate; it sends out cilia after the manner of zoospores, and is capable of motion like an Amœba. The cilia soon disappear, and the germ grows in a mucous irregular mass or Plasmodium, a kind of pseudo-mycelium, which I prefer still to call mycelium, to simplify mycological language.

The Myxogasters are most abundant in the humid seasons of the year (Spring and Autumn) and of all other fungi are most influenced by the weather. They occur on living plants, such as mosses, &c., and upon decayed wood and straw. These fungi differ widely from other species, in the rapidity with which they reach the mature state. Their growth is so rapid that they appear to obtain the elements of their existence from the surrounding air, rather than from the nidus on which they are sometimes found, as the mycelium does not penetrate and they adhere but feebly.

The transformation of the Myxogasters, says Montagne, is a process as marvellous at it is incomprehensible; it is often performed in a few hours, so that the observer may easily watch all its phases.

This charming little family, the different species of which may be so easily preserved, and which obtains so small a share of attention, is second only to the mosses in the ease and pleasure attending its study. The delicacy of its forms does not escape the unassisted eye as in the case with the *Mucedines*, and its fine and vivid tints mingled with metallic lustre offer a great contrast to the sombre shades of its dwellings. In this part of the world, among so many objects which claim our attention, the Myxogasters present one of the most attractive and certainly the most mysterious of studies.

DR. L. QUELET.

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REMARKS SUGGESTED BY THE STUDY OF THE EPHEMERIDÆ.*

BY W. BLACKBURN, F.R.M.S.

IN considering this family of insects in reference to the number and distribution of existing species, and the number of fossil remains of reputed species that have from time to time been found in the Devonian and other rocks, we are led to regard its chief characteristics under two heads—ubiquity and antiquity. In reference to its ubiquity, we find that of the 180 species already classified, 74 are found in Europe, of which 37 are British, 67 are peculiar to America, nineteen belong to Asia, seven to Africa, eleven to Australasia, and two to Oceania. These are exclusive of fossil and undetermined recent species. Notwithstanding this limitation of *species* to certain areas, if we consider the distribution of any single *genus*, we find in most cases it is spread over a considerable portion of the globe. The genus Heptagenia, for instance, of which there are eight British species, has been found in such distant localities as Hammerfest in Finmark, the most northerly town in Europe, in Spain, China, India, the Philippine Islands, Java, Manitoba, the United States, the Andes, and Chili. This genus frequents cold streams and the rapids of rivers; one species being found at the Lac de Combal, near the foot of one of the glaciers of Mont Blanc, at an altitude of 6,300 feet, and surrounded by snow, which is melted only in warm seasons. Another species is found in the rapid Rhone at Geneva, and others in the immediate vicinity of American falls. The genus Cænis, which has four British species, is found to inhabit such distant localities as Russia, Ceylon, and Florida. The genus Ephemera, represented by the common May-fly, has four species peculiar to Europe, three to America, and four

* A paper read before the Manchester Microscopical Society on the 2nd Feb.

to Asia; and the genus Cloëon is found in these continents as well as in Africa. Of 180 species, only four have been found in more than one continent, and none of these four in more than two continents; and even in these widely-distributed species the areas inhabited by each in any one continent are of limited extent; as, for instance, in the case of Baetis binoculatus, which has been found in temperate and arctic Europe and the Hudson's Bay Territory of America. In respect to their geographical distribution, therefore, they accord with the general law of the distribution of animals, viz: That existing species are, as a rule, confined to limited areas, each area being known by its characteristic fauna, whilst the allied species of several areas constitute a genus.

Seeing that the abortive mouth of these insects in the imago state necessitates a very brief span of aërial life, usually but a few hours, we are led to inquire into the object of their final transformation. Could they not have provided for the perpetuation of the species without leaving the water, in which the female might deposit her eggs more securely at the bottom than by dropping them on the surface, as is her custom? The chief purpose probably of the wings of those insects that pass their lives before maturity in the water was originally to find fresh breeding grounds in which to deposit their eggs; as otherwise certain waters would have become overstocked, their food exhausted, and the perpetuation of the species unprovided for. As the waters in which they live are often isolated, and never intercommunicate to any great extent, the ubiquity of the family could be secured only by the acquisition of wings. The winged state of the Ephemeridæ is thus accounted for to some extent. But when we consider the beauty of their variegated colours, especially of the female, which could be produced only by reflected light in the air, and how much such adornment may contribute to the development of the sexual instinct of the more sombre male; and when we realize from observation of their mazy dances in the sunlight, as they hover with ceaseless motion above the water from which they have just emerged, the amount of physical enjoyment that may be comprised in their novel mode of life—an enjoyment which nature so bountifully provides for all who obey her laws,—if we could analyze their sensations and translate their significance into language, we might, perhaps, arrive at the conclusion that these little creatures share the opinion of certain ambitious spirits of the human family, that

> "One crowded hour of glorious life
> Is worth a century of ease."

In reference to the antiquity of these insects, we meet with various statements from time to time as to their fossil remains having been found in the Palæozoic rocks. Sir Charles Lyell writes: "The earliest known insects were brought to light in 1865, in the Devonian strata of St. John's, New Brunswick, and are referred by Mr. Scudder to four species of Neuroptera. One of them is a gigantic Ephemera, and measured five inches in expanse of wing." Dr. Dawson, of McGill College, Montreal, in a work on the "Geology of Nova Scotia," describes the wing of the genus Haplophlebium, found in the carboniferous strata, and on the authority of Mr. Scudder pronounces it to belong to a gigantic Ephemerid that must have measured seven inches across the wings. He gives us a graphic picture of the swarms of the Ephemeridæ of that remote period, as they "would flit in millions over the quiet waters and through the dense thickets of the coal swamps." Another specimen, the Xenoneura antiquorum, has been described as having a stridulating apparatus, and representing a synthetic type of insects, allied to the Ephemeridæ and the Locusts. Various authors have ascribed fossil specimens of Neuroptera to sixteen genera of ancient Ephemeridæ, in some instances from obscure fragments of the wing only. The Rev. A. E. Eaton, who has investigated the merits of this question, is of opinion that only three fossil species can be pronounced to belong to this family, of which the oldest known fossil was found in Bavaria, in the Solenhofen slate, which Sir Charles Lyell places, in reference to its position in geologic time, between the Kimmeridge Clay and the Coral Rag, in the Oolitic series of rocks. This fossil is in the British Museum. It represents a portion of a wing well reticulated, somewhat in the manner of the anterior wing of the common May-fly. Specimens of extinct species of the family have been found in Stettin amber, differing only slightly from existing forms.

There is no doubt that those insects, the larvæ of which are chiefly aquatic, viz., those of the orders Neuroptera and Orthoptera, are represented by the earliest fossil forms, their remains having been found in the Devonian rocks; whereas the next order in point of antiquity, the Coleoptera, are not found in strata earlier than the coal measures. This consideration led Sir John Lubbock, after investigating the development of the aquatic form of Cloëon, to propound an ingenious theory of the origin of the wings of insects, which will be found in a small volume of the "Nature Series." You will recollect that Cloëon has external branchial plates on the first seven segments of the abdomen, which are gradually acquired during growth, the larva being born without branchiæ, and the six anterior pairs being at first single and afterwards double plates. He says that insects may originally have come from a type like the larva of Cloëon in form, but without legs, and having a pair of single plates on each segment of the body, serving both for respiration and locomotion. Those plates placed near the centre of gravity "would serve the most efficiently as propellers: the same causes which determined the position of the legs would also affect the wings. Thus a division of labour would be effected; the branchiæ on the thorax would be devoted to locomotion, those on the abdomen to respiration. This would tend to increase the development of the thoracic segments, already somewhat enlarged, in order to receive the muscles of the legs." The necessity of wings would occur only when fresh breeding grounds were required, and their development would, therefore, be "relegated to a late period of life; and by the tendency to the inheritance of characters at corresponding ages, which Mr. Darwin has pointed out, the development of wings would thus become associated with the maturity of the insect." As the characters of the species became more and more differentiated from the original form, in order to suit various conditions of life, genera and orders would result. Sir John Lubbock at the same time admits that the earliest fossil remains, "though in some respects less specialized than existing forms," represent "as well characterized insects as any now existing, and we have no reason for supposing that the other orders of insects were derived from either the Neuroptera or Orthoptera." It appears to me that an objection to this theory is found in the fact that locomotion is now universally effected by the abdominal muscles of these aquatic larvæ, assisted only by feeble strokes of the legs; the thoracic and abdominal plates are not used for this purpose, even when the latter do not vibrate during active respiration, and might, therefore, be supposed to subserve a double function, whereas the plates on the thorax are to some extent contributory to the respiratory function. It is not, however, desirable to criticise too severely a theory which has at least the merit of ingenuity, and which emanates from so high an authority, until more is known concerning the early forms of insects, especially in their aquatic condition.

Much more might be written concerning the subject of this paper. Its intention, however, is merely to record a few disconnected thoughts which have arisen during the study of this interesting family of insects.

OUR BOOK SHELF.

British Fresh-Water Algæ. By M. C. Cooke, M.A., LL.D., A.L.S. 1882. London: Williams and Norgate. 8vo., No. 1., pp. 28, with 11 coloured plates.

The first number of this excellent work by Dr. Cooke has just reached us, and promises to be useful as a handbook to all those studying or collecting our Fresh-water algæ. It seems to be written on the lines of Rabenhorst's "Flora Europæa Algarum," but though the classification is the same, the omission of Diatoms and Desmids, and the rearrangement of some of the genera, makes it quite a distinct work.

Dr. Cooke starts off with the class CHLOROPHYLLOPHYCEÆ, and in the order COCCOPHYCEÆ treats us to a minute description of the Palmellaceæ, with which the whole of the twenty-eight pages is taken up. Perhaps the best feature of the work is that the plates are naturally coloured, and this generally goes much further in aiding the beginner than any written description, assisted by plain wood-cuts, could ever hope to do.

There is an omission which, if noticed here, may perhaps be guarded against in future. The first genus Eremosphæra is admirably illustrated by plate 1, containing 12 coloured figures, but all the reference to it is "*Plate 1*, cells in various conditions, all magnified 400 diameters"—this is certainly too concise; in a work of this kind an explanation of each figure is very necessary.

Although, as we have already mentioned, the classification of Rabenhorst has been followed, still his genera have been disturbed: our old friend *Palmella cruenta*, usually found as gelatinous blood-like patches on moist walls or on the bare ground, and classified by Rabenhorst amongst the RHODOPHYCEÆ, is here taken as the seventh genus of the Palmellaceæ, and rightly, too, in our opinion, although we firmly believe that before many years are over, an entirely new and more rational system of classification will have to be adopted, as it is by no means certain that the whole of the order COCCOPHYCEÆ, comprising the families of Palmellaceæ, Protococcaceæ and Volvocineæ, are autonomous members of the vegetable world. *Palmella cruenta* is here described as *Porphyridium cruentum*, the only species of the genus.

Here we find also *Palmella prodigiosa*, the organism, generally supposed a fungus, which forms blood-red spots upon cooked rice, bread, potatoes, etc. This protophyte has been a bone of contention between algologists and fungologists, and though it is here settled down amongst the algæ, we cannot bring our minds to consider the evidence brought forward in support of this view of a definite or convincing character; but this, of course, is a matter of opinion.

The plates are satisfactory, the printing also, and if the general character of the work is kept up, we have no hesitation in saying that its issue will be a success.

NOTICES OF MEETINGS.

BOLTON MICROSCOPICAL SOCIETY.—The usual monthly meeting of this Society was held on Friday evening, Jan. 13th, when Mr. W. W. Midgley read a paper on "Some forms of aquatic life." The audience were asked to suppose themselves standing by the side of a pond, where the Lecturer described various forms of life one by one, which were generally to be found in such a locality. Various interesting creatures were described in detail, and were shown on the canvass by means of a pair of oxyhydrogen lanterns, kindly lent and manipulated by Mr. Shipperbottom. Almost the whole of the illustrations were the work of Mr. Shipperbottom, he having succeeded in obtaining micro-photographs of exquisite beauty and finish. At the conclusion of the lecture, which was listened to with great interest, Mr. A. S. Pennington proposed a vote of thanks to Mr. Midgley for his valuable paper. A similar compliment having been paid to Mr. Shipperbottom for the elaborate way in which he had illustrated the paper, the Society spent the remainder of the evening in examining a variety of forms of pond life by means of the microscope.

BOLTON MICROSCOPICAL SOCIETY.—The usual monthly meeting of this Society was held on Friday, February 10th. The minutes of the previous meeting having been read and confirmed, the Rev. W. E. Codling, The Manse, Edgeworth, was proposed as a Member. It was moved by the Rev. R. Best, seconded by Dr. Hunt and carried, that an arrangement be made to subscribe to Mr. Bolton, of Birmingham, for a supply of twenty-six tubes, containing living specimens of pond life, to be sent at such times and in such quantities as the Society may require. It was also moved and carried that during the recess, arrangements be made for one or more field excursions in search of specimens of pond life and other micro-organisms, under the leadership of Messrs. Midgley and Shipperbottom; these gentlemen, together with the Honorary Secretary (Mr. Rideout), to form the Committee, and make the necessary arrangements.

During the meeting, Mr. Jackson exhibited Davis' graduating diaphragm, for use behind the objective, as described in the *Northern Microscopist.* Its performance was tested by many of the Members, and was greatly admired, the result in giving penetration being better than had been expected. Mr. Jackson also exhibited some remarkable specimens of saws and saw-flies, and remarked upon the curious modification in these organs to suit the conditions under which these creatures live.

The Rev. R. Best exhibited a series of mounts of spores of ferns, put upon black paper backgrounds without covering glasses. This method of mounting them was considered to afford many advantages, especially when saving of time was an object.

Mr. Pennington exhibited some very beautiful preparations of zoophytes, from the Zoological Station at Naples, and also some prepared by himself and Mr. Russell.

Mr. Midgley exhibited some stained vegetable sections, and a discussion took place on staining with aniline dyes. It was stated as the experience of several Members, that while these dyes are excellent for staining vegetable matter, when applied to animal substances the dye is perfectly soluble, and washes completely out in spirit, oil of cloves, or even in balsam.

Mr. Walmsley exhibited Lepisma alive, and several Members brought specimens of failures in mounting for criticism and correction.

LIVERPOOL MICROSCOPICAL SOCIETY.—The thirteenth annual meeting of the Microscopical Society of Liverpool was held on Friday, January 20th, in the picture gallery of the Royal Institution, Colquitt-street, under the presidency of Dr. William Carter. The first business on the programme was the election of officers, and, accordingly, the following gentlemen were elected:—Mr. W. H. Weightman, president; Dr. Carter and Mr. F. T. Paul, vice-presidents; Mr. W. J. Baker, hon. treasurer; Mr. I. C. Thompson, hon. secretary; Dr. Hicks and Messrs. G. H. Morton, H. M. Bennett, and H. R. Boult, to the vacancies on the committee. The following report of the committee for the past year was read:—

In presenting the thirteenth annual report the committee are again able to give a satisfactory statement as to the condition of the Society. The meetings throughout the session have been numerously attended, and the interest taken in the papers read and in the conversaziones indicate that the popularity of the microscope as a means of both instruction and recreation is on the increase. This fact is further confirmed by the many invitations received by the members to exhibit at soirées, &c., the microscope being now considered an almost essential part of such entertainments. Your committee would, however, like to see a larger amount of original investigation undertaken by the various members than appears to be the case, and would specially commend this to individual attention. Nineteen new members have been enrolled during the past year, and six members have left or resigned. The numbers on the list now stand, 10 honorary members, 162 ordinary members, and 1 associate member. By death the Society has lost two of its earliest members, Mr. John Abraham and Mr. Alexander Cooke. Mr. Abraham was a former president, and throughout his long connection with the Society one of its warmest friends and most able supporters. The associated Science and Art soirée and the soirée of the Chester Society of Natural Science have again been benefited by the friendly co-operation of the Chester Society with our own. The library has been further augmented by the addition of the volumes of the Challenger Expedition as published, and by other works. The committee have to thank the donors of books, material, and of slides to the cabinet for their various presentations.

The treasurer's financial statement showed that the income of the Society during the past year was £102 6s. 8d., and that there was a balance in hand of £18 13s. 3d., as compared with an overplus of £24 12s. 6d. in the previous year.

The reports having been adopted, the President-elect proceeded to deliver his inaugural address, in which he stated:—

"All the members of our Society are, I am sure, anxious to promote its interests, and many do this by keeping up a steady attendance at its meetings, which gain some of their attractiveness by the variety of the objects exhibited. They could, however, do more service still by recording their observations by pen and pencil, and bringing them before the Society from time to time. The great hindrance perhaps to this being more generally carried out is the desultory mode in which a large proportion of our microscopic observers apply themselves to the use of the instrument. Though no one should so shut himself up in a narrow speciality as to become blind to the great interests of human life, or to the grand phenomena of nature, yet it is obvious that when the subjects of study are so many, and the time for their pursuit so short, a definite and precise end must be continually kept in view, if any considerable measure of success is to be attained. A cursory and indiscriminate examination of all the minute forms of life one meets with may be pefectly allowable as a pastime, but can scarcely be expected to lead to important and permanent result. It will, indeed—and it is not a small advantage—give a sense of satisfaction to the dilletante while perusing or listening to the lucid teaching of some master in science, but it will not cause the aimless student himself to excel or advance by a fraction the boundaries of knowledge. On the other hand, a selection of some special line of study, made with judgment and in a direction congenial to the taste and abilities of the observer, can scarcely fail to be rewarded with success in the discovery of new aspects of truth; and it would be a happy beginning of our

Society's new year if each member resolved to contribute, according to his opportunities, a measure of faithful labour throughout it to the cause of microscopic progress and research."

He also referred to improvements in microscopic manipulation during the last twelve years. Referring to the Society, Mr. Weightman said the members were to be congratulated on the great deal of sympathy it had for some time past evoked, and the interest that had been generally manifested in it. The Society had lately been considerably strengthened and increased in numbers, and no doubt a continuance of such support, with kindly co-operation, would be more and more beneficial.

On the motion of Dr. Carter, seconded by Dr. Drysdale, a vote of thanks was accorded to the president for his address, after which the meeting resolved itself into a *conversazione*, when, amongst other interesting demonstrations, objects illustrating the results of the Challenger and Porcupine expeditions were illustrated.

The second meeting of the present session of this Society was held on Feb. 17th, in the gallery of the Royal Institution, Colquitt-street, the president in the chair, and there was a good attendance.

Mr. A. Smetham, F.C.S., read a paper on "Chemistry as an Aid to Microscopical Research. " In the course of his remarks he pointed out the close connection which subsists between the various branches of science, and the impossibility of placing limits to scientific research. He showed, also, the close connection there is between chemistry and microscopy, and afterwards proceeded to describe the various tests which may be applied under the microscope, and the methods whereby objects may be prepared for microscopic examination. He also described the chemico-microscopical researches of Pasteur, and showed how, by his system of inquiry, not only had he bestowed an inestimable boon on science, but had even revolutionised the art of brewing, restoring it from its empiric position, and placing it on a firm scientific basis. He also showed how these methods might be applied with great benefit to butter and cheese making, and that there appeared very good reasons to hope that in the not very distant future similar researches would enable us the better to understand the precise nature of many forms of infectious disease, and thus to allay or prevent their so frequent occurrence. Among the specimens exhibited during the conversazione which followed, were some rotifers, by Mr. Oelrichs, concerning which he addressed the meeting. He said : A few remarks on vorticella and rotifers may be of interest to the members of the Society. In examining a trough in which I had placed, some days before, a small piece of anacharis, to which a few floscularia, a large colony of vorticella and others were attached, I found that a large number of vorticellæ had left the leaves and attached themselves to the glass of the trough. Amongst the vorticellæ, a few rotifers of the brachionus species were disporting themselves and attacking the vorticellæ in the following manner. The rotifer would attach itself by its tailfoot to the footstalk of a vorticella, and try to get hold of the outer rim or lip of the opened bell of the vorticella ; but as long as the regular play of the cilia of the vorticella continued the rotifer was unable to get a hold of its prey. A momentary stoppage of the play of the vorticella's cilia, however, was sufficient for its enemy, which, making a sudden dart, obtained a hold of the vorticella's lip, and began to eat the lip or rim with extraordinary rapidity, in spite of the evident strenuous efforts of the vorticella to get rid of the rotifer by contracting its footstalk. The rotifer would retain its hold of the vorticella's lip, and I could observe the small particles entering the rotifer's stomach quite distinctly. In about half a minute the rotifer had devoured the rim of the vorticella, which died immediately, the footstalk becoming rigid. I watched the same rotifer for half an hour, during which time it killed five vorticella and devoured their lip or rim, but in no case did the rotifer eat anything but the lip, which appeared to be thoroughly relished, and from which I conclude that the main body or bell of the vorticella is composed of a comparatively solid substance, while the rim is soft and fleshy, if I may use such a term. I further conclude that the most vital part of the vorticella is situated in its rim, because in every case the animal died immediately on its rim being eaten by the rotifer, while vorticellæ continue to show signs of life for a long time after being crushed between two slips of glass and flattened to a considerable extent, but without special injury to their lip or rim. I am afraid my remarks are no novelty to most gentlemen present, and if my conclusions are erroneous I hope some more experienced microscopist will favour us with his opinion.—The proceedings concluded with the customary vote of thanks.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the last meeting of this Society, Mr. Thomas Brittain, in the chair, distributed several species of Lichens which he had recently collected, *Parmelia aquilla* being one of the species, in fruit.

Mr. Stanley brought his microscope and exhibited slides of the two new *Hepatics.*

Mr. Pearson exhibited specimens of an Hepatic new to the *Manchester Flora. Diplophyllum minutum* (Dmrt) collected by Mr. G. A. Holt lately on Kinder Scout; also specimens of the rare *Liochlæna lanceolata* and *Harpanthus scutatus*, collected in Eskdale by Mr. B. Slater, and *Sphærocarpus terrestris*, from Herefordshire, collected by Mr. B. M. Watkins.

Captain Cunliffe has recently made an excursion in the neighbourhood of Barmouth, a veritable moss paradise in winter time; amongst the mosses brought home and exhibited were specimens of the rare *Campylostelium saxicola*, *Hypnum Schreiberi*, *Hylocomium brevirostrum*, and the rarely fruiting *Didymodon cylindricus.* Some of these were generously distributed by Mr. Cunliffe, with reference to the specimens of *Didymodon* exhibited.

Mr. Cash read a short communication on its discovery and detection. He stated that the species was described as new by Hooker and Taylor in the Muscologia Britannica (Ed. 2, 1827) under the name of *Weissia tenuirostris*, the figure (for which, as well as the description, Dr. Taylor was alone responsible) was unfortunately bad, and contemporary bryologists disputed the right of *Weissia tenuirostris* to be considered a good species. Hooker himself did not believe in it. He was of opinion that the figure of the capsule, as it appears in the Muscologia, was drawn from *Weissia curvirostra* (Brid) = *Didymodon rubellus* (Roth) whilst Wilson imagined that Dr. Taylor had picked up some form of *Tortula tortuosa.*

Dr. Taylor had found the moss at the foot of the Campsie Hills, near Glasgow, during an excursion with Hooker and Greville in or about the year 1826. When they came to examine their gatherings, this alone struck Dr. Taylor as something "rare." The others, however, were sceptical, and "did their utmost to demolish the pretensions of the plant to be considered distinct." The controversy (or "wrangle" as the Doctor himself called it in writing to Wilson) was both long and warm.

Fourteen years or more after its discovery at Campsie, this moss was the subject of a long correspondence between Taylor and Wilson. Specimens found by the latter at Dolgelly, and by Dr. Taylor near Dunkerron, in Ireland, where he then lived, proved it to be specifically distinct: the controversy turned chiefly upon the generic characters. Dr. Taylor, whilst confessing that his figure of the peristome in the Muscologia Britannica was "inapt," still claimed it as a *Weissia.* Mr. Wilson, on the other hand, insisted upon its being referred to *Didymodon*, and, in support of his contention, sent Dr. Taylor dissections of his own Irish specimens, which, if they did not convince, threw the Doctor "into such difficulties and such perplexity that he was not in a fit state for forming any decision." He added in the letter, from which we quote, "It is a bewildering theme, which I had rather relinquish for the present."

Mr. Wilson's view triumphed. The moss was by all leading Muscologists accepted as a species of Didymodon; and it is now universally known, not by the name bestowed upon it by Dr. Taylor, but by that of Bruch and Schimper, *Didymodon Cylindricus.*

The Hon. Sec. of this Society wishes us to state that the correction in last month's number was sent by him, but came too late, as we had already gone to press.

MANCHESTER MICROSCOPICAL SOCIETY.—The usual monthly meeting of this Society was held on Thursday, Feb. 2nd, Dr. John Tatham in the chair.

Dr. John Smith distributed pork full of Cysticerci, and gave some valuable hints for their mounting and preparation.

Mr. W. Blackburn then read two papers, one entitled, "On a nymph of the genus Cænis : family Ephemeridæ;" the other, "Remarks suggested by a study of the Ephemeridæ," a subject upon which he has devoted the past two years. Both these papers appear in the present number.

Mr. W. Stanley then read the following communication on Starch :—"In observing the tissues of plants we find the cells are more or less filled with minute, oblong, translucent granules called Starch, and with the exception of some small groups of Algæ and Fungi, these granules are found in almost every plant, and have even been found in the brain of man; but, although so common and well-known, their mode of growth has long been a problem to microscopists. In examining the starch of potato in particular we shall find the mature grain consists, as a rule, of a number of layers deposited around a central nucleus or hilum, the point at which, in its early stage, it is attached to the interior of the cell, and having all the appearance of growth by the formation of layer upon layer; this appearance however is stated by some authorities not to be caused from increase of layer upon layer, but to be the result of a larger or smaller quantity of water in the different layers. Perfectly dry starch being unstratified throughout.

Mr. A. F. W. Schimper, of Baltimore University, who has recently made a series of experiments on the growth of starch grains, says, 'that in the parts of plants which contain chlorophyll, and are in a growing state, the starch grains show certain constant peculiarities of structure.

'They are usually disk-shaped, thick at the margins and very uneven, and present under the microscope a flaky appearance. These appearances are due to a partial disintegration in consequence of the starch being partially used up for the growth of the organ; this is shown by the fact that grains formed after the cessation of growth of the organ have not this character, and that a similar structure is seen in the starch grains of germinating seeds.

'After the growth of the starch-containing organ has ceased, the formation commences of definite forms of starch grains, either by a new growth of those already in existence in the form of a thin shining layer around the disintegrated grain, and which gradually becomes thicker and more dense, or new sperical grains are produced, having no trace of the structure described, and which are developed in the following manner:—

'1. Differentiation of the original homogeneous grain into a central watery nucleus, and a dense peripheral layer. 2. The formation of three layers, of which the central one is always watery, surrounding the grain. 3. Increase in the number of layers, the outermost being always dense. 4. Increase in the amount of water in the centre with the increase in size of the grain. Thus growth takes place by exogenous stratification.'

Starch is of the same chemical composition as cellulose, viz., Carbon, 6; Hydrogen, 10; Oxygen, 5, and is always originally formed within the chlorophyll granules, whence it is conveyed in solution in the form of dextrine or sugar, to those tissues in which growth is actually taking place, or is redeposited as starch, and stored up as a reserve food material, being found in large quantities in bulbs, tubers, seeds, pollen grains, and in those organs which, when vegetation awakes, are the starting points for the new formation of cells. On the recommencement of growth or germination, the starch is reconverted into dextrine or sugar, is then soluble in water and becomes absorbed by the protoplasmic contents. This change is necessary before it can afford nourishment to the growing parts of plants. Its composition is also altered by the addition of three parts of Hydrogen, being now Carbon, 6; Hydrogen, 13; Oxygen, 5.

Under ordinary conditions the granules are insoluble in cold water, but swell up very strongly in boiling water. They are readily detected by means of a solution of Iodine, which colours the granules a dark blue or purple. No other substance but starch has this distinctive blue appearance under the influence of Iodine.

With the polariscope the granules become coloured in a peculiar and beautiful manner, revealing the characteristic black cross, which, according to Ganot and Deschanel, is due to the power of double refraction, a property possessed by many other organic substances. The cross takes the form of four arms meeting together at the hilum, and which on revolving the polarizer, are alternately black or white, with an intermediate shade of cross exactly between the two extremes. The largest granules known are those from the Canna édulis, popularly known as Tous-les-mois, a plant similar in characteristics to the Arrowroot, its average size in thousandths of an inch being $3 \cdot 5 \times 2 \cdot 3$, while the smallest are from the Parsnip, and only measure $\frac{1}{10{,}000}$ of an inch in diameter, being so minute as to require high magnifying power, and only recognizable with difficulty.

A variety of starch obtained from the tubers of Dahlia, Jerusalem Artichoke, and a few other plants is termed Inuline, and Lichenine is the peculiar starch of Lichens, and is found in Iceland Moss, Reindeer Moss, and Carrageen, or Irish Moss.

Starches should be mounted in carbolized water for ordinary refracted light, and in balsam or dammar for polarizing.

To the beginner, no other objects present so few difficulties, the material being almost ready to his hand. For carbolized water one ring of cement is sufficient, with another for fixing the cover, and one or two drops of carbolic acid is enough for any reasonable quantity of water. By placing a small quantity of the starch in the centre of the slide and just tapping the slide with your finger or thumb, a sufficient layer of starch will adhere; the rest of which can be blown off. For mounting in balsam or dammar, centre the cover glass of the thin layer of granules, when two drops of the media placed at two sides of the cover, but not exactly opposite, will, by capillary attraction, permeate the whole of the space under the cover glass, without displacing the starch, and can then be put away to harden and ring in the usual manner."

During the conversation which followed, the undermentioned objects were shown:—

Larva of crane-fly	Mr. H. Hall.
Head of caterpillar, mounted without pressure	,,
Mature polypite of *Tubularia larynx*	Mr. H. Chadwick.
Pleurosigma angulatum	Mr. D. Alston.
Starches in Gum Damar	Mr. E. Napper.
,, Carbolized Water	Mr. W. Stanley.
Oil immersion condenser and diatoms	Mr. E. Napper.
Trichodactylus osmiæ (bee mite)	Mr. Alex. Hay.
Delesseria sinuosa	Mr. Alex. Hay.
Actinocyclus Ralfsii	Mr. Alex. Hay.
Section of potato (showing starch *in situ*)	Mr. Miles.
Nymph of Cænis	Mr. W. Blackburn.

NORTHAMPTON NATURAL HISTORY CLASS.—At the monthly meeting, held on Tuesday evening, Jan. 24th, in the Council Chamber of the Town Hall, a goodly number of members were present. Eight new members were elected.

The evening was devoted to the exhibition of microscopic objects, when Messrs. Osborn and Gregory explained the mode of preparation and mounting the objects exhibited by them. The following is a list of the various slides shown:—

Structure of the Spider...Mr. Osborn.
Ferns—leaves and stems. Single and double stained .. Mr. Gregory.
Parasite of Owl (mounted without pressure) .... ,,
Microscopic Moths—viz., *Lithocolletis quercifoliella* ...... ,,
,, *Cemiostoma Larbarnella*.............. ,,
,, ,, *Scitella* .... ,,
,, *Nepitcula*, &c............ ,,
Prepared and mounted by the exhibitor.
Epistylis gracilis, Polycistina ....Mr. Kempson.
Hydra, Diatoms, Desmids.......................................Mr. Durham.
Adulteration of Mustard ....Mr. Dangerfield.

NORTH OF ENGLAND MICROSCOPICAL SOCIETY.—The Annual Meeting was held at the Literary and Philosophical Society's Rooms on the evening of Wednesday, January 18th, when there was a good attendance of members. Mr. John Brown, one of the Vice-Presidents, in the chair.

The minutes of last meeting having been read and confirmed, the Hon. Sec. then read the Annual Report; this was succeeded by the Hon. Treasurer's (Mr. Mason Watson) financial statement, which went to shew a favourable balance to the Society's credit on receipt of current subscriptions. A vote of thanks was then passed to retiring Officers, and also accorded to the Committee of the Literary and Philosophical Society, together with Mr. W. Lyall, Librarian to that Institution, for the courtesy and attention rendered since the meetings have been held in their rooms; also to the Royal Microscopical Society for copies of the proceedings and Journals.

Dr. Jeaffreson was then unanimously elected President for the ensuing session. Prof. G. S. Brady, M.D., F.L.S., &c., having now officiated for three years was elected by an unanimous vote the first honorary member.

Mr. John Brown, Dr. Ellis, and Mr. Joseph Craggs were appointed Vice-Presidents.

Ten Members of Committee were elected, and the Hon. Treasurer, Mr. Mason Watson, and Hon. Secretary, Mr. M. H. Robson, reappointed.

Messrs. John Brown, Jun., and J. B. Young were appointed Hon. Custodian and Librarian respectively.

Three out-door meetings were arranged to be held in June, July, and August, it having been found advisable to have a recess during the summer months.

The Hon. Sec. called attention to the inconvenience of Wednesday as a night of meeting, it usually being a lecture night at the Literary and Philosophical Society, and one also when many Members were otherwise engaged. After consideration, it was determined to alter the night of meeting to the first Tuesday in each month, excepting June, July, and August.

Some very interesting objects were exhibited, amongst them, Mr. Mason Watson shewed several examples of Fossil Polyzoa; Mr. John Arthur, Stomata of Mistletoe; Mr. T. H. Swallow, Ræstelia cancellata; Mr. John Brown some beautiful preparations of Spiders' eyes, amongst them those of the jumping Spider—Salticus tardigradus; Mr. John Brown, Jun., Transverse section of upper jaw of Mole.

A vote of thanks to the Chairman terminated the proceedings.

ROCHDALE AND WHITWORTH MICROSCOPICAL SOCIETY.—At the usual monthly meeting of this Society, J. W. Mellor, Esq., presiding, Dr. A. Welsh read a paper on "The Borderland of Plants and Animals." At the close of the discussion which followed, some very interesting Microscopic organisms were examined, comprising the spawn of the Trout, shewing the circulation of the blood.

The larva of the Ephemera (May Fly) also shewing the circulation, and Volvox Globator.

Mr. T. Spencer Smithson shewed some slides of Arranged Foraminifera, etc.

Mr. Alderman Hudson shewed a piece of Silk, *supposed* to be the work of the gossamer Spider.

The Secretary shewed longitudinal and transverse sections of the jaw of the Mole, with all the teeth *in situ*.

The Society, which is in a fairly healthy condition, has a good syllabus of papers promised for the coming session.

The ordinary monthly meeting of the Society was held on Thursday evening, the 2nd of February, Henry Standring, Esq., in the chair.

After the usual preliminary business of the Society had been transacted, a paper was read by the Hon. Sec., Mr. I. Renshaw, L.D.S., subject, "The History of a Human Tooth," illustrated by diagrams and Micro-slides, representing its development, character of structure, and causes of destruction.

NOTES AND QUERIES.

CATALOGUE OF THE DIATOMACEÆ.—We have received a notice that Part I. of this catalogue is now complete; it is a complete index to the literature describing or figuring the Diatomaceæ, published previous to the year 1881. The species are alphabetically arranged under the genera, with references to the descriptions in chronological order. It embraces a list of more than five thousand species.

OBITUARY.—The death is announced of Professor Theodore Schwann, of Liège, at the age of seventy-two. He may be said to occupy in biology the same position that Faraday holds in the history of electricity. In 1839 Schwann published his "cell theory," which asserts that the most different elementary parts of organisms are developed on one common principle, and that this principle is cell-formation. This theory, and the investigations by which it was supported, had an important effect on the study of biology—in fact, it marks an epoch in the history of that science.

IMPROVEMENTS IN TURNTABLES.—An improvement in Kinné's self-centering turntable has been lately devised by Mr. W. D. Smith. In theory this table is perfect, but unfortunately glass slips are seldom if ever cut quite accurately, so that the slip instead of being exactly in the centre is a little to one side of it. The improvement referred to consists in substituting for the angle pieces two straight slips of brass three inches long, one of which is fixed at right angles to one slot, and the other is moveable in the second slot. These evidently centre quite accurately for breadth, and longitudinal centering is secured by fixing a pin in the upper surface of the table $1\frac{1}{2}$ inches from the centre.—A. J. D.

[We cannot see how a slide can be *centered* by this arrangement.—Ed.]

Photo-micrography.—The sketch of the shutter on page 48, Vol. II. of The Northern Microscopist may be used for ascertaining the correct exposure as well as the difference in adjustment. It is more correct in principle for ascertaining the exact exposure than the usual method of drawing out the shutter a little farther each time, on account of its working from the centre.

Your "aperture shutter" will be of great use to the Photo-micrographer. When I first saw Collins' graduating diaphragm, I thought of its use in Photo-micrography if it could be applied to the objective, but was under the impression that it would require a new mount for each objective, as I presumed the diaphragm was fixed at the best working distance. I now find it useful in the form you figure it in the Journal for January.—*W. Shipperbottom.*

Diatoms in Thames Mud.—An observation showing the value of the Microscope in settling vexed questions may be found in the Proceedings of the Holmesdale Natural History Club, wherein it is proved beyond doubt that the mud-banks forming in the river are due to the discharge of matters from the sewage out-fall.

Mud from different localities was microscopically examined:—At half-a-mile above Teddington Lock sixty-six fresh water diatoms were found, but no salt-water species; at one mile below the Lock fifty-four fresh-water forms were found. At Kew fifty-two fresh-water, and thirty-seven marine forms; at Blackwall thirty-nine fresh-water, and forty-five marine; while in the Estuary of the Thames only nine fresh-water species were found, accompanying sixty salt-water species.

Standard Gauges for Eye-pieces.—The Committee appointed by the Council in October last, to consider the question of standard gauges for eye-pieces and substages, duly presented their report, which was thereupon ordered to be printed and circulated amongst the members of the Council, and is now under consideration.—*J. R. M. S., Feb., 1882.*

The Aperture Shutter.—Mr. Chas. Collins, it appears, has sent one of his "aperture shutters" to the Royal Microscopical Society for exhibition. At the meeting held on the 8th inst., it was referred to, and the credit given to Dr. Royston Pigott. We here claim the apparatus for Mr. J. B. Dancer, of Manchester, and shall allude to it in a special article in our next issue.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

C. C. C.—Your fungus is *Stemonitis fusca*, one of the Myxogasters.

T. R.—We are sorry you felt annoyed at the correction, but we went to press a week earlier than usual—in fact a day or two before your letter came. You will remember it was Christmas week.

H. A. R.—We would rather not express any opinion upon the subject of your letter. Try both naturalists.

A. A. C.—We think the least you could do, if you wished your letter forwarded, would be to enclose a stamp.

T. B. K.—The matter will be under review next month, and then you will be able to judge whose was the prior instrument.

J. C. C.—We shall be glad to receive the copies of Nos. 1 and 4 of THE NORTHERN MICROSCOPIST you offer; full price will be paid for both.

B. T.—The aperture shutter has been used successfully in photo-micrography, especially for high powers. Dancer or Collins will supply you.

H. G.—We shall return you the transparencies in a few days; they are very clean for gelatine plates.

A. P. Y.—See last year's volume for the terms and conditions of the verification department. We cannot add to our labour in the direction you wish.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

ALGÆ AND DESMIDS.—Wanted, British or Foreign correspondents for the interchange of specimens. For particulars apply to W. JOSHUA, F.L.S., Cirencester.

MICROGRAPHIC DICTIONARY.—Good slides, materials, and books in exchange for this work. Send for lists. —J. C. BLACKSHAW, Cross St. South, Wolverhampton.

CODDINGTON LENS.—Wanted, a good pocket Coddington lens in case. Can offer good exchange in slides.—J. E. FAWCETT, Rawdon, near Leeds.

ECCREMOCARPUS SCABER.—Slides of this seed in balsam (and others) in exchange for well mounted slides.—T., Decoy Farm, Crowland, Lincolnshire.

APPARATUS. — Several pieces of Microscopical Apparatus in exchange for good slides. Send list and requirements.—V.E., care of the Editor.

HYALONEMA MIRABILIS.—For a piece of this, including glassy threads, send good and rare diatomaceous material.—J. TEMPERE, Storrington, Sussex.

BOTTERILL'S TROUGH, in exchange for several (6) slides of the Hepaticæ in fruit.—D.A.R., care of Editor.

PUCCINIA UMBILICI.—For a specimen of this fungus, send stamped directed envelope to E.C.J., 3, Florence Villas, Ilfracombe.

ZOOPHYTES AND POLYZOA.—I am making a collection of these, and shall be glad to make exchanges. Lists exchanged.—W.H.C., 5, Birch Grove, Rusholme, Manchester.

SOLANUM AURICULATUM.—Fine stellate hairs of this plant from the Mauritius for exchange. Send lists.—Rev. A. C. SMITH, St. John's Vicarage, Crowborough, near Tunbridge Wells.

BOTTERILL'S LIFE SLIDE.—I have several to exchange for good slides. Send lists.—J.J., care of Editor.

THE NORTHERN MICROSCOPIST.

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THE CYPRIS AND ITS FOSSIL ANCESTORS.

By R. T. Burnett, F.G.S.

A Paper read before the Manchester Microscopical Society.

THE Cypris is a small bivalve, of the class Crustacea, sub-class Entomostraca, and of the tribe Ostracoda. He is a very active little fellow and is almost a perfect cosmopolitan, being found, as we shall hereafter see, under the general term Ostracoda, in all parts of the globe, living in sea water, brackish water, and clear water. Very few seas are without him. He flourishes abundantly in estuaries, is to be found in running waters, and loves ponds, both sweet and foul. The foregoing applies to the tribe more particularly to which our Cypris belongs than to the small crustacean itself.

The "pond hunter," upon turning out the contents of his bottle after reaching home from a collecting expedition, will invariably come upon an oblong object about one-tenth of an inch in length, somewhat resembling a kidney bean in shape, and of a dark green colour with markings of paler green. Upon watching the object for a while he will observe it suddenly rise up swiftly from the bottom of the jar in which he may have placed his "finds," and appear to paddle itself along with great rapidity, suddenly to change its course, and as rapidly descend once more to the bottom, and seek refuge in whatever muddy deposits it can find. Upon attentively watching it again, he will see that it propels itself with leg-like organs, which appear to project a slight distance only beyond the main bulk of the object from its fore part and undersides. This kidney-shaped object is our little Cypris.

Take him out and for a moment lay him upon a piece of paper, and examine him through your pocket lens, when behold you find the "legs" have almost disappeared, and you see but a minute, bean-shaped shining little object, with a fine line running from end to end, where before you had seen the "legs." Turn him over and you see that that which you took for a line-marking simply is in fact the line of opening identical to those of the oyster, mussel, or cockle; it is in fact the lips of two valves which are united on the opposite sides with a hinge in like manner to the mussel, or any other bivalve mollusk. But bear in mind this is not a mollusk; it is a crustacean enclosed in bivalve shell, as we shall hereafter prove.

By applying your Coddington or platyscopic lens to those valves you will see that they are invariably prettily marked with small pittings either all over, or at the end only, and you will sometimes find that the valves are fringed on the margins with a delicate row of fine hairs which undoubtedly act to filter the water as it passes inwards to the animal. Now remove your Cypris to the microscope, and whilst there take away the valves, and lay bare the structure of the little animal, and, astonishing fact to the uninitiated, we find him built up on the same structural platform as the lobster. Do not misunderstand; we do not mean to say that he is either a young lobster, or a degenerated form of it, but that the general arrangement of his organs is the same. In the lobster we have the abdominal parts segmented, which segments are visible by reason of the close adherence of the shell to the body, and being jointed move about with the action of the several segments. In the lobster we have also segments of the body fused together, forming one hard covering to the vital parts of the creature, and, further, we have in the lobster certain appendages which we all recognise as antennæ, claws, and feet.

Now, in the Cypris we do not find any close-fitting, hard segments, movable with the various parts of its body, but in the place of these we have the hard, brittle little shell covering the delicate body within, from which shell when opened project its antennæ and feet, which serve the same office to the Cypris as do those organs to the lobster.

According to Brady, the anatomical structure of the Ostracoda, and consequently of the Cypris, is as follows:—It has a pair of upper antennæ which are seven-jointed, and have at the end a set of beautifully fine hairs, long and graceful, which have the power of beating the water and creating a current, probably for the purpose of bringing small prey within reach of the animal. It has a second pair or lower antennæ which are stouter than the first, and is geniculated or bent back. These antennæ are clawed, which makes it adapted for walking, and have also a lash of hairs which adapts the creature for swimming. No doubt the hairs upon the first antennæ will also assist in this office when required, and conjointly will mainly cause the rapid motion which we observed at the outset. There is also a pair of feet which project beyond the shell when in use, and, being clawed at the extremity, assist the lower antennæ when in the act of walking.

All the foregoing organs are used externally, as are the similar organs in the lobster.

Within the valves are the mandibles, which are elongated and triangular, with the base directed upwards. The mandibles are divided into teeth-like structures, and have four jointed palpi, at the basal joint of which is attached a branchial appendage. The jaws, which lie immediately behind the mandibles, consist of two pairs. The first pair, which is larger than the second, is divided into four segments, and has a large branchial plate attached, which is the principal breathing organ. The second pair of jaws is much smaller than the first, to which it is attached. It is a non-articulate palpus, and in the male sometimes becomes modified into a prehensile organ.

There is also within the shell a pair of feet of a slender flexuous character, which always remain tucked up close to the body. Is this a modification subject to the laws of the great doctrine of Evolution? or what is the reason that this little animal possesses two legs, apparently never used, and, apparently, by their softness, incapable of being used? The post abdomen consists of two flattened elongated rami, which are very movable, and are strongly clawed at the extremity, and lie side by side mostly within the shell. These may probably be to assist the animal in climbing, or aid it in battle. The eyes of the Cypris are sometimes two, but mostly confluent. The ovaries lie round the body, immediately beneath the shell, and they are so numerous and the female so prolific, that it is computed that one impregnation lasts an entire lifetime; and, further, that the young females so produced are capable, for generations, of producing fresh individuals without the aid of the male. The male Cypris is very rarely met with. The copulative organs are of beautiful and peculiar structure, consisting of a mucous gland with a double central cylinder formed of whorls of radiating filaments.

Just as the lobster sheds its shell periodically, so does the Cypris shed its shell or valves.

The Cypris is not, by any means, an epicure. It will feed upon almost anything, and when driven to it by the forces of adversity, will dine upon its own brother; but it will in the first instance fulfil the great object of its being, namely, eat up all decomposing animal matter, and then turn upon the vegetable, and, when that has fallen short, then—and then only—will it fall back upon a dainty relative.

We said that the Cypris was cosmopolitan, and when we come to reflect upon his abundance in ponds of all sorts, that it is found pretty numerously in lakes, occasionally in high mountain tarns, and that it revels in rivers, estuaries, and salt marshes, we begin to feel indeed how justly accurate is the term, especially when we learn that in Lakes Superior and Huron, in America, there are deposits "on the grandest scale" of sands and clays enclosing shells of existing species. If our observation applies so pertinently to the fresh water and brackish water species, what shall we say with regard to the marine species when we find, by a careful study of the Challenger Expedition, how wide-spread indeed is this little Crustacean.

The following is a short summary of "The Challenger" work as regards the subject in question. Out of the multitudes of Cypridæan forms taken on board, ten species were obtained from the North Atlantic, and ten from the South Atlantic; six species were procured from the South Indian Ocean, and twenty-seven species from the Australian seas; five species come from the South Pacific and six species from the North Pacific, while from Eastern Asia three species only were taken.

The interesting fact follows that, of the various sedimentary and other deposits, in which the Cypris was found, mud seems to have been the most congenial, because in the West Indies, North Brazil, Bermudas, and Pernambuco, from depths ranging from 390 to 675 fathoms, mud was in every case the sediment. Where formed in sand the depths were 38 to 40 fathoms only, while in one case only of coral at Tongatabu 18 fathoms was the depth. The greatest depth from which the Cypris was procured is that of 1,452 fathoms off Tristan D'Achuna found in the globigerina ooze. Now as this globigerina ooze of the Atlantic is said to be not only an equivalent of the chalk deposits of the cretaceous period, but by many presumed to be a continuous co-extension of that age—it shows that we are still in the chalk age. It would become an interesting study for some of our readers to work out, as far as practicable, the organic microscopic remains of this ooze, and see how far they agree with those of the chalk itself. Although the Cypris has been found in the globigerina ooze, or red clay of the Atlantic at such a great depth, it is remarked as being singular that it is generally wanting, as half the dredgings contain no trace whatever.

The tow net was used at various stations, and as from twenty-nine dredgings at depths beyond 500 fathoms fifty-two species were taken; at depths below 1,500 fathoms nineteen species only were taken; and, further, when we find that of the shallow water dredgings—Booby Island twenty-eight, Port Jackson twenty-three, Torres Straits nineteen, and Balfour Bay nineteen species—it is obvious that our Cypris is *not* a lover of the great depths, but rather prefers the light of day.

Although, of all the species taken in the seven areas of distribution named, only two species of Ostracoda were sufficiently pliant to live in all these areas, it is an interesting fact to find that it is possible for one or more species of such a minute crustacean to be able to adapt itself to the various temperatures. The two species were natatory pelagic, and are named *Halocypris Atlantica* and *Halocypris brevirostris*, and Dr. Brady considers it is because they are natatory pelagic that they are so widely distributed.

Now we have stated that the chief economy in nature of the fresh water Cypris was the removal of dead animal matter, and there is every reason to believe that the same offices are performed by the marine forms, especially those that live far from land where little else than animal matter could reach them.

Having taken a sketchy view of the anatomy and geographical distribution of our little friend, and having seen by such wide spread distribution how greatly it works to assist in keeping down the deleterious results of organic decay at the present time, and having also seen that his valves or shells are conspicuously present in the mud and sands of the existing seas and lakes, let us see whether the rocks, representing the deposits of former seas and lakes, and lands, reveal to the taps of hammers aught upon the subject.

Of course it is known to most readers of the *Northern Microscopist* that the stratified crust of the globe is divided into certain "formations." To get an insight into the ancestral line of the Cypridian family, it is necessary to note the table of the principal formations of these stratified rocks, which are as follows—reading them from the newest to the oldest:—

TERTIARY OR CAINOZOIC	Recent....................
	Pleistocene ....
	Pleiocene.................
	Meiocone ....
	Eocene ....
SECONDARY OR MESOZOIC	Cretaceous ....
	Wealden ....
	Purbeck ....
	Oolitic ....
	Liassic....................
	Triassic ....
PRIMARY OR PALÆOZOIC	Permian ....
	Carboniferous ....
	Devonian or Old Red...
	Upper Silurian ....
	Lower Silurian ....
	Upper Cambrian.........
	Lower Cambrian.........
	Laurentian ....

By referring to the preceding diagram, which is based upon a similar arrangement prepared by Sir Chas. Lyell, it is seen that the column shews upon the left hand side the names of the three principal divisions of these formations. These divisions are worthy of note as indicating two breaks, illustrative of the remarkable change in the fauna and flora at these periods. Upon the right hand side of the column is a diagrammatic line, shewing, by its attenuations and thickenings the persistency of Ostracoda life and the periods during which it most flourished. It will be seen that at the present time or 'recent,' the existence of it is almost as prolific as it was during the Wealden and Purbeck, during which periods it attained its maximum as we shall hereafter see. In the next formation, viz., the Pleistocene, and in the Meiocone and the Oolitic and Liassic the genera is held on only by a few species which do not shew any prominent features as a strata. This may be owing to peculiar conditions of climate at those periods, and also to the material of the formations being unsuitable to either the life of the animal or to the preservation of its remains.

In the "Permian" the line is altogether wanting here. We see there is a total break, the Palæozoic forms ending abruptly in the carboniferous, and the secondary forms, almost as abruptly, beginning in the Triassic, and continue without break into the Tertiary formations.

This break may be only apparent for the want of evidence, or it may be so in actual fact. We should be inclined to think it is apparent only, and that careful research may reveal the "missing link." Whichever it may be, it is only another instance of the great change which took place in both the fauna and flora of those periods.

The earliest records we find in the rocks of the fossil ancestors of the Cypris are in the Lower Cambrians, discovered by Dr. Hicks in the Solva grits a few months ago.

Since then, Prof. T. Rupert Jones has worked them out from the Wenlock shales of Shropshire in the upper Silurian formations.

Previous to either of these discoveries being made the earliest prominent traces were those so ably recorded by Sir Roderick Murchison, as occurring in the Downton sandstones or 'passage beds,' existing between the Silurians and old red sandstone. These beds have just recently been renamed, and are called the "Devono-Silurian beds."

The earliest types of the Cypris found in the solva grits of Lower Cambrian rocks occur in rocks at St. Davids, and are called *Leperditia ferruginea* and *Leperditia Cambrensis*, and were most probably marine.

The next indication we have of its existence is a little higher in the scale of rocks—in a member of the Upper Cambrian, viz., the

Lingula flags, wherein it rejoices under the name of *Primitia Solvensis*, and from the assemblage of fossils found with it—is also undoubtedly marine.

Ascending into the Silurian formation we no sooner enter into its lowest or basement beds than we are confronted with its first appearance under a new name—that of Beyrichia. The rocks, in which this probably modified form appears are the Arenig rocks of North and South Wales.

And now we find that, whereas we had hitherto met with but one species at a time, namely: first, Primitia, and afterwards Beyrichia; at the top of this Arenig formation the two species now exist conjointly.

At the top of the Lower Silurian we come to indications that the Ostracodean ancestors of the Cypris had undergone material development in point of species, because we find them represented by the forms of *Leperditia*, *Beyrichia*, *Cythere*, and *Primitia*, all of which forms have been carefully and skilfully worked out by Prof. Rupert Jones, to whose labours we are much indebted for the knowledge we possess upon the Ostracods of the Lower Palæozoic rocks.

We now make a great rise in these ancient rocks, and pass with one bound from the Lower Silurian to the middle of the Upper Silurian, namely, the Wenlock group. Here some new genera and species come in, namely, the *Cytherellina*, *Primitia excavati*, *Primitia lenticularis*, and *Cythere Grindrodiana*, and especially *Beyrichia Klœdena*, which is conspicuously present in the Downton beds. It is stated by Mr. Etheridge that no less than twelve species of Primitia, besides other Ostracoda, have been determined in these rocks by Prof. Rupert Jones.

The next group of rocks, namely the Ludlow, at the top of the Upper Silurian formation, witness the coming in of four new genera of Ostracoda,—viz., *Cypridina*, *Entomis*, *Kirhbya*, and *Moorea*,—and here we may note that in the Cypridina we begin to have the, so to speak, more direct lineal descent of the Cypris. The forms of the Ludlow formations pass into that of the Downton sandstone before alluded to. From the lithological appearance of this rock, as observed at Ludlow, we should say that, although all these forms are marine, the presence of *Beyrichia Klœdena* in the fine light-coloured sandstone indicates a shallowing sea, and that they were entombed not far from a coast line.

In the Devonian, the Ostracoda holds its position in full force, but as no new genera or species come in, we may pass up to the next formation, the Carboniferous, where we find the Ostracoda represented by 130 genera or species, an enumeration of which would be too lengthy for this paper.

We now come to the fact that the ancestors of our Cypris became one of the most important order of the Crustacea at this period, because, upon scrutiny, we find that of all Crustacean orders the Ostracoda is most prominent. The following comparison will show how important this little fellow has become. In the Silurian seas the Trilobite numbered nearly 320 species, and the Ostracods not more than 4; now, in the Carboniferous the Ostracoda number 85 genera, and the Trilobite only 3. It may be noted here that as the Trilobitas became extinct in this formation at an early period—namely the Carboniferous Limestone—it is just possible that the marine forms of Ostracoda, as survivors, had better opportunities for surviving through the extinction of the Trilobite. This will also apply to those found in the higher Carboniferous rocks, where the Cypris itself is found fossilized in great quantities in the Burdihouse Limestone and in the black shales of the Scotch coal measures. The fossilized forms of the Cypris in these sandstones and shales present a singular appearance *in situ*, and would indicate that the shale represents a dark muddy shore of an estuarine character.

Leaving the Carboniferous formation, the next in order is that of the Permian, before alluded to as representing the first break in the column, and consequently the close of Palæozoic rocks.

Passing the Triassic rocks, in which are carried through the Cypridean forms, we may just notice the fact that in the Liassic rocks the Cypris is found fossilized amongst the fossil bones of the animals which lived in those seas. What clearer proof can we have than this that the functions of the Cypris then, as now, were to eat up dead animal matter. The simple history of which deposit has been that some unfortunate Ichthyosaurus or other saurian of those waters has got stranded by venturing too far up the river into some tidal pool,—has died,—and then the Cypris, amongst other such busy little bodies, have begun their work of eating up the creature, when, probably, lo, suddenly has come down, from some short distance up the river, a flood so heavily laden with some muddy sediment as to enshroud both saurian and crustacean so completely as to entomb them, to be in after ages revealed in fossil form, and record the fact to enquiring man.

That the Cypris also existed in other than marine waters is recorded by the fact that in Gloucestershire they are found in the fresh water or estuarine deposits of the Lias, in a shale overlying the well-known "Insect-beds."

Although we can find no record of any special prominence of the Cypris in the Oolites, yet they undoubtedly existed where the circumstances were favourable, because in the succeeding Purbeck and Wealden beds we find them at their maximum, but in such a changed form from the Silurian types as to call for special note. Now, the

Purbeck and Wealden formations are mainly composed of brackish and fresh water deposits, and represent a period when the physical geographical aspect of the south of England was much different to that at any preceeding or succeeding age,—a period when all the coast, stretching from Folkstone down to Eastbourne, was the mouth of a great river, and for many miles inland an enormous estuary. This great river received all the sand and muddy sediments derived from the degradation of land stretching up to the North and North-west, which land yielded enormous quantities of clay and clayey loam. These clays and loamy deposits in this estuary became worked by torrents and tidal actions into shallows and pools, which became the homes and feeding grounds of the Ostracoda, consequently of the Cypris, which flourished and cast their valves in vast quantities. Some of these brackish water-beds are twenty feet thick, and abound with Cypris. The fresh water marls of the Lower Purbeck yield *Cypris Purbeckensis* and *Cypris punctata*, whilst in the middle Purbeck, in the fresh water strata, we come upon the more remarkable Cypridean forms, viz., *Cypris striato-punctata*, *Cypris fasiculata*, and *Cypris granulata*. These have been found along with the remains of turtle and fish.

The *Cypris striato-punctata* has wavy markings arranged concentrically all over its valves, and the *C. fasiculata* and *C. granulata* have tubercles at each end only of each valve.

In the Upper Purbeck we meet, in a fresh water bed of fifty feet thick, with forms much like the preceeding, viz., *Cypris gibbosa*, *C. tuberculata*, and *Cypris leguminella.*

In the Wealden proper we have a form of the Cypris called *Cypris spinigera*, so plentifully deposited throughout the fresh water clays as to give a laminated appearance similar to mica. In this, and the Purbeck, the remains of the Cypris are so great as to form of themselves a deposit of two or three inches thick—a deposit mainly composed of the valves accumulated in layers upon the soft, fine muds.

Space will not permit us to trace in further detail the fossil ancestors of the living Cypris ; sufficient, however, has been brought forward to show that its tribe has existed through countless ages and that although the markings of its valves show variations and modifications, at different periods, notably in the Purbeck series, its fundamental character has undergone no material change. True, by comparing the indented structure of the valves of the *C. beyrichia* with the wavy markings of the *C. striato-punctata*, or with the typical pittings of the *C. tuberculata*, we see wide differences, and would be inclined to consider it a great change in character, yet, nevertheless, the general form is maintained throughout. Of course as the anatomical parts of the Cypris are too delicate to resist decay, we have in all cases been obliged to fall back upon the shell or valves, which being siliceous, are more likely to be preserved as fossils, particularly where the matrix has been of a finely levigated character. Where the sediment has been arenaceous, such as the Downton sandstone, we rely then mostly upon casts such as from which the *C. beyrichia* have been worked. When the imbedding substance is an argillo-calcareous, the valves are tolerably accurately preserved, and are easy to make out.

Our short and necessarily imperfect sketch of this little Crustacean is at an end, yet we cannot close without being struck with the remarkable fact of the persistency with which the Cypris family has held its own through all the ever-varying changes of climate, of temperature, and of time. That from the earliest periods, whilst ancient continents were being ground down, and new ones built out of the degraded matter; that whilst land has changed places with the sea, and the sea has possessed the land areas; throughout all the vicissitudes of the moisture-laden atmosphere of the Carboniferous period, the semi-tropical climate of the Tertiary, and the Arctic condition of the Pleistocene, throughout all these, and more changes than we can enumerate, has this apparantly insignificant form held its own.

More particularly are we struck with the fact when we reflect upon all the huge forms, such as the Mastodon, and some of the Elephants, of the Tertiaries, the Pleisosaurs and Ichthyosaurs of the secondary periods, and the Labrinthodon and the Devonian fishes of the Palæozoic which have all had to succumb to the various changes of the past, and have either been exterminated from our land or become totally extinct. Yet, here we have that which some of these extinct creatures may have sucked up into their huge jaws, and swallowed by the thousand, still existing in forms little modified since its earliest advent.

Finally, to what does this apparent persistency of type point? Is it persistency of type? If so, then where does the great doctrine of Evolution step in to this particular form? If it is *not* persistency of type, then how can we account for its repeated appearance, through the geological range of the stratified rocks, other than by special creations?

That it is persistency of type, and not special creations we believe, and believing that, we say that this is one of the many instances of persistency which go to say that Evolution is not yet universally made out.

"THE NORTHERN MICROSCOPIST" VERIFICATION DEPARTMENT.

EXPLANATIONS.—Columns *a* and *b* give the denomination of the objective as issued by the maker. Columns *c* and *d* show the results of measurements made at a distance of TEN INCHES from the front lens of the objective, to the plane surface of the eye-lens of the ocular. The column *d* shows the actual distance between the upper surface of the covering glass and the front of the objective, when used over a slide of *Amphipleura pellucida*, the frustules being mounted dry, on a cover suitable for observation with a one-twenty-fifth dry objective. The column *e* gives the actual focal length of the objective determined by Cross' formula $\frac{n\,l}{(n+1)^2}$ where l = the distance between the two micrometers and n = the amplification at this distance.

The eyepiece used is a Ross A, with a diaphragm aperture of 0·75 inch, and yielding approximately an amplification of 5 diameters.

Column *f* contains the results of the aperture measurements by Professor Abbe's Apertometer; they are the mean of several, but the individual measurements scarcely differ from each other. Column *g* is calculated from the numbers in column *f*.

REGISTER NUMBER.	SOLD AS		AT TEN INCHES.			REAL APERTURE.		REMARKS.
	a Inch.	*b* Air-angle or Aperture.	*c* Amplifying Power. Diameters.	*d* Working Distance. Inches.	*e* $\frac{n\,l}{(n+1)^2}$	*f* Numerical.	*g* Air-angle.	
Number 86......	C	50°	140	.06	.263	.42	50°	The G and W in columns *b* and *g* refer to apertures in glass and water respectively.
" 87......	C C	90°	140	.01	.263	.68	86°	
" 88......	D	75°	250	.03	.158	.60	74°	
" 89......	E	110°	360	.01	.107	.866	120°	
" 90......	1″	... ...	43	.40	.776	.25	29°	
" 91......	⅛	112° G	390	.004	.102	1.20	129° W	
......	... ...	... ...	... ...	... ...	... ...	... ...	104 G	

THE APERTURE SHUTTER.

A PARAGRAPH in our Notes and Queries column of last month referred to the fact that this little piece of apparatus was exhibited by Mr. Collins to the members of the Royal Microscopical Society. The plan was there discussed and the credit given to Dr. Royston Piggott, save the revival of the idea, with which we were credited.

Now, as we described in the January issue (1882) of this Journal, we had been using stops of blackened cardboard, with wide aperture objectives, to secure penetration, and it was owing to a conversation with Mr. Dancer, of Manchester, that the iris was constructed. Mr. Dancer produced, during the conversation, a graduated diaphragm with a square aperture, made at least ten years since, but he thinks in 1870, to measure the extreme aperture to be given to the fixed diaphragm placed behind the back lens of all his objectives.

When working thus, he discovered that small apertures gave greater *penetration* than wide ones, though he never seems to have done more than to note the fact.

If we turn our attention to the literature of the Monthly Microscopical Journal, we shall come across some curious statements, but, nevertheless, if a claim of securing penetration from wide angle objectives was made during the years 1869–1877, we shall doubtless find it there. Upon searching, however, for Dr. Piggott's claims, we come upon a host of matter which caused much discussion at the time, but in no case can we find any special piece of apparatus devised for ridding wide angle lenses of what was then called their "want of penetration."

It will be remembered by most of our readers that Dr. Piggott's papers were to prove that nearly all objectives of that day (1870) were possessed of some residuary aberration, and that most structures were beaded. He also held that in order "to define some of the most minute lines of diatoms, fine definition is often sacrificed to too large aperture."

Dismissing the beaded structures, insect scales and diatom frustules in particular, with which the earlier volumes teem, and also the "Aplanatic Searcher," which was stated "to improve penetration, amplify magnifying power, and raise the objective somewhat further from the dangerous proximity to the covering glass," we meet in M. M. J., iv. 300, with the Aberrameter, used for cutting off excentrical rays, and have followed it to a later volume, where it is described as made by Messrs. Beck.

It seems to have been used for giving better definition to glasses possessing uncorrected margins, but not a word in the whole series of discoveries is said about using it to produce penetration. This dissertation appears in M. M. J., xi. 175, and the foot-note clearly sets forth what the instrument was intended for.

Mr. Slack also mentions this instrument in the M. M. J., xiii. 234, and those interested in this matter will, no doubt, find this paper worthy of perusal, but no mention is made of its producing penetration, and the way this term is applied throughout the paper

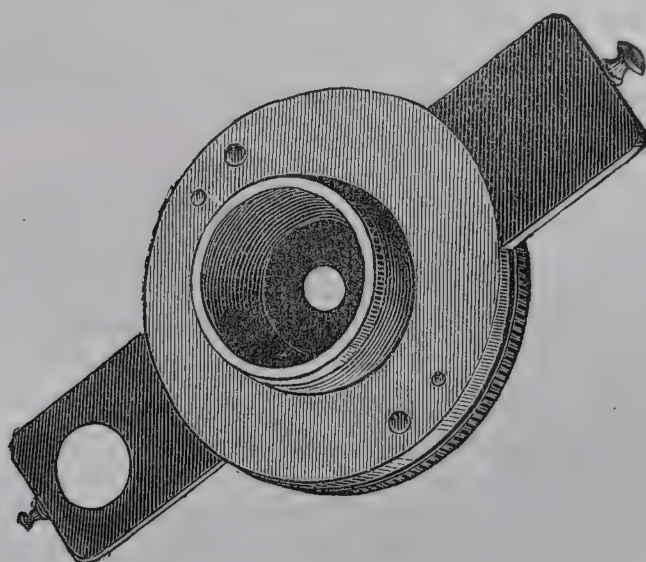


Fig. 7.

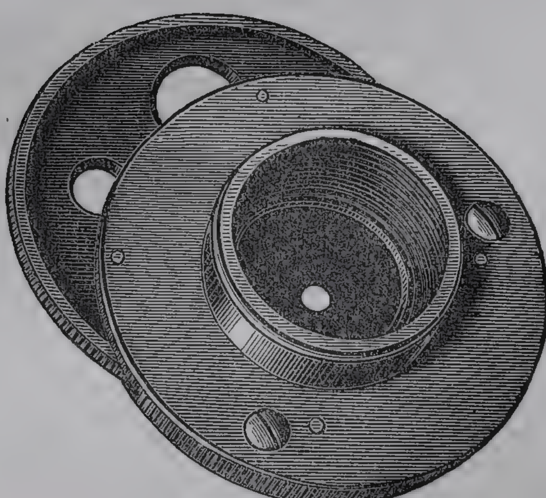


Fig. 8.

leads one to suppose the author really believed penetration to be an attribute in itself, and had no connection with anything, but some mysterious performance known only to a select few. Those who remember this lengthy series of articles and the correspondence thereon, will know that the doctrine attempted to be laid down, was, that an aperture beyond a certain limit injured the defining power of an objective, which was stated to be improved by cutting off some of the peripheral rays.

This may be set forth more clearly by reference to Dr. Carpenter's "Microscope and its Revelations," 6th Ed. "He (Dr. Piggott) has shown that the black margins, or black marginal annuli, of refracting spherules constantly displayed by small aperture objectives are attenuated gradually to invisibility as the apertures are widened to the utmost; that the black margins of cylinders, tubules, or semi-tubules also suffer similar obliterations, and that in consequence *minute details are concealed or destroyed till the aperture is considerably reduced.*"

Now, let us see what the Editors of the Journal R. M. S. say to this paragraph. "The statements that there is an inherent incompatibility between good definition and large aperture should be deleted, as it is now known, both from theory and experiment, that the definition of objectives of the widest aperture (1-47 out of a possible 1-52) is as perfect as with those of less aperture. The wider the aperture of the objective the greater the technical skill required on the part of the practical optician; but the notion that as the aperture of an objective is increased, its defining powers must necessarily, either on theoretical or practical grounds, be impaired happily belongs to a closed chapter of microscopy." In all these remarks there is no mention of the Aberrameter being used to avoid that bugbear of all antagonists to wide apertures—want of penetration.

We have already on page 14 of this present volume figured the aperture shutter as made for us; it is very similar to the Aberrameter, but as the aperture is not circular, Mr. Dancer has constructed the two forms shown in figs. 7 and 8.

In fig. 7, the apertures are drilled in a sliding shutter, while in fig. 8 they appear as a wheel of diaphragms. The figures explain their use, and it will be seen that as the apertures are fixed, there is no gradation from one to the other. On one objective that we tried (a half-inch of 78°), the second aperture reduced the angle to 56°, and the second to 36°, though of course the reduction must vary with each objective. Mr. Dancer has devised another method of using a limiting diaphragm, which may be found in a subsequent page.

THE WORKING MICROSCOPE.

OUR ideas respecting the working microscope expressed in The Northern Microscopist for September in last year have at last been carried out in Manchester. At the last Soiree of the

Manchester Microscopical Society Mr. H. P. Aylward exhibited a form which we can conscientiously recommend to all beginners, and a somewhat similar pattern of the same degree of excellence was exhibited by Mr. E. Ward at the March ordinary meeting of the same Society. Several important alterations have been carried out by both exhibitors. In Mr. Ward's pattern the stand has been raised to allow of greater space beneath the stage, for greater convenience of illumination, and this is also furthered by the addition of a crank-arm to the mirror. The greatest advantage of this stand is however in the increased diameter of the optical tube, which allows of the use of the large oculars of Ross and others, and this tube is also supplied with an adapter to carry Zeis's and other foreign oculars. The draw-tube is made to extend to a length of ten inches. The stage is made to revolve; it is of glass and a wheel of diaphragms revolves close to the surface, and the carrier for substage accessories is cut away on one side to allow of excessively oblique illumination.

Mr. Aylward's model has an enlarged foot, so that the stage is three-quarters of an inch higher than the illustration in our issue of September last, and the foot is made to extend further back so as to give greater steadiness when the body is placed in a horizontal position. The larger stand gives plenty of room for substage accessories, and a crank arm is also supplied to the mirror. The rackwork has also been cut lower than in the form already illustrated so that objectives of greater focal length may be used. The tubes of Mr. Aylward's instrument are made to take Ross's full size eyepiece, and an adapter is supplied to take any purchaser's oculars.

We feel sure that in the absence of a standard gauge for eyepieces, students could not do better than inspect these forms. Each of these instruments is adapted to all the requirements of the microscopist; they are cheap, and may be purchased either with or without oculars and objectives.

OUR BOOK SHELF.

Portfolio of Drawings and Descriptions of Living organisms sent out by Thos. Bolton, F.R.M.S. London, David Bogue. No. 7. 17 plates.

Mr. Bolton's portfolio of drawings has now reached its seventh number, and is perhaps one of the most interesting of the series. In the Vegetable Kingdom we have illustrated:—Bacteria, *Asterionella formosa*, *Surirella bifrons*, *Pleurosigma angulatum*, *fasciola*, *speciosum*, &c., and *Spirulina Jenneri*—while the Animal Kingdom is represented by :—

Trachelomonas bulla.
Telotrochidium crateriforme.
Amœba.
Acineta grandis.
Sertularia pumila.
Aglaophenia pluma.
Ophiocoma neglecta.
Tubifex rivulorum.
Floscularia cornuta.
Polyphemus pediculus.
Canthocamptus minutus.
Doris tuberculata.
Eolis Landsburgii.

There is a marked improvement in the general style of the drawings. Has any reader taken them as the basis of a good drawing in color?

ON A METHOD OF MOUNTING THE LIMITING APERTURES FOR INCREASING THE PENETRATING POWER OF OBJECTIVES.

To the Editor of the "Northern Microscopist."

SIR.—Since sending you the two forms of apparatus for limiting the angular aperture of objectives (figured in this number) I have employed a double nose piece as a receptacle for the circular limiting apertures when in use. A shallow recess or rebate is made in the top edge of one of the female screw parts of the nose piece, thin metallic discs with holes of suitable diameters are made to fit the shallow recess, and where the nose piece is attached to the microscope and the objective is screwed into its place a disc with the required aperture can be dropped into the recess by merely moving the arm which carries the objective on one side. They can also be easily lifted out of the recess by means of a wire hook, thus obviating the necessity of touching them with the fingers. Each disc is numbered, so that when a satisfactory limiting aperture has been selected by experiment the number on the disc may be noted for future use. The metallic discs are packed in a small brass box along with the wire hook. The plan now proposed has several advantages over the sliding shutter apparatus, which I used for the same purpose some ten years ago, and will render the Iris diaphragm and the forms figured in this number unnecessary to those microscopists who possess a double nose piece. I have devised another simple form of apparatus for carrying circular apertures, but will not trespass more on your columns at the present time.

J. B. DANCER, MANCHESTER.

NOTICES OF MEETINGS.

THE BLACKBURN FIELD NATURALISTS' SOCIETY. CONVERSAZIONE.—The first meeting and conversazione for the present year of the Field Naturalists' Society was held in the Free Library on Thursday evening, Feb. 16th, under the presidency of the Mayor (Mr. John Lund). The entrance hall and room were decorated with valuable hothouse plants, sent by the President of the Society, Major-General Fielden, M.P. There was a large and influential attendance.

The Mayor, in opening the proceedings, said he was much pleased to preside, and, if he were permitted to give an opinion, would say to the members that to be practical and definite should be the aim of the Society. There were so many specialists and workers in connection with many learned societies that that Society should not be too ambitious, and attempt to rival those of more favourable position. Its labours should be more particularly directed to add to our knowledge of the fields and flowers, &c., which one could see within an easy distance of home. The production of original papers should be encouraged, and efforts should be made by those who possessed any special information to convey it to others as opportunity offered. Photographs, objects noticed, and even a list of the trees and plants in the Park, or the varieties of stones in the streets, would not be without interest. Any one who had read Gilbert White's "History of Selborne," knew how much might be done within a limited area of observation. He was glad to know that two very creditable collections of flowering plants had been made during the year—one by a lady, and the other by a gentleman. He was also told that a most interesting series of geological specimens had been collected during the year by their hon. secretary. A gentleman had also made progress in collecting mosses; but he did not know all they had been doing during the past year, or what they proposed to do during the present, except from the programme which had been put into his hands. It was pleasing to see the efforts put forth by the council of the Society in providing subjects adapted to interest the members.

The Rev. J. Shortt, one of the vice-presidents, read a paper, of which the following is an extract:—The title of the Society should, he said, furnish him with his theme—the study of nature in the field. What nature really was could not be learned from human imagination, which it infinitely surpassed; nor from books, but from herself—sight of her own face. A professor of natural history in the last century at a certain university was a man of great book-lore; but, having found a sparrow in his library, after much thought he pronounced it to be a crow. He had read many books, but not the book of nature, and mistakes, not indeed so glaring, but in substance as bad must be made, unless we go to the actual reality itself. Taking the word "Field" in its most restricted sense, every such enclosure near Blackburn might yield matter for very interesting thought. If it is rocky, those barren stones once bore the weight of vast forests, part of whose timber we now burn in our grates as coal. They could tell of trees of huge size, but uncouth shape and form that for ages and ages waved above them. And if these stones could tell of their own origin, they could give account of many changes in extent and level of sea and land. A brickfield, so repulsive to others, was to them an object of even weird interest, for it spoke of a time when England was like what Greenland is now, with great glaciers streaming forth from the hills through the valleys to the sea, and sending forth at their extremities the ground-up mud that now constitutes our brick-clay. A sandy field speaks of a time when the site, where they were now, lay many feet under the sea—a sea that gradually stole upon the land, and as gradually left it; and on the bosom of which icebergs floated, melting as they proceeded southward. Nature, studied in the field, told them these surprising but true tales. The grass of our neighbouring fields had its own marvel to unfold to us. A grass has been proved to possess a power of sight such as many human beings lack. It has turned with perfect exactness towards a light too dim for most of them to discern; and it can feel and turn from surfaces rough and hard to the touch. So remarkable is its capacity in this latter respect that a part of it has been seriously compared to the brain. A troublesome weed is to a naturalist a conquest or a victor in its own realm; one who has trampled out all its competitors by vigour and skill, and who is ready to fight again, even with man, in order to uphold its own well-won predominance. Pluck it up, it comes again. To its perseverance is due its abundance and luxuriance. Other plants thrive, not from their own energies, but from a whole chain of various external circumstances. The red clover depends for its success in life on cats. This plant requires for its healthy growth to be cross-fertilised, that is that the pollen of one plant should be transferred to the stigma of another. This is done not by the hive-bees, but by the humble-bee. The more numerous humble-bees, and the better for the red clover. Now, humble-bees are largely preyed upon by field-mice, who, therefore, are injurious to the plant. But field-mice are destroyed by cats. Thus, cats are serviceable to red clover by keeping down animals that are, though indirectly, yet seriously hurtful to it. The same is true of heartsease. Hence, red clover flourishes best in the neighbourhood of houses. Some plants exhibit wonderful sensitiveness in different ways. The common crocus can feel a change of temperature of even one degree of the ordinary thermometer. This has been proved by the movement of its petals. Few of us could discern so slight a variation. But a plant, in some places abundant, and to be found not very far from this, exceeds this sensitiveness, as regards another faculty, namely, that of taste. This plant, whose nature is, in other respects also, truly marvellous, can taste the twenty-millionth part of a grain of a certain chemical substance. No imagination could have dreamt of this. It is a conclusion arrived at, nay forced upon the discoverer, from repeated and vigorous experiments. The plant showed no movement when immersed in pure water, but in water so diluted as to contain but that inconceivably small part of a grain, it showed a certain characteristic motion. With what feelings trees may come to be regarded, we may judge by the saying of one eminent Lancashire man to another—the celebrated Professor Joule to Mr. Binney—"A man who can take pleasure in felling a noble tree must be destitute of the finer feelings of humanity." The sunbeams, which are to us so transient, are by those wonderful creatures—trees—stored up for ages. They can retain the sun's light and heat. And *apropos* of this storing up by trees and other plants, it may be truly said that some ladies in this room are wearing in their dresses sunbeams shed millions of years ago. Some great benefactors to our race, hitherto unknown, have lately been recognised. Who are these? Again nature tells us a tale transcending all romance. The worm that crawls along the field is this human benefactor. The rich and fertile mould is in a great measure due to these creatures, who have been proved, by actual weight, to have thrown up on a single acre more than 18½ tons of castings in one year. It is these creatures, too, who cover over in time rocky or stony fields with productive soil. Insects play also their parts in the naturalist's world of wonders. To them is due indirectly the bright colour of flowers. In order to attract them, flowers have learned to dress themselves in brilliant hues—hues which they have acquired the art to steal from the sun. Passing over other countless marvels—marvels ever increasing in number and in degree with the glorious advance of knowledge—no marvel can equal that luminary just mentioned. Should he condescend to shine upon the Naturalists' excursion, he alone would suffice to supply boundless subject for thought. "Our Society is then," continued the speaker, "a truly philanthropic one. Its object is to promote genuine human enjoyment by furnishing men and women with an unfailing, an inexhaustible source of amusement and interest. There can be no tedium of life to one who enters thoroughly into its spirit. You, ladies and gentlemen, will join with me in wishing the Blackburn Field Naturalists' Society along and prosperous career."

After the address the visitors examined with much interest the objects exhibited under the microscopes and arranged on tables and cases in the room.

The *Microscopical Section* was well represented by the following members, and the objects enumerated were exhibited by the aid of some very fine microscopes by the first opticians:—

Trichina spiralis in pork	Mr. Bickerdike.
Diatom—*Isthmia nervosa*	,,
Spicules from Sponge	,,
Gizzard of Cricket	,,
Volvox globator	,,
Hydra vulgaris	,,
,, *viridis*	,,
Embryo oysters (Polar)	,,
Barium chloride ,,	,,
Peristomes of Moss	Mr. Bowdler.
Eggs of House Fly	,,
Polycistina—Barbadoes	,,
Spine of Echinus	,,
Diatom—*Heliopelta metii*	,,
Tendon of Wild Cat (Polar)	,,
Rhinoceros Horn ,,	,,
Quinine ,,	,,
Chalcedony ,,	,,
Lava, from Lodore (sections of)	Mr. Hart, F.G.S.
Do. from No. 4, Falcon Crag, Keswick (do.)	,,
Granite, Eskdale (do.)	,,
Dyke, Red Screes, Ambleside (do.)	,,
Armboth Dyke, Thirlmere (do.)	,,
Dolorite, Castle Head, Keswick (do.)	,,
Syenite, Scale Force (do.)	,,
Limestone from Chipping and Clitheroe (do.)	,,
Daphnia vetula and parasites	Mr. R. C. Pilling.
Corethra plumicornis	,,
Hydatina senta	,,
Embryo—Fresh Water Mussel	,,
Various Polariscope Objects	,,
Various Animalcules, Sections of Wood, &c.	Mr. Thos. Hart.
Rosa canina—Section	Mr. A. P. Garland.
Raphides from Turkey Rhubarb	,,
Various	Mr. T. W. Gregson, M.B.

Mr. J. D. Geddes, with the aid of his Oxy-Hydrogen Microscope, exhibited various slides of *Animal Life*, Sections, Mounted Insects, &c., in the Committee Room to crowded audiences.

Special interest was taken in the Electrical Apparatus under the care of Mr. A. P. Garland, and the live and other objects of the lower forms of life shown by the Oxy-Hydrogen Microscope by Mr. J. D. Geddes. The curator, Mr. Geddes, kindly placed for inspection a case of exceptionally fine specimens of *Paludina vivipara*, and his valuable and interesting series of geological specimens collected by him during the past year, illustrating the rocks of the Isle of Man, Skiddaw, Keswick, Ingleborough, Whernside, Pennyghent, Pendle, and the principal drift rocks found in West and East Lancashire. The botanical collection by Mr. Rigby, which obtained the Society's prize, was displayed, while Mr. H. A. Surr exhibited a sheet of typical mosses.

A case of miscellaneous lantern transparencies by Mr. J. D. Geddes were much admired. A capital musical programme was rendered by Messrs. J. Baguely, J. Tomlinson, W. H. Varley, Fred Marwood, and John Davis.

LINCOLN SCIENCE CLUB.—The members of the Lincoln Science Club held their first *conversazione* in the County Assembly-rooms on Wednesday evening, Feb. 15th. Invitations had been issued to the leading residents, and the result was a crowded attendance. The gathering proved to be of a most enjoyable and instructive character, and on all hands was pronounced a complete success. Shortly after the guests had assembled, the President, on behalf of the Club, gave them a kind and hearty welcome, and in a few words dwelt upon the advantages to be derived from gatherings of this kind. He subsequently read a paper on Geology, in which he alluded to the pleasure and profit of a study of that science, and pointed out certain features of interest in his collection of geological specimens, which was on view in the room.—Mr. J. F. Burton illustrated the vibration of musical sounds by means of a brass vibrating plate. The examples were exceedingly interesting.—The Rev. R. J. Doble exhibited electrical apparatus, including a large induction coil, vacuum tubes, &c., and delivered a short address, explanatory of the laws, or rather the phenomena, of the induction coil. The microscopical department was well attended. Polarization of light under the microscope was illustrated by Mr. T. Sympson, F.R.C.S. There are four principal processes by means of which a beam of light may be polarized—reflexion, ordinary refraction, double refraction, and scattering by small particles. Of these, double refraction is used with the microscope usually in the form of two Nicol's prisms, one employed as an analyser, the other as a polarizer. The following slides were shown under polarized light:—Chlorate of potash, carded sheep's wool, tartrate of lime, cholesterine, aspartic acid, sulphate of nickel, Cornish granite, Brighton pebble, breccia from Labrador, Rowley-ragstone, zeolite, section of ox's tooth, gallic acid, cuticle of wheat straw, silicious cuticle of Dutch rush, tendon of ox, young oysters, vertical section of rhinoceros horn, horizontal section of ditto, hoof of horse, injected toe of white mouse, hoof of ass. Living organisms, including *Hydra fusca* and *Volvox globator*, were exhibted under the microscope by Mr. R. J. Ward, and some pleasing effects of polarized light, together with miscellaneous objects, were shown under similar instruments by Mr. J. G. Williams, and others. Other microscopes were lent by Dr. Harrison, Mr. T. M. Wilkinson, Mr. Wallace, &c. The Rev. H. G. Jameson was in charge of his spectroscope, exhibiting very beautifully, spectra of metals with an induction coil. A telegraphic apparatus was also on the same gentleman's table. Mr. F. M. Burton, of Gainsborough, exhibited a number of specimens of Algæ and Zoophytes—plants and plant-like animals, showing the similarity between plant and animal life, only to be found in the lower organisms. In one of the anterooms a large triunial lantern and oxy-hydrogen microscope was exhibited by Mr. A. H. Simpson, F.R.M.S., of the University College, Nottingham, who was introduced by Mr. Cant. Various natural microscopic objects were represented with remarkable clearness, and the heart-beating and circulation in an ordinary water flea plainly and vividly shown.

LIVERPOOL MICROSCOPICAL SOCIETY.—The third meeting of this Society was held at the Royal Institution, Colquitt-street, on Friday, March 3rd. Mr. J. Sibley Hicks, F.R.C.S., F.R.M.S., read a paper "On some varieties in the mouths of insects," illustrated by the oxy-hydrogen lantern.

At the conclusion of which the meeting resolved itself into a conversazione, when the following subjects were illustrated:—

Cheese Mites	H. C. Beasley.
Crystals—Native Sponge Copper	J. T. N. Thomas.
Daphnia pulex	J. K. Gardner.
Diatomaceæ—living	W. J. Baker.

Eolis elegans, under Zeiss A*	Frank T. Paul, F.R.C.S.
Fungus—*Peziza stercorea*	Rev. W. Banister, B.A.
Mouth Organs of Honey Bee	William Oelrichs.
Do. Hornet and Wasp	George F. Healey.
Do. Sand Wasp	John Vicars.
Do. Spider and other insects	T. W. Bruce.
Do. Wood Ant	I. C. Thompson.
Parasite of Rook (*Colpocephalum subæquale*)	H. R. Boult.
Pedicellaria of Echinus	Henry M. Bennett.
Pollens, various	J. J. Howell.
Proboscis of Blow Fly	Charles Botterill.
Do. do.	Dr. Hicks.
Pupa of Dragon Fly	H. Kendall, B.A.
Seeds, various	Thomas C. Ryley.
Stephanoceros Eichhornii	A. T. Smith, Jun.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the last meeting of this Society, held on Feb. 20th, Captain Cunliffe, F.R.M.S., who was in the chair, exhibited varieties of *Distichium capellaceum* and *Grimmia apocarpa*, as well as a series of slides of species of the genus Andrœa, which had been collected during the recent Scotch excursion, but had not been fully determined. Their further examination had been undertaken by Mr. Cash.

Mr. Stanley exhibited a number of Hepatics which he had mounted for microscopical investigation.

Mr. W. H. Pearson made a few remarks on one of the forms of *Lophocolea ardentata*, which had been raised to the rank of a species by Limpricht under the name of *Lophocolea cuspedata.*

It is distinguished from the typical form in addition to other characters by being monoicous. Dr. Carrington and Prof. Lindberg record it from Ireland, Mr. George Davis from the South of England, Mr. Wild from Stump Wood, and Mr. Pearson from Bettwys-y-Coed. It is probably commonly distributed, and many of the species are peculiar in having a strong aromatic smell.

MANCHESTER MICROSCOPICAL SOCIETY MOUNTING CLASS. —At the last meeting of the mounting class the evening was devoted to practical illustrations with the dissecting table, Mr. W. Chaffers, the demonstrator, showing what beautiful and instructive objects for microscopical investigation such creatures as the much-despised cock-roach could furnish. The gizzard of the cricket was carefully and quickly dissected and compared with that of the cockroach, and directions given for mounting them, after which the tongues of the horse fly (Tabanus) and the cricket (Gryllus domesticus) were extracted and commented upon as the operation proceeded. The gizzard of the cockroach is a wonderfully constructed apparatus, armed internally with rows of formidable teeth, and externally connected with powerful muscles. It is usual to cut the gizzard open for mounting, so as to display its structure and gastric teeth, but it is a very instructive and pleasing object viewed whole, externally; not much unlike, in miniature, some dark-coloured jelly turned out of a pretty conical mould. The tongues of the cricket and the horse fly, and in fact the tongues of insects generally, are very elegant formations, structures of fairy-like lace work and proportions, objects of admiration and astonishment to all who look at them through the microscope.

MANCHESTER MICROSCOPICAL SOCIETY.—The third annual soirèe in connection with this Society was held in the large lecture hall of the Manchester Athenæum, on Saturday evening, Feb. 25th. Over 400 persons, including many ladies, were present. The President, Mr. Thomas Brittain, F.R.M.S., in introducing the Rev. W. H. Dallinger, called attention to the advantages offered to the scientific student by the Society, which embraced all departments of natural science, except those connected with pure mathematics. The Society was but young, having been in existence only two years, and from having about a dozen members now numbered 175. Scientifically the success of the Society had been equally great and surprising. The main object of the founders had been to gather round them young persons and others who were turning their attention to scientific study. The low subscription, and the practical character of the Society's operations, met the wants of this portion of the community, while the social advantages that the Society afforded were not inconsiderable.

The Rev. W. H. Dallinger, F.R.S., F.R.M.S., then delivered a lecture—"Most recent researches into the origin and development of the putrefactive organisms." The lecture was illustrated by drawings made by Mr. Dallinger, thrown on a large screen, and illuminated by the oxy-hydrogen gas lime light. This method of illustration gave additional interest to the treatment of the subject. At the close, and on the motion of Mr. John Aitken, J.P., seconded by Mr. George E. Davis, vice-president, a vote of thanks was passed to Mr. Dallinger for his lecture.

We must not forget to mention the excellent display made by the members, both before and after the lecture. Over fifty microscopes had been set up, and under each was shown some interesting object. The variety of stands was worthy of a careful inspection. The best English and Continental makers were well represented. First-class stands by Ross, Powell and Leland, Smith and Beck, Swift, Crouch, and Zeiss; while serviceable and good students' stands were also shown by Messrs. Ward and Aylward, of Manchester. The latter had also on view his new "concentric" turntable, and also his new arrangement of mounting-cabinet and turntable combined, all enclosed in case.

Too much praise cannot be given to Messrs. Graham, Mills, and Stanley who had been appointed to assist the Secretary in making the necessary arrangements.

The following is the list of the objects exhibited, together with the exhibitor's names:—

A choice selection of Diatoms shown by a Wray's ⅛ object glass	D. Alston.
Jaws of garden Spider	Parsons Shaw.
Fore leg of *Dytiscus marginalis*	,,
Head of ditto	,,
Lophopus crystallinus	,,
Mange insect	John Boyd.
Body Louse	,,
Daphnia pulex	,,
Cyclops quadricornis infested with *Epistylis digitalis*	,,
Crab Louse of man	,,
Section of Lycopodium stained	Edward Ward.
Hydroid Zoophytes, Mounted at Naples, with tentacles expanded	,,
Zeiss, No. 1 stand, kindly lent by Dr. Frazer	,,
Micro-photographs	,,
Burnet Chain brand	,,
Trachea and Nerve centre of Moth, photographed by Mr. Shipperbottom, of Bolton	,,
Foraminifera, Lagena	,,
Tail of Common Stickleback, shewing the muscular systems	H. C. Chadwick.
Lophopus crystallinus stained in picro-carmine, and mounted in balsam	,,
Gnat	W. J. Mills.

Lancets and Tongue of Gad Fly ....J. W. Pettigrew.
Delessera in fruit ....Alex. Hay.
Cysticercus cellulosæ .... ,,
Section of Horse Radish .... ,,
,, Ovary of Poppy .... ,,
Transverse section of spine of Cidaris..................Richard Brance.
Longtitudinal ,, ,, ,, ... ,,
Marine Algæ from Geelong Harbour .... ,,
Young Crab, prepared without pressure, and mounted in balsam................................ ,,
Zoophytes ....J. C. Brown.
Volvox globator .... ,,
Vorticella...J. Dutton.
Stentor... .... ,,
Plumatella repens .... ,,
Collection of Mosses (British) ....William Stanley.
Slides, shewing the Development of *Funaria Hygrometrica*, mounted by Captain Cunliffe, Handforth .... ,,
Twelve dozen slides, in various media, mounted in connection with the Mounting Class ...... ,,
Section of Ivy (Stained) and other wood sections ...E. W. Napper.

The ordinary Meeting of the Society was held on March 2nd, 1882, at Seven o'clock. The President, Mr. Thomas Brittain, F.R.M.S., in the chair.

The minutes of the last meeting were read, and after a slight alteration, proposed by Mr. Ward, were unanimously adopted.

A series of Sketches, illustrative of Mr. Dallinger's lecture were exhibited by Mr. Chaffers.

The President notified that he had brought for distribution some specimens of *Puccinia Betoneæ.*

Mr. E. Ward, F.R.M.S., brought before the notice of the members a new and enlarged form of Student's Stand, with large draw tube, and adapted to take the smaller Continental eyepiece.

Mr. Herbert C. Chadwick, F.R.M.S., read a communication on the caudal fin of the Stickleback (*Gasterosteus leiurus*) illustrated by slides and a coloured diagram.

Mr. George E. Davis, F.R.M.S., then gave his paper (which was the first of a series) on "The Human Eye." It was an exhaustive paper, and well adapted to be read before the Society. The paper was capitally illustrated by photographic transparencies thrown on the screen, and illuminated by the Oxy-Hydrogen Lime Light, under the superintendence of Mr. John Bathe.

On the conclusion of the paper a short discussion was held, in which Messrs. Fleming, Stanley, Ragdale, and Brittain took part.

The usual display followed :—

Phantom Larva, mounted as a permanent object, without pressure....................Mr. Miles.
Ciliary processes, from the eye of an ox ......Mr. Thomas Lofthouse.
Effect of London Fog on Human Lung ......Mr. R. L. Mestayer.
Section of Lycopodium, stained ....Mr. E. Ward.
Transverse section of crystalline lens of Human Eye....................................Mr. E. W. Napper.
Pigment cells of Choroid Coat .... ,,
Tail of Stickleback (*Gasterosteus leiurus*) showing the muscles of the rays under polarized light................................Mr. Herbert C. Chadwick.
Micro-slides of *Puccinia Betonæ* ....Mr. Thomas Brittain.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

H. A.—Several correspondents, with yourself, have enquired when the Journal is to be permanently enlarged, to which we answer, when our list of subscribers is enlarged also. The new year has not increased the names upon our books to an appreciable extent.

C. C.—We are trying what can be done to provide a series of articles upon Mosses, but there are many things in the way which prevent us making a hurried start.

E. R. T.—If you send your objectives in to the Verification department, the fee is payable for each measurement of aperture. If measured at both extremes of the collar adjustment, they will be reckoned as two objectives. You can set the index at any number you think fit, and if we measure at that point, it will be charged as an ordinary non-adjustable objective.

M. H. S. — Notice of meeting crowded out of this month's number.

C. L. C.—For continuation of list of objects shown at Soirèe see next number.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

PARASITE OF COD-FISH.—Will send this splendid object for other first-class slides.—Rev. J. HORN, 75, Castle-road, Scarbro'.

AIR PUMP.—A good air pump of small pattern, in exchange for a good 2″ objective, Wray's first series preferred.—G., care of Editor.

NOTICE.

With a view to increasing the efficiency of this department, we have decided to publish only the names and addresses of those who have general lists to select from. Intending exchangers need therefore merely send an application by post card, "Please insert my name and address in your list for general exchanges." Will our readers assist us in making this department more useful?

SALE COLUMN FOR APPARATUS, BOOKS, ETC.

Advertisements in this column are inserted at the rate 4d. for each 12 words or portions of twelve.

Advertisers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied by a penny stamp for each letter, to cover postage.

All Advertisements intended for insertion in this column must reach us before the 14th of each month.

WANTED, a good preparation of one of the larger Diatomaceae in conjugation, for which £5 will be gladly paid. Address, L. D., care of the EDITOR.

MICROSCOPIC SLIDES. — A small but well mounted collection to be disposed of. Address, "Micro.," care of the Editor of the *Northern Microscopist.*

WANTED, for cash, first-class microscopic section of HETERANGIUM, or material. A. S. G., 50, Lowden Road, Herne Hill, London.

The Northern Microscopist.

No. 17. *MAY.* 1882.

PREPARATION OF TRANSPARENT SECTIONS OF ROCKS AND MINERALS.

By H. C. Sorby, LL.D., F.R.S., &c.

A Paper read before the Sheffield Microscopical Society, March 3rd, 1882.

IT is generally stated that Mr. Witham was the first to introduce the method of preparing thin sections of stony material for use with the Microscope. He published many years ago a work on the Microscopical structure of fossil wood, but I think it is very much open to doubt whether he was the man who invented that method.

A good many years ago I had the pleasure of making the acquaintance of Mr. Nichol, of Edinburgh, well known as the inventor of "Nichol's Prism." He was about seventy years of age, and was a very fine man indeed for that age. He had an exceedingly interesting collection of sections of wood and minerals, and he told me that it was he who originated the method of preparing thin sections of fossil wood for the use of the Microscope, and that Mr. Witham did not write that book. It was written for him, and the author had special instructions given to him never to allude to Mr. Nichol. He is now dead, however, and I suspect that all who knew about the circumstances are also dead, but I am inclined to believe that Mr. Witham bought his sections of fossil wood from Mr. Nichol, and had the book written for him, and he thus got the credit of being the first to introduce the method.

Of course we have not now the opportunity of ascertaining what was Mr. Witham's view upon the matter; but in any case there can be no doubt that Mr. Witham's book was the first account of the method by means of which sections of fossil wood could be prepared so as to be examined as transparent objects with the Microscope.

Sometime after that a similar method was adopted by Professor

Owen, and Mr. Nasmyth, a celebrated dentist in London, in studying the structure of recent teeth. And then I believe that Dr. Carpenter was the first to introduce the method as applied to the study of the structure of recent shells.

Very little else was done for some time, and, as far as I am able to ascertain, nothing whatever had been done in applying the method to the study of sections of rocks for geological purposes.

Curiously enough, up to some years after I introduced that method, the old plan of studying the structure of rocks was still adopted, namely, crushing portions of the rock and examining the powder.

I was aware of the application of the Microscope to fossil wood and teeth, and it occurred to me, about thirty-three years ago, that a very great deal of light might be thrown on the structure of rocks by preparing thin sections of them, and, as I daresay many of you are well aware, that suggestion has borne a wonderful amount of valuable fruit.

I believe that the first sections I prepared were some very imperfect ones from the Carboniferous Limestone of Derbyshire. I have not seen them for years, and the only interest attaching to them would be that they were the first that were prepared.

But a short time after that I established myself at Malvern, to study the Geology of the Malvern Hills; and it was with specimens obtained here that I first began making sections of any kind of value for use with the Microscope, and I thought it would be interesting to the Members of this Society if I brought down for inspection one of the very first sections that were prepared for this purpose. And here I may say a word or two with regard to this form of glass. I find that glasses about $1\frac{6}{10}$ inch square are much better for my kind of work than the ordinary form, because you can have a larger piece of rock, and you can work them more evenly in every direction, than if you have a long narrow glass. As an illustration of how subjects like these are developed in a manner which appears amusing when looked at afterwards, I will describe how I was led to adopt the form and size of these objects. Not very long after I had begun the examination of the structure of rocks I grounded myself well in the optical properties of crystals, and made for myself a rather complicated polariscope. This was made out of brass tubes of various sizes, and ultimately there was a tolerably large top portion to enable me to put crystals underneath, and I had to leave a square piece at the top into which the glasses might fit, and then was made the right size for the tube I happened to use. Some of these earlier glasses were ground by myself and the gardener on a grinding stone used to sharpen the scythe.

The size then was determined by the accidental size of this polariscope, and having prepared sections of calcite and other minerals, I had a box made to hold these, and when first preparing sections of rock the natural thing was to fasten the rocks on these pieces of glass. The result is that I have now a very large collection of sections of rock, all mounted on squares of glass of this size.

With these few preliminary remarks I will begin by giving an account of the method I have adopted in preparing sections of rock.

Of course everything had to be learnt, and there were then none of the facilities you have now.

The most obvious method now would be to use a slitting machine, but I commenced and afterwards continued to adopt a method which would not be used now, but which led to good results. I found that if you had specimens such as you would get out of a museum, it would be very desirable to saw thin portions off, but nearly all the specimens that I have studied have been collected *in sitû*. Of course there are obviously great advantages in that, because you are then acquainted with the conditions under which the specimens are found, and you can break off thin portions. I always used to break them at right angles to the stratification, and in the case of rocks with slaty cleavage, one portion in the line of the dip and another in the line of the strike, reserving larger pieces for hand specimens.

Having then collected specimens in that manner, the next thing is to deal with them in such a way as ultimately to give you a thin section. A deal of the work I did myself, but afterwards I found it very convenient to get much done by glass cutters. I had them thus ground into portions such as the specimens I have here, say about one inch square and $\frac{1}{8}$ inch thick. Then, having got a portion of rock like this, the next point is to finish off one surface, so as to have it as perfect as possible. You can well understand that it should be absolutely flat,—a perfect plane,—because many sections of limestone must not be more than $\frac{1}{1000}''$ in thickness. If not quite flat in grinding them down, ultimately you are liable to grind one portion away whilst the other is too thick. The method adopted to obtain a perfectly plane surface on which to rub these sections was as follows: I had a sort of flagstone, about two feet square, fixed on a table in the yard,—it was a sawn flag, tolerably level; then I had two portions of little flags, about fourteen inches square, of good quality, such as you obtain in this neighbourhood; then the first consideration was to rub these two flags with emery backwards and forwards on the large flag till perfectly smooth. You might get them both a little convex, perhaps, but both alike. The next thing to do is to rub these two stones together, and the stones being of the same hardness and the same curvature, when you come to rub them down they are worn evenly until they are perfectly flat, and you have really then got two small flagstones with a comparatively plane surface.

You require a number of different kinds of stones to work your specimens upon. I first used to apply sandstone with emery, but this was inconvenient and wore hollow; but I have found that a convenient method was to do the rough grinding on a plate of zinc about a foot square and hammered flat, rubbing the specimens down on this zinc first with fine ground emery and then finishing them off with finer still. I had two zinc plates, one worn somewhat hollow and the other as flat as possible, doing the rough work on the first and finishing it off on the more level with finer emery; but you cannot get a flat surface in that manner. The specimens always wear away more at the corners, and that is, perhaps, one of the greatest difficulties in the preparation of these objects, because it entails so much labour, but I do not see how it can be avoided.

Having got the specimens dressed up in that manner, the next point is to get the surface into a far better condition than it can be got by emery, and I used to employ two or three kinds of stone. It is not always easy to get pieces of a satisfactory character, but I used to employ a kind of stone called Congleton stone, and also Water-of-Ayr stone. This Congleton stone does not scratch, and it does not polish, but keeps a good cutting edge, so that you can rub down tolerably quickly. The specimens are finished off ultimately on the Water-of-Ayr stone, and for that purpose I used to have two portions, six inches square, one of a soft grain and the other a hard grain for finishing. These stones are rubbed flat on the little flags that I alluded to. Having got these Water-of-Ayr stones, you grind both of them first on one stone and then on the other, so as to thoroughly equalise any irregularity. Then these two were rubbed together, and by this means you get such a perfect plane that you can obtain far more accurate results than you require, but when you can get absolutely perfect results it is as well to do so. I find that if a drop of water was put on one stone and the other put upon it, it would float about as if on water, the perfection of the plane being such and the capillary attraction so powerful that the stones did not touch one another, but moved about quite readily.

The specimens of rock roughly ground on the zinc plates were ground down on these stones, and then finished off on the harder. When you come to reflect on the question you will see that to get a perfect section of some rocks it is absolutely requisite to use all this care.

As an illustration of the perfection to which this method may be brought I may say that very often Limestones contain sand, and there is not the slightest difficulty whatever in preparing a section so that these grains of, perhaps, the $\frac{1}{300}''$ or $\frac{1}{400}''$ in diameter, shall be ground down and polished on both sides, and I could show specimens of slates in which sections of grains of sand not thicker than $\frac{1}{1000}$ of an inch are cut and ground down so as to be shown as transparent objects.

It is very important indeed in studying some kinds of rock to slice through the minerals in that manner, because otherwise you might be misled by false appearances.

In some cases a single grain of sand has a complete history of its own—there are fluid cavities and enclosed crystals—and possibly in the case of some volcanic rocks you have minute glass cavities, all of which can be distinctly seen in a grain of sand $\frac{1}{100}$ of an inch in diameter. Of course, to see these satisfactorily it is requisite that the preparation should be made in a satisfactory manner.

When you come to rub the pieces of rock down on these smoother stones, you find that the emery has ground them down so as to be a little convex. When you rub on the smoother stones you do not tear up portions from the specimen, but wear it down by a perfectly legitimate grinding of the constituents. For example, in the case of a limestone the emery pulls out the little grains of sand; it makes a flat surface, but it is not a mathematically true section of the rock, which, of course, is unsatisfactory. When you begin rubbing on the smoother stones you find that these grains of sand are worn down on a level, and the first result is that you begin to polish the surface of these grains in the centre of the specimen, and gradually by continuing the grinding it is ground flatter and flatter, until you get close up to the corners. The process must be continued till you feel persuaded that the harder portions are not only polished but that they are worn down to the level of the softer portions, and then made as smooth as they can be got.

I have never used polishing material in preparing sections of rock, because it penetrates into the rock and makes you see things which are not naturally there, and so may deceive you.

Having got your portion of rock dressed off as described, the next point is to fix it down on a piece of glass with Canada balsam. I have a little tripod stand, under which I can have a jet of gas, and on the top of this a piece of brass so that it will keep the glass in the proper place in the centre. You heat this sufficiently, and put a portion of Canada balsam on to it, and an important point is to get rid of all the bubbles,—they rise to the top, and with a little manœuvring you may get them to the centre and with a pin draw them all out. Then you carefully stir it, keeping it hot until you have got the balsam sufficiently hard. I have found the best indication of that was to take a portion out with a large pin, and when the balsam has got so hard that when cold it will just break to powder between your fingers it is satisfactory. If it is not hard enough you will perhaps find subsequently that portions of this solution will break away; whilst if it is too hard and brittle portions break off from the opposite fault. If you maintain the heat sufficiently long to make the balsam so hard that when a portion is taken up with a pin you give it a bit of a squeeze with your fingers and it just breaks to powder, it is, I take it, in the state of a happy medium between the two objectionable extremes. Then you have your portions of rock hot; you put it on the tripod stand with the finished side upwards, and keep it sufficiently hot so as to be ready to mount it. But you must not make it too hot; if so you might sometimes expel the fluid from the fluid cavities that occur in some minerals, which would spoil the whole object as far as certain questions are concerned. Then, having kept the rock moderately hot, and having got your Canada balsam sufficiently hard, the next object is to spread over the surface of the rock a portion of *hard* Canada balsam kept for the purpose. You then put this on and spread it so as to get the balsam to penetrate to a certain extent. Do not put the rock straight on the Canada balsam, but get it coated over, and then take off all you can,—stroke it off with a flat wire till you have got the surface just wetted with balsam,—the object being to prevent the formation of too many bubbles when you come to put the portion of rock on. Having done this, press it down with a pencil carefully till you squeeze out all the excess of balsam. It should not be pressed into absolute contact. A thin portion of Canada balsam should be left between the glass and the object, and then you may turn it upside down to see that you have no bubbles underneath it. You have now your portion of rock fastened down, but probably a considerable amount of balsam more than is necessary, which you take off with a large pin. This is the balsam that you keep for the purpose just mentioned, *i.e.*, to put on the surface of the rock when you are going to mount it down.

The next thing is to reduce the thickness of the portion of the rock thus fastened down.

The manner I adopted was to place them in the hands of a very intelligent glass cutter, and he used to grind them down till he left them about the thickness of a good stout card,—not thinner, for fear of portions being torn up and damaged.

If you can avoid it, it is as well not to scratch the corners of the glass, though it is of no very great importance. I found that the most satisfactory method was to cement at each corner a portion of thin sheet zinc, fastening it down with Canada balsam.

(To be continued.)

"THE NORTHERN MICROSCOPIST" VERIFICATION DEPARTMENT.

EXPLANATIONS.—Columns *a* and *b* give the denomination of the objective as issued by the maker. Columns *c* and *d* show the results of measurements made at a distance of TEN INCHES from the front lens of the objective, to the plane surface of the eye-lens of the ocular. The column *d* shows the actual distance between the upper surface of the covering glass and the front of the objective, when used over a slide of *Amphipleura pellucida*, the frustules being mounted dry, on a cover suitable for observation with a one-twenty-fifth dry objective. The column *e* gives the actual focal length of the objective determined by Cross' formula $\frac{n\,l}{(n+1)^2}$ where l = the distance between the two micrometers and n = the amplification at this distance.

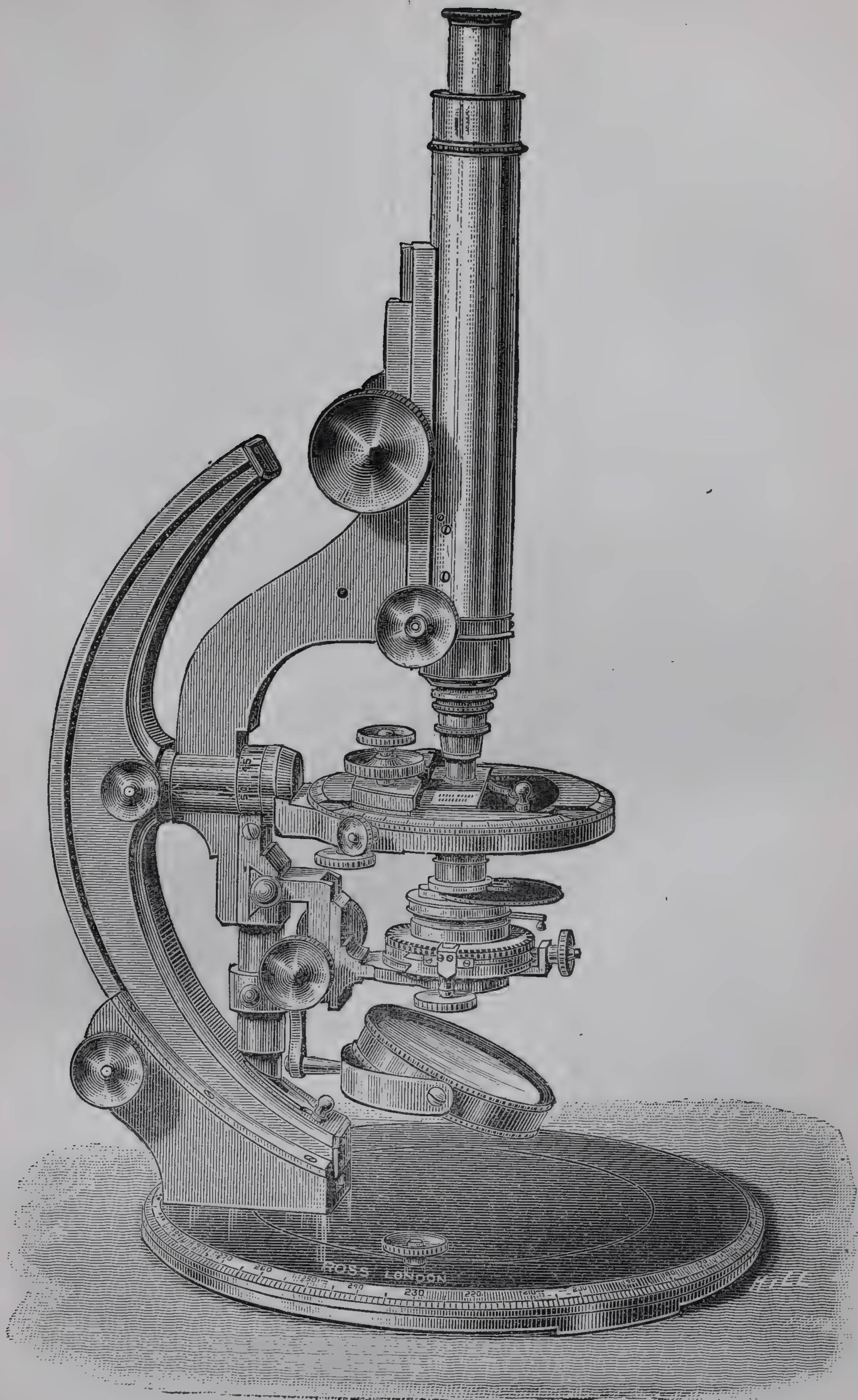
The eyepiece used is a Ross A, with a diaphragm aperture of 0·75 inch, and yielding approximately an amplification of 5 diameters.

Column *f* contains the results of the aperture measurements by Professor Abbe's Apertometer; they are the mean of several, but the individual measurements scarcely differ from each other. Column *g* is calculated from the numbers in column *f*.

REGISTER NUMBER.	SOLD AS		AT TEN INCHES.			REAL APERTURE.		REMARKS.
	a Inch.	*b* Air-angle or Aperture.	*c* Amplifying Power. Diameters.	*d* Working Distance. Inches.	*e* $\frac{n\,l}{(n+1)^2}$	*f* Numerical.	*g* Air-angle.	
Number 92......	C C	90°	140	.02	.263	.69	88°	
" 93......	C C	90°	140	.02	.263	.69	88°	
" 94......	D	75°	250	.035	.158	.655	82°	
" 95......	1"	30°	39	.39	.864	.29	34°	
" 96......	1"	... ...	31	.69	1.03	.13	16°	
" 97......	"1/2	... ...	83	.08	.407	.50	60°	
" 98......	"1/4	... ...	185	.04	.192	.60	74°	
" 99......	"1/6	95°	238	.014	.156	.63	78°	
" 100......	"1/7	105°	290	.009	.126	.73	94°	
" 101......	"1/2	60°	83	.12	.407	.50	60°	
" 102......	3"	12°	12	1.85	2.15	.10	12°	

A NEW MICROSCOPE.

THE latest effort of Mr. Wenham, as an inventor, is an ingenious Microscope stand, lately made by Messrs. Ross & Co., and exhibited at the March meeting of the Royal Microscopical Society. It is called Wenham's universal inclining and rotating Microscope, and its special intention is to obtain a greater variety of effects of oblique light than has hitherto been obtainable without losing sight of the object under examination. The base consists of a circular plate, a ring of which rotates within a graduated arc, and carries a vertical bearer with it. Within the jaws of this bearer slides a sector, from near the centre of which rises radially an axis, which carries the main limb of the Jackson pattern, holding the optical body, stage, swinging sub-stage, and mirror bar. By means of the sliding sector the optical body can be placed in any inclination from the vertical to the horizontal position, and, in combination with the axial motion at right angles to the former, it can be placed in any conceivable position within a quarter of a sphere, the centre of which is the focal point of the objective. The limits of this motion can be extended by rotating the instrument on its base. The centre of all these motions, both circular and axial, is also the centre of the stage, at about the thickness of any ordinary object slide above it; so that in whatever position the optical body be placed, the object under examination will always remain in the same place, whilst the object plane may be tilted about in every direction within certain limits. The advantage of this arrangement will be evident when finely striated objects like diatoms are examined by direct light from a fixed source transmitted through the object; because in that case, by merely altering the position of the optical body, every variety of light as to obliquity and direction can be obtained on one side of the object, and, by a rotation of the stage through 180°, on the other side also. If the mirror and sub-stage condenser be interposed in the ordinary way, the inclination of the mirror will, of course, require altering with every alteration of position of the optical body; but this can be done gradually without losing sight of the object. The mirror bar can, however, be clamped to the sector, when the fixed mirror will still transmit its light to the object, whilst the optical tube is moved laterally upon the axis passing through the object. The instrument is furnished with Ross' diatom stage, which allows extremely oblique light to be transmitted to the object from beneath. The coincidence of the optic axis with the centre of the rotating plate is secured by adjusting screws; and the mechanical motion of the object carrier, which is very thin, is effected in rectangular directions by screws placed within the circumference of the stage, so as not to



Wenham's New Patent Microscope.

[*To face page 108.*

interfere with its complete rotation. The edge is graduated for goniometry, and finders are engraved upon the surface. A simple arrangement beneath the stage is provided for holding an iris diaphragm, hemispherical lens, or Wenham's "half button." The sub-stage is provided with rectangular and rotary motions, and both stages can be removed, if necessary. The coarse adjustment is by means of a diagonal rack moved by a spiral pinion. The fine adjustment is effected by milled heads on both sides of the nose piece, operating on a vertical slide, which holds the objective. There are graduated arcs for measuring the inclination of the main limb and optical body of the swinging tail-piece, and the graduations on the base plate can be utilised in measuring the angular apertures of objectives. There are clamping screws in various positions for fixing the instrument, which is very firm and well balanced.

Some modifications of the leading principle introduced in the construction of this instrument have already been adopted by other makers, but in most of the previous inventions, the object under examination remained fixed in only one plane of motion of the optical tube. In 1866, M. Jaubert, of Paris, produced a microscope with a lateral inclining movement at right angles to the vertical motion of the body, by means of an axis running through the trunnion bar between two upright pillars; but the object under examination did not remain fixed in any plane of motion of the optical body. It was claimed by the maker that the tilting of the stage in this instrument would be found useful in chemical experiments. More recently, some American stands, such as the Centennial Zentmayer and the Acme of Sidle, have been provided with a rotating base, the object plane passing through the axis of motion of the optical body, so as to facilitate the measurement of the angular apertures of objectives without an apertometer. By this arrangement when the body was placed horizontally, the rotary motion of the base would tilt the object plane through 180° of azimuth without moving the object away from the light; but in every other position of the body the object would move away. This principle has been adopted in this country in Ross's Improved Zentmayer Stand, and in Beck's International. Messrs. Watson and Sons have recently produced a stand in which the axes of motion, in both altitude and azimuth, pass through the object, so that the object plane may be tilted in every necessary direction with respect to the light, without moving the object from its position; but as the motion in azimuth is produced by a vertical pillar, which carries the main limb, moving round the circumference of a circular base, in some positions of the object plane, the object will be screened from the light altogether by the pillar being interposed. In other respects this stand approaches very nearly in its capabilities Mr. Wenham's new form, but by very different means. The principle of the main limb moving in sector between vertical jaws has been already adopted by Swift and Son in a new form of student's microscope, the model of which was an American invention by Wale; but the end aimed at in both cases was merely to control the centre of gravity in varying positions of the body, and the object was not fixed in any plane of motion of the optical tube. It has, therefore, been reserved for Mr. Wenham to introduce a form of stand which is said to possess perfect steadiness under high powers, is adapted for all the requirements of the most exacting "diatomist," and is at the same time a serviceable instrument for general use. It is necessarily expensive.

CESTOID WORMS.

By Jno. B. Wolstenholme, M.R.C.V.S.

A Paper read before the Manchester Science Association, Feb. 14th, 1882.

THERE are phenomena and histories, which we tacitly agree not to inquire into, and that to be ignorant of is better than to be well versed therein. At a superficial glance one is almost tempted to say of cestoid or tape-worms that the less we have to do with them the better, and indeed I would endorse this readily if by so saying these creatures would stand on their dignity and decline any further acquaintance, but this they positively refuse to do, and seek every opportunity of becoming our guests and of being entertained at our expense. This sometimes becomes a most alarming item, for Dr. Krabbe, of Copenhagen, estimates that one-sixth ($\frac{1}{6}$) of the human mortality of Iceland with a population of 72,000, is caused by a single species of tape-worm in its larval condition; less serious, but still of great moment, is the record of disease and mortality caused by them in India, Australia, and indeed all over the world, varying only in degree. This being true it is an imperative necessity that some should study and strive to know the details of their existence, if only with the object of adopting measures to minimise their baneful effects. Apart from this, I may add that to a student of nature the wonderful adaptations and co-ordination of means to secure their perpetuity render the investigation one of no small interest.

The generic name of 'Tænia' is derived from the Greek meaning 'a band' or 'ribbon;' whilst the term 'cestode' or 'cestoid' comes from the Latin 'cestus,' signifying a 'band' or 'tie.'

These worms have been recognised for a very long period.

Hippocrates, Pliny, and Aristotle were familiar with and have described one of those infesting our own species.

In the adult condition tape-worms are restricted to vertebrates, but in the larval or cysticercal stage they infest, a very large proportion of the animal kingdom, being found in insects and extending up to man; in both conditions (larval and adult) they are parasitic, mature worm being always located in the bowels of mine host, whilst the cysticercus may be found in almost every organ and structure of the body.

It is usual to speak of this living ribbon as *a* tape-worm, and most people are under the impression that it is a single individual; this is erroneous, and examination proves that it is made up of a great number of segments, each of which is a distinct animal; they are attached to each other, end to end in single file, the whole forming a colony. For mutual advantage, the individual at the attached extremity is so modified as to afford means of anchorage for the community; it is termed the head, of which there are two kinds,—the *unarmed*, which has four muscular sucking discs at its free extremity, and the *armed*, which, in addition to the suckers has one or more circlets of hooks: both arrangements are merely for the purpose of holding fast on to the mucous membrane of the bowel. The suckers are in no way adapted for, nor used as receptacles for food, and I desire to impress the fact that the tape-worm possesses neither mouth, bowel, nor any other digestive apparatus whatever; there is no need for it, because the colony is constantly bathed with chyme within the bowel, which as you know is that pultaceous material formed from the food eaten by the host, and elaborated for the nutrition of his tissues. The tape-worm lives then by simply aborbing through its skin the fluid food with which it is surrounded; indeed the tape-worm is almost wholly constructed for the purposes of reproduction, and in this particular direction we shall be satisfied, I think, that the organism is fairly complete and effective.

In glancing at the anatomy of these creatures we must notice that externally there is a more or less fibrous skin, beneath which is a little muscular tissue, after which we find a loose reticulate tissue or parenchyma, which makes up the interior of the worm and envelopes the generative organs. There is also the so-called "Water vascular System." It consists of a single or double tube of minute calibre, which runs along the entire length of the colony from end to end on each side, with a transverse canal in each segment communicating with the longitudinal ones. The use of this system is rather obscure, but is generally referred to as being partly excretory and partly that of conveying a nutrient fluid all over the colony, and it is worthy of notice here that this tubular arrangement is the only one that is the common property of the community;

for this reason, it largely assists in connecting the individuals to each other, strengthening and maintaining the close opposition which is necessary for this purpose.

The nervous system is very suppressed, only a few nerve filaments in the region of the head having been made out.

Of the crown of hooklets previously referred to, they vary in number much; some possessing only twenty-four, others several times this quantity. In structure they are the hardest organs possessed by tæniæ, being composed of chitine, that dense and insoluble substance which forms the outer covering of the beetle.

Scattered through the soft groundwork of the community, but more particularly at the attached extremity may be observed a number of shining particles which are composed of lime; on further examination of the tape-worm colony a number of small projections are observable, usually one at the margin of each segment, though sometimes there are two, and they may be placed between the margins. These elevations are the reproductive papillæ; on each of them are two orifices, one communicating with the male and the other with the female reproductive system; from this we observe that each segment or individual is bi-sexual, or hermaphrodite, and indeed in those species which possess two reproductive papillæ, there is a double set of these organs in every segment.

The generative process may be described thus:—A germ passes from the ovary along its duct to the uterus, where it meets with the spermatozoa which have traversed to this point; then a single male and female element unite, and by a vital process form a new organism—the embryo, which becomes surrounded by an appropriate quantity of the yelk, and the whole is then enveloped in a secretion from the uterine walls, thus forming an egg. Two other projective layers are added as the egg passes onward, and it finally escapes at the genital pore. To this brief outline I may add that it is generally supposed that the male organ does not impregnate that of the opposite sex in the same segment, but that the union is between those of adjoining segments.

Each mature zooid or segment will contain some 30,000 eggs, and some Tæniæ are composed of as many as 1,250 segments, so that the aggregate number of eggs they are capable of producing at one period or growth is enormous; but to this we must remember that other segments are being continually reproduced by budding from the posterior extremity of the first zooid (the head), and it is thus that when once the head is attached to the bowel, that by a non-sexual process the remainder of the colony are evolved; and when by medicinal agents we effect the removal of the entire colony, except the head, that from this organ the whole is again and very quickly reproduced. The buds, at first very ill-defined, become more distinct, and as they recede from the head first, the reproductive organs gradually develop, then the process of egg formation is arrived at, the segment still enlarging, the uterus enlarging also, until the branched form of this organ disappears in the cramming it has undergone; finally the segment appears as a sac completely filled with eggs. It is now mature; has become the largest and the terminal one of the colony, and finally it drops off, passes along the bowel of the host, and leaves the same along with the fœces; and those small flat worms, often seen on the excreta of the dog, are these detached members of the tape-worm community. The eggs they contain are either expressed at the genital pore during the contortions caused by exposure to a lower temperature, or they are liberated *en masse* at the decomposition of the segment.

To follow on the cycle it is necessary that the *intermediary* bearer shall devour these eggs,—should an unsuitable animal do so they would be inert; but, arrived in the stomach of a proper bearer, the egg coverings are quickly dissolved by the digestive juices, and the embryo, a minute bladder-like creature with six hooks, is set free; at once it attacks the small blood vessels, pierces them and enters the circulation. In experiments which have been made it has been found that a drop of blood taken from an animal twenty-four hours after eating the eggs, that it contained many embryos; carried thus by the circulation of the blood, the six-hooked embryos select a suitable part, reattack the lining of the vessel they may then be within, pass through it and into the adjacent structures. Their power of selection is great, and very constant; those of one species choosing one, and those of another a different habitat, in which to develop up into perfect cysticerci or larval tæniæ,—thus it is that the *Cysticercus cœnurus* is found in the brain; the *Cysticercus pisiformis* generally beneath the peritoneum; the *Cysticercus cellulosæ* and *Cysticercus bovis* being respectively the pork and beef "measle" in the voluntary muscles of the bearer. Here the process is—first, the hooklets drop off; the cyst enlarges, then at one point it becomes invaginated, much after the manner of inverting the finger of a glove. From the bottom of the pit thus formed a head is gradually developed, and in a varying period becomes complete; a single head resulting from one embryo. This is the usual condition; but in at least two instances a much more complex arrangement obtains: First, in the larval *Tænia cœnurus*, the egg results in a single embryo. This usually locates itself in the brain substance, and a cyst is formed; but instead of a single invagination of its wall a large number are made, and from the base of each a head is developed, and as many as from two to three hundred heads have been counted. The second exception occurs in the larval *T. Echino-*

coccus, a single egg and embryo of which resulting in a cyst as before, has the pitting arrangement of the last; but instead of developing single heads, they become secondary cysts, and each recommences the pitting on its own account. In this case either developing heads form the base of each, or forming into tertiary cysts, which ultimately have the same pitting arrangement and develop a tape-worm head from the base of each. This process is known as the formation of daughter and grand-daughter cysts, during which the primary one has been enlarging to an enormous extent, so much so that I have seen the lungs and livers of sheep and pigs almost entirely occupied by them; and on one occasion saw a human liver, of which very little remained except its outer envelope. I remember when a student, Dr. Cobbold relating to us a case of a man in a London hospital, whose lungs and liver were so invaded by these cysts that there was communication between the lungs, liver, and a suppurating wound in his side, so that it was possible to have passed a bougie down the trachea, through the lungs, diaphragm, and liver, and out again at the wound in the side.

The period required for these changes to take place is as before remarked various; some require only two months, whilst in that last referred to, a period of from one to two years is necessary for completion. After this, it is necessary that the cysticercus shall be transferred to the stomach of its ultimate host; and it is a noticeable provision of nature that the intermediary bearer is usually one, that in the ordinary course becomes a prey to the higher animal which is adapted to support the mature tape-worm. Thus cuttle fish bear a large number of cysticerci, which in the adult condition infest the shark and allied fishes which prey upon them. The *Tænia crassicollis* of the cat resides in the cysticercal stage in the mouse. The *T. cucumerina* of the dog passes through the *Trichodectes latus* (dog louse). Man becomes host to his particular cestode enemies by eating pork, beef, and mutton, which contain their larval forms. Rabbits and hares bear the *Cysticercus pisiformis*, which will only develop up in the dog, as the *T. serrata*, and the facts arrived at by experiment with these particular worms may be briefly summed up thus:—

First, feed a number of rabbits with eggs of *T. serrata*, and kill the first rabbit. Twenty-four hours afterwards the blood will contain numerous six-hooked embryos, to be seen with a ¼″ objective.

About fourth day kill another, and a number of specks may be found with a lens on examining the liver; under the microscope they prove to be vesicles of about $\frac{1}{80}''$ diameter.

Fifth day they are about $\frac{1}{40}''$; sixth day $\frac{1}{25}''$; twenty-first day are elongated and about $\frac{1}{12}''$ in length; at about twenty-fourth day the vesicles have coalesced, forming canals along which the larvæ make a second migration: this time falling into the abdominal cavity, or becoming re-encysted beneath the outer capsule of the liver, or under the peritoneum, beneath the spine. This wandering occurs from about the sixth to the eighth week, and by the ninth week they are all re-encysted and may be found in most wild rabbits. Further experiments shew that if a dog be fed with the larvæ in the wandering condition, they will not develop up into Tæniæ; they must first have arrived at the stage of mature cysticerci; and further still, if more than a month elapses after arriving at maturity, they degenerate into a cheesy substance and loose the property of further development, even if transferred to the stomach of the dog. When, however, a dog eats a portion of rabbit in which is a mature and not degenerated cysticercus, the changes which follow are found to occur in the following order and time, viz.:—In from three to six hours afterwards the cysts and caudal vesicles are digested. In twenty-four hours only traces of cysts and caudal vesicles remain.

On the	3rd day	the Tænia is	½ inch long.		
„	12th	„	„	4 to 6 inches	long.
„	21st	„	„	12 to 18 „	„
„	28th	„	„	2 or more feet	„
In 2 months		„	„	sexually mature.	

We may here note that the period which elapses between the voiding of the detached proglottis (or segment), and its death, is the only one in which the worm is without some host. The eggs retain vitality under most varying conditions; they are dispersed by the wind, the feet of animals, &c., &c., and ultimately either in the act of eating or drinking. Some of them enter the body of a suitable intermediary bearer, and the cycle is again commenced.

Some Tæniæ in the adult condition infest only a single species; others extend to various animals of similar habits. The same may be said of the larval or cysticercal stage; some having a very limited range of intermediary bearers, as the larval *Tœnia cucumerina*, which is only found in the louse. The *Cysticercus cellulosœ* usually found in the pig will also develop up in man; whilst the *Echinococcus veterinorum*—the larval form of the *Tœnia Echinococcus* has a very extended variety of bearers, having been found in the lion, antelope, sheep, ox, pig, monkey, kangaroo, the turkey, and in man: it is in the human bearer that it attains to its greatest development.

In thus roughly sketching the life history of a tapeworm, I have incidentally drawn attention to the amount of disease and mortality they may occasion in the human subject. This is always in direct proportion to the sanitary precautions adopted. In India, where the natives defœcate in the pastures and exposed places near villages, where cattle graze and eat the same, the *Tœnia* *mediocanellata* abounds, because the host is constantly supplying the ox with eggs, which, in due course, become cysticerci or beef measles, the flesh containing which is eaten by mankind again, resulting in further generations of tape-worms, which in a similar manner quickly reproduce others.

At the commencement of these remarks, I drew attention to the human mortality in Iceland, due to the larval *Tænia Echinococcus*, which in the adult state infests the dog, and is only ⅓ of an inch in length. What Sanitary precautions are here adopted? The people are dirty in habit. Dogs are most plentiful, and the quack doctors of the country, in their extended knowledge of disease, prescribe for almost every ailment, the recently voided excrement of the dog. No wonder that tape-worms flourish, and that the resulting mortality is so great.

In conclusion, we will take a morsel of comfort, based on the results of many experiments, which go to prove that thorough cooking will destroy these animal parasites when they are contained in our flesh meat. It is estimated that a temperature of 140° F. prolonged during five minutes is sufficient for this purpose, but we must remember that every portion of the meat must be heated up to this point, and it is quite possible to have the exterior of a joint considerably over 212° F., without the interior having attained to the required temperature. As a rough guide, meat has been raised to at least 140° F., when the bright red colour of undercooked meat has been replaced by the browner appearance we recognise in joints known as "well done."

After a paper of this description, and to the present audience, it is almost superfluous to point out how necessary it is that imperial and local authorities should appoint men who, by training and profession, are qualified to protect the public by a proper inspection of its supply of flesh meat. Very much will have to be done yet in this direction, and as compared with our neighbours on the continent, we are very much behind in this respect.

MOSSES:
THEIR STRUCTURE AND CLASSIFICATION.

By William Stanley.

Read before the Manchester Microscopical Society, April 6th, 1882.

THE cells of Mosses and Hepaticæ, from their great beauty and variety of form, are extremely important in their classification, affording both generic and specific distinctions; the Muscates being a family of Cryptogamic plants which are primarily distinguished as Cellulares; Phanerogamic plants being composed of various vascular tissues. There are, however, many exception to this rule, as in the vascular tissue of Ferns and Lycopods, and in the spiral cells and elators of Mosses and Hepaticæ; and we find that the different parts of Nature are so intimately bound together, that it is impossible to give exact definitions, as in pure science, which, without exception, shall separate with accuracy any one family from another.

Another feature of Cryptogams is their superficial development, the spores being free and placed at the end of threads or Mycelium. This definition must be taken in a very general manner, as there are many exceptions.

The third, and perhaps the most important feature, is the absence of true pollen and seeds; for although they possess Antheridia and Archegonia corresponding to the Anthers and Pistils of Phænogams, their development arises from mere contact of the parts, and not by the extension of a thread piercing the ovule as in true pollen; hence there is an absence of anything like a true embryo.

Mosses and Hepaticæ form the sub-kingdom Bryophyta, and are described by Berkeley as having spores numerous, never solitary, produced within variously formed capsuliform organs and giving rise after impregnation to an annual or perennial plant. Archegonia springing from the perfect plant and producing sporiferous fruit.

I purposely omit saying anything further with regard to the development of the Moss, as I hope to explain this more fully in a subsequent paper, and shall refer only to so much as is necessary to explain its structure.

In the male plant the leaves surrounding the Antheridia, or male inflorescence, constitute the Perigonium and are termed perigonial leaves; while the cluster of leaves about the flask-shaped Archegonia, or female inflorescence, are called perichætial leaves, and constitute the Perichætium. Both Antheridia and Perigonia are mixed with jointed filaments called Paraphyses.

Mosses are also generated by means of Gemmæ: minute cellular bodies found in the axils of the stem and on different parts of the leaf.

After impregnation the perfect Archegonium soon becomes distended by the enlargement of the embryonal cell, and is eventually torn asunder near the base; the upper portion being now termed the Calyptra, and the lower the Vaginula.

The cell or vesicle is now converted into a fruit-stalk, or seta, and not until it has attained its full height does the apex swell and become a capsule.

The capsule contains a central column, the Columella, round which the spores are generated within the sporacular sac. The mouth of the capsule, with the exception of a few genera, is closed with a lid or operculum, surrounded by a ring or annulus which causes the lid to fall when the capsule is ripe, and discloses the beautiful series of teeth or Peristome, whose hygrometric action regulates the escape of the spores. The inner fringe of the Peristome when double is called the Endostome.

The roots of Mosses for the most part are fibrous, springing from several parts of the stem, and in some cases even from the leaves. The leaves are destitute of any kind of stalk or petiole, being attached by their base and generally half enclosing the stem, hence semiamplexicaul.

In the classification of Mosses authorities widely differ; no two writers agreeing as to the exact arrangement of the orders and genera. Some prefer the artificial method which is based upon the nature of the Peristome—terming them Astomi, without lid; Gymnostomi, without Peristome; and Aploperistomi and Diploperistomi, with a single or double Peristome.

The correct method is the natural one, based upon the agreement of the greatest number of parts. This was permanently adopted by Bruch and Schimper, upon whose work the last edition of the Bryologia Britannica was based. The first two editions of this work were by Messrs. Hooker and Taylor; the last was revised and considerably extended by our greatest English authority, W. Wilson, of Warrington.

Greater attention was paid to the fructification by Wilson, as the form of development affords permanent distinctions; and Hoffmeister states in his work on the higher Cryptogamia that this will prove to be the ultimate base of classification in the future; for although nothing is better known by botanists than the germination of the spores of Mosses, still only a small number have been thoroughly investigated with regard to their development individually.

All agree in artificially dividing Mosses into Acrocarpi, Cladocarpi, and Pleurocarpi; and the last edition of the London Catalogue has a fourth division termed Amphocarpi, containing three genera with Acrocarpus and Cladocarpus characters.

The Acrocarpi are easily distinguished by their terminal fruit, as in *Bryum hornum;* Pleurocarpi by their fruit being lateral to the creeping stem, as in the Hypnums; and Cladocarpi by fruit terminal on a lateral branch.

The next distinction is the absence or presence of a deciduous lid. Those without lid being termed Schistocarpi, the capsules of which, as in the Andræaceæ and Sphagnaceæ, burst in a four valvular manner, and are thus linked to the Hepaticæ. The Stegocarpus Mosses, or those with a lid, are again divided into Mosses with no Peristome, with a single Peristome, and with a double Peristome.

In distinguishing genera, the Calyptra, the capsule, and areolation of the leaves are the most distinguishing features.

The Calyptra, whether mitriform, mitre-shaped, or dimidiate, divided in the centre; whether smooth or striate; and whether inflexed at the base or not inflexed.

The shape of the capsule varies from globose and truncated to oblong-cylindrical, and is either upright or with every degree of inclination to that of drooping or pendulous; the particular inclination, however, is fairly constant in different genera, and there is a swelling at the base of many capsules termed an Apophysis.

The areolation of the leaves may be either dense or open; round, angular, quadrate, or hexagonal; the basal cells, or those nearest the stem, differing considerably from those at the apex, and distinctly separates such closely allied genera as Dicranum and Dicranella, Bryum and Mnium.

The form of the lid, with regard to its point, and the number of teeth in the Peristome also afford generic distinctions; the teeth being four, eight, sixteen, thirty-two, or sixty-four; these numbers being a multiple of four, which is always constant.

Specific characters are derived from the leaf, which varies in size, form, &c., its most marked characters being a midrib, which is either thickened and raised above the leaf, or transparent and buried in the leaf, this midrib terminating either below the apex, at the apex, or is carried beyond the leaf, excurrent, forming a hair-like point of very various lengths. With the exception of a few, as in the Mniums, the apices of all leaves terminate in a point, varying from obtuse to acute and needle-shaped. The margins of the leaves are either entire, serrate, or cartilaginous, that is, with a thickened border, and may be either incurved or decurved; while the surface is smooth or papillose, studded with round or pointed prominences.

The insertion of the leaves is also characteristic, and is either two, three, four, five, or eight ranked, according to the number requisite to circumscribe the stem.

Mosses are Monoicous, Dioicous, or Synoicous. Dioicous species having the male and female organs on separate plants. In Monoicous species the organs are on separate branches of the same plant; while Synoicous species have both Antheridia and Archegonia in the same inflorescence.

Many Mosses are both Monoicous and Dioicous, and a few are Monoicous, Dioicous, and Synoicous.

Although they have many features in common, the foliaceous Hepaticæ are widely separated from the true Mosses by their leaves, which have no midrib, are more delicately membranous, and are rounded at the apex or deeply cleft.

A great number of the Hepaticæ have also stipular appendages to the leaves called Amphigastria, affording generic distinctions; in the Mosses, however, these are very rare and rudimentary.

In the majority of cases the fruit of the Hepaticæ, when ripe, splits into four valves, while the urns of Mosses open with a lid.

In drawing distinctions between the two, one feature is absolute; that is, the presence of spiral threads called elaters, mixed with and assisting in the dispersion of the spores of the Hepaticæ. These elaters are never found in the spore cases of the true Mosses. In Ricciacæ, a family of the frondose Hepaticæ, no elaters are found, and the fruit being buried in the frond they are thus linked to the Lichens.

I cannot close these few remarks without quoting an extract from "A Tour round my Garden," by Alphonse Karr; he says, "But here is displayed a luxury; a velvet, a thousand times more fine, more brilliant, more wavy, more rich, than that which is displayed with so much care in the interior of palaces; about which much anxiety is felt, lest is should be spoilt. A green velvet entirely covers the thatch of the house, and that is a true and beautiful luxury. The owners do not trouble on account of it; they are neither the slaves nor the victims of it; they allow it to be exposed to the sun, the wind, and the rain, they cannot spoil it."

This velvet is Moss.

OUR BOOK SHELF.

The Journal of the Postal Microscopical Society. No. 1, March, 1882. London: W. P. Collins.

The first number of this Journal is a very useful and interesting production, but whether there is room for another Microscopical Journal is a question open to doubt. Our own experience is decidedly unfavourable to such a supposition; still, if the Council of the Postal Microscopical Society has any surplus funds, it cannot be employing them in a more laudable manner than in publishing the information their note books have collected. The papers to be found in this number are:—A History of the Postal Microscopical Society; Numerical Apertures; The Microscopical examination of Chlorophyll, &c.; Tubifex rivulorum; Diatoms; Lichens; How to prepare Foraminifera; An Hour at the Microscope with Mr. Tuffen West; Selections from the Society's Note Books, &c., &c. These "Notes" are certainly the most valuable, the correspondence the least so, and queries will have to be dealt with in a different manner to those in most journals. A reply "in our next" will not be of much practical use when issued quarterly.

We wish the publication every success. The record alone of the notes from the Society's note books will be valuable, and we hope the Council will not be deterred from publishing if the Journal should not turn out a financial success. A special contribution annually from each member of the Society would enable the publication to be carried on.

TO SECRETARIES OF SOCIETIES.

In view of the constantly increasing pressure upon our columns, we find it impossible to give such full and complete lists of objects shown at the Ordinary Meetings and Soirees of Societies, as we hitherto have done.

We do not wish all lists expunged from reports, but that there should be some method in enumeration is evinced by the numerous letters we have received during the last six months, to the effect that in the opinion of our correspondents, many of these lists are of but little use. Our own views coincide completely with those of our correspondents. We had long been of opinion that the lists of objects might be cut down with advantage, but wished for twelve months at least, to provide a permanent record, useful to young Societies and to those wishful to exhibit at Soirees. We have done this, and therefore ask the Secretaries of Societies to aid us in making their lists as interesting as possible, confining it to objects shown to illustrate papers or other communications, new apparatus, and to *rare* specimens met with in the district.

NOTICES OF MEETINGS.

DONCASTER MICROSCOPICAL SOCIETY.—At a meeting in the Grammar School, on Wednesday evening, March 8th, Dr. J. Mitchell Wilson in the chair, a paper on "Diatoms" was read by Mr. J. M. Kirk. Twenty-nine members were present. Diatoms, like Desmids, are simple cells, having a firm outer coating, within which is enclosed an endochrome. The Diatomaceæ are divided into two chief groups; those which are single frustules, and those which cohere in masses. The name seems to have been given to them by the readiness with which the latter may be cut or broken through; hence they are sometimes called "brittle worts." During the healthy life of a Diatom, the process of self-division is being continually repeated, and a very rapid multiplication of frustules thus takes place, all of which are repetitions of the same individual form. These original forms are of great variety. A large part of the 'infusorial earths' deposited at the bottom of lakes is composed of Diatoms, one such remarkable deposit being the tripoli or rotten stone, used for polishing metals. The well-known Turkey stone, also "silicon," now sold for polishing plate, is similarly composed. Such is the abundance of Diatoms in some rivers and estuaries, that their multiplication is affirmed by Ehrenberg to have exercised an important influence in blocking up harbours and diminishing the depth of channels. It is remarked by Hooker that the universal presence of this invisible vegetation throughout the South Polar Ocean is a most important feature, since there is a marked deficiency in this region of higher forms of vegetation; and were it not for them there would neither be food for aquatic animals nor (if it were possible for these to maintain themselves by preying on one another) could the ocean waters be purified of the carbonic acid which animal respiration and decomposition would be continually imparting to them. A Diatomaceous deposit exists in Sweden and Norway, under the name of "Berg mehl," or mountain flour; and in times of scarcity the inhabitants mix this with their dough in making bread. Mr. Kirk explained the methods for collecting, preserving, and mounting the various Diatoms, and illustrated his paper by a large number of beautifully executed drawings of typical forms, among the most elaborate of which may be mentioned the representations of Arachnoidiscus, Heliopelta, and Isthmia. A discussion followed, after which a vote of thanks to Mr. Kirk was proposed by Mr. Selby and seconded by the Rev. George Smith; and the meeting resolved itself into a *conversazione*, many microscopes being exhibited showing specimens of Diatoms.

DONCASTER MICROSCOPICAL AND GENERAL SCIENTIFIC SOCIETY.—A meeting of the above Society was held in the Grammar School on Wednesday evening, April 4th, the Rev. G. Smith (vice-president) in the chair. An extremely valuable and interesting paper on "Cell Life" was read by Mr. J. W. Smith, L.R.C.P. Mr. Smith first defined what is meant by a cell, and incidently referred to the question of the genesis of cells. Taking the amœba as the most convenient and typical representative of the cell, its actions were described—(1) It exhibits movement, (2) receives and digests food, (3) is sensitive and volitional, and (4) is reproductive. These qualities are the common endowments of all cells wherever found, and may be taken as representing all the ordinary manifestations of vitality as seen in the higher animals. Whilst these fundamental qualities appertain to every cell, they are capable of wide modification and of bringing about many diversified results, as is well exemplified in studying the life history of the lowest forms of life, such as the yeast plant, protococcus, bacteria, sponges, foraminifera, and the diatoms, all of which are essentially single-celled organisms. There is a limitation, however, to the performances of the cell organism in its isolated existence. Under such circumstances there can be no advance in function. This result is only attained when by aggregation, mutual association, and interdependence, a division of labour is brought about. The sponges and foraminifera were referred to as presenting cell associations in which the separate units are merely banded together for obtaining food supplies without establishing any more important reciprocal relations with one another. Hence no advance to a higher grade of existence. This advance is seen in the higher animals, which are simply aggregations of cells, and may be regarded as cell communities in which division of labour obtains, certain cells being set apart for the performance of certain functions or duties. It was pointed out how in tracing the highest from the lowest in the animal kingdom one gradually increasing purpose seems to run, viz., aggregation and colonisation of cells with an ever increasing division of labour, differentiation of structure and exaltation of function. Illustrative examples were given. Mr. Smith remarked that in the infusoria we see the greatest perfection attainable by the simple cell as an isolated individual. The organisation of the *Hydra fusca*, which is perhaps the lowest organism in the sub-kingdom Cœlenterata, was described as presenting one of the most rudimentary instances of purposive cell federation. The contractility of the tentacles which are used for obtaining food, the performance of digestion by the cells of the endoderm, and of reproduction by those of the ectoderm, were mentioned as examples of the division of labour which obtains in these little animals. The class actinozoa, comprising the corals, sea-anemones, &c., and constitutes a more advanced division of the cœlenterata, exhibits further progress in cell organisation. In these animals a rudimentary alimentary canal exists. In other words, instead of the entire cells of the endoderm performing the office of digestion, certain cells are grouped into the formation of a digestive sac for this purpose. Moreover, some of the animals of this tribe present the first commencement of a nervous system. Following this line of investigation, it might be shown how in the ascending scale of the animal kingdom each more perfect organism is but a further instance of advancement in cell federation and in the more or less complete division of labour. In conclusion, Mr. Smith said that the same principles held good in respect to the vegetable kingdom. The lower plants are but single celled organisms. The highest are congeries of cells in which different groups perform different functions, yet all work harmoniously together for the good of the whole. Thus one group of cells extracts material from the ground, others again draw material from the air, while a third set is concerned in the propagation and regeneration of the species. How far the facts stated support the doctrine of evolution is a matter for much difference of opinion. After a good discussion, a vote of thanks to Mr. Smith was proposed and seconded, and the meeting terminated.

LIVERPOOL MICROSCOPICAL SOCIETY.—The ordinary monthly meeting of this Society was held in the Royal Institution Rooms on Friday, March 31st, Dr. Carter in the chair.

A paper was read by Mr. J. Michael Williams, on the "Micrŏscopical Aspects of Silica," illustrated by original drawings, and shewn by the Oxy-hydrogen lantern. The paper described the natural condition of Silica as an earth, the drawings shewing its forms under Polarized Light, as it exists in a nearly pure state in Quartz, Jasper, Agate, Chalcedony, &c. Its secretion by living organisms in the higher forms of vegetable were then dwelt upon, illustrated by the Silicious structure of several plants, and their secretion of Silex in the form of Scales, Silicious hairs, &c.; and under the head of Diatomaceæ, various examples in the lower form of vegetable structure were exhibited, shewing their relative size, beauty of contour, delicacy of making, &c.

The secretion of Silica by the lower form of the animal kingdom was then illustrated, beginning with the Silicious sponges, the various and curious forms of their spicula being pointed out—the paper closing with a series of illustrations of the beautiful Silicious shells of the Radiolaria and Polycistina.

At the conclusion of the paper the meeting resolved itself into a Conversazione, when the following subjects were illustrated :—

Animal Hairs	Rev. W. Banister, B.A.
Candona reptans	John Vicars.
Cuticle of Equisetum (polarized)	W. Oelrichs.
Lophopus crystallinus	J. T. N. Thomas.
Micro-organisms	Dr. McClelland.
Nitella in fruit—filaments of Antheridia highly magnified	I. C. Thompson.
Nitella in fruit—Carpogonia showing cyclosis in the "twisted" cells	Charles Botterill.
Plumatella repens	George Thomas.
Pollen of Ivy	H. Kendall, B.A.
Polycistina, &c.	Harold Swift.
Rock sections, various	H. M. Bennett.
Section of stone used in the Mosaic Pavement of Baths of Caracalla, Rome	H. C. Beasley.
Seeds—various	Thomas C. Ryley.
Slag Wool (Silicon Cotton)	H. R. Boult.
Sponge Spicules (*Hyolonema Sieboldii*)	Dr. Hicks.
Volvox globator	W. J. Baker.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the monthly meeting, March 20th, held in the Town Hall, King Street, Dr. Carrington, F.R.S.E., in the chair, the Hon. Secretary placed a number of rare mosses before the members present. Amongst them were fine examples of *Trichostomum mutabile* and *T. flavo-virens* in fruit, and a barren specimen of *Didymodon sinuosus* gathered in January last by Messrs. Boswell and Westell, in Oxfordshire.

Mr. Rogers also exhibited a specimen (which he has just received from California) of *Selaginella-lepidophylla*, or as it is popularly known in that country as the "Resurrection Plant." It is sold in the natural history shop at San Francisco as a curio, on account of its apparent revival after having been dried up for years; and in this respect it is like another so-called Resurrection Plant, known as the "Rose of Jericho."

He also exhibited the following lichens: *Platysma triste* and *Umbilicaria cylindrica*, from Ben Cruachan, and *Lecidea ophœroides*, from Barmouth. These had been identified by Mr. West, of Bradford, and it was remarked that the latter species had not hitherto been recorded by Leighton as occurring in the seventh Watsonian province.

Another lichen exhibited by the Secretary was *Ramalina reticulata*, from California, where it grows profusely on the oak trees, and is popularly known as the "lace Moss," from the beautiful lace-like reticulations of the thallus.

Mr. Stanley exhibited a number of Microscopic slides of mosses, amongst them were specimens of *Zygodon viridissimus var rupestris*, *Eurynchium Hesdalii* and *Gymnostomum calcareum* recently gathered in the neighbourhood of Buxton and Miller's Dale.

Messrs. Cunliffe and Cash had recently visited Rant-y-Fydd, near Wrexham, and had found abundance of *Gymnostomum commutatum* and *Orthodontium gracile*, specimens of which were kindly distributed by Mr. Cunliffe.

Mr. Foster brought a number of singular varieties of the Harts tongue fern, and two very remarkable varieties of *Tomasia spicant*, known as the var *Maundersi*, and *trinervium*. The plants were living and in excellent condition, and had been grown in Salford.

The rest of the evening was occupied in the examination of a fine collection of mosses, collected by Mr. Atkinson, during his residence in the Lake district, 1867-68.

MANCHESTER MICROSCOPICAL SOCIETY.—The following list of objects shown at the last Soiree was unavoidably left over from last number:—

Selection of Mosses, and leaf sections	John Atkinson.
Collection of Zoophytes	F. W. Lean.
Scales of moths and butterflies arranged as a boquet.	Robert Graham.
Volvox globator	,,
Hydra vulgaris	,,
,, *viridis*	,,
Lophopus crystallinus	,,
Actinophrys sol.	,,
Foraminifera	William Chaffers.
Diatoms	,,
Fossil woods	,,
Recent Polycistina from Mid-Pacific	,,
Micro-Photograph, Lord's Prayer in 500th sq. inch	,,
Section of Fern Stem	John Smith.
Trachea, larva of Dytiscus	,,
Spiracle and Trachea of Silkworm	,,
Eyes of Jumping Spider	J. Turville Smith.
Anther and pollen of Mallow	,,
Eggs of common Bug	,,
Crystals under Polarized Light	James Fleming.
Hydra fusca and *H. viridis*	,,
Drosera rotundifolia and insect	J. B. Robinson.
Pond-life, various	,,

Entomostraca (new species)	J. Robinson.
Hydra fusca	,,
Lophopus crystallinus	,,
Corethra plumicornis	,,
Stentor Mulleri, as an opaque object	George E. Davis.
Section, shewing the springing of the feathers in the tail of a young bird	J. Buckley.
Section of Cleopatra's Needle, Oysters, and various Crystals (Polarized Light)	H. Seville.
Stickleback, Stained	J. Dunkerley.
Lung of Frog, and Frog's skin injected	,,
Lophopus crystallinus	W. Blackburn.
Cristatella mucedo	,,
Heliopelta and *Isthmia nervosa* by reflected light...	,,
Spicules of Gorgonia	,,
Eye and Proboscis of House Fly	Hy. Greenhalgh.
Sting of Bee	,,
Fossil Plants, lower coal measures	,,
Palates of mollusca, *Trochus zizyphinus*, *Sepia officinalis*, and Haliotes	Thos. W. Lofthouse.
Crystals—various, under Polarized Light	C. Jumeaux.
Proboscis of Blow Fly	,,
Anterior leg of D. Marginalis, shewing dilation of Tarsi	,,
Polycistina—various	,,
Photo-micrographs and Transparencies	G. Johnson.
Larva of *Ephemera danica*	George E. Davis.
Crystals, &c., under Polarized Light	R. L. Mestayer.
Lung of Sheffield Saw Grinder	,,
Lice from Slug	,,
Trichina spiralis (man)	,,
Toe of Mouse injected	E. B. Cook.
Pollen of Mallow	,,
Elytra of Diamond Beetle	,,
Proboscis of Blow Fly	
Hydatina senta	H. F. Jenkins.
Embryo of Hermit Crab	H. P. Aylward.
Foot of Dytiscus (dry)	,,
Nuggets of Gold	,,
Vase of Flowers made from Insects Scales	,,
Crystals (various) Polarized Light	C. W. H. Kneebone.

MANCHESTER MICROSCOPICAL SOCIETY.—The ordinary meeting was held at the Mechanics' Institution on Thursday evening, April 6th, the President, Mr. Thos. Brittain *(ex officio)*, F.R.M.S., in the chair.

The communications were many and of a varied character, and an enjoyable evening was the result.

Mr. Brittain announced a second ramble to the Bolton valley on Saturday, the 22nd, under the leadership of Mr. Hy. Hyde.

Mr. Herbert C. Chadwick, F.R.M.S., gave a short communication, describing his method of extracting the poison glands of the House Spider.

Mr. Wm. Stanley read a very interesting communication on the classification of Mosses, illustrated by coloured diagrams.

Mr. J. B. Wolstenholme, M.R.C.V.S., gave a short communication on two species of *Acari* form the horse.

Mr. Wm. Blackburn, F.R.M.S., brought before the notice of the members a new form of Microscopic Stand made by Ross, after designs by Mr. Wenham.

He fully described the Stand, and the description was well illustrated by a large drawing which he had prepared, and also by several smaller engravings, shewing the instrument in its various positions.

Mr. Jas. Fleming called the attention of the members to a slide, in which he had been successful in mounting *Volvox globator* in glycerine jelly.

Mr. J. L. W. Miles, by the aid of a coloured drawing which he had prepared, explained his theory of the building up of the tube case *Melicerta ringens*.

Mr. H. P. Aylward exhibited and described Beck's Ideal Microscope, with swinging substage and mirror. He also shewed a new Live Box which he had made at the suggestion of Mr. Burnett, F.R.M.S. Mr. Burnett briefly explained the many advantages of the improved instrument.

Mr. Stanley brought for distribution packets of various Mosses, and Mr. Miles distributed *Melicerta ringens*.

The usual display followed, and among the exhibits were the following ;—

Muscular fibre from Crab	Mr. Alston.
Poison glands of House Spider	Mr. Chadwick.
Mounts of rare Mosses gathered between Buxton and Miller's Dale	Mr. Stanley.
Volvox globator mounted as a permanent object	Mr. Fleming.
Melicerta ringens	Mr. Miles.
Symbiotes Equi and *Symboites spatheferus*	Mr. Wolstenholme.
Hermit Crab and *Nymphon gracile*	Mr. Brauer.

Mr. George E. Davis exhibited Tolles' 1/8th solid ocular and Gundlach's one inch periscopic eye-piece. He also exhibited a first quality one-inch objective by Tolles, the performance of which over a scale of *Morpho Menelaus* was remarkable, while when used over the scales of *Polymmatus argus*, it showed that these objects were not in any true sense of the word tests for it. Over the larger scales of *P. argiolus* the lines are clear and sharp with the 1/8th solid ocular combined with the use of Tolles' amplifier, yielding thus an amplification of at least 1600 diameters.

ROCHDALE MICROSCOPICAL CLUB.—At the monthly meeting, held on April 3rd, at the Club-room, 68, Yorkshire-street, Rochdale, Mr. J. Astin gave the first of a series of practical demonstrations on "Microscopical Illumination." He first shewed what was meant by the terms—direct light, oblique light, and dark-ground illumination. The first did not need any detailed explanation. With different instruments he then shewed various methods of obtaining and using oblique light—first, by means of the mirror inclined at a considerable angle to the axis of the mirror; secondly, by inclining the body of the instrument nearly to the horizontal, and using the bull's-eye condenser; thirdly, by a combination of the two former methods, so as to obtain a true dark-ground illumination. He proceeded to shew more elaborate methods of obtaining the same results by means of the spot-lens, and also by a bull's-eye condenser, with a round spot of black paper in the middle, placed under the stage, and between it and the mirror. To make the demonstration really practical, he then disarranged the various appliances, and the younger members of the club then essayed to arrange them again so as to obtain the same results.

The following rare pond-life forms have been obtained by the members in this district :—ALGÆ: *Batrachospermum moniliforme*, *Coleochœte scutata*. ANIMAL LIFE: *Melodinium Uberrinum*, *Synura Uvella*, *Floscularia cornuta*.

ROCHDALE AND WHITWORTH MICROSCOPICAL SOCIETY.—The usual monthly meeting of this Society was held on Thursday evening, April 13th. There being no special business and no paper, the meeting resolved itself into a conversazione, when some very interesting objects were exhibited by the members.

NOTES AND QUERIES.

Obituary Notice.—Sir Charles Wyville Thomson, late Professor of Natural History in the Edinburgh University, died at his residence, near Linlithgow, a few weeks since, from an attack of paralysis. Sir Wyville will be remembered as the director of the civilian staff engaged in the Challenger Expedition.

Appointment and Resignation.—The Queen approved of the appointment of Mr. E. Ray Lankester, M.A., F.R.S., to the Chair of Natural History in the University of Edinburgh, in the room of the late Sir Wyville Thomson, LL.D., but he resigned a few days after the appointment. One of the causes of resignation is that he is disinclined to stay in Edinburgh for nine or ten months in the year; but it is stated that the chief reason is that in his commission of appointment is a clause to the effect that he takes the post subject to changes which may be made by the forthcoming executive commission. He also finds that the laboratories are not suitable to the work of a zoologist.

Death of Mr. Charles Darwin.—Mr. Charles Darwin, the naturalist and philosopher, breathed his last on Wednesday afternoon, April 19th, at his residence, Down House, Down, near Farnborough, Kent, at the age of 73. He had been suffering for some little time past from weakness of the heart, but has continued to do a slight amount of experimental work up to the last. He was taken ill on the night of Tuesday last, when he had an attack of pain in the chest with faintness and nausea. The latter lasted with more or less intermission during Wednesday, and culminated in his death, which took place at about four o'clock on Wednesday afternoon.

Photo-micrography.—Mr. M. H. Stiles will read a paper on May 3rd before the members of the Doncaster Microscopical Society, on "Photography, as applied to the Microscope."

Preparing Foraminifera from Shore-sand.—The various operations may be summed up thus:—

1. Well wash in fresh water to remove salt.
2. Dry perfectly and allow to cool.
3. Sift. (Sieve No. 50 or 60.)
4. Float the fine material in cold fresh water.
5. Dry the floatings.

Perhaps it may also be needful to—

6. Boil the floatings in *liquor potassæ* P.B.
7. Wash away every trace of potash.
8. Dry thoroughly.

9. Re-float in a beaker.
10. Dry again, after which they are ready for mounting.

—*Chas. Elcock*, in *J. Post. Mic. Soc.*

Collecting Diatoms.—Amongst the few localities (says Mr. Partridge in the "Journal of the Postal Microscopical Society") near Stroud, in which I have collected are :—

Stroud Upper Reservoir—*Cocconema* and *Pinnularia.*
Seven Springs, Bisley—*D. vulgare* and *Gomphonema.*
Salmon's Springs—*Synedra radians*, *nobilis*, etc.
Stratford Mill Pond—*Surirella* and *Pleurosigma.*
Lightpill—*Cocconema lanceolatum.*
Pond, Bowbridge—*Pleurosigma*, etc.
Heven's Spring—*Navicula.*

The Aperture Shutter.—Mr. W. H. Bulloch, the well-known manufacturer of microscopes at Chicago, has informed us that it is now more than five years since he adapted the iris diaphragm as a nose-piece to his microscope, "for reducing the angle of light in the instrument." This is perfectly true, and several other catalogues mention the fact of an iris diaphragm adapter being in existence.

Our connection with the "aperture shutter" is simple enough. We tried to prove to the microscopical public that wide angle objectives would give *penetration* when properly used. All antagonists to wide apertures revelled in the argument that such objectives did not possess this attribute, and histologists were advised to sacrifice the finest definition to good penetration. This called into existence two classes of objectives, and there is but little doubt that this demand for two glasses in the place of one, retarded the general introduction of wide apertures.

We wish to give opticians every credit due to them, but to Prof. Abbé entirely belongs the credit of demonstrating that penetration could be secured by reduction of aperture; and we are unable to find any account, before our own, that wide angle objectives could be made to yield penetration under any circumstances.

Biological Appointment.—There is some talk of Mr. Patrick Geddes, a Scotch biologist, who has recently attracted considerable notice by special discoveries, being appointed to the Chair in University College, rendered vacant by the transference of Prof. Ray Lankester to Edinburgh. Nothing is settled, however, and several of the younger and more eminent Cambridge biologists may be expected to enter the field.

Our Verification Department.—We have heard that dealers in microscope objectives have expressed opinions that this department is "not infallible," and that "angle is only a secondary matter;" we, therefore, beg to inform our readers that every care is taken to avoid mistakes, and if angle is only "a secondary matter," we ask, why is it that so much stress is laid upon it by the vendors? We argue that if an objective is bought as one of 95°, it should be more than 78°. It may be urged that the makers cannot produce the same aperture twice in succession, but that they can be much nearer than 17° is proved by the statistics of this department. If a purchaser does not receive what he asks for, the law provides that he can return it within a reasonable time.

THE ELECTRIC LIGHT FOR MICROSCOPY.—In Feb., 1881, we wrote to Mr. Swan of Newcastle, asking him to make us a special lamp for use in microscopic illumination, so that the direct light might be used with high powers, and also as an aid in photo-micrography. After some delay, a lamp came to hand, and we made many experiments with it, but on the whole were not completely satisfied with the results so far as cost was concerned. We found it much more economical for photo-micrography to use as a magnesium lamp.

It appears that Dr. Van Heurck, the diatomist, has been using Swan's lamps, and a paper from his pen appears in No. V. of the Proceedings of the "Société Belge de Microscopie," which we hope to translate in full for our next number.

MOUNTING VOLVOX GLOBATOR IN GLYCERINE JELLY.—Amongst fresh water Algæ perhaps there is no more interesting object than Volvox. Its perfectly globular form, the outer delicate membrane or network which encloses the brilliantly green progeny, and, when freshly taken from its native water, its active rolling motion, render it particularly attractive.

Various attempts have been made to secure this object as a permanent slide; camphor water and other Media have been employed, but, while the form has been retained, the natural colour of the Volvox has been lost, and with this much of its attractiveness.

In order to retain colour in Algæ, and indeed, all vegetable objects, Glycerine Jelly is advisedly the favourite medium, and in this the writer attempted the mounting of Volvox, boiling, &c., in the usual way.

In one case he used a sunken glass cell and in the other an ordinary glass slip; in one case without pressure, in the other applying a clip to fix the cover glass.

In each case, after a month's time, the *Volvox globator* is perfect in form and colour, and the success of the attempt goes to prove that this Alga can be treated like any other, and may be boiled and pressed without the destruction of its shape.

JAS. FLEMING.

Wood Sections.—We have lately received a complete set of Dr. Nordlinger's transverse sections of the most important and most common trees. They are adapted to a thorough teaching of wood-technology, enabling the observer to distinguish the species by means of a very minute portion of it.

To the teacher these sections are invaluable, for when he is engaged with a large number of pupils it is a great aid to be able to place in their hands ready-prepared sections for the illustration of an oral demonstration.

We shall be glad to divide our collection, and will forward twenty specimens ready for mounting, on receipt of twenty-four stamps; each specimen will make from two to four slides. Collections of one hundred for seven shillings and sixpence. Only a limited number can be supplied.

To Northern Societies.—Some time ago the following paragraph appeared in *Nature*:—"If the various Northern Societies were to do nothing more than prepare local lists of all the varied species of animal and vegetable life, which come under the well-known denomination of 'microscopical forms,' and if *The Northern Microscopist* were to be the medium of publishing these, it would become a Journal of importance, one that would be constantly referred to; and it would in the meantime be doing a good work in advancing the study of the biological sciences."

[We shall be glad to help in such a work, as we are of opinion that such information would be of greater use than lists of objects exhibited at Soireès, etc.]

Typhoid Fever Germs.—In Typhoid Fever, the poison is propagated in the bowel, and is thrown off with the discharges from it. It thus passes from the system in a manner, and in a combination, which ensure its speedy removal from the neighbourhood of the sufferer. The Typhoid germs are there; but they are mingled with discharges which may be removed, and as matter of course are removed, before the germs can pass off from them into the surrounding atmosphere. The seat of the propagation of the Typhoid poison has no direct relation with this atmosphere; germs cannot pass directly from the one to the other.

Fatty degeneration.—With a view of directly observing the effect of diminished food supply upon protoplasm, Mr. Cunningham, some time since, undertook an elaborate series of experiments upon easily observable plants and animals, selecting for his purposes two common moulds, *Choanephora* and *Pilobolus*, and the tadpoles of a toad (*Bufo melanostictus*), and of a frog (*Rana tigrina*), all of which were kept for a longer or shorter period in freshly distilled water, and the effect upon their tissues of the deprivation of food observed from time to time.

The fresh hyphæ of the fungi were filled with cloudy protoplasm, containing vacuoles and here and there highly refracting granules of an oily nature. Replacement of the nutritive solution by distilled water produced an entire change; the oil-globules gradually accumulated, the protoplasm at the same time undergoing disintegration, until, at the end of twelve hours, the hypha contained a mere network of protoplasmic threads crowded with bright fat-granules. These further accumulated, and, the network disappearing altogether, were set free in the cavity of the hypha, often uniting into large oil-globules.

Practical Microscopy.—The Editor thanks the reviewer H.H. of his book in "The American Monthly Microscopical Journal" for his favourable notice, but begs to point out that the following sentence is not according to fact:—"Though mentioning some of the better-known American manufacturers, the author does not describe any of their instruments, with a single exception, and seems not to be acquainted with the various American stands of the higher grade, for he makes the rather remarkable statement that the difference in cost of the English and American stands is due to the superior workmanship of the former." The so-called "remarkable statement" (p. 24) reads as follows:—"The superior workmanship of details in fig. 15 (The Ross-Zentmayer stand) over the Biological stand of Bulloch is only to be expected, owing to the difference in price." Evidently H.H. is off his horse a bit. It was not the author's intention to have introduced *any* American stands, but Mr. Bulloch's possessing so many advantages for the student was the reason of its insertion.

Manchester Literary and Philosophical Society.—The report of the council, to be presented at the annual meeting of this society on Tuesday next, states that the number of ordinary members on the roll of the society on the 1st of April, 1881, was 146, and seven new members have been elected; the losses have been —resignations nine, and deaths three. The deceased members are Mr. John Blackwall, Mr. A. G. Latham, and Mr. E. W. Binney. The treasurer's annual account shows that the balance against the general fund has increased from £90 0s. 7d. on the 1st of April, 1881, to £120 12s. 5d. on the 1st of April, 1882; that the balance in favour of the natural history fund has diminished from £76 5s. 8d. to £35 7s. 11d.; and deducting the difference between these two sums from the compounders' fund, £125, there is a balance of £39 15s. 6d. in favour of the society on the 1st of April, 1882, against a balance of £111 5s. 1d. on the 1st of April, 1881.

Endowment of research.—The Government proposes to grant £4,000 this year for the endowment of research.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

B. C. C.—We shall be glad of your report, but please notice our paragraph in Notes and Queries relists of objects.

P. D.—Mr. W. H. Bulloch's address is 101, West Monroe Street, Chicago.

C. J.—You may be correct. The normal size will be 32 pages in future instead of 24.

B.—We trust you will be satisfied with the paragraph; it was the *least* we could say.

J. J.—It is quite easy to get goods from America. Go to work in the same way as if the vendor resided in Scotland. Send the order by post and remit payment by Foreign Money Order by next mail.

T. H.—Our "Free List" will be revised in July.

W. B.—See reply to T. H.

A. R.—An article upon the subject will appear in July.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

AIR PUMP.—A good air pump of small pattern, in exchange for a good 2" objective, Wray's first series preferred.—G., care of Editor.

WELL-MOUNTED SLIDES of Pathological and Histological specimens, injected and otherwise, in exchange for Insects, Polariscopic or Pathological slides.—Frank P. Hudnut, Orange, N. J., U. S. A.

A SLIDE of well-cleaned *Epithemia turgida* offered for any other well-mounted object or material.—H. S. Woodman, P. O. Box 87, Brooklyn, E. D., New York, U. S. A.

A BEAUTIFUL collection of wild seeds of Central Ohio to exchange. List furnished on application.—F. O. Jacobs, Newark, Ohio, U. S. A.

GENERAL EXCHANGES.

Dr. Lewis M. Eastman, 349, Lexington Street, Baltimore, U. S. A.

A. Norris, Church Lane, Urmston, near Manchester.

R. L. Mestayer, Town Hall, Salford.

C. J. Jones, 15, Princess Street, Manchester.

SALE COLUMN FOR APPARATUS, BOOKS, ETC.

Advertisements in this column are inserted at the rate 4d. for each 12 words or portions of twelve.

Advertisers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied by a penny stamp for each letter, to cover postage.

All Advertisements intended for insertion in this column must reach us before the 14th of each month.

WANTED, a good preparation of one of the larger Diatomaceae in conjugation, for which £5 will be gladly paid. Address, L. D., care of the EDITOR.

MICROSCOPIC SLIDES.— A small but well mounted collection to be disposed of. Address, "Micro.," care of the Editor of the *Northern Microscopist.*

The Northern Microscopist.

No. 18. *JUNE.* 1882.

PREPARATION OF TRANSPARENT SECTIONS OF ROCKS AND MINERALS.

By H. C. Sorby, LL.D., F.R.S., &c.

(Concluded.)

WHEN you commence to grind down you can do it with your eyes shut and without any trouble; and you find it easy, if it touches at one part and not at another, to humour it until the specimen is ground down evenly and the zinc touches at all four corners.

Then comes the finishing off, which is really the troublesome point. You take off the zinc and must use more care. There is not so much difficulty in keeping it even, and now you see the advantage of having the glass made square. Instead of having to keep constantly looking you can tell at once by the feel whether the rock is uniformly thick. You have to rub down on the stones that I have described, and ultimately finish off on the very fine Water-of-Ayr stone, and leave the section of the thickness desired, a matter of course depending on the circumstances of the case. In some instances the section ought to be not more than the $\frac{1}{1000}$ of an inch in thickness, but in the case of other rocks you would not be able to learn what you wanted from a section of that thickness, you would have to leave it thicker. With very fine grained limestone or slate—a roofing slate, say—you must have the section exceedingly thin or you would learn nothing at all, because you require a power of 400 linear to explore such rocks, and unless the sections are exceedingly thin you would not be able to study the character of the individual constituents. There are no large fragments; all the material is finely divided, and you must have the section thin or one constituent hides another.

If you want to study a fine grained material make the section thin. On the contrary, if you want to study the optical characters of some of the larger fragments of minerals that occur here and there, the section must be thicker. If I had to prepare my own again I should be disposed to make some of them thicker than they are.

But I found it very convenient to examine these sections as I went on, so as to learn what was the general character of the rock, as a guide to finishing it off and leaving it the best thickness for the study of its characters.

Having thus reduced the rock to the proper thickness, and being satisfied that all is right, the next point is of course to mount over the whole a portion of thin glass, and I found it very desirable not to do this at once, but to leave the preparation for some weeks so that the Canada balsam would get thoroughly hard, in order to prevent the section breaking up when you mount the thin glass over it with the balsam. Taking glass $\frac{1}{200}$ or $\frac{1}{100}$ of an inch thick (because when you have to mount a larger cover, if you have the finest glass it would all break to pieces) you melt a small portion of balsam on the cover glass, keeping it sufficiently soft to get rid of all the bubbles; then I found it very desirable to wet the section with turpentine and wipe it off. The effect of this is that when you put the thin section of rock down on the Canada balsam, the balsam spreads all over it without difficulty; if it were dry you would have a great number of bubbles formed.

The next thing is to press the thin glass down on to the object so as to get it as nearly as may be in contact, keeping the section warm so that the balsam may be fluid, but not so that the balsam which is employed to fasten down the object will melt, otherwise it might break up. You will now see the reason why the balsam should be allowed to get thoroughly hard. With a little dexterity you may mount the thin glass on and have the whole as perfect as you may desire.

I may make a few remarks on some of the difficulties you have to contend with in the case of some rocks.

When you see certain kinds of mica-schist in the field you would think it impossible to prepare a thin section perpendicular to the foliation. I never dreamed of being able to do such a thing at first. It is almost like making a thin section of the leaves of a book at right angles to the plane surfaces. Mica-schist is so friable in one direction that a very little thing causes it to break asunder. To think of making a section perpendicular to the foliation at first sight appears a very unlikely thing, but ultimately I found that it could be done. The plan that I adopted was this: I broke off a portion of fair thickness,—you cannot break them off thin, they fall to pieces directly, you must have one fairly thick, then you deal with it in the way I have described,—but having reduced it to a certain thickness, say about $\frac{1}{8}''$, you must contrive so as to get it hardened. Having got it into something like the proper shape, I wetted it well with turpentine so that it might penetrate into the pores of the rock, and then covered it over with Canada balsam, and kept it hot inside the fender in the room.

The result was that the balsam penetrated into the loose material, and ultimately got hardened. The balsam thus supplied artificially what Nature had failed to supply, in not having hardened it sufficiently by infiltered quartz.

Then one could proceed to work. But when you have got some little distance down, it may be as well to repeat the process once or more.

This method is necessary for rocks of the softest description. It is necessarily tedious, but very important results come from the study of the rocks most difficult to deal with.

You have then the mica-schist not at all broken up, but the weak points and the planes of discontinuity filled with hard Canada balsam. It is, in fact, thoroughly hard throughout, and you can rub it down and leave the section of the thickness that you desire. You would hardly believe what awkward things some of these mica-schists are. They are not only foliated with alternations of mica and quartz, but you have what had been originally flat planes of foliation all crumpled up in the most complicated manner, and a vast number of joints; another set of planes of discontinuity crossing all the others, so that you have lines of weakness in every direction that you could *not* desire; but with a little care and management I succeeded in making sections of these rocks that left nothing to be desired; and I do not know that I was ever able to observe facts of more interest than in the study of some of these rocks.

One of them was the mica-schist in the neighbourhood of Dunkeld, and I was able to unravel a number of most interesting problems. I was enabled to ascertain that a considerable amount of the quartz was bona-fide grains of sand,—a most important point on the origin of mica-schist, for it is a most complete proof that they were originally rocks containing grains of sand, as well worn as you could get them in the Thames, over white quartz subsequently crystallised in perfect optical continuity.

There you have the history of the original material and the history of the chemical changes that took place, and after this crystallisation had occurred, you have the subsequent history of the crumpling up and the formation of the joints. All these points were made out by the study of this most unpromising rock.

I may say that in the case of some of these the trouble was thoroughly rewarded; but whether it would reward another student is a different matter, because when the whole field was before me and these facts had never before been observed, it did not signify what trouble I was at to establish facts of this kind. But having been established it would be a questionable thing to make other sections of these rocks. But there is a vast amount to be learnt, and I would not hinder anyone from attacking such questions.

Then I found that you might take a somewhat similar method in preparing sections of very soft material indeed. The chalk on the Yorkshire coast is so very hard, and almost a limestone, that there is no difficulty in preparing thin sections; but the chalk of the South of England is exceedingly soft and friable, and you can brush it into fine material and study the minute foraminifera and coccoliths that constitute such a large proportion of it. But it was important to study the natural condition of the chalk,—not to wash it and study the débris, but to ascertain its condition when all the particles were *in sitû*, and I found no difficulty in doing that. I rubbed down a portion of the chalk into a convenient size, and then hardened it with balsam by soaking it in turpentine so as to get all the particles well wetted, and then putting on it a lot of Canada balsam and keeping it hot for some time. The balsam thus sinks into the chalk, and ultimately all the cavities are filled with hard balsam, and you can deal with it as though you were dealing with a rock. You rub it down and mount it on glass in the usual way, but you must take care that you have got the balsam very hard, and must take care not to make it very hot, because if you should it would all break to pieces. You can in this manner get sections of very soft chalk, and even of clay, if you desired to study the way in which the particles were associated in the material.

In the case of chalk, you may compare the soft chalks of the South of England with the hard ones of the Yorkshire coast. When you study the structure of the soft chalks you find that the cells of the foraminifera are empty, unless they may be filled with the soft chalk. Perhaps you might see a little crystal of calcite here and there, but as a rule the foraminifera and minute shells are wholly empty. In the case of the chalk of the Yorkshire coast, however, you find all the cavities filled with calcite. The Southern chalks are as they were deposited; there has been no introduction of soluble carbonate of lime to crystalise and fill the pores. But in the Yorkshire chalk carbonate of lime has been infiltrated and hardened the whole.

I remember making some experiments by ascertaining the increase in weight when thoroughly soaked in water, and calculating from the difference in the specific gravity the volume of water absorbed; and it was interesting to see what a large amount of empty space there was in the chalk of the South of England, but very little in the Yorkshire chalk—the whole having been consolidated by the introduction of carbonate of lime.

In preparing sections of mica-schist, notwithstanding all the care that you may use, you sometimes cannot avoid cracking them. In spite of your care you see a discontinuity between the rock and the glass. When this is the case you must warm the preparation and allow the worked balsam to close up again; but that does not always succeed. Sometimes you must put Canada balsam over it and keep it hot for a considerable time. The balsam penetrates inside and the bubbles disappear.

Sometimes I have been unfortunate enough to break the glass, or found that I could not very well get rid of certain of the bubbles in the way I have mentioned, and it was occasionally desirable to remove the thin section from the glass and put it on another.

If you think it desirable thus to remove a thin slice of rock from one glass to another, you must clear away the Canada balsam all round up to the edge, cast plaster of Paris over it and allow it to harden, then make it hot and push the thin slice of rock completely off. A section can be moved completely off the glass, although it may be only the $\frac{1}{1000}$ of an inch in thickness. The plaster of Paris holds it firm, and you mount it as if it were bearing down a piece of the rock. You can get the plaster off and leave the section clean without any difficulty, and finally mount it in the usual way.

I also devoted a considerable amount of time to preparing sections of shells and corals. You can make very good sections of shells perpendicular to the structure, not by attempting to cut a thin portion of the shell, but by taking the whole shell—supposing it were a uni-valve, one of the Gasteropods—and rubbing it down, so that the shell itself holds the portion firm that you want to deal with. It would otherwise be impossible to make a thin transverse section of a shell perhaps only $\frac{1}{50}$ of an inch in thickness. With a thicker shell you deal as if it were a portion of rock. The surface must be polished with putty powder and all sections made very thin.

I must not conclude without saying a word or two with reference to the preparation of sections of minerals.

In the case of some minerals, when wanted for the study of the fluid cavities, you deal with them just as though you were preparing a section of rock, modifying the process according to the character of the mineral; but in some cases it is desirable to prepare much thicker sections, in order to study certain optical properties, especially to measure the index of refraction. It is very important that the two opposite surfaces that you polish shall be perfectly parallel with each other If you want to guide the sections in some very particular direction, as, for example, perpendicular to the axis, of course it requires a great amount of care, and you must make very careful observation of the angles of the crystal before you commence with it. You must do it by degrees, so as to be sure that you are cutting perpendicular to the axis. But in the case of fluor spar, when there is no section of any particular interest you need not be so particular. You grind down one surface and polish it, grinding it very fine, and then you deal with the other; and the point that I am especially dwelling on now is the method by means of which you can ascertain that you have got the sides approximately parallel. When grinding it down look at a crossbar, say of a window, and turn the section about, looking partly through the crystal and partly through the glass. If it is at all wedge-shaped the crossbar will be as it were thrown down, and you can ascertain the direction in which it is not parallel. If on looking in this way, and having ascertained that you have done something wrong and have corrected the error, if you again look at the crossbar and, turning the crystal any direction you like, find that the crossbar looks the same and does not undergo any change, it proves that you have got your section cut sufficiently parallel for all ordinary purposes.

In cutting sections of minerals for the same purpose you must ascertain that you are looking in the particular direction that you want. If, for example, you are preparing a section of calcite so as to look right along the axis, you must take very great care to prepare a perfect rhombohedron to begin with, and then when roughly finished you must examine it to see that you are looking in the line of the axis.

You may often see certain things very well indeed through minerals that are imperfectly polished by putting them in benzole. Supposing you had a portion of calcite rubbed down roughly, and you wanted to ascertain if it were cutting it in a proper direction, you would get some glass and a thin cover, put some benzole between this and the section. The benzole having nearly the same index of refraction as the calcite makes the rough surface so transparent that you can ascertain then whether the section is cut in the proper direction or not.

This method was very useful when looking at different loose sands. By having them in benzole you can study the minute particulars of grains of sand, and ascertain the portion of the fluid cavities that are contained in them.

I am afraid I have given a very imperfect account of this subject. I have endeavoured to point out some of the principal difficulties, but I daresay I have left out a great many. For, when you have been for years practising an art, you do a great many things instinctively and do not know that they are difficult; it is only when you are beginning that you find them difficult. Especially in mechanical work you get by degrees not to realise points that perhaps might be difficult to others. But I hope that I have pointed out the principal facts and methods which I have employed.

I have not dwelt on the methods employed by others. If I had to begin again I should not adopt the plan I have done. I should economise my time by getting a deal of work done by others. But you must bear in mind that when I commenced this subject there were no people that could make these sections; such a thing was unknown. But I am very pleased to see that the method I had the pleasure to propose and first carry out has now become so universally adopted, not only in England but on the Continent, that there are many men who make a trade of preparing these sections.

Of course there are great advantages if you have the time and opportunity to work these things for yourself, because you can learn a great deal in preparing them that you otherwise could not learn. You give a specimen to the lapidary and he would not know the desired thickness; he would probably rub down everything to a uniform thickness, and you do not know yourself what thickness it should be; but if prepared in the way I have described you can learn something about it. You can learn that there are certain characters that it is very important to study more fully, and you perhaps find that the section has been rubbed down quite thin enough to show some important facts; but perhaps another operator who did not examine beforehand might think it was not anything like thin enough, and would rub it down and lose some of the most important characters.

There are two points to consider: first the structure of some of the constituent materials, and secondly the structure of the material existing between them. In the case of certain igneous rocks it is more important to be able to study the minute structure of some of the constituent materials, which you cannot do if they are very fine. Some of these contain scattered fluid cavities and enclosed crystals. If you leave the sections of sufficient thickness you can focus up and down with a proper object glass. You do not want a very thin section because the mineral is quite transparent. If you were to rub it down very fine you would let out the water from these fluid cavities by cutting them open.

But if you want to examine the minute structure of some of the fine grained material that exists between these structures, then you must make it very thin; and I should now be inclined to make two sections of each rock, so as to ascertain the constitution of each,—the larger and the finer grained material.

As to the fluid contents of cavities in crystals, I thought it desirable to ascertain what the fluid was when the crystal was of considerable size. I obtained a crystal of quartz, which I was told had belonged to Francis Chantrey. It froze at 32° Fahrenheit. Then the next specimen I examined was a quartz from Ceylon, with fluid cavities of perhaps $\frac{1}{50}$ of an inch in diameter. I reduced the temperature far below the freezing point of water and it would not freeze. Still I felt persuaded that it was water, from other considerations, and that caused me to investigate the effect of the freezing of water in minute tubes, and I found that when it is in capillary tubes and small cavities that you can reduce the freezing point of the water far below its usual one; but if the least portion of ice were in contact with it it would freeze immediately. But you may reduce the temperature to below 10°, I believe, without freezing it, if no ice is present.

But that the substance was water was easily ascertained by its optical properties, because they are so different to the optical properties of ice. The above will explain, then, why it did not freeze in small cavities. Then one could determine the rate of expansion that agreed with water.

Then there was another method. You see cavities filled with fluid in the quartz, and you know the diffusion of steam will burst the cavities if you heat the specimen. I had a tube and put the crystal at the bottom, then pumped thoroughly dry air into the tube. Then I had a freezing mixture. After heating the crystal I got a deposition inside the tube of what looked like hoar frost and had all the character of frozen water. I now put this into salt and water below the freezing point, and found as soon as the temperature rose and got to the melting point of ice, the material obtained in this manner thawed.

But the liquid is not pure water. In some cases it contained chloride of sodium or chloride of potassium.

Sometimes the cavities are large crystals of these substances, this being especially the case in volcanic rocks, so that some of the salt so present then can be dissolved at the ordinary temperature.

That was the kind of evidence on which I relied in determining that the liquid in the cavities was water.

In addition to the two chlorides named, I think there is sometimes hydrochloric acid; but that is rather doubtful, because it may have been set free by the action of the quartz on the chlorides.

Of course, many cavities contain liquid carbonic acid. I first established that fact by proving that the rate of expansion was the same as that of carbonic acid, and very unlike that of anything else.

THE ELECTRIC LIGHT APPLIED TO MICROSCOPICAL RESEARCH.

By Dr. Henri Van Heurck.

A Paper read before the Microscopical Society of Belgium.

IN spite of the perfection of homogeneous immersion objectives, which easily shew up fine details, it often happens that the complete study of diatoms, especially of the more minute forms, is very wearisome, both on account of the difficulty experienced in resolving the striæ, and the almost impossibility of counting them with the aid of only a medium magnification.

Recourse must then be had to high magnification, sometimes even to the mono-chromatic light, but the sun by its non-appearance often renders the work impossible, especially in winter.

For some time past we had been thinking of the electric light for the illumination of the microscope, but only thought of obtaining the mono-chromatic light. Our recent experience, however, has shewn us that the incandescent light fulfils *par excellence* the demands of the micrographer.

It is proposed, then, in the present article to examine into the means that the micrographer can employ for the utilization of the electric light, and the advantages to be obtained from its employment.

I. Production of the Electricity.

Everything at present goes to shew that in a not far off future the inhabitants of large towns will be able to receive electricity in their houses by means of a subterranean or aërial communication with the place where it is generated. It would therefore be unnecessary for us to occupy ourselves with the production of electricity, were it not for those dwelling in the country or in small centres who would wish to avail themselves of the advantages offered by electrical illumination.

There are at present two means of producing electricity; dynamo-electric machines and batteries. Dynamo-electric machines, of which the most common is that invented by our countryman, M. Gramme, produce electricity at a cheap rate. Unfortunately they are costly themselves and require a gas or steam motor much more costly still, which brings the total cost to a considerable sum. A micrographer will therefore seldom have recourse to one of these for observations at irregular intervals, when a small battery will enable him to obtain the desired illumination at a slightly higher cost but almost without trouble.

The number of forms of batteries existing at the present day is very considerable, but as yet Bunsen's is unrivalled, especially for the production of light. But the vapours of hypo-nitric acid, which it gives off together with the difficulties of charging it, are a great bar to its introduction, save in the open air, or in a laboratory where little account is taken of these inconveniences. The Bunsen battery, therefore, as arranged by the German chemist cannot be recommended to micrographers, but there is now a very good modification of it, which not only does away with almost all the above mentioned inconveniences, but also allows the production of the light at a price much less than when the ordinary Bunsen battery is used. It is that contrived by M. Tommasi, and is manufuctured by the *Societé universelle d'electricité Tommasi*, at Paris.

This battery is mounted in a very simple manner upon a kind of wooden trestle, and is composed of fifty cells, of which each one comprises:—

1. An exterior stoneware jar.

2. A porous jar containing another vessel of glass, in the bottom of which a hole is so contrived as to facilitate the flow of the liquid coming in to supply the place of that which has become useless, and which gradually escapes by the pores of the jar.

The glass bottle, and consequently the porous jar, are filled with a mixture formed with two parts of a saturated aqueous solution of nitrate of soda and three parts of sulphuric acid solution, acidulated to 45° B.

Besides these a carbon conductor is plunged into the porous jar.

As the exhausted liquid flows away by the pores of the porous jar it is replaced as we have just said by the unused supply in the glass bottle.

The exterior jar encloses a copper wire support, having on its upper part a platinum claw intended to grasp the carbon conductor of the next cell.

About the porous jar and in the exterior one are arranged four zinc rings, one centimètre thick, which rest upon the support we have just mentioned.

The exterior jar is filled to the brim with water acidulated to 4 p.c. with sulphuric acid, and which is introduced into it in the manner now to be described.

The exterior jars communicate with each other in series of five, by means of glass tubes provided with caoutchouc coverings and placed at the lower part of each jar. By means of this arrangement the charging of the battery is accomplished in the twinkling of an eye by the aid of ten taps mounted upon two leaden rails set in communication with the central box, previously filled with acidulated water.

To charge the battery therefore it is only necessary to open the ten taps, of which each serves a series of five cells. The battery is thus prepared for operation instantaneously.

The Tommasi battery prepared and charged as has just been explained will work for ten hours. After each such period it is emptied by means of caoutchouc tubes fixed upon the exterior jar of the last cell in each series and leading to a collector for the waste water. The zincs are then left dry and are not being consumed save while the battery is working.

With regard to the renewal of the mixture and of the zinc it is sufficient every other day to refill anew the glass bottle, and place a ring of zinc in each jar when it is necessary.

The battery is never taken down. To keep it in proper condition it is enough to fill the central box with water once a month, open all the taps, lower the caoutchouc tubes into the collector, and let all run until the supply is exhausted.

This monthly precaution is sufficient to clean out the pile perfectly, and free it from whatever residues may be left there.

We may see that the management of this pile is very easy, and—what is most important—its employment is very economical, taking into consideration the results obtained. For some time we have had such a battery of fifty cells, and are very well pleased with its performance.

But we may remark that when illumination for the microscope is the only thing to be considered there is no need of such an apparatus; with ten cells one has more than is necessary, as we shall soon shew, to illumine the new microscope lamps of Mr. Swan.

II. Storage of Electricity.

The electricity produced by the battery or by the machine should not be employed directly it is obtained. It may even be stored for several days in secondary batteries or *accumulators* as they are really called. These apparatus, devised by M. Gaston Planté, have been perfected by numerous inventors. One of the most practicable systems is that of M. Faure. We represent, page 144, the accumulator of this system as it is manufactured by M. E. Reynier. It consists essentially of two leaden plates covered with a thick coating of red lead, separate, rolled up in flannel and plunged into a glass cylinder, tightly closed, and containing water acidulated to 10 p.c. with sulphuric acid.

The accumulators allow the utilization of all the force of the primary battery in storing the electricity produced, both when it is not being used and afterwards in exhausting the liquids placed in it.

We have coupled a series of such accumulators which remain constantly in the current; when stopping work for the night we connect all the accumulators with the battery, and they remain thus till the next evening.

III. Lamps.

The micrographer can utilise all kinds of lamps, nevertheless the voltaïc arc regulators are not often convenient save in some

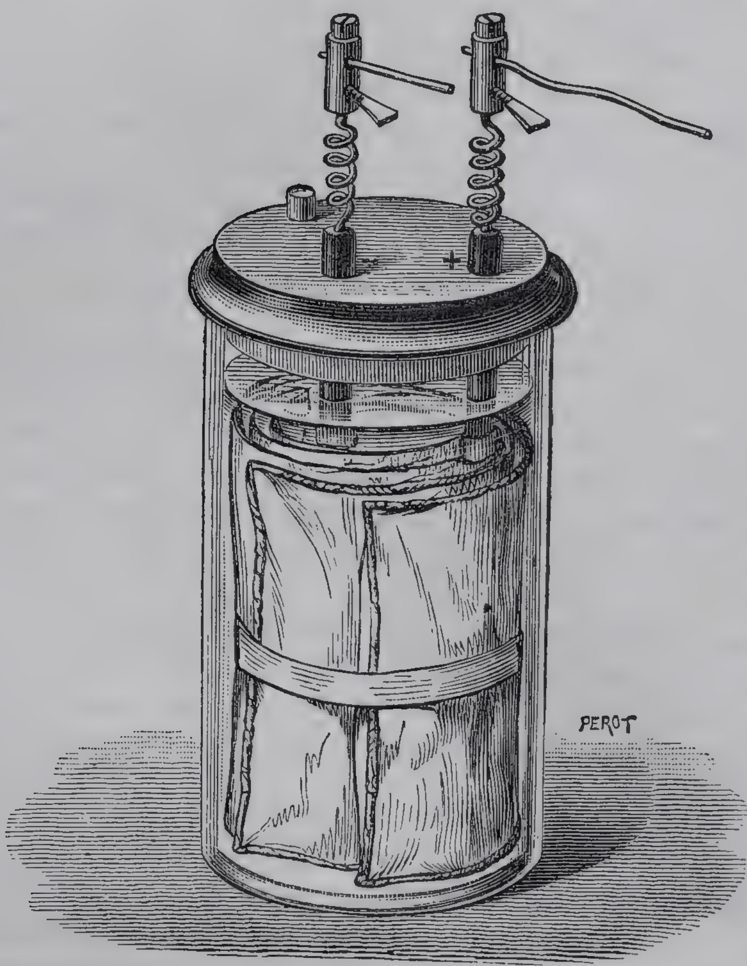


Fig. 9.

experiments of photo-micrography. The incandescent are the lamps that will supersede all others.

We may name two kinds of them,—incandescent lamps in free air and those in vacuo or rarefied gases.

Incandescent lamps in free air, of which there are numerous examples, were invented by E. Reynier, of Paris.

These lamps consist essentially of a carbon of the thickness of 1, 2, or 3 millimetres which touches against a copper or carbon point of contact of relatively large size. This contact is produced either by a weight or by the pressure of a column of mercury into which the pencil is plunged. The incandescence of the carbon pencil is limited by a lateral contact to one or a half centimetre.

The light produced thus is at once vivid and soft, and we get the equivalent of several carcel burners with a small number of cells or accumulators. This bluish light is well suited to the experiments of photo-micrography, but is too vivid for ordinary work. The chief incandescent lamps in vacuo are those of Edison and Swan. Those of Maxim are incandescent in a rarified hydro-carbon. We have tried those of Maxim, but the Swan lamps are the ones we use daily. These suit the micrographer better than any other, both because their incandescent filaments are united upon a small space, and also because they can be made to work with much less force than the Maxim lamps. Some weeks ago we received from the Newcastle electrician some special small lamps eminently suited for micrographical research, and now we employ these alone. These small lamps are almost spherical and about three centimetres in diameter. They give a vivid light and require but a small force.

To obtain a beautiful white light it is only necessary to connect with it from six to eight Tommasi cells, or four Faure-Reynier accumulators.

The micrographer therefore can provide for all his researches by means of ten Tommasi cells or four accumulators.

These accumulators are easily charged by the aid of the ten Tommasi cells (these first having only an electro-motive force of 8.5 volts, while the ten Tommasi have 18 volts), and as these four accumulators, according to our experience, will supply the small lamp for more than twelve hours, we may have the electric light continually at our disposition by setting the pile in operation once or twice *a week.*

Application of the Electric Light to the Microscope.

Let us see now what the micrographer will desire from the use of the electric light. These advantages are of two kinds:

IV. Illumination of the Microscope.

The incandescent electric light surpasses all other illumination. It has the softness of good rock oil lamps, and shews up fine details almost as well as the mono-chromatic light. The delicate striæ of *Amphipleura*, the 19th band of Nobert's test can be seen with perfect distinctness. Prof. Abbé, to whom we have communicated the result of our researches, finds a theoretical explanation or it. He attributes it to two causes:

1. The great whiteness of the light. Consequently the light contains more blue and violet rays. Now, as it has been proved by measurements made by Prof. Abbé, in different mono-chromatic illuminations, that the resolving power of an objective of given aperture increases in the same ratio that the length of the wave of light decreases, it follows that the electric light must shew fine details more easily than the yellowish light of gas or lamps.

2. The specific intensity of the electric light being much greater than that of other artificial lights, a sufficient illumination can be got by means of a much smaller pencil than it is necessary to employ to secure the same luminous intensity with the illumination of gas or diffused daylight. Rays much more oblique can be utilised.

To employ the electric light the lamp is placed in a little case, the covering of which is pierced with an aperture. The microscope is set on the case, the mirror having previously been removed from the axis or taken off altogether. The light of the lamp is then concentrated by means of a plano-convex lens, and directed to the condenser of the microscope. It is by the management of this latter that the illumination is modified.

V. Photomicrography.

Another advantage of electric illumination is that it allows the micrographer to photograph instantly any object which shows itself in the field of the microscope. The operation is simple, and it will be as well to devote a few lines to speaking of the *modus operandi.* The gelatino-bromide process is the most simple, as the plates can be bought ready prepared. We use those of Marion, 22, Soho Square, London, which are excellent, and may be preserved for any length of time; and for photographic apparatus, the small photographic chamber of Ross and Co., which fits into the microscope in the place of the eyepiece.

The plate is exposed in the ordinary way for a period varying with the light and the magnification employed. We have obtained excellent results with the one-tenth of Tolles in ten minutes.

The plate is allowed to soak in rain water and then put into a basin containing 20 c.c. of the developing bath, which is a sufficient quantity for quarter plate negative.

When the image has come out with all its details, the plate is taken from the bath, washed carefully and fixed by the aid of a rather strong solution of hypo-sulphite of soda. It is then washed again with the greatest care, sheltered from the dust, and allowed to dry.

On account of the sensibility of gelatino-bromide plates all the preceding operations must be performed in a very weak yellow light, and this, moreover, ought to pass through ruby-red glass before being admitted into the room. When the negative is obtained, positive proofs are taken in the ordinary manner, or again positive enlarged proofs may be obtained on gelatino-bromide paper. For this it is only necessary to project the negative by the aid of an apparatus for projection—a single sciopticon will do—upon a sheet of the prepared paper which has then to pass through the same series of operations as the plate.

In conclusion is given the formula of the developing bath :

Neutral potassium oxalate 400 gms. dissolved in a litre of boiling water, to which, when all is dissolved, is added 155 gms. of proto-sulphate of iron. The mixture is then to be set aside and preserved for use.

When the solution is used, add to each 20 c.c. three or four drops of the following solution.

One gramme of hypo-sulphite of soda in 200 gms. of water.

AN ELECTRIC BATTERY FOR THE LABORATORY AND DWELLING-HOUSE.

By Emile Reynier.

IT will, perhaps, be remembered by some that two years ago we proposed a zinc couple, soda-copper, sulphate of copper. This battery was as powerful as those in which nitric acid was used, and was free from emanations, while it required the manipulation of no acid at all. To make it suitable for domestic use it behoved us to reduce its cost, and we thought to arrive at this result by the electrolytic regeneration of the residues, but the great improvements made by M. C. Faure in the Planté accumulator came almost immediately to shew that the solution of the problem lies in secondary batteries, the charge of the accumulators requiring no previous manipulation of the residues.

The question of primary batteries remains none the less interesting on this account, as regards the convenient and independent production of the current; moreover, accumulators, while supplanting primary batteries in their application to the distribution of energy, brought them as compensation a new element of success: the possibility of the production of the electricity beyond the hours during which it is required, in such a manner that it may be stored up and amplify the intensity of the electric energy during the discharge.

A battery of small power can thus, by working without interruption for twenty-four hours, generate the supply necessary for a more powerful but less prolonged discharge.

Hence we see that certain voltaïc contrivances, which have been set aside as not possessing sufficient energy, may be taken into use again, and in the first rank are the zinc couple, sulphate of zinc—copper, and sulphate of copper, which is very constant, quite inodorous, and relatively economical.

This cell, generally known under the name of the Daniell (though the principle of it was owing to Becquerel), had before received from M. F. Carré and Sir W. Thomson improvements which rendered its internal resistance very small. It was, therefore, already shewn that batteries of this kind, without exceeding suitable dimensions, gave effects of quantity; little was wanting for them to become, by the aid of accumulators, convenient generators of electricity for laboratories and domestic use.

It is this little that we have supplied in simplifying the service of the battery, and reducing, within certain limits, its daily expense.

The receiver is of copper, and acts the part of the positive electrode, the zinc, of rectangular form, is enveloped by a porous case of paper-parchment, made in the same way as those of our former battery, but much narrower. The zinc fills this porous case almost entirely, and this case we shall call the partitioning. A fine canvas sewn underneath protects the paper.

A zinc thus partitioned off, and steeping in a sulphate of copper solution, forms, with the sides of the receiver, a constant couple with little resistance.

In the narrow compartment, which holds the zinc, sulphate of zinc is formed at first by local action, at the expense of the electrode and of a small quantity of sulphate of copper which reaches it through the partition. The couple places itself therefore in its normal condition of operation. The excess of sulphate of zinc which eventually finds its way out at the fastening of the circuit will be diffused towards the outer compartment. This action of osmose is sufficiently rapid, favoured as it is by the great solubility of the salt, and by a phenomena of transport effected from the negative to the positive in the interior of the couple by the current itself. Thus the osmose becomes powerful just when it becomes necessary that it should be so.

We have not, therefore, to occupy ourselves about the zinc compartment; the service of the apparatus is practically that of a battery with a single liquid.

Again, the renewing of the sulphate of copper is a work of the most simple kind. It consists in lowering the caoutchouc tube with which each couple of the battery is provided, to allow a portion of the exhausted liquor to flow away, then raising these tubes again to add ordinary water, and putting a previously weighed charge of copper sulphate into a wicker case suspended in the upper part of the receiver.

To diminish the interior resistance we can throw into the couple a few grains of a conductive mixture, composed of several neutral or acid salts, which are soluble and very cheap, such as chlorides and sulphates of potassium and sodium, sulphate of ammonia, nitrate and bisulphate of soda, &c.

Once a month the battery is taken down to change the enclosed zincs and to collect the reduced copper, which is deposited in thick plates upon the sides of the cells, whence it may easily be detached with a wooden knife. This copper, free from metalloids, will fetch a high price for the fabrication of conducting wires and of certain alloys. Its price will of course have to be deducted from the general outlay.

Nothing limits us in the choice of forms and dimensions for the cells and the zincs. These latter, moreover, with their partitions can be folded or bent, which gives an increase of exposed surface in a given space, always as if it were a question of a battery with a single liquid.

The couples of our smallest model have the following dimensions—Zinc: length $0^{m}.333$; breadth $0^{m}.160$. Cell: length $0^{m}.440$; breadth $0^{m}.050$; height $0^{m}.220$.

For this form the constants are—$E = 1^{volt}.07$; $R = 0^{ohm}.14$.

The consumption per twenty-four hours, when results close upon the maximum are obtained, would be practically 1 kg. sulphate of copper 0.4 kg., zinc about 0.1 kg., with a production of close upon 0.90 kg. of metallic copper.

We have in use a battery of sixty-eight small couples. It occupies a place under the windows of the hall in a small yard of a width of two metres, which separates the house from the street. This battery is employed alternately in supplying light for the laboratory and the house, by means of Faure accumulators.

For the laboratory it is a sure and convenient electromotor, the use of which will obviate many of the difficulties previously experienced.

When applied to illumination the battery, in connection with thirty-six Faure accumulators, will supply five incandescent lamps in free air for five hours. We reckon that it would supply from eighteen to twenty Edison lamps for the same time. In either case the expense for an equal amount of light would be much higher than that of gas, but a little less than that of stearine wax.

Applied to the production of motive force, the same battery would cost about 2 fr. 70 cents. for 60,000 kilogrammetres.

The expense, though much greater than that of machines, is less than with the batteries hitherto in use. We are endeavouring to reduce the net cost still further.

For all this, we believe that in the condition in which our battery is now presented, it may be at once admitted into laboratories and adopted by amateurs for domestic use.—*La Nature.*

NOTE.—Dr. Henri Van Heurck writes us that he has had a battery of 40 of these elements working for the past two months to his entire satisfaction.

Referring to our note on p. 129 of the present volume, the Swan lamp in our possession required 12 quart Bunsen cells to get a light of any degree of brilliancy, working without an accumulator. Some valuable notes in this direction by Dr. J. M. H. Munro may be found in the present number.—Ed.

BATTERY POWER FOR SWAN LAMPS.

By Dr. Munro.

(From the Mechanical World.)

FOR the benefit of those of your readers who wish to experiment with or exhibit the electric light, and who are yet unable to understand the jargon of volts, ohms, and amperes, I will relate my own experience as to the battery power necessary. I feel sure from the number of queries that appear on the subject, and the discordant replies elicited, that many will be glad of the information. A few days ago I wished to exhibit the electric light, and had at my disposal forty Grove cells of the usual size, three Swan lamps of 25 to 50 candle power (sold at first at 25s. each, and lately at 12s. 6d. each), and a Serrin arc lamp, in which the approach of the carbons is regulated by clockwork. I was assured by the local vendor of one of the Swan lamps that fifteen Grove cells were guaranteed sufficient to work the same. The dealer from whom I procured the loan of the other two Swan lamps, however, stated that less than 40 cells would give an unsatisfactory result, even with one lamp, but that 40 cells would be quite sufficient for one, two, or three lamps. I first tried one Swan lamp with 10 Grove cells, with no visible result; 15 cells gave a red glow with one lamp, which diminished to a very dull red when three lamps were tried together; 25 cells gave a fairly good light with one Swan lamp, considerably diminished when two or three were brought into circuit; 40 cells produced a light of wonderful brilliance and steadiness with one lamp (quite equal to any incandescent light I have seen produced from the currents of a dynamo machine), and with two or three lamps in circuit the result was perfectly satisfactory, although there was a distinct falling off in the light from each lamp taken separately. In all these cases the battery was coupled in simple series (*i.e.*, intensity fashion), and the lamps when arranged in multiple arc (*i.e.*, each lamp was independently connected with the two poles of the battery). When the Serrin lamp was also introduced into the arrangement (being also connected independently with each pole of the battery) the 40 cells were found sufficient to give a brilliant light, when the carbons were approached to the proper distance, the three Swan lamps simultaneously falling off to a barely visible glow. By simply separating the carbons the Serrin light was extinguished, and the whole of the current sent through the Swan lamps, illuminating them as brightly as before. The reason that the Serrin lamp takes away nearly all the current from the Swan lamps is that its resistance is very much less. To charge the above battery, rather over half a gallon (1 Winchester quart) of strong commercial nitric acid was required, and rather over 1 quart ($\frac{1}{2}$ Winchester) of strong commercial sulphuric acid. The ordinary public would probably have to pay 6d. or 7d. per pound for the former, and 2d. per pound for the latter. One charge is sufficient to work the above lamps well for one or two hours. I should not omit to state that Swan lamps can now be procured of 5 candle power, costing 5s. each. These would probably work well with 8 to 10 cells.

Experimenters must expect to incur considerable expense in broken Swan lamps. The slightest jar is sometimes sufficient to snap the carbon thread, and repair is, of course, impossible without destroying the vacuum. Finally, I may add that, as was to be expected, the light of the Serrin lamp exceeded that of the three incandescent lamps together, but there could be no comparison as to steadiness and comfort.

J. M. H. MUNRO, D.Sc.

CORETHRA PLUMICORNIS.

BY MR. A. C. BOWDLER.

A Paper read before the Blackburn Field Naturalists' Society.

Order, DIPTERA.......Family, CULICIDÆ.......Genus, *Corethra.*

THE Micrographic Dictionary names this insect, and refers to Kursalo's monograph on *Corethra plumicornis*, and to other writers—Ray Lancaster, Pop. Sc. Review, 1865; Rymer Jones, Mic. Dy., 1866, page 99, and others. Its larva is so transparent that it is easily overlooked, although very generally distributed. It inhabits fresh water. Last year I obtained several specimens from a pool of water in a quarry at Ramsgrave, also from a pool near Ribchester. In February this year I found it very abundant in a small pond at Pleasington, and brought away some 40 or 50 specimens. The head of the larva is small, and furnished with two remarkable looking hooks bent towards the mouth. The tail has a fan of hairs on the underside, which appear to act as a paddle. Its popular name is the Phantom Larva, and in Mr. Cooke's "Ponds and Ditches," p. 208, there is a sketch of it and a detailed description. The simplest plan of collecting the larva is by sweeping the water with a net, and they are then seen wriggling on the muslin. They are more difficult to obtain with the bottle. The first peculiarity one notices is that mentioned by Cooke. He says, "They differ from all larva with which I am acquainted by the habit of remaining suspended in mid-water, seldom seeking the surface for purposes of respiration, as in the case of other diptera." Another peculiarity is the rapid half turn they make—"It is familiar to every pond collector," Cooke says, "and has been for generations, and yet its life history is not yet fully traced through all its stages." The larva butt at one another when they approach pretty closely, but I have not observed them do so to the extent he says. In the third segment of the body of the larva, which is the broadest part, are two kidney-shaped air sacs. These are beautifully marked with parallel lines when examined under the microscope, and dotted with a dark pigment. In the ninth segment are two similar air sacs, only smaller. The four air sacs undoubtedly act as floats to keep it suspended in the water, but are also connected with the breathing system all through. These air sacs are the only traces of tracheæ found. Dr. Cooke says this larva is a most beautiful object with polarized light and selenites, the muscles and other parts being wonderfully distinct. Down the body the ganglionic nervous system is to be seen, the nerve fibres vibrating backwards and forwards, and all the details of its structure may be made out.

For further particulars as to the structural arrangements in this larva, I refer you to "Ponds and Ditches." Dr. Cooke does not give us any particulars as to its pupa condition. This, however, is readily observed. Several of the larva obtained in Feb. changed into the pupa state about the middle of March, and continued to do so, one or more every day or two, hence I am able to bring for your inspection the larva, the pupa, and the perfect insect, male and female.

At our Conversazione I gave our Secretary a trough containing two specimens of the larva to throw on the screen. While in the trough one of them assumed the pupa state, and we had therefore enlarged before us on the screen, larva, pupa, and larval skin. The larva appears to get rather darker before changing, and when the transformation has taken place it no longer floats horizontally in the water but in a perfectly upright position; the body is shortened; the two air sacs in the third segment are now external, and stand upright, being connected with the tracheal system, now much developed.

The two air sacs in the 9th segment have disappeared, and are represented by two external terminal plates connected with the tracheal system. These also appear to act as paddles, and enable the pupa by bending the body and straightening it again to strike the water and force itself along in jerks.

Mr. Bolton, of Birmingham, in one of his portfolios of drawings, gives a photo-lithograph of a drawing illustrating Professor Rymer Jones's paper on the structure and metamorphosis of the larva of *Corethra plumicornis* from the Quarterly Journal of Microscopical Science, 1867.

Rev. J. G. Wood, in his "Insects at Home," page 608, gives a drawing of *Tipula longicornis*—one of the Craneflies—and alongside he depicts the larva and pupa, which I am disposed to think are incorrect, these being the larva and pupa of *Corethra plumicornis*. In Knight's "Animated Nature," page 360, the larva, pupa, and perfect insect are shown, the two former both magnified and natural size. The pupa is very active when disturbed, and rapidly finds the bottom of the aquarium. It gets rather darker as it approaches its final change. After watching for some weeks in order to witness the imago emerge, I was enabled to do so on March 30.

The pupa came to the surface and lay horizontally—being in a bottle it was easy to watch with a lens. After a few movements, it bent the body several times, until it split at the head, and the head of the imago rose out of the crack. It then disengaged first one foreleg and then the other, which were placed on the water, and after a short rest, the body was drawn out of its case, and the perfect fly was free.

The male Corethra is furnished with a pair of handsome plumes. The description of *Corethra plumicornis* in Walker's "Insecta Britannica" is as follows:—

"Brown; antennæ testaceous, with brown bands; thorax with a whitish stripe on each side; pecters whitish; wings slightly greyish; veins and borders thickly ciliated, the former testaceous; halteres white; abdomen pale brown, having legs pale, testaceous, pubescent.

"*Male*—Plumes of the antennæ testaceous."

THE SALMON DISEASE.*

FOR some years past an epidemic disease has been known to prevail among the salmon in certain British rivers. The disease has from time to time been attributed to various causes: the outward sign of its existence is the appearance of one or more whitish patches upon those parts of the body of the fish not covered

* Abstract of "A Contribution to the Pathology of the Epidemic known as the Salmon Disease." A paper read at the Royal Society, March 2nd, 1882. By T. H. Huxley.

with scales, which patches are very variable in size. It is important to observe that a single small patch of this kind may be seen upon a fish otherwise perfectly healthy. The patch once formed rapidly increases, while the central portion undergoes an important change, and the underlying tissue can be lifted up in soft flakes from the derma, or true skin, which it covers. As the patch spreads, the true skin sloughs, and a sore is formed which may extend down to the bone, while it passes outwards into burrowing sinuses. This causes great irritation, and the fish dashes wildly about, thus, in all probability, aggravating the evil. One vast sore may cover the top of the head, from the snout to the nape, and even extend over the gill-covers. The disease also enters the mouth, and is said to attack the gills, though Prof. Huxley has not found it so in any fish which has come under his observation. The fish which succumb to the disease grow weak and sluggish, seeking the shallows near the banks of the river, where they finally die. A disease similar to that described has been known among salmon in North America and Siberia. The *Saprolegnia*, which is the true cause of the salmon disease, is closely allied to the *Peronospora*, the cause of the potato disease.

It was already known that the papyraceous slough-like substance, which is seen to coat the skin of a diseased salmon, when subjected to microscopical examination, is composed of a number of fine filaments which are terminated by elongated oval enlargements or zoosporangia. Within these the protoplasm breaks up into numerous particles, each less than $\frac{1}{2000}$ of an inch in diameter. These particles or zoospores are set free through the opening formed at the apex of the zoosporangium, and become actively or passively dispersed through the surrounding water.

Prof. Huxley could find no satisfactory information as to the manner in which the fungus enters the skin, the exact nature of the mischief which it does, or what ultimately becomes of it. He therefore made a careful examination both of the healthy and the diseased skin, properly hardened and cut into thin sections.

He also tried experiments on the transplantation of the *Saprolegnia* of living salmon to dead animal bodies. The body of a recently killed housefly was gently rubbed two or three times over the surface of a patch of the diseased skin of a salmon, and was then placed in a vessel of water. In the course of 48 hours innumerable white cottony filaments made their appearance. As these filaments had approximately the same length, the fly's body became enclosed in a white spheroidal shroud, having a diameter of as much as half an inch. These filaments in size, structure, and the manner in which they gave rise to zoosporangia and zoospores were precisely similar to the hyphæ of the salmon fungus, and the characters of the one and of the other prove the fungus to be a *Saprolegnia* and not an *Achlya.* Moreover, Prof. Huxley states that it was easy to obtain evidence that the body of the fly was infected by the spores swept off by its surface when it was rubbed over the diseased salmon skin.

Saprolegnia has never been observed on decaying bodies in salt water, and there is every reason to believe that as the saprophyte it is confined to fresh water. Prof. Huxley says that, so far as he is aware, there is only one case on record of the appearance of fungus on fish in salt water, and in this case it was not certain that the fungus was *Saprolegnia.*

Thus it becomes evident, or at least highly probable, that the origin of the disease lies in spores of *Saprolegnia* which emanate from dead organic bodies in our fresh waters.

Having infected dead flies with salmon *Saprolegnia* once from Conway and once from Tweed fish, Prof. Huxley fancied it would be easy to determine the exact species with which he was dealing, but the experiments were not thoroughly satisfactory, and although from the result of them he has very little doubt that the *Saprolegnia* of the salmon is one of the forms of the *S. ferax* group of Pringsheim and De Bary, he has at present no proof of the fact.

A curious and unexpected peculiarity of the salmon *Saprolegnia*, both on the fish and when transferred to flies, is that locomotive ciliated zoospores do not appear, but whether the season of the year or the conditons under which the saprolegnised flies were placed had anything to do with their non-appearance he cannot say. Whether the zoospores are actively locomotive or not, they are quite free when they emerge from the zoosporangium, and, from their extreme minuteness, must be readily disseminated through the surrounding water. Hence a salmon entering a stream inhabited by the saprophyte will be exposed to the chance of coming in contact with *saprolegnia* spores. At a very moderate estimate, a single fly may bear 1000 fruiting hyphæ, and if each sporangium contain 20 zoospores, and run through the whole course of its development in twelve hours, the result would be the production of 40,000 zoospores in the day. It appears that 2,000 diseased salmon have been taken out of a single comparatively insignificant river in the course of the season.

There are many practical difficulties in the way of directly observing the manner in which the zoospores effect their entrance into the skin of the fish and the structure of the healthy integument is dealt with in Prof. Huxley's paper. It appears that sections of young patches of diseased skin shew that the hyphæ of the fungus not only traverse the epidermis but also bore through the superficial layers of the derma, in some cases as much as $\frac{1}{10}$ of an inch. In the derma the root hyphæ branch out, pierce the bundles of connective tissue, and, usually, end in curiously distorted extremities. The effect of the growth of the stem hyphæ is to destroy the epidermis altogether. Its place is taken by a thick felted mycelium which entangles the minute particles of sand suspended in the water, no doubt constituting a very irritating application to the sensitive surface of the true skin. When the fungus was found penetrating the true skin and gaining access to the lymphatic spaces and blood-vessels, it was of interest to ascertain whether the hyphæ might not break up into toruloid segments, as in the case of *Empusa muscæ*, and then give rise to general septic poisoning, but the occurrence of such a process was not observed.

A very important practical question arises from the discovery that the fungus penetrates into the derma. There is much reason to believe that if a diseased salmon returns to salt water all the fungus which is reached by the saline liquid is killed, and the destroyed epidermis is repaired, but the sea water has no access to the hyphæ which have burrowed into the true skin, and hence it must be admitted as possible that in the case of a salmon which has become to all appearance healed in the sea, the remains of the fungus in the derma may break out from within when it ascends the river, and the fish again become diseased without any fresh infection.

Prof. Huxley's general observations have led him to the following conclusions :—

1. That the *Saprolegnia* attacks the healthy living salmon exactly in the same way as it attacks the dead insect, and that it is the sole cause of the disease, whatever circumstances may, in a secondary manner, assist its operations.

2. That death may result without any other organ than the skin being attacked, and that, under the circumstances, it is the consequence partly of the exhaustion of nervous energy by the incessant irritation of the felted mycelium with its charge of fine sand, and partly by the drain of nutriment appropriated by the fungus.

3. That the penetration of the hyphæ of the *Saprolegnia* into the derma renders it at least possible that the disease may break out in a fresh-run salmon without re-infection.

4. That the cause of the disease, the *Saprolegnia*, may flourish in any fresh water, in the absence of salmon, as a saprophyte upon dead insects and other animals.

5. That the chances of infection for a healthy fish entering a river, are prodigeously increased by the presence of diseased fish in that river, inasmuch as the bulk of *Saprolegnia* on a few diseased fish vastly exceeds that which would exist without them.

6. That as in the case of the potato disease, the careful extirpation of every diseased individual is the treatment theoretically indicated; though, in practice, it may not be worth while to adopt the treatment.

NOTICES OF MEETINGS.

BLACKBURN FIELD NATURALISTS' SOCIETY—MICROSCOPICAL SECTION.—The first meeting of this section was held on the 24th Feb., 1882, in the Free Library, when, after a general discussion as to the objects and working of this section, it was resolved that the meetings of the section be held every alternate Monday, at 7-15 p.m., commencing on March 6th.

Mr. A. C. Bowdler exhibited *Conochilus Volvox*, which he had obtained from a pond at Pleasington. For description see M. Micro. Journal, Vol. 16 p. 1; also "*Ponds and Ditches*," p. 156-7.

20th March, 1882. At this meeting, Mr. Bowdler exhibited slides of Spider, and Winter Gnat of his own mounting in balsam, also Larva of May Fly.

Mr. J. D. Geddes exhibited Pond Life consisting of various Larvæ, *Hydra viridis* and *H. fusca;* various Desmids, Diatoms and Algæ, obtained in a ramble on the moors at Dale Head, West Riding of Yorkshire. Also the circulation of the blood in the tadpole of the Frog.

3rd April, 1882. At the meeting held this day, Mr. Bowdler read a paper on *Corethra plumicornis*, which may be found in the present number: he also illustrated it by the aid of the Microscope with slides, showing larva, pupa, and imago. The meeting afterwards resolved into a conversational one on Microscopic matters.

CARLISLE MICROSCOPICAL SOCIETY.—The usual meeting of the Carlisle Microscopical Society was held on Friday, April 21st, 1882, at their meeting room, the Young Men's Hall, Fisher Street. The Rev. Canon Carr, F.R.M.S., presided, and there were also present the Mayor of Carlisle, treasurer of the Society, Mr. J. R. Tiffin, Mr. Hepworth, Mr. Blair, Mr. Hill, Dr. Lediard, Mr. Thompson, Mr. Parker, Mr. Young, Mr. Pattinson, Mr. Wightman, and Mr. A. Barnes-Moss, hon. secretary. The Hon. Secretary read the first annual report of the Committee and the treasurer's statement of accounts. The report stated the Society had increased in numbers during the session, and they had now 38 members. The interest in the meetings had been well sustained. The opening address was given by the president, the Rev. Canon Carr, M.A., F.R.M.S., to a large and influential meeting in the Young Men's Christian Association Hall, on Nov. 23rd, 1881, and the interest excited by the lecture induced some gentlemen to join the Society. Two demonstrations of an educational character were given at the regular meetings by the president on vegetable cells and tissues. Papers were read by Mr. R. J. Baillie, F.R.A.S., on the Spectroscope, and by Mr. Parker on Adulteration of Food. A great many interesting objects were shown at the several meetings by the members which tended to advance the study of microscopy and to increase the interest in minute organisms. The Society was indebted to the Rev. Canon Carr, president; Mr. Hall, vice-president; Mr. Pattinson, Mr. Parker, and Mr. Tiffin for gifts of books and slides. The Society had purchased slides of an educational character illustrating vegetable cells and tissues and also a number of books on microscopical subjects. Financially the Society was in a good state. The accounts had been balanced up to this evening, and the Treasurer had a balance in hand. The report, on the motion of the Mayor, seconded by Mr. Hepworth, was adopted. It appeared from the treasurer's statement that the Society had expended in various purchases £12 8s. 7d. Mr. Moss added that the Committee had purchased a set of 12 lamps in order to avoid the inconvenience to members of bringing lamps to the meetings. The statement of accounts was adopted. Mr. Hepworth moved that the Rev. Canon Carr be re-elected president for the ensuing year. No one could fill the post so well, and it was a great satisfaction to the members to have such an eligible gentleman to nominate again. Mr.

Pattinson seconded the motion, and it was unanimously agreed to. Mr. Moss said Mr. Hall (vice-president) being in London was not able to attend the meeting, but he had desired him to say that it would be a great pleasure to him to hear of the president's re-election, he being sure that the Society could not prosper so well under anybody else's management. Mr. Moss then proposed the re-election of Mr. Hall, vice-president. Mr. Young seconded the motion, and it was carried. Canon Carr thanked the members for again electing him president. It had been a great pleasure to him to attend the meetings. They had been very helpful; no one could attend them without learning something which he did not know before with reference to the subject on hand. They had increased the number of members; and the greater the number the more numerous would be the objects shown and much wider the diversity of those things which gave a general interest to the subject. On the motion of Mr. Tiffin, seconded by Mr. Pattinson, Mr. Moss was re-elected secretary, the President stating that Mr. Moss had been kind enough to take the burden of the work, and he hoped he would continue to do so with great advantage to the Society. The Mayor of Carlisle was re-elected treasurer, and Mr. Wightman and Mr. Pattinson were appointed auditors. The old Committee were re-elected by ballot. This finished the business part of the meeting. Mr. Moss then read a paper on "Polarized Light," illustrated with models, &c., which proved very interesting. He described and illustrated in the first place the phenomenon of ordinary light, describing the laws which govern it, and explaining by diagrams on the black board. He next explained the phenomenon of Polarised Light—its history, and the result obtained by its use. This was further illustrated by wooden models—showing the wave motion of light. The last part of the paper was devoted to the phenomenon of the beautiful colours produced in the polarized ray by interference, which was also illustrated with models. A vote of thanks was given to Mr. Moss for his paper before the meeting separated.

MANCHESTER MICROSCOPICAL SOCIETY.—A SPRING RAMBLE TO GATLEY CARRS.—Twenty members of the Manchester Microscopical Society took advantage of the Easter Monday Bank Holiday to have a ramble in that beautiful bit of Cheshire know as Gatley Carrs. They left the Central station by an early morning train, and, on arriving at Withington station, set out on foot for the hunting ground they had in view. Mr. Brittain, the president, who acted as conductor, led them along the banks of the river Mersey to Northenden, and a little beyond the village the work began in earnest. The Goutweed (*Ægopodium Podagraria*), a plant very scarce in many parts of Britain, is here in great plenty. On the conductor calling the attention of the members to the fact that an interesting smut might be found upon the leaves of the plant, an immediate hunt began, with the satisfactory result that all the members obtained a good supply of the parasite which is known as *Puccinia Ægopodii*. In the same locality a tolerable supply of an Ascobolus was met with, but the species was not identified, the question being left for microscopic examination. Two other micro-fungi were looked for in vain; the season, though early, was yet to soon for their development. After refreshment, the party proceeded to the Carrs, when a successful hunt was made for the beautiful cluster cup (*Æcidium ranunculacearum*), which grows upon the leaves of the lesser celandine. On the leaves of the same plant an interesting smut was found, *Uromyces ficariæ*. Several of the party devoted themselves to pond life, and brought home with them well-filled bottles for future examination. The weather was all that could be desired, and for so early a period in the spring the expedition was extremely satisfactory.

MANCHESTER MICROSCOPICAL SOCIETY.—RAMBLE IN THE BOLLIN VALLEY.—The second ramble of the season of the members of the

Manchester Microscopical Society, under the leadership of Mr. Henry Hyde, took place on Saturday, April 22nd, to that specially interesting district at this time of the year, the Bollin Valley. On leaving the road at Bowden, the wild and mock strawberries, the stitchwort, the adoxa, and the cow parsley were picked up, also a few Pucciniæ or cluster cups. After passing that old botanical landmark, Bank Hall, with its seventeen yew trees, the common but pretty moss, "*Ceratadon purpureus*," was collected in fine fruit, and the adder's-tongue fern was noticed. Reaching the river side the red campion, the marsh marigold, the wood anemone, the dog violet, the primrose, and a host of others were met with; and here attention may be called to the ruthless manner in which flowers are plucked and thrown aside by many so called botanists, as if in mere wantonness; every few yards revealed dead blossoms strewn about the footpath. Before leaving the valley the cuckoo was distinctly heard for the first time this season, and the bryologists were successful in finding *Lophocolea heterophylla* very plentiful and in good fruit, *Mnium hornum*, *undulatum*, and *punctatum*, also a very pretty species of lichen, *Cladonia extensa*, resplendant with its bright vermillion-red tubercles. This is the red cup moss of which Mrs. Hemans sings :—

"They find the red cup moss where they climb;
And they chase the bee o'er the scented thyme."

It contains a small quantity of gummy and starchy matter, and has been used, boiled in milk or syrup, in hooping cough and other chest affections in children. In Thuringia a decoction is used in intermittent fevers. In crossing Hale Moss on the return journey *Polytrichum gracile*, *Scapania irrigua*, *Cephalozia bicuspidata*, and *Calypogei Trichomanes* were also collected. The following are the names of the flowering plants not already mentioned, which were collected and named by Mr. Hyde: The Bed-straw, Bluebell, Lesser Celandine, Wild Turnip, Red-dead-nettle, Dog's-mercury, Ground Ivy, Red-rattle or lousewort, Woodruck, May-flower, Sweet Woodruff, Speedwell, and Orchis.

MANCHESTER MICROSCOPICAL SOCIETY.—The ordinary monthly meeting of the Manchester Microscopical Society was held on Thursday evening, May 4th, Mr. Thomas Brittain, the president, in the chair. Two papers were read, one by the president, on the Magnifying Power of Microscopes and Telescopes, and the other by Mr. R. C. Smith, M.D., on the Injurious Effects of Smoke on the Lungs. The latter was illustrated for comparison by mounted and prepared sections of the natural lung and the lung of a coal miner, the latter showing the havoc which is wrought on the respiratory organs by the constant inhalation of solid particles of carbon. Dr. Smith showed that similar results, though in a lesser degree, are produced upon the lungs of all dwellers in towns where black smoke is prevalent.

Mr. John Boyd made a communication, in which he stated that most Microscopists are familiar with the story that on a certain old church-door some nails were shewn fastening what appeared to be fragments of leather, and that tradition stated that the skin of a felon who had been flayed had been nailed to the door. These portions of leather were examined under the microscope, and were found to be really human skin, proving the correctness of the tradition. Quite recently a circumstance came under my notice, in some respects similar. That is to say, that a statement made as to a certain object was proved to be correct from microscopical examination. I was visiting in a country house in Scotland, and one day, to amuse a child who was playing about in the room, a peculiar carved stool was brought out. It was of a very unusual shape, narrow at the bottom, and broader and wider at the top; and this top instead of being flat was hollowed out. The material was the twin-trunk of a small tree. It was said to have been brought by a missionary from Africa, and although apparently a stool was really a pillow. As is well known to you, many tribes dress their hair into most extravagant shapes. The process takes a very long time, and the hair is not again dressed for a month or two. The small stool is used to support the neck, to prevent the hair being dis-arranged. The thought at once struck me that such a style of hair dressing would be particularly conducive to the plentiful propagation of *Pediculus capitis*, and that I might by careful search find traces of these interesting and beautiful creatures; and on further examination I discovered dozens of the small white eggs of this parasite in recesses of the carving on the little stool. When I announced this, there was quite a commotion, and the question was asked if there was any danger of the eggs hatching. Evidently for the moment, the fact of the many years which had elapsed since the stool was brought from Africa was lost sight of. However, I was able to shew under the microscope that the little lids which give such a pretty finish to the eggs of this and of many other parasites were in each lifted off, shewing that the little tenant had made his exit at some previous time.

In mentioning this as another instance of how microscopic examination, of an object which apparently was of little interest to the microscopist, may confirm or confute statements made about it.

The missionary's tale about this peculiar little and apparently uncomfortable stool, being used as a pillow, was abundantly confirmed by the presence of these eggs.

MANCHESTER MICROSCOPICAL SOCIETY.—RAMBLE TO STALEYBRUSHES.—The members of the above Society, under the leadership of Mr. W. Stanley, paid a visit to Staleybrushes on Saturday, May 6, for the purpose of collecting objects of general microscopic interest. This neighbourhood has lost none of its interest to field naturalists, although considerably altered by the formation of the Swineshaw Waterworks, four large reservoirs with a total capacity of 76 million gallons, for the supply of water to the Districts of Ashton, Stalybridge, Dukinfield, Mosley, and Hurst. The members were accompanied by Mr. Robert Stanley, late chairman to the Stalybridge Committee, who kindly explained the process of Fish culture carried out under his direction during the last five years, and which has resulted in over 30,000 Trout and Windermere Char being reared from spawn and placed in the dams. The spawn, when taken from the female, is placed in a basin and covered with the melt of the male; as soon as impregnation takes place a distinct change of colour is observed and the eggs are then put on grills, slips of glass placed edgewise in a long narrow box with a layer of sand at the bottom, and through which a constant stream of water is kept slowly running. The time of hatching varies with the temperature from 70 to 100 days; the cold and long season breeding the healthiest and most hardy fish. By means of a quill two or three young trout were teased out of the egg, and were exceedingly interesting, as when newly born they are about half an inch long and perfectly transparent, showing clearly the interior organs and circulation of the blood by the aid of a small pocket lens. After hatching, the young fish are placed in small ponds and tanks specially prepared for their reception until they attain a considerable size, and are able, when placed in the large reservoirs, to defend themselves against the attacks of their voracious elders. Leaving the fish house the party wended their way along the stream which winds in and out for about a mile in a very picturesque manner, and is studded with numerous waterfalls and shaded pools full of microscopic life at this season of the year. Some very fine views of the surrounding country were obtained as we ascended the gorge; Saddleworth with its Potts and Pans, Hatshead pike, with its ancient beacon, and the old Saxon town of Ashton-under-Lyne with its Parish Church of St. Michael, a fine specimen of the later English ecclesiastical architecture. It has been several times rebuilt, and was founded anterior to 1291. After striking the Roman road, which runs along the top of the ridge called North Britain, a good picture of the whole of the Longdendale valley is seen with Mottram on the right; Woodhead on the left, and the Dinting viaduct and Coomb's rocks straight before us, with Kinder Scout in the distance. With the exception of the water violet, *Hottonia palustris*, *Ranunculus Lenomandi*, and the three species of wood-rush; the specimens gathered chiefly consisted of Mosses and Hepaticæ, of which over 40 species were collected; the most noticeable being *Tetradontium Brownianum*, *Campylopus fragilis*, *Bartramia calcarea*, *Webera nutans*, with its puzzling forms, *Hookeria lucens*, *Hypnum flagellare*, *H. velutinum*, and *H. denticulatum*; of the Hepaticæ *Lepidozia reptans*; *Cephalozia bicuspidata*, and *C. multiflora*, *Leapania undulata*, *L. purpurea*, and *L. curta*, *Jungermannia Flœrkii*, and *Nardia scalaris*. After tea at the keeper's house a cordial vote of thanks was passed to Mr. R. Stanley, and also to Mr. C. Wild, who named the whole of the plants collected during the ramble.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the monthly meeting of the Manchester Cryptogamic Society on Monday, May 8th, Dr. Carrington, F.R.S.E., who presided, distributed specimens of *Orthotrichum Lyellii*, which he had collected in fruit on trees near Lodore Waterfall, Cumberland.

Some discussion took place in reference to the specific identity of the so-called *Gymnostomum commutatum*, which grows at Nant-y-Fydd, near Wrexham. A general concurrence of opinion was arrived at unfavourable to its claim other than a form of *Gymnostomum curvirostrum*.

Captain Cunliffe exhibited a beautiful series of microscopical slides of Hepaticæ, which he had just finished mounting, and in which he had succeeded as well as in those of his manipulation of the mosses. Mr. Cunliffe also exhibited *Funaria fasciculare*, *Hypnum giganteum*, and *H. scorpioides* in fruit. These had recently been collected as Cheshire plants and were remarkably fine, the latter species being eighteen inches in length of fronds.

Mr. Cash read an interesting paper on some rare British Mosses, especial reference being made to the history and discovery of *Hypnum Blandovii* and *Paludella squarrosa* on Knutsford Bog.

NORTHAMPTON NATURAL HISTORY SOCIETY.—A meeting of the Microscopical Section of this Society was held in the Curator's Room, Town Hall, on Thursday evening, March 23rd, 1882. Mr. A. Kempson presided, and there was a good attendance of members. Mr. J. Gregory, of Holdenby, explained the manner of mounting objects for the microscope. He spoke of the necessity of thoroughly cleaning the slide, and practically illustrated the mode of building up the cells by means of cements and varnishes for the reception of the objects; also the mounting of objects in various media. He was listened to with much interest, and a cordial vote of thanks was given him at the close, on the proposition of the Chairman, who urged all members not possessing a microscope to procure one, assuring them, from his own experience, that it would prove a source of instruction and amusement. Mr. Gregory exhibited a large number of objects mounted by himself, and Mr. G. Osborn also showed under his microscope a very good section of a cat's tongue. Previous to the meeting of this section the members of the Botanical Section met and elected the following officers:—President, Rev. M. J. Berkeley, F.L.S.; Secretary, Mr. C. E. Crick. On the suggestion of Mr. E. A. Durham, it was decided to meet fortnightly, and at each meeting to take one order of plants, Mr. Crick to commence with a paper on "Ranunculaceæ."

ROCHDALE MICROSCOPICAL CLUB.—At the monthly meeting of the above club held on Monday evening, May 1st, Mr. J. Astin gave the second of his series of practical demonstrations on microscopical manipulation. He treated of the various forms of lenses used in microscopical work, either as condensers, or in the construction of eyepieces, objectives and sub-stage illuminators. He gave the means of determining the vocal distances of the various forms, and thus shewed how each lens was adapted to its place and the work it had to perform. He then explained the working of concave reflectors and their application in various forms to the microscope.

The only new pond life form of any importance found during the past month is the Crown Animalcule *Stephanoceros Eichhornii.*

NOTES AND QUERIES.

Mounting Volvox Globator.—In the last number of *The Northern Microscopist* there is a communication, remounting volvox, in which the expression, "boiling, &c., in the usual way," occurs. Does the writer mean that he boils the volvox before mixing with the jelly? Further particulars of the method employed will, I am sure, be desired by many. In my own case, slides mounted in 1878 are as good to-day as when fresh, with the exception of a *very slight* loss of colour, which was not noticeable at first. These, both *V. Globator* and *V. stellatus*, were mounted while alive in glycerine jelly as *cool* as possible. Volvox mounted in Canada Balsam have not changed colour at all. —*T. R. B.*

Eggs of Parasite of Rook.—Walking a few days ago near the rookery of Fallowfield Brow, as the place is called, I was impressed with the angry chatter of the birds, and the large number of black feathers scattered on the ground. It occurred to me that the eggs of the rook parasite might be upon the feathers. I collected a number of them, and on my return home examined them under the microscope, when I found that my conjecture was correct, for hundreds of the eggs were crowded in a mass upon the stalk of one feather only. Other feathers had but a comparative few upon them. As I examined the eggs I noticed several young parasites escaping from the fractured shells, prepared to begin public life on their own account. Thomas Brittain.

Mounting Insects, &c., whole without Pressure.—Will some microscopist kindly give me information as to preparing and mounting insects, larvæ, &c., whole and without pressure. Also the medium used. The same as Enock's mounts.—*R. C. P.*

A Warning to Collectors.—At Skipton, on Saturday, April 19, a young man from London was charged with taking two ferns from Gill Beck, Bolton Woods. Mr. Heelis prosecuted on behalf of the Duke of Devonshire. Police-constable Renton said he had cautioned the defendant many times. The bench fined the defendant 5s. and costs.

KILLING INSECTS.—What is the best and most humane way of killing insects, such as flies, moths, &c., so as not to damage them, or render them unfit for either dissecting or mounting?—*G. P.*

THE LICHENS OF CUMBERLAND.—We would wish to call attention to this *brochure*, which may be obtained from the author, Rev. W. Johnson, 14, Catherine-street, Hartlepool. It has been reprinted from the transactions of the Cumberland Association for the advancement of literature and science.

MOUNTING WITHOUT PRESSURE.—We have lately received from Mr. Enock some very good specimens of his preparations by this process. These slides possess the advantage that the organs are seen *in situ*, and either side of the slide is available for examination. Mr. Enock is about leaving London for Woking, in Surrey, and when he is settled in his new home he expects to be able to send out many new preparations.

STUDIES IN MICROSCOPICAL SCIENCE.—Under this title an 8vo. eight page journal is issued at weekly intervals, edited by A. C. Cole, F.R.M.S., to accompany a series of preparations intended to show students how microscopical work should be prepared. Three numbers have been issued, each illustrated by means of a well executed chromo-lithograph, the first showing the yellow fibro-cartliage in the ear of the cow magnified 333 diameters; the second illustrates a doubly stained section of the stem of copper beech, *Fagus cuprea*, while the third shows a transverse section of the shaft of a long human bone. The illustrations are exceedingly well done, and the slides sent out with them excellent, and beside this, the letterpress gives one the whole of the information known to refer to the subjects under consideration. We notice several important omissions in the Bibliography, but this section, no doubt, will be rendered more complete as time goes on.

PORTABLE MICRO LAMP.—Will some reader kindly say if he knows of a really good pocket lamp, suitable for meetings, which has the double advantage of being cheap, and occupying small space. A figure appeared a year or two ago in *Science Gossip* of a handy lamp, but it was, I suspect, costly.—*B.*

SEASIDE COLLECTING GROUND.—Which is the best placc, within easy distance of Manchester, for a microscopist?—*B.*

CHAIR OF NATURAL HISTORY.—Professor Cossar Ewart has been appointed to the chair of Natural History in the University of Edinburgh, vacated by the resignation of Mr. Ray Lankester.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

G. P.—We have inserted your query, but you should refer to Practical Microscopy for a complete answer to your query.

G. P. Congleton.—Your object is a Vorticella, probably *Vorticella nebulifera*. Any book treating of Microscopic objects will give a description of it. Have you read "Ponds and Ditches," published by Bogue?

J. T. — Fasoldt's or Rogers' test plates are not nearly so expensive as Nobert's were. Nobert's plates are now very rare.

T. T. Warwick.—Your organism is *Paramecium aurelia;* it is very common where sewage matter is poured into streams.

J. S.—Bacteria are a very difficult study, and you certainly cannot expect to get reliable results from your experiments when carried on in the way you name. Think the matter over.

D. H.—A sixteenth objective would be very little use in the hands of one who has "never before used a higher power than an inch."

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Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

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C. J. Jones, 15, Princess Street, Manchester.

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MICROSCOPIC SLIDES. — A small but well mounted collection to be disposed of. Address, "Micro.," care of the Editor of the *Northern Microscopist*.

PLATE I.

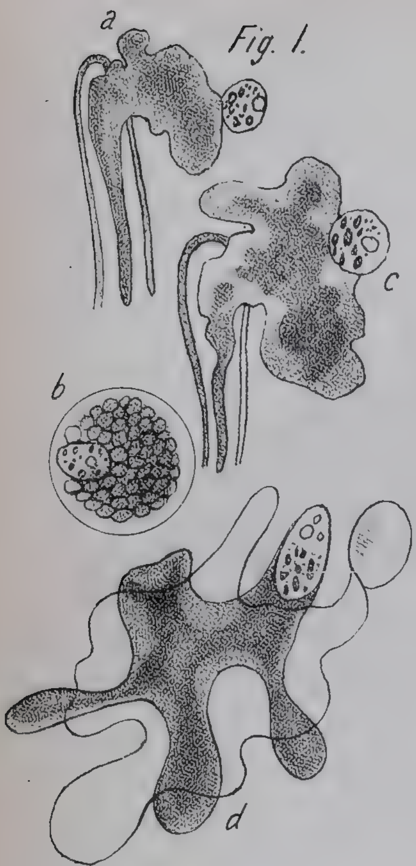


Fig. 1.

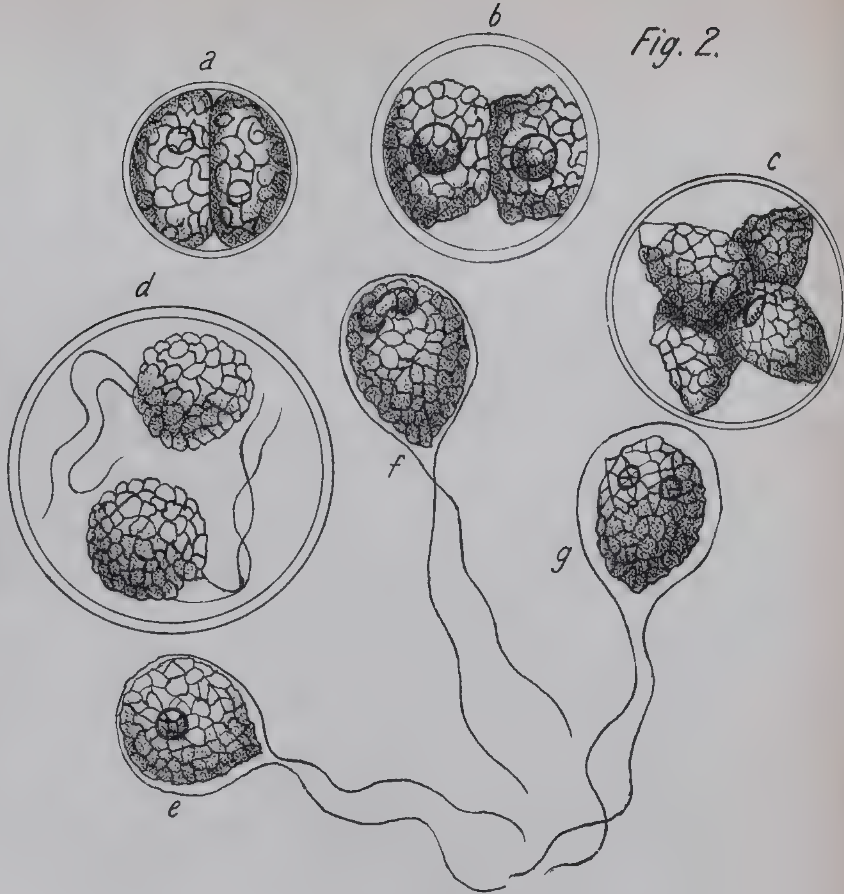


Fig. 2.

Fig. 3.

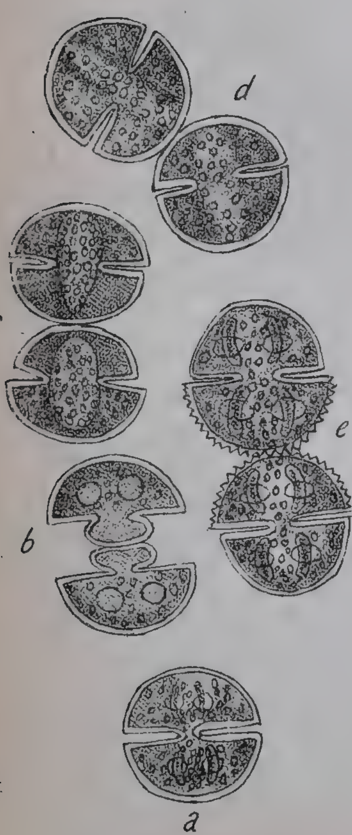
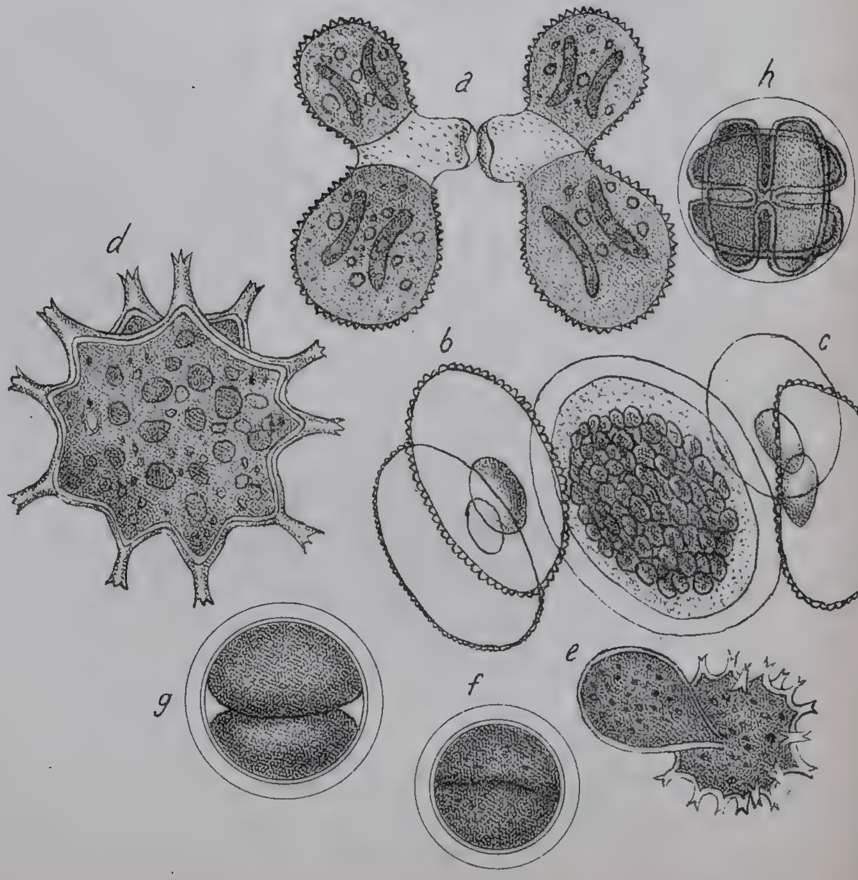


Fig. 4.



THE NORTHERN MICROSCOPIST.

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LIFE-HISTORIES AND THEIR LESSONS.

BY REV. W. H. DALLINGER, F.R.S., F.R.M.S.

THIS paper is extremely simple in its aim. It was written (with no intention to publish) at the request and in the interests of a large number of microscopists and amateur students of the phenomena of life as seen in the flora and fauna of our ponds, ditches, and sea-side, as well as in septic fluids. Some industrious observers amongst them had, from a desultory method of observation, of necessity, met with paradoxical phenomena. The products of pond and ditch were placed for an indefinite time in "live boxes," kept as long as possible from evaporation. The results were the inevitable commingling of life and death; the destruction or decomposition of one set of forms providing nidus and pabulum for quite another. In all probability the life-histories of none were really known, and parasite, epiphyte and septic organisms succeeded, or were concurrent with, each other. The possibility of erroneous interpretation in such a case is immense, specially when the "observation" is broken and occasional. The result has been, that ardent minds have endeavoured to show that some of the issues observed were only to be accounted for on the hypothesis of "Heterogenesis."

Some of the cases appeared striking; and at the instance of a large number, who thought good service might be rendered by it, I have taken a series of similar or corresponding instances to interpret the anomalies, and show that "Heterogenesis" is no part of the phenomena of minute life when studied with sufficient care and continuity. It is in deference alone to the strongly-urged request of these that the discourse is printed.

We have frequently, during the past few years, had our attention called to apparent anomalies in minute organic forms and minute organic processes. In these, besides the portraiture of what were considered the "facts," there has been an attempt made to show that along the border and margin where life manifests itself on this earth, amongst its minutest developments and least organised products, there is uncertainty of developmental action :—either no law at all, or if there be law, that we are wholly without knowledge as to its character; and that it must be unlike the laws which we know are in constant and unvarying operation where our knowledge of vital processes is absolute and complete.

Now, it must be remembered that by the modern microscope a realm of life and organisation is opened up to us almost infinite in its extent and variety; and increased optical power, instead of exhausting, only widens out, intensifies, and renders it more entrancing. But as it required the aid of moderate lenses to understand exhaustively the mode of life and methods of growth of an oak-tree—large as it is—so it must require the magnifying power of our most perfect and powerful object-glasses to discover the modes of life, methods of metamorphosis, and manner of origin, of the immeasurably lesser forms, which are not seen at all, until the lens needful to discover the germination of an oak tree is used. As we pass downward, we come to less and still lesser forms, all equally endowed for, and adapted to, their environments. But as we come to the more and the most minute of the organic forms in nature at present discoverable by us, we come upon forms that multiply with an inconceivable rapidity; many of them will, by one process of multiplication alone, produce, in the course of three hours, as many individuals as there are at present human inhabitants on the surface of this earth; and in a paper read only a few days ago in the French Academy of Science, M. Pasteur, proposing to destroy Phylloxera by fungoid growths, said: "The extraordinary multiplication of Phylloxera is a mere trifle compared with the power of life and propagation of certain parasites. The Hall of the Academy of Science . . . is pretty large: it has hundreds of cubic metres of capacity. I would undertake," said Pasteur, "to fill it with a liquid of such a nature, that by sowing in it a microscopic organism, the whole of the immense vessel would in a few hours be troubled with the presence of the parasite, and in such great abundance, that all the *Phylloxeras* in the world, compared in numbers to the individuals of the parasite, would be like a drop of water in the sea." But their *modes* of multiplication, in their completeness, are either defiantly beyond our present powers of research, or if here and there known at all, they have to be very patiently, persistently, and with the highest powers of the microscope, worked out.

Now, whoever engages in this work will learn many things indicative of caution, and will be slow indeed to make hasty inferences.

There happens to be, however, a fine army of such workers in the world just now; men who, with all the necessary mental endowments and training, are, with the most splendid lenses the world can produce, working amongst the mazes of this wonderful margin and edge of living things. They are trying to individualise the components of the apparently confused mass, and make out the life-histories of these minutest of living things. And they are slowly succeeding. Life-history after life-history is being drawn by resolve and patience from the depths of the confusion:—and with what result? Everywhere, where the work has been exhaustively done, with the affirmation that Biological processes amongst the least and lowest living things are as orderly rigid, and within certain limits, as capable of predication, as amongst the Butterflies or the Entomostraca.

Here are men, forever working amongst forms of life, similar to, or identical with, those brought before us in the papers the inferences of which I seek to controvert. But they use far higher magnifying power, and pursue another method of research essentially exact; do they reach like results? Do they infer that one form of minute life may transform itself into another? That the protoplasm from a cell of Chara or Nitella may become, of its own caprice, or by some hidden law, and without the intervention of parent or egg, a Paramæcian?

Verily, no! The testimony of Balbiani, Pasteur, Van Beneden, Bütchli, Fol, Hæckel, Huxley, Pelletan, Asa Gray, Louis Agassiz, H. J. Clarke, W. Roberts, Balfour, Ray Lankester, Ewart, and a host of others is unanimous—and it is this—that wherever we work out a minute life-history thoroughly, we come upon as orderly a process of nature as in the development of a frog or the growth, from its fertilised germ, of a primrose.

All this of course is no reason why others should not find what is, or what seems to be, uncertainty or caprice in the lower strata of vital action in nature. Only that they should do so, implies a method of research either inconceivably higher, and more analytical, than that adopted by these leaders of research in minute Biology; or else it can be explained as error arising from a method not competent to cope with the conditions of the problem.

Approach the question of vital action as displayed by Protoplasm fairly. What is that in natnre which, above all things, impresses us as we study the phenomena, and the results of her countless cycles of activity? The stability of her processes; and the mathematical precision of her action. Does anyone doubt the invariable and inviolable nature of the laws that control chemical combination and physical phenomena? Would any amount of paradox or perplexity that might arise in complex experiment induce a man to believe that the proportions of carbon and oxygen which constitute carbonic acid are uncertain and capricious? or that the combining proportion of oxygen and hydrogen are very uncertain in the synthetic production of water?

If you heat a bar of platinum under certain fixed conditions, on two following days, you do not expect that it will indicate different powers of expansion, or melt at a lower temperature to-day than yesterday. A given musical note will depend on the same number of vibrations to-morrow as to-day.

Yes. But it may be said all this applies to the inorganic world. Is it true of that which lives? Properly understood, I profoundly believe it is.

What do we know of life? Only this with certainty:—that wherever you have life it is inherent in a definite compound. This compound has special and unique properties. But wherever you find it as *protoplasm* in the sense in which I use that word, it exhibits the properties of life, and you will nowhere find the properties of life except associated with, and inherent in, protoplasm.

Now, has this protoplasm an ascertainable composition? Yes; you can analyse it chemically—that is when it is dead—and it is found that its chemical elements are everywhere practically alike. To say that the life-stuff of the lowest fungus, and that of the most powerful human brain, are identical, is, there is no doubt in some sense, absurd; it is an abuse of language; they, without question, differ inconceivably. But if you consider only the chemical composition, and discoverable physical properties of protoplasm from a mildew, or protoplasm from the apparatus of human thought, they are alike. Their difference is potential and not physically manifest. Then we may ask, "How, and in what, do matter living and matter not living differ?" In their properties—and in these they differ as the finite and the infinite differ—absolutely and wholly. We may not dwell upon what they are; but we may add that even the chemical reactions of living protoplasm are quite different from those of the substance which represents the protoplasm, when its life is gone.

Professor Huxley writes concerning protoplasm thus:—"The properties of living matter distinguish it absolutely from all other kinds of things; and," he continues, "the present state of our knowledge furnishes us with no link between the living and the not living."*

Then, so far as the evidence will carry us, there is to-day in our laboratories, and in our facts from nature, no evidence of the existence of spontaneous generation—no phenomena that prove, or even suggest, that what is not living can, without the intervention of living things, change itself into that which lives?

* *Ency. Brit.*, vol. iii., page 679, 9th ed.

The masters of Biology agree that there are none. Only that which is living can produce that which shall live. Dissociated molecules of lifeless matter, with no vital affinity to marshal them, are, as a matter of fact, never seen to endow themselves with the properties of life.

Dealt with physically, it has, as a question, received masterly treatment at the hands of Tyndall, and his answer is emphatic—it is, that that which is not living does not give rise to that which lives.

Biologically, it has been dealt with by all the workers in minute Biology, and their answer is, That as far down as we can reach, or see, with certainty, living things arise ultimately in living products—parental germs or spores—the equivalents of eggs or seeds.

"But," says the shallow reasoner, "if there be no spontaneous generation in nature, how can we have consistency in the great doctrine of Evolution? That process must have been a march of mighty progression from the beginning until now. Evolution is in danger by your facts!" I answer, if that be so, then I prefer the facts, to the doctrine of Evolution. But I affirm that such reasoning is wrong, and Professor Huxley shall give the answer. If once, in the mighty activities of the evolving past, dead matter was at some point of crisis and necessity changed into that which lived, and one of its properties was the capacity to multiply itself indefinitely, why do we need the *constant* change or transmutation of that which is dead into that which is living to-day?

Says Huxley, "If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should once have appeared on the globe, as the result of no matter what agency; in the eyes of a consistent evolutionist any further independent formation of protoplasm would be sheer waste."*

Then the facts are:—1. That protoplasm or "bioplasm" is a certain definite compound possessing the properties of life.

2. That life is nowhere found without it.

3. That only living matter can produce living matter.

Now, I ask, Do the stability and precision discoverable in the operation of chemical and physical law, as applied to non-living substances, hold good in the operation of the discoverable laws of Biology? I maintain that they do.

One error often entering into a discussion of matters concerning protoplasm, is to suppose that we are discussing an abstract thing. Who ever saw abstract protoplasm? There is no such thing. You may have the protoplasm of an alga, or of a trout, or of a man; but you cannot have protoplasm that belongs to nothing. As there is no abstract matter discoverable by us, so there is no abstract

* *Ency. Brit.*, vol. iii., p. 689.

protoplasm. You may have matter endowed permanently with the properties of gold, or silver, or hydrogen; but the matter common to and underlying them all is not discoverable.

You must therefore, if you have matter at all, have it specialised, endowed with certain properties.

It is so with protoplasm. It is never within our reach as an unspecialised compound. We know it as the protoplasm of a mushroom, or an oak, or an amœba, or a sparrow, and therefore with the special properties belonging to that and to nothing else.

Living stuff is the product of living things. Living things are developed according to known and discoverable laws, as rigid as those which determine the composition of carbonic acid or chloride of sodium, only more complex.

All the living things with which we are acquainted originate in an egg, or a seed, or their equivalents; or else in the multiplication of forms already existing, by fission.

But are not the processes of multiplication rigid and determinate? Take a group of primitive ova. Let them represent forms so diverse as the Stentor, the Daphnia, the Trout, the Pig, and Man. Physically, chemically, optically, they are alike: the severest effort and most rigid scrutiny can discover no essential difference between them. But is there no difference? Nothing can be more inconceivably diverse than the possibilities that are enfolded in those germs. But no one supposes that they will either of them be recreant to their mission and do the work of the other!

Is it conceivable that the stentor could hatch out into a trout, or that the trout ovum could perchance produce a rabbit? No; these eggs have their laws as much as the molecules of carbon or of chlorine.

But, say my opponents, it is of the protoplasm of the cells of living things, not of the mission of the egg, that we argue.

And what, I would ask, is the protoplasm of the cell but the outcome and product of the egg? And what is the whole economy of organisation but the specialised function of grouped cells? A sponge is a bundle of living cells with varying but mutually adapted endowments. So is a man. Every animal is, in fact, a perfect commonwealth of cells adapted and endowed each for its work, and all adjusted to each other.

What is the primitive seed but a cell endowed with a potentiality to give origin to other cells, beautifully grouped together, to constitute a mussel or a man?

Then why should the protoplasm of individual cells go astray, and become capricious, any more than the egg from which they sprang, and from which they become possessed of their peculiar and inherited qualities? True, it is now an established fact in biology that the products of eggs are never precisely alike. There may even be deformity, but this is exception, and may, in the course of time, be reduced to a law. But always there is variation, and if that variation be for the benefit of the organism, it will survive and be perpetuated. But there are no leaps—there is no caprice. The egg of a linnet will not produce a grasshopper, or that of a trout a butterfly. And if there were not equal certainty that the cells begotten by the egg were equally true to their mission, and loyal to each other, as the egg-cell was true to its work, could organic life exist at all? It seems impossible.

But there are certain phœnomena in the protoplasm of cells which, if not understood, may lead to the profoundest error. This especially amongst the lowlier forms of life.

Protoplasm is soft and plastic, varying in consistence, but it is never a fluid proper. It defies the laws of fluids; and one of the things common to it in the lowlier forms of plant-life especially, is circulation or cyclosis within the cell.

To illustrate this we may take an illustration placed at our disposal, viz., the stellate hair from a bud of *Althæa rosea.* In this minute vegetable growth the circulation of the protoplasm is clear and beautiful. The course of the stream being clearly visible. Now, suddenly *rupture* these cells, the protoplasm is at once set at liberty, but is not dead; and, consequently, it creeps about like a living amœba for minutes, or possibly for hours.

The wonderful movements of the naked protoplasmic bodies of *Myxomycetes* are known to every careful botanist.

But put some *Vaucheria* into a live-box, and let it slowly, as it must do, decompose and die. The plasmodia does its dying slowly; but the sacs are ruptured by decomposition—and what happens? Here (Plate I., Fig. 1) is an illustration directly from life in two cases. At *a* the protoplasm has emerged from the cell, carrying a clear globule with it, and then, after a few moments of amœboid movement, became a walled cell and granules, as may be seen at *b.*

In the other instance, shown by *c*, the protoplasmic contents broke off from the cell, and became free, like an amœba. In its free state it is shown at *d.* This drawing is a facsimile of it as it appeared at an interval of four minutes. The outline shows, in fact, its shape four minutes before. And this movement continued for two and a half hours, and then both pieces of plasma died and dissolved.

What was this? a change in the mission of the vaucheria protoplasm? No; only the pertinacity of the life that was in it, with its necessary properties.

And let it be observed this is by no means a rare incident. It is one of the common facts of botanical physiology.

I shall serve the end I have in view, then, if I ask you now to permit me to glance at two or three of the lowliest life-histories in nature, to see whether they—where we know them well—indicate uncertainty or suggest caprice.

I begin with one of the simplest and lowest algæ known in Nature, *Protococcus pluvialis*, and I deal with it in its simplest condition, *i.e.*, the resting and the motile states of the green unicellular plant.

The history I give has been long known, and has been confirmed by many, but the drawings I give have been verified from nature, and the objects are magnified 1,000 diameters.

The whole plant is a microscopic globule. In its "still" condition it is a delicate globe, transparent, but filled with a reddish yellow granular mass; if not seen to be at first constricted centrally, it quickly becomes so, as in Fig. 2 *a*, and each part contains a nucleus, as the drawing shows. It soon increases in size, as in *b*, the nuclei enlarging and the area of the envelope becoming much extended; at this time the colour of the granular mass changes into greenish, and then distinctly green; but the nuclei becomes almost colourless. Cross division now ensues, as in *c*, which may go on until sixteen or more cells are seen to be formed within the hyaline envelope. Soon the cells separate and fine vibratile lashes or flagella show themselves (shown for the sake of clearness only in two instances in Fig. 2 *d)*. The envelope now opens, and these flagellate globules go free; but a nucleus manifests itself, as is seen in *e*, which is shortly seen to be undergoing constriction, as at *f*. This speedily divides into two, as in *g*, then the flagella falls off, the hyaline envelope becomes more manifest, the little organism is perfectly at rest, and soon assumes the condition seen at *a*. with which the cycle begins again.

Observe, then, that although this process is so simple as to be immeasurably below those that come immediately above it, there is no caprice, no unformulated phœnomena, and yet this may be observed for weeks, or even months together.

Only clearly remember, this is the observed phœnomena in the living and normal plant. Let, however, a mass of dead protococci accumulate in trough or live-box, mingled with living ones, and all the complex issues of decomposition immediately arise.

Proceed now a step higher. We are still with the lowly algæ, and I select a Desmid. With the group you are mostly, doubtless, familiar. They are minute but elegant plants, consisting of isolated cells, which live in every pond, ditch and streamlet on the surface of the earth. They are exquisitely minute, with delicate grace of form and beauty of colour. They are amongst the lowliest of living things. How do they multiply? and in the life-history of these delicate cells is there irregularity, uncertainty, or caprice? No; there is no discoverable departure from the secular process formulated by the great Darwinian law. They increase immensely by cell multiplication, which in one section of the conjugatæ remain united in long embranched threads of remarkable beauty. But the form of desmid, known as *Cosmarium botrytis*, has been sufficiently worked out by De Bary to serve as an excellent type. The cell is symmetrically bisected by a deep constriction, as in Plate I., Fig. 3 *a*, but soon the narrowest part of this constriction elongates, then widens laterally, as in *b*. This new process rapidly widens, lengthens, and takes the required form, until, as *c*, *d*, *e* indicate, the one cell has become two, which are in all respects perfect, and, freed from each other, rapidly repeat again this process.

This goes on for an indefinite length of time, but it cannot go on for ever. It exhausts the vital capacity of the plant; there must be regeneration, the beginning of the cycle afresh. To this end, two of these elegant cells, placed together, and stimulated by what we have no means at present of discovering, open their cell walls and pour out their contents, which meet, as seen in Fig. 4 *a*, and fuse wholly together, deserting the original coverings, which are left empty beside the mass, as in *b*, *c*. The mass now rapidly becomes spherical, forms a triple cell wall, and pushes out spinous growths, seen in *d*. The wall of the spine sphere now opens and sets free small spheres of sacrode, as in *e*. The history of each of these is the growth from it of two new cosmaria. A gelatinous wall forms, as in *f*, and a constriction of the contained sarcode is soon visible, which increases, as in *g*. Then each constricted half again constricts, and becomes again a symmetrically divided cosmarium cell, as seen in *h*. The mother cell wall is then absorbed, and the new cells separate from one another, and are free.

With competent powers, patience, and a continuous non-evaporating stage, supplied with *Cosmarium botrytis* in vigorous vitality, this may be confirmed by any careful and competent observer. But he who supposes it can be done when the cosmaria are mingled in a cell with decomposing vegetable forms from a hundred other sources, present in the cell, giving rise to the production of the septic organisms on the one hand, and a variety of epiphytic forms of algæ, with all their complex, and in many cases unknown modes of development on the other, is wholly and absolutely mistaken. But let the life-history of this form, by itself, be thus carefully followed, and it will be seen to be from a biological view as rigidly, according to law, as that which in physics is known to be the determining cause of a lightning flash or the production of oxide of iron.

But we may advance one step further. The confervoid algæ are quite well known to the students of the pond and stream, and the thallus of the vaucheria is not unfamiliar amongst them. Now, it is well known that this lowly plant multiplies in two ways, but the distinctly genetic character of the one is more marked than in the preceding case; it is brought about by the formation upon the branches of the vaucheria of female cells (oögonia) and male cells (antheridia). These grow very near to each other, and in the antheridia are formed spermatozoids, while the contents of the oögonia are transformed into an oosphere. The oögonium and the antheridium open simultaneously, and the spermatozoids enter and are lost in the contents of the oögonium which is thus fertilized, giving rise again to the plant.

The asexual mode of reproduction is quite simple, but quite regular. The growing end of the thallus becomes clubbed and filled with brown granular contents; these shrink, becoming brown in colour, and force their way through the ends of the thallus, as a gonidium, which, on escaping, is found to be ciliated, to swim freely, and ultimately to settle and give rise to new plants.

We have here a lowly plant indeed; but, none the less, we have remarkably specialised function and efficient differentiation. All this is palpably subservient to the reproduction of the plant, its multiplication and continuity. How did all these complex apparatus and adaptations arise? Only by the slow operation of the Darwinian law—the conservation of ever-recurrent beneficial adaptations. But if the non-sequential attempts at deduction such as our attention has been frequently called to, could be taken as sound, if a Desmid, or Diatom, or a Paramæcian, or a Rotifer may by one capricious bound, or freak of nature, be produced directly, and without its parental product—the egg or its equivalent—from the decomposing cell-contents of (say) Chara or Nitella,—why did nature spend what to us must appear as its truly awful energies on the production of processes so complex and wonderful as we have seen them, even in the lowly algæ, to be; intended as they manifestly are only for the preservation and multiplication of the special forms? Heredity, known to be so powerful a factor in biological processes, would thus have no place. There can be no "survival of the fittest," for the Paramæcian coming by no conceivable method out of the decomposing "protoplasm" of an algæ, need have no "struggle" for existence, but having done its little life-work, may, in decomposing, give rise thereby to—a Rotifer!

The absurdity of this position seems only to require to be shown to be admitted. To assert it of the larger forms of life would to the least observant be to excite a smile. No one supposes that a grasshopper's egg will give rise to a "painted lady," or that the decaying sheep upon the moor, because there is life upon it, has had the life that it has, as an organism, lost, transformed directly and without the intervention of other life-forms into the living things it harbours and sustains. No; it is only because we are amongst the minute and unknown that the idea of heterogenesis is capable of being for a moment entertained; and here it vanishes as our knowledge of the form involved becomes more clear.

To know the life-history of any organism we must study that; we must separate it from the crowd of other forms amidst which it flourishes, especially if amongst these there are organisms whose developmental history is not clearly known. Then observation should be continuous, not broken. Sequence in morphological development can only be certainly made out by unbroken observation. Therefore, to do as some of our local observers have done, put Chara, Nitella, Vaucheria, or Desmids into a "live-box" with water, and keep them in a moist cell, and take them out for an hour's observation to-day, and a couple or three hours' observation to-morrow, and, because different phenomena present themselves, suppose them to be developmental sequences, is full of potential and actual error. The algæ alone have hundreds of epiphytic algæ parasitic upon and within them, whose life-histories are at present entirely unknown to us, and therefore, as the plants themselves slowly decompose, we must of necessity become lost amidst the mazes of the mingled life and decomposition into which we are looking.

Mr. Archer, of Dublin, a distinguished algologist, referring incidentally to these, says that they "are numerous and of common occurrence; but the scientific world may not even yet possibly be aware of the newest 'facts' put forward by Dr. Bastian, as to their nature and origin *(Beginnings of Life)*, who explains all in the most off-hand manner by gravely assuming that the varied and often very heterogeneous epiphytic fringes of algal form which are met with attached to higher plants, are developed as merely heterogenetic outgrowths from the latter!"

But in attempting hastily to make inferences in favour of heterogenesis, still more glaring proofs of ignorance may show themselves.

Amongst the lowliest of the fungi are the group *Saprolegniæ*. The parasites composing it were until recently known as being chiefly confined to the bodies of insects, as flies, spiders, &c., in water. They are now, however, known to infest the fish that inhabit our rivers, and are the actual cause of the "salmon disease" recently so prevalent in England. As a group it is closely allied to the *Peronosporæ*, of which the fungus producing the European potato disease is a conspicuous example. For a long time both these groups baffled endeavour to decipher them, but at length Worthington Smith and Berkeley have succeeded in working through the life-cycle of the *Perenospora infestans*, or potato fungus; and De Bary has made out the history of a *Saprolegnia*, or, as he prefers to call it, *Achlya*. But lowly as these forms are, the cycle of their history is as rigid along inherited lines, and by means of specificially specialised function, as are those of an *Agaricus* or a rose. De Bary finds that *Achlya prolifera* is reproduced by alternate methods like vaucheria. The asexual spores accumulate rapidly at the apex of the thallus, which ultimately bursts, and sends the spores forth by thousands, possessed of cilia and motile power, to germinate and grow.

But the ultimate preservation of the vitality in the plant depends, as ever, upon fertilised spores. The process is seen in Plate II., Fig. 5, which is a thread of the thallus. *a* is a branchlet, bearing a sac-shaped cell, in which the protoplasm collects and swells into a globular form, *b*, while arms at *d*, *c* begin to show themselves. Soon a septum forms, as at *e*, making the cell separate; the antheridium tubes, *f*, *g*, are by this time lengthened and closely applied to the cell; the nuclei resulting within the cell now strongly contract, and after fertilisation by the antheridia, these surround themselves with a cell-wall. An illustration from Cornu of *Achlya racemosa* shows, at *h*, *i*, the separated cell or oogonium, and at *m* the action on this of the antheridia tubes is manifest. The same is seen at *n*, *o*, in another illustration; but is more delicately shown by De Bary by the combined action of the antheridia and the oogonium of Peronospora, as at *k*, *l*.

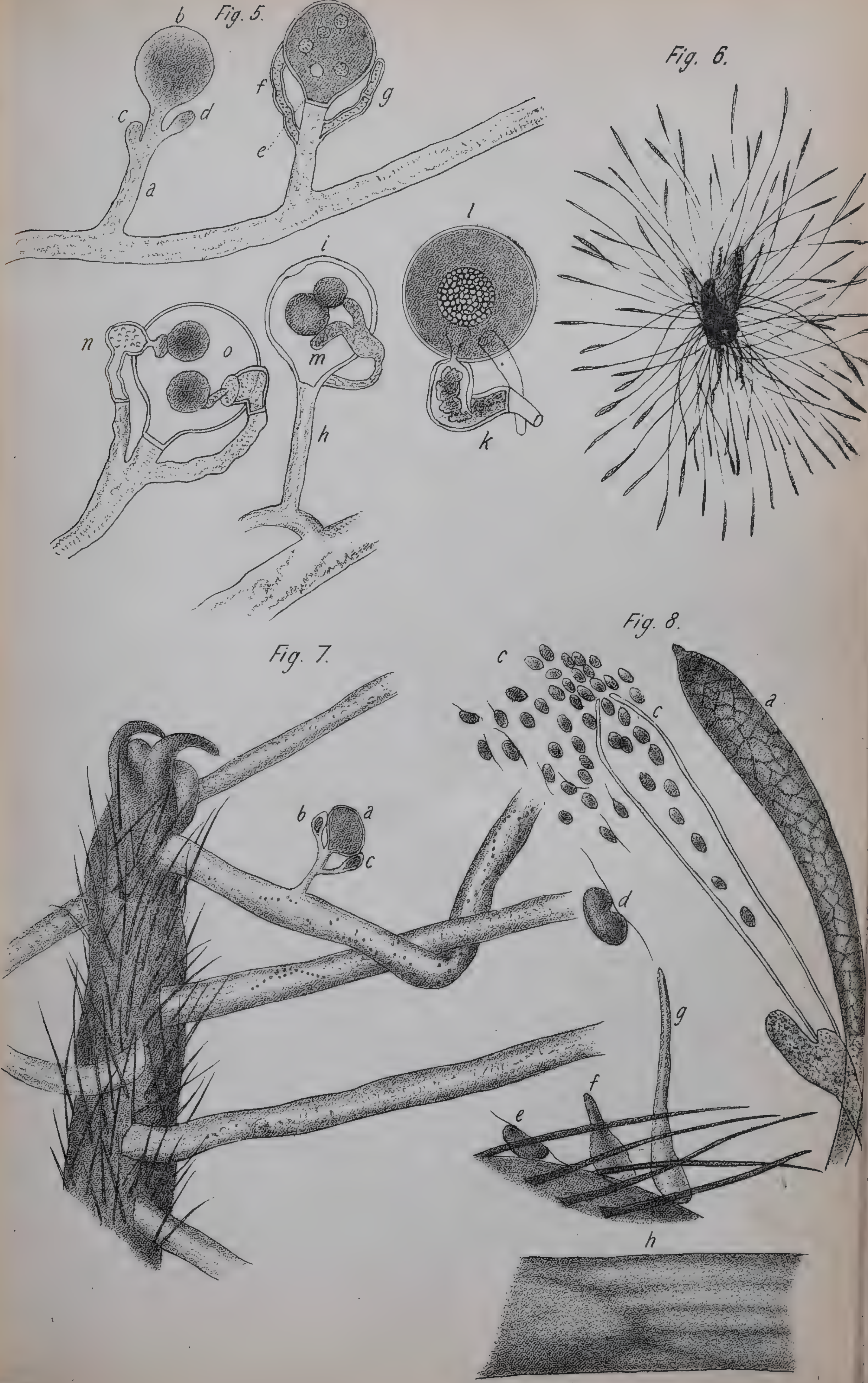
Now the speciality of this case, in my illustrative evidence of the fallacy of the attempt made by some amongst us whose industry we respect, to establish evidence of "Heterogenesis," from their observations is this, viz., that it enables me to point out one source of the error of inference; that is, want of knowledge of the life-histories of the forms from which inferences are made. One of the illustrations placed before this society in "proof" of the heterogenetic origin of living things was what was called a saprolegnia growing on the body of a dead fly in the water. The fly had been attacked by fungus on a window pane and died. It was put into water and the result watched. Without doubt Mr. Berkeley would have anticipated the result, but it was not so in this case. The saprolegnia grew apace, spread in all directions, and soon there arose visible circulation of protoplasm within the thallus, and minute granules were carried in the stream.

The inference made from this was, that the "protoplasm" of the dead fly's leg, had directly changed itself into the protoplasm of the saprolegnia, and was in visible circulation there.

But for the persistence with which this "heterogenetic fact" has been presented both at the Microscopical Society of Liverpool and at this Society, it would seem needless to repeat the facts; but in the interests of the younger students and workers it is needful.

Originally this fungus, which attacks the fly in the air, was called by Cohn, *Empusa muscæ*. By Fries it was called *Sporendonema*

PLATE II.



muscæ, and afterwards *Saprolegnia ferax*. But it has been shown more recently, by the work of Cienkowski, De Bary, and Berkeley, that this aërial fungus, so common on flies in the autumn, is only a terrestrial and imperfect condition of an *Achlya* known as *prolifera*, and which in an early aquatic state is shown slightly magnified in Plate II., Fig. 6. "This plant forms resting spores like Vaucheria; and there is every probabilty that they are generated by a like sexual process. They may remain unchanged for a long time in water when no appropriate *nidus* exists for them; but will quickly germinate if a dead insect or other suitable object is thrown in." The tubes contain a colourless, slightly-granular protoplasm, the particles of which are seen to move slowly in streams along the walls as in Chara, the currents anastomosing with each other.

(To be continued.)

THE MOTION OF DIATOMS.*

By C. M. Vorce, F.R.M.S.

It is with great pleasure that I observe the awakening of interest in this phenomenon. Like many others, I have watched faithfully the curious movements of the diatoms, in the effort to learn the means by which they are accomplished, but up to this time I have not been able to satisfactorily account for them on any theory I have yet heard of, so that I am still in the very unsatisfactory predicament of being unsatisfied with any of the theories advanced by others, yet having none of my own.

However, I have accumulated quite an array of facts bearing on the subject, and it seems to me that with the objectives now to be obtained, the solution of the mystery concerning this motion may yet be accomplished by some persevering observer. Therefore, I offer the facts I have observed in the hope that they may aid, in some degree, to develop the truth.

I have observed positive movement in the following diatoms: *Amphiprora ornata*, *Nitzschia sigmoidea*, *Nitzschia sp.*, *Synedra sp.*, *Surirella turgida*, *Surirella biserrata*, *Surirella splendida(?)*, *Cymatopleura solea*, *C. Hibernica*, *Cymbella cuspidata*, *Navicula cryptocephala*, *N. cuspidata*, *Pinnularia viridis*; and apparent movement in *Stephanodiscus Niagaræ*, in a *Gomphonema*, and in *Cymatopleura elliptica*. Also I have seen detached valves, free of endochrome, exhibiting apparently voluntary motion which, it is obvious, must

*American Monthly Microscopical Journal, March, 1882.

have been caused by some force foreign to the diatom. Most of my observations have been made on fresh filterings from the water of Lake Erie, in which a large amount of flocculent matter was present, and in which infusorial life was abundant.

The common phenomena of the motion of diatoms are well described by the Hon. J. D. Cox, in this JOURNAL of April 1881, p. 66, and may always be seen in a gathering of diatoms where much light matter is present in the water. The same writer gives some observations reported by Dr. Wallich as very curious, in the JOURNAL of November, p. 206.* The phenomena reported by both the above-named gentlemen have repeatedly come under my notice, as well as the growth of the silicious filaments referred to by Mr. Mills in the JOURNAL for January,* p. 8; and I have observed a similar growth on frustules of *Nitzschia*. From my observations, I believe these silicious filaments to be mere adventitious excrescences, like a wart or tumor on the human body; yet I am satisfied that they affect the motion of the diatom on which they grow, just as a rudder or centre-board affects the motion of a vessel, without any connection with the cause of the motion. In one case I observed a very active *Nitzschia* having eight or ten of these bristle-like filaments, all on one side, one much longer than the others, and this frustule moved in curved lines, the filaments on the inner side, although ordinarily this diatom has a rectilinear course. Presently the long filament became entangled in some rubbish, and for a time the diatom swayed back and forth, as on a pivot, when suddenly the bristle broke short off, close to the valve, and the diatom thus freed moved away to some distance, resuming an almost straight course. Since I first saw these filaments on a diatom I have frequently recognized them, and doubt not they are often overlooked in the fresh gatherings and detached in boiling if the gathering is cleaned. By means of such filaments, if very small, a diatom might seize and carry along extraneous matter with which it came in contact, as it is often seen to do, without the filaments being perceived; but this would not account for the travelling of particles along the diatom while it is held fast, as so commonly happens.

Many of the phenomena connected with the motion of diatoms seem to indicate that the frustules are enveloped in a membrane, and such I believe to be the case. This enveloping membrane, if adhesive, would cause many of the appearances noted, provided the motion be accounted for; but adhesiveness of the diatom would not of itself cause motion. I have often seen a small diatom moving along beside a much larger, stationary one, cause the latter to revolve by the friction, often partly overturning it. But in the

* American Monthly Microscopical Journal.

cases where extraneous matter is seen adhering to, or trailing after a diatom, how do we know that the adhesive property does not reside in the adhering matter and not in the diatom at all? I have often seen such masses of flocculent matter adhere to entomostraca and rotatoria when they happen to brush against it, and remain attached some time until detached by the violence of their movements.

The remarkable alternation of motion seems to me a very strong objection to the ciliary theory, and equally so to that of the prehensile filaments. No other ciliated or flagellate organism that I know of exhibits such alternation, but whether animal or vegetable, when free to move they swim hither and yon in a purposeless and indefinite course, without limit. But if prehensile filaments exist, they should, to be in accord with other provisions of nature, bear a relative proportion in size to the diatom by which they are borne. Yet, in large diatoms, like *Amphiprora ornata*, *Surirella splendida*, *S. turgida*, etc., when active and moving with great force, no trace of cilia, pseudopodia, filaments, or anything of the kind has yet been discovered. I have watched a large thick *Surirella* plowing its way through tangled masses of *Tabellaria*, and sweeping before it masses larger than its own bulk, and hoped to find some trace of the means by which the resistless motion was imparted, but without success, although I brought to the task objectives capable of resolving the *Amphipleura pellucida*. No trace of currents, of cilia, or any external appendages could be seen, nor any motion in the endochrome of the diatom. I have also observed that these large diatoms do not show the same attraction towards loose particles in the water which the smaller ones do.

I have seen living diatoms, both still and moving forms, with a substance adhering to them which had exactly the appearance of a fragment of an amœba, but without the movement natural to the latter. And I have seen the same substance adhering to dead diatoms entirely free from endochrome. In all cases I am convinced it was foreign to the diatom and had no connection with the motion of the diatom to which it adhered.

Most diatoms, even when unobstructed, move with a quivering or staggering motion, much like a drunken man, which does not seem consistent with ciliary action, or with currents produced by osmotic action; and, besides, we should expect the currents produced by cilia or any other force capable of moving the diatom, to be strong enough to move adjacent particles when the diatom is held fast. Yet we do not see free particles moved, or any evidence of current in the water, except where there is contact with the diatom. Frequently we see a small mass moving along the diatom while another mass, apparently in contact with it, is not affected until the moving mass strikes the stationary one, when both move as one, or as if stuck together by some adhesive substance.

The appearance mentioned by Mr. Mills, of a clear space surrounding diatoms like *Cyclotella* is not an invariable characteristic. I have seen the complete space around some frustules, while others of the same species in the same gathering were matted with light stuff, and often themselves matted in groups, while all, judged by the appearance of the endochrome, were equally alive and vigorous. In addition I have at times noticed a peculiar clear space adjoining one side of a diatom, as if a drop of some invisible oil was attached to it, while everywhere else the dirt and loose matter in the water adhered to the frustules. The same clear space is often seen around other particles, such as sand and dead diatoms, etc. If a layer of jelly-like substance did in fact surround the living diatom, and had the power of wave-like motion in its substance, it might give rise to motion of the diatom, like the creeping of a snake; but it seems impossible that a layer of such substance sufficient to accomplish the result, especially in large diatoms, should escape detection, and the alternation of motion would still be unexplained.

But in some cases, at least, the shape of the diatom has an influence upon its motion. *Amphiprora ornata*, which has a half twist, moves through the water endwise, with a rocking motion exactly like that of a vessel in the trough of the sea, and the curved webs or projections on the sides of the valves would give just such a motion to the frustule when forced through the water, but if prehensile filaments caused the motion the effect of the shape of the diatom would be little or nothing, and in clear water prehensile filaments would affect nothing unless they could fasten to the shifting atoms of water as to a solid body.

NOTES ON MOSSES.

IN this practical age nothing is made to appear so important in training the mind to precise and logical processes of reasoning as a good mathematical education.

While conceding the immense value of mathematics in this respect, it is felt that the absolute certainty of its deductions are a drawback to the practical application of its methods of procedure to the events of every-day life. In a recent number of *Knowledge*, chess is advanced as equal in mental training, and possessing at the same time some of life's improbabilities; but I venture to think that, as a means of culture, both fall very far short of the study of natural history; for whatever department we study, we see in it the necessity for the highest as well as the most exact thought, requiring a keenness of observation and nice balancing of probabilitities specially fitted to the exigencies of our every-day life, while the acquired knowledge is a source of constant and ever increasing pleasure.

In none of nature's bye-paths is this so clearly seen as in the study of Mosses; their minute character and similarity, though with endless differences of form, testifying to the great law of creation—unity of type with variety of development. In lichens, fungi, or algæ there is nothing to lead the passing observer to higher types of vegetation; but in Mosses we have, for the first time, distinctions of roots, stems, branches, and leaves, clearly prefigurative of the flowering plants, which they may be said to equal if not excel in beauty of form and structure.

To the botanical student, whose time and opportunities for rambling are limited, Mosses hold out every advantage, for they extend from the sea-shore to the highest snow-line—from the tropical plains of Africa to the mountains of Greenland; and no spot is so barren or desolate that some species or other is not found, while some species or other is in fruit all the year round, contributing much in winter and early spring to the verdant covering of the earth and to the supply of oxygen, afterwards given out by the leaves of higher plants. From their cellular character they rapidly swell up and expand when soaked in water, and look as fresh as when growing, even after being dried for years in the herbarium. Mosses belong to the foliaceous or highest family of cryptogamic plant, and although of little direct economic use to man, are of immense value in nature as the precursors and diffusers of vegetation.

The *Sphagnaceæ*, or Bog-Mosses, have been ranked as a distinct family by many writers, and their importance may be estimated when we recollect that we owe our peats to the decomposed tissues of Sphagna, and that peat bogs occupy one-tenth part of the whole of Ireland, and also furnish in the Highlands of Scotland the largest proportion of the fuel. The Sphagna are pale, almost white, in colour, and attain a length of six or seven feet in deep water. Their fruit has a lid but no peristome; the whole of the species fruiting in summer being found on bogs, mosses, and wet moors. Nine species are given by Wilson, but this number has been considerably extended by Dr. Braithwaite in his work on the British Sphagnoceæ.

S. *acutifolium*, slender bog-moss.
S. *cymbifolium*, blunt-leaved bog-moss.
S. *rubellum*, red-dwarf bog-moss.
S. *compactum*, compact bog-moss.
S. *molluscum*, pale-dwarf bog-moss.

S. fimbriatum, fringe-leaved bog-moss.
S. cuspidatum, wavy-leaved bog-moss.
S. contortum, black-stemmed bog-moss.
S. squarrosum, spreading-leaved bog-moss.

The first three are distinguished by a reddish tinge, and *S. rubellum* is rare in fruit.

A large family is the *Dicranaceæ*, or fork mosses, named from δικρανον, a forked instrument. They belong to the dimidiate calyptra group of the acrocarpus or terminal fruited division, and vary considerably in size in the various species.

The leaves are in five or eight rows, and are mainly distinguished by their secund character, that is, all turned to one side. The reticulation of the leaves is very variable, but usually small and dot-like; the inflorescence is either monoicous or dioicous; capsule erect or cernuous and varying from ovale to cylindrical. *Calyptra cucullate*, or hood-shaped, with a long beak, reaching half-way down the capsule; lid with a slender oblique beak, varying in length. Peristome single of 16 equidistant teeth. Annulus seldom absent. *D. cerviculatum*, the spur-necked fork-moss, is found frequently on sandy banks or black turf, growing in extensive patches, of a yellowish-green colour, with stems not half an inch high, and is so called from the goitre-like swelling at the base of the capsule. The leaves are lax, sub-secund, crisped when dry, and almost bristly at their apex. Four others of this genus are in fruit this month. *D. polycarpon*, many-fruited fork-moss, found on Alpine rocks, but not frequent in fruit. *D. Scottianum*, after Dr. Scott, found on rocks. *D. scoparium*, broom fork-moss, very common on shady banks and rocks, capsule cylindrical, led with a long beak; leaves secund, lanceolate-subulate with inflexed margins and serrated at the apex. *D. majus*, tall fork-moss, found on shady banks and rocks in woods, with stems from four to six inches long, covered with radicular fibres, distinguished from *D. scoparium* by the pale aggregate fruitstalks, olivaceous cernuous capsules and long falcate or falchion-shaped leaves. Allied to the Dicranium are *Blindia acuta*, acute-leaved Blindia, and *Ceratadon purpureus*, so called from the bright purple of its fruitstalks, rendering it a great ornament to our walls in winter and early spring. It is a very common moss on banks, &c., not only through Britain, but in all parts of the world. Stems cæspitose, or matted together; leaves oblong-lanceolate, margin recurved, nerve excurrent, capsule oblong or oval and erect or sub-inclined, furrowed when dry. The teeth of the peristome are long, narrow, and deeply cleft, and form a very beautiful object under the microscope.

This species is subject, according to locality, to many variations, and perhaps is best recognised in a barren state by the square character of its cells.

The best known amongst the mosses is the wall screw-moss, which takes possession of our walls in a very short time, even in our largest towns. This genus, named Tortula, from *tortus*, twisted, and now renamed Barbula, is easily recognised by its peristome of 32 long filiform teeth, twisted from left to right round the apex of the columella, while the species *B. muralis* is very marked from the long obtuse leaves, with strongly recurved margin and nerve excurrent into a distinct hair point. Monoicous, capsule erect, oblong, lid with a short conical beak. Resembling *B. muralis* in size and aspect, but whose leaves have a thickened border, is *T. marginata*, the border-leaved screw-moss. It is found on sandstone walls, and is rare.

The other Tortulas in fruit this month are *T. convoluta*, convolute screw-moss, and *T. revoluta*, revolute screw-moss, both on walls, chiefly limestone.

T. lævipila, smaller-hairy screw-moss, on trunks of trees. *T. subulata*, awl-leaved screw-moss, on sandy hedge-banks, &c.; and *T. tortuosa*, curly-leaved screw-moss, on rocks, chiefly limestone, not common in fruit, but frequent about Matlock.

A very useful moss in the domestic economy of the Laplanders is *Polytrichum commune*, the common hair-moss. Linnæus tells us they use it for their beds, and highly praise it for not harbouring insects or any infectious disease; and another writer says the bear lines his winter quarters with a thick bed of the same moss. The Polytrichaceæ, like the Pogonatums, are distinguished by their hairy calyptras, whence the name Hair-moss from πολυξ, many, and θριξ, hair; but their capsules, instead of being round like Pogonatum, are four, five, or six-angled, and have a discoid apophysis or swelling at the base of the capsule. Capsule at first erect, horizontal when ripe, lid rostrate, the beak variable in length, straight or oblique. Peristome of 64, rarely 32 teeth; stems from two inches to six or eight inches in height; leaves lanceolate, horizontally inserted. Growing in dry or moist uncultivated places, especially in heath and wood, and the whole of the genus, of which there are seven species, fruiting in summer, with the exception of *P. sexangulare*, which is not ripe until September, and is known by its spreading incurved entire leaves, with the margins reflexed. *P. gracile*, slender hair-moss, is very similar to *P. commune*, but smaller and more slender and with a shorter capsule, of which the angles are very obtuse and indistinct. *P. commune* is known by its acutely four-angled capsule and its distinct apophysis; both *P. commune* and *P. gracilis* have sharply serrated leaves. *P. juniperinum*, juniper-leaved hair-moss, *P. strictum*, and *P. piliferum*, bristle-pointed hair-moss, have their leaves bristle-pointed with entire, inflexed, broad margins, capsule quadrangular.

Many of the Bryums and Mniums are in fruit this month, the most common being *B. capillare*, and *B. cæspiticium*, the greater and lesser matted thorn-moss, found on walls, rocks, &c.; also *B. amiotinum*, *B. turbinatum*, *B. palleus*, and *B. bimum.*

Mnium hornum, the swan-necked thyme-thread-moss, very frequent on shady banks and in woods. *M. undulatum* and *M. stellare*, the long-leaved and the star-leaved thyme thread-moss; the last being not found with fruit in Britain.

The next interesting species to the moss student is the common cord-moss, *Funaria hygrometrica*, as the fructification of this moss has been carefully watched by our best authorities, both at home and abroad, and the whole plan of moss development mapped out. Fruiting from May to September, it is found everywhere, perfectly fruited specimens having been picked up by the writer, within the last few days, from between the chinks of the flags in one of the busy streets of Salford. It is especially abundant on burned or carbonaceous soil, hence called by the French la Charbonnière. Named from Funis, a cord, the hygrometric action of its fruitstalks is very peculiar, the upper part twisting to the right when dry, the lower part in an opposite direction. Stems crowded, leaves broadly ovate—lanceolate, concave, entire, nerve reaching almost to apex. Capsule pyriform and furrowed when dry; mouth very oblique, lid conical. Peristome double of 16 outer teeth, and an inner membrane divided into 16 lanceolate processes; monoicous.

In the pleurocarpous division, the Feather-mosses, *Hypnum denticulatum*, *H. giganteum*, and *H. cuspidatum*, may be gathered on wet banks and marshes, and in streams and still-water *Fontinalis squamosa* and *F. antipyretica.*

WILLIAM STANLEY.

POND-LIFE NEAR ASHTON-UNDER-LYNE.

IN Manchester and the neighbouring towns the study of Pond-Life appears to be a very popular pursuit, and I venture to say there is a great deal of work being done in this direction, though but little is recorded, if we except the occasional exhibits at Soirées and other meetings. If all the finds were recorded in the NORTHERN MICROSCOPIST we should have a list which would compare very favorably with others from various parts of the country, and in order to commence such a list of *Flora* and *Fauna*, I send a few notes on the objects found near Ashton-under-Lyne.

Starting from the Clarence Mills Bridge, and proceeding along the towing path of the Ashton canal, in the direction of Guide

Bridge, an occasional dip will supply any student with materials for a week's study. The various forms of microscopic life are here found in the greatest abundance, although the water appears like ink itself and but little likely to sustain such beautiful organisms as may be found therein.

Shortly after leaving Clarence Bridge, the collector will not fail to observe the *Hydra vulgaris*, covered perhaps with its parasite *Trichodina pediculus.* It occurs on the walls of the canal, and also on loose stones near Whitehead's Twist Spinning Co.'s Mills: its color when found in this locality is milky white.

Along with the Hydra may be found *Plumatella repens*, but rather sparingly, and it is very difficult to procure, owing to its close adhesion to the stones. After passing the last lock and crossing the bridge, *Riccia fluitans* may be seen growing upon the walls of the canal at the water line—many species of Vorticella, Epistylis and Carchesium are to be found on this Hepatic, amongst others, the following:—

V. microstoma, *V. nebulifera*, *V. campanula*, *E. anastatica*, *E. grandis*, *E. digitalis*, *E. nutans*, and the rather rare *E. plicatus*, *C. polypinum*, and *C. spectabile.* I have met with the foregoing, also, on the *Ricciæ conferva*, near Park Parade station.

Upon the walls, near the bottom of the canal, may be found *Fredericella sultana*, *Stentor Mülleri*, *Trachelius ovum*, *Limnias ceratophylli*, *Cothurnia imberbis*, *Vaginicola crystallina*, *V. valvata.* I have also found one cluster of *Ophrydium*, but not lately in the canal, although searched for very carefully.

On crossing the junction at Dukinfield the Fresh-water sponge (*Spongia fluviatilis*) is found in plenty, and in the autumn produces a vast quantity of gemmules, which are very interesting to the microscopist. Imbedded in the sponge may often be seen *Fredericella sultana*, which in this situation appears to be less shy, for they open out immediately they are placed in water. Following the canal beyond Guide Bridge and near a new mill there, Plumatella may be found in fine condition, a variety I think only attached at the base, and not creeping as in the typical form. On nearing the Stamford colliery and leaving the canal, there is a foot-road leading close to the pit-shaft, near to which are two ponds rich in microscopic life.

At various times I have obtained the following:—*Dinobryon sertularia*, *Chætophora elegans*, *Ophrydium versatile*, *Stentor polymorphus*, with Desmids and Diatoms in abundance.

Below the Snipe Inn, near the new railway, off Droylsden-road, there are a number of pits, which, taking them together, are the best in this neighbourhood. I have gathered *Volvox globator*, *Pandorina morum*, *Gonium pectorale*, *Draparnaldia glomerata*, *Batrachospermum moniliforme*, and *Chætophora elegans.* A species of

Vaucheria is very abundant here, upon which may be found *Floscularia ornata* and *Cothurnia imberbis*. I once found an organism very much like the *Ophrydium versatile*, but living in a single tube which I could not identify at the time, and have searched in vain for it since. Once I have found *Lophopus crystallinus* on floating timber, and I have but little doubt that it may be found on the submerged plants in some of these pits.

THOS. WHITELEGGE.

ILLUMINATION AND RESOLUTION.

IT is not unfrequently the case, as we have had sufficient reason to know, that when a person first tries to resolve the *Amphipleura pellucida*, or some other difficult test-object, with an objective that is quite capable of showing the lines, the result is very unsatisfactory. Sometimes the lines cannot be seen at all, and we have known persons to own such objectives for months, without being able to show the lines. There is a "knack" about it, to be sure, but it is by no means difficult to acquire. In most cases the fault is entirely in the illumination. An adjustable objctive will not resolve well unless the proper adjustment is made, and the lines on a delicate test-object cannot be seen without careful focussing—all this is well understood at the beginning. Nevertheless, in most cases the greatest difficulty met with by the novice is in the management of the light. A few suggestions concerning this matter may prove of assistance to some of our readers.

One may sit at a table and put the elbow on the partly opened drawer, and hook the heel of the left foot over the front round of the chair, as Prof. J. Edwards Smith has directed in his celebrated book. But we can assure the reader that lines on a *A. pellucida* can be reasonably well seen without any such formalities. In truth, one of the best resolutions we ever saw was shown by Mr. Herbert Spencer, in his shop at Geneva, with light from a cloudy sky, the microscope standing on a packing-box, which was also used as a seat, if we recollect aright.

The novice will not succeed as well by daylight as with light from a lamp, and the simple, low hand-lamp with a flat wick is the best of all. A student-lamp is not good for this work. To get the best result, remove all substage accessories and also the mirror. Then fasten the Woodward prism, hemispherical lens, or whatever attachment may be used in their stead, to the test-plate with glycerine. It is a good plan to paste a strip of paper on the back of the slide for the side of the prism to rest against. This prevents the prism from sliding down if the glycerine does not hold it well. The microscope should now be arranged so that the source of light will be as nearly as possible at a right-angle to the axis of the tube. If the stand is a low one it may be raised on a cigar box. Place the lamp about a foot from the centre of the stage, on the left, with the edge of the flame toward the stage. Then introduce a small condensing lens, and focus the flame carefully upon a piece of white paper placed upon the stage. Then put on the slide, with the prism attached, and it will not be difficult, by slight changes in the position of the lamp or bull's-eye, to make the lines visible.

It is much more easy to make a resolution in this way than by using the mirror. It is necessary to have a sharp point of light upon the object in order to get the best resolution, and if the mirror is used it should be carefully focussed upon the object. However, a large mirror is very difficult to use in this kind of work, for there is a flood of light from it, which is detrimental to good resolution. —*American Monthly Microscopical Journal.*

MICROSCOPICAL LABORATORIES.

By H. Hatch, M.D.

IN the February number of the Journal, there is an article by Dr. J. W. Crumbaugh, in regard to which I would like to offer a few words. Many of his suggestions are good, but in some respects I would beg leave to differ with the writer. Dr. Crumbaugh's idea is to surround the student with altogether too much and too expensive paraphernalia, which has a tendency to discourage him at the start. It has been my experience, and is also taught by the leader of pathological science, Virchow, that the more simple the microscope the better. Better work can be done without fancy rack stages and a multitude of screws, as has been illustrated by some of the work done by students under Prof. Bunker, of L. I. Hospital Medical College. In place of Queen's revolving table, I much prefer tables made square or long, of heavy, polished wood, well oiled, and fastened firmly to the floor. It has always seemed rather strange to me why some microscopists prefer artificial to natural light; the former is much more trying to the eyes, and, according to my idea, for general work it is not so good. I would have the light come in from only two sides, east and north. The material for the student to examine should always be as fresh as possible, and when pathological, the history of the case as known should be given with the preparation. After such a course, when the student comes to the work of every-day life in the routine of practical medicine, he finds laid a solid basis upon which to extend his future observations.

All physicians cannot be specialists with the microscope, but all should know the pathological difference between fatty degeneration and amyloid degeneration when they see it. Yet how many do? I venture not ten per cent. of them, and so long as you insist upon surrounding the student with so complicated an outfit as the writer above mentioned would suggest, so long will he continue to turn out physicians from our medical schools ignorant of the essential principles of histology and pathology. I well remember while I was a student in the Pathological Institute in Berlin, that the great endeavour of Virchow was always to simplify things as much as possible; and had I been obliged to buy my whole outfit, the cost, including my microscope, would not have exceeded seventy-five dollars. In the future I may have more to say upon this subject. —*American Monthly Microscopical Journal.*

TO SECRETARIES OF SOCIETIES.

In view of the constantly increasing pressure upon our columns, we find it impossible to give such full and complete lists of objects shown at the Ordinary Meetings and Soirees of Societies, as we hitherto have done.

We do not wish all lists expunged from reports, but that there should be some method in enumeration is evinced by the numerous letters we have received during the last six months, to the effect that in the opinion of our correspondents, many of these lists are of but little use. Our own views coincide completely with those of our correspondents. We had long been of opinion that the lists of objects might be cut down with advantage, but wished for twelve months at least, to provide a permanent record, useful to young Societies and to those wishful to exhibit at Soirees. We have done this, and therefore ask the Secretaries of Societies to aid us in making their lists as interesting as possible, confining it to objects shown to illustrate papers or other communications, new apparatus, and to *rare* specimens met with in the district.

NOTICES OF MEETINGS.

BLACKBURN FIELD NATURALISTS' SOCIETY.—Microscopical Section.—Meeting 1st May, 1882, Mr. Knowles exhibited Larvæ of Whip Tail Fly (*Eristalis tenax*), taken from a ditch behind Revidge. Vulgar name for Larva—Rat-tailed Maggot. Mr. Pilling, Spores of Equisetum, obtained at Feniscowles, on 25th April, samples of which he gave to those present. He at the same time pointed out an error in Hogg's sixth edition, p. 311, in which he says that, "While the spore remains in the sporange these fibres are rolled "round the spore as seen, etc., but by gently slackening the fruit spike, the "spores are discharged. The coiled fibres immediately unroll as at F., their "elasticity causing them to spring about in a most curious manner. In a few "minutes this motion apparently ceases, but if breathed upon they again *unroll* "and dart about with wonderful elasticity." The contrary is the fact. When *dry* the elaters are *uncurled* and *expanded,* and upon *moisture being supplied* to them, they *contract* and *coil round the spore.*

LIVERPOOL MICROSCOPICAL SOCIETY.—On Friday, June the 2nd, Mr. E. J. Sing, B.A., read a paper on "The Anatomy of Cydippe." Having made a few remarks on the Ctenophora generally, he proceeded to describe minutely the distribution of the gastrovascular canals and the peculiar organs of group—the Ctenophores,—pointing out that the Cydippe might be taken as the most primitive form, as the various organs have in it the least complexity. The various organs at the aboral pole of the animal were then described, special attention being directed to the structure of the auditory organ. The development of the individual was then followed up, the discrepancies between the statements of Kowalesky and Agassiz being pointed out. Several diagrams of the distribution of the gastrovascular canals, and the relative positions of the various organs, were exhibited, and Mr. Sing concluded by pointing out the obvious resemblance of the gastrovascular canals of the Ctenophoræ to the body cavity in those animals (Echinoderms, Amphioxus, etc.), in which it grows out from the archenteron as lateral diverticula.

The President pointed to the fact that we have in Polyzoa and Vorticella distinct bands of cilia differentiated for certain purposes, and asked whether any difference existed between the phosphorescence of Noctiluca and that of the Ctenophoræ.

Mr. Sing replied that it did not strike one as natural that the phosphorescence *after* irritation had primarily been evolved as a protection, and said he had observed in Noctilula the light proceeded from the region of the nucleus and the intersections of the protoplasmic threads, but was ignorant as to whence it proceeded in the Ctenophoræ. The agglutination of the cilia he held to be unique.

MANCHESTER MICROSCOPICAL SOCIETY.—The ordinary meeting of the Manchester Microscopical Society was held on Thursday, June 8th, in the Lecture Hall of the Mechanics' Institution, the President, Mr. Thomas Brittain, F.R.M.S., in the chair. Interesting communications were made by Mr. Wolstenholme, M.R.C.V.S., Mr. Ward, F.R.M.S., and the president. A donation of slides of mosses, gathered in the ramble to Staley Brushes, was made by Mr. Miles.

Mr. Parkes, of Rhodes, exhibited a quaint microscope which had been figured in Baker's treatise on the Microscope published 140 years ago. The stand was designed by Messrs. Culpepper and Scarlet as an improvement on Marshall's stand, it is therefore the second form of stand sold in England. The body is made of bone and cardboard, strengthened by brass pillars. The object glasses magnify from 30 to 200 diameters. This particular instrument has somewhat of a local history, it having belonged to Sir Ashton Lever, of Alkrington Hall, near Middleton. He had at one time the largest private museum in England, and in 1783 an Act was obtained to enable him to dispose of his collection by lottery, which he did for £10,000. It was won by a Mr. Parkinson, who exhibited it for a time and then disposed of it. At the sale this instrument was bought by a Middleton entomologist, who shortly before his death, some three years since, handed it over to the Botanical Society of that town, in whose possession it still remains.

Mr. G. J. Johnson read a paper on Insectivorous Plants, the Sundews and the Bladderworts. Specimens of *Drosera rotundifolia* and *Utricularia vulgaris* were distributed among the members present, and photographs of the same, the work of Mr. Johnson, were also freely distributed. At the conversazione which followed, Mr. Stanley exhibited Mosses and Hepatics collected at Staley Brushes; Mr. R. Parkes, fish scales and foot of scorpion fly; Mr. J. B. Wolstenholme, the head and neck of the slave *Tænia solium* found in the brain of a dog; Mr. E. W. Napper, F.C.S., a double-stained section of skin, showing sweat glands; Mr. Arthur Doherty, vertical section of dog's tongue, the same of the human tongue, and a section of human brain; and Mr. Johnson, *Utricularia vulgaris*, showing aggregation in pedicles, *Stephanoceros Eichhornii*, and *Drosera rotundifolia*.

MANCHESTER CRYPTOGAMIC SOCIETY.—Monthly meeting, June 19th, Dr. B. Carrington, F.R.S.E., in the chair. The minutes of the previous meeting having been confirmed, the Hon. Secretary read a letter he had received from Mr. C. P. Hobkirk, author of the "Synopis of British Mosses," in reference to the Society's reports on the "Naturalist;" and also on the advisability of the students of Cryptogamic Botany acquiring a more intimate knowledge of the anatomy and the development of Cryptogamic plants generally.

Mr. Cash exhibited specimens of *Myrinia pulvenatà* which he had very recently collected near York, and *Selegeria tusticha* from Millers Dale, of both of which he distributed specimens.

The Hon. Secretary placed upon the table a good sized vasculum of freshly gathered mosses, which he had received from the neighbourhood of Nyborg, in Denmark. It was observed that nearly all the species were identical with the species which grow in our British woods. The mosses were placed at the disposal of the members present.

NORTH OF ENGLAND MICROSCOPICAL SOCIETY.—The ordinary monthly meeting, held on the evening of Tuesday, March the 7th, was well attended, the chair being occupied by Mr. John Brown. After the minutes of last meeting had been read and confirmed, Mr. Mason Watson read from the Journal of the R.M.S. a portion of Dr. Lionel Beales' paper on "The Microscopic Limit and Beyond." This was attentively received, and Mr. Watson was thanked by the meeting. Discussion was postponed until the concluding portion of the paper is read.

The meeting of Tuesday, April 4th, was well attended by members and visitors, Mr. Joseph Craggs being in the chair. After the minutes of the last meeting were read and confirmed, Mr. Mason Watson proceeded to read the concluding portion of Dr. Lionel Beales' paper on "The Microscopic Limit and Beyond." This was received with marked attention and evoked some discussion.

The fifth meeting of the session was held as usual in the patents' room, Literary and Philosophical Society, on May 2nd, Mr. John Brown, one of the vice-presidents, in the chair. It was agreed that the first outdoor meeting should be held at Crosdale, near Durham. Mr. J. G. Dickenson demonstrated that a polished shilling, when used a reflector, is a brilliant source of illumination when fixed beneath the stage and supplied with light in the ordinary way.

NOTES AND QUERIES.

IRIS DIAPHRAGMS.—Messrs. Sidle & Co. have succeeded in producing this accessory in an improved form, and at much less than half the rates usually charged by other makers. Its appearance is that of a rather short objective, the shutter being in the upper end, and thus may be brought up close to the object slide. It is provided with a society screw, and consequently will fit any adapter intended for using an objective as an achromatic condenser. The iris is worked by a milled collar, corresponding to an adjustment collar of an objective.

In Sidle's "Acme" Stands all the stages rotate, are furnished with a means of centering by lift and press screws, and are provided with stop for Maltwood finder and socket for stage forceps. The stages are thin, admitting the use of very oblique light. For illumination of still greater obliquity, the stage may be turned over, so as to have the object slide on the lower side of the stage. The fitting on which the stage reverses is divided into single degrees, for twenty degrees upon either side of the horizontal, for experiments in the resolution of lined objects. This is accomplished without throwing the object out of centre of the swinging sub-stage. The stage ring or bed-plate is furnished with a spring clip arrangement, which admits of the easy interchange of the mechanical and plain stages and insures a smooth motion in rotation.

The Filmograph.—Mr. Pumphrey, of Birmingham, is issuing rapid gelatine films, intended to supersede the ordinary gelatine plates now so largely used in photography. We have seen pictures produced by them, which are in all respects satisfactory, and we notice them here, thinking they may be possibly applied to the production of transparencies for the lantern. If such could be done, they would be very convenient for lecturers, as a dozen films, $8\frac{1}{2}$ by $6\frac{1}{2}$, weigh but three ounces, or one-twentieth of the weight of glass.

The mode of manipulating these films is given with each packet, and differs but little from the ordinary method for gelatine plates.

The Late Charles Darwin.—Westminster Abbey, as was fitting, was chosen as the last resting-place of Charles Darwin. The pall-bearers were the Duke of Argyll, the Duke of Devonshire, the Earl of Derby, Sir Joseph Hooker, the American Minister (Mr. Russell Lowell), Dr. Spottiswoode, President of the Royal Society, Professor Huxley, Mr. Alfred Russell Wallace, Canon Farrar, Sir John Lubbock, M.P., and there was an immense and representative gathering of all sections of society. The grave is nearly in the centre of the nave, slightly to the left of the entrance to the choir, and in the organ gallery, and immediately against the grave of Sir Isaac Newton. An anthem composed for the occasion by Dr. Bridge was sung to the words from the Book of Proverbs, "Happy is the man that findeth wisdom, and getteth understanding. She is more precious than rubies, and all the things thou canst desire are not to be compared unto her. Length of days is in her right hand, and in her left hand riches and honour. Her ways are ways of pleasantness, and all her paths are peace."

The will (dated September 27th, 1881) of Mr. Charles Robert Darwin was proved on the 6th of June, by William Erasmus Darwin and George Howard Darwin, the sons and executors, the value of the personal estate amounting to upwards of £146,000. The testator leaves to his son William Erasmus the family portraits and papers, all medals, the silver candlesticks presented to him by the Royal Society, his manuscript of the voyage of the Beagle, and his manuscript autobiography; to his son Francis, his scientific library; to his wife, Mrs. Emma Darwin, £500, all his furniture, plate, books, effects, horses and carriages, and his residence at Down for life; and to his friends, Sir Joseph Dalton Hooker and Thomas Henry Huxley, £1,000 each, free of legacy duty. The residue of his real and personal estate is to be held upon trust for his wife for life, and at her death as to twelve seventy-fourth parts for each of his five sons, and as to seven seventy-fourth parts for each of his two daughters; certain advancements made to his children are to be brought into account on the division.

CORETHRA.—I hear a number of different accounts of the Larva of the Corethra, and a beautiful creature it is when examined. In addition to what is said of it in your last number for June, I would add a little more, as I have not seen it noticed in other accounts. It has two jaws, and feeds on other animals—the bloodworm for one, as I once found the head and part of the body of one in its stomach. On squeezing the Larva between two glasses, the stomach is forced out of the mouth, and it is a good object for the Microscope, as it is covered with rows of spines. I suppose they help to retain its food. The use of the shell-like bodies has, I suppose, something to do with the breathing or circulation. At any rate, they are beautifully spotted, and can be taken whole out of the body; they are hollow and of a fibrous structure.

EDW. THOS. SCOTT.

MOUNTING VOLVOX IN GLYCERINE JELLY.—In reply to your correspondent T. R. B., I beg to say that I boiled the Volvox in the Jelly on the slide, the cover glass being held in position, during the boiling process, by a rather loose clip.

JNO. FLEMING.

KILLING BOTTLES.—The most effective way of making this is, to take a wide mouth bottle and pour in some cream of Plaster of Paris to cover the bottom to the extent of half-an-inch, incline the bottle, so that the mixture runs round the sides for half-an-inch upwards. This must be allowed to become dry, and afterwards baked in a cool oven. When cold, insert some fragments of cyanide of potassium (which by the bye is a very deadly poison) to the depth of about a quarter of an inch, and pour in more plaster cream until the cyanide is about half an-inch below the surface. When dry, cork the bottle tightly, as it will be ready for use.—*A. R. D.*

STUDIES IN MICROSCOPICAL SCIENCE.—Four more numbers of this important Journal are now in subscribers' hands, and the character of the publication is well sustained. No. 4 contains a chromo-lithograph of a transverse section of the closed fibro-vascular bundles of *Cyperus alternifolius*, the umbrella plant, the text giving a full description of the methods of preparation and a good Bibliographical list. No. 5 illustrates the beautiful section of Human Skin accompanying it, while Nos. 6 and 6A are devoted to a description of Pikrite from Inchcolm on the Firth of Forth; the former shows its appearance under polarized light, while the latter contains a plate serving as an analytical chart to the former. The four numbers are exceedingly interesting. Great praise is due to the Editor and his assistants; and we must add a few words of praise also on behalf of the chromo-lithographs, which Messrs. Watson and Son, of Birmingham, have sent forth from their establishment.

MICROSCOPICAL LITERATURE.—Mr. W. P. Collins has just issued his June catalogue of new and second-hand books upon Algæ, Bacteria, Desmids, Diatoms, Foraminifera, Infusoria, Histology, Petrology, Botany, Biology, Natural History, Physiology, &c., &c. It furnishes a complete list of works for the Microscopist.

PHOTOMICROGRAPHY.—We have received a small treatise, *Précis de Microphotographie*, from the author, M. G. Huberson. In the compass of 100 pages he tells us how photomicrography is practised abroad, and the English operator may find a few hints to aid him in his work, though we fear he will not adopt the apparatus figured in the treatise. The book is illustrated by a plate (photo-engraved) of *Pinnularia nobilis*, and there is an appendix, giving a few very useful receipts, comprising the silvering of mirrors and the solutions used therein. On the whole, the work may be perused with profit, but it must not be forgotten that considerable advances have been made of late in this country and in America.

THE RELATION OF APERTURE AND POWER IN THE MICROSCOPE.—A paper from the pen of Prof. Abbe appears in the June number of the Journal of the Royal Microscopical Society upon this subject. We mention this in order that those of our readers who wish to read it *in extenso* may do so; but we purpose giving an abstract of this paper in our next number.

DOUBLE STAINING.—The coloring matters generally recommended for the double staining of vegetable tissues have already been mentioned in this Journal. Mr. J. M. Macfarlane states that saffranine and emeraldine are preferable, as the former is a more permanent dye and the latter imparts a much brighter color than iodine green.

THE LIMITING DIAPHRAGM, OR APERTURE SHUTTER.—In the June number of the Journal of the R. M. S., when speaking of Dancer's diaphragm holder, it is stated "that the object for which these diaphragms was suggested is not practically attainable." This will cause a smile from those members of the Manchester Microscopical Society who were present when Mr. G. E. Davis demonstrated the amount of penetration given to a Tolles one-inch objective of 35°, the aperture being reduced to 12°, and also the half-inch of 60° when reduced to 35°. Considering that the objects shown were such as would clearly demonstrate the practical value of the "shutter," foraminifera, globular micro-fungi, &c., it is not a little surprising to find that the object sought after is "not practically attainable." The publications of the first-mentioned Society have always been characterised by the presence of theories advanced to show the impossibility of something which others have practically accomplished, and we do not think that such writers give sufficient credit to the practical optician for being able to accomplish any more than has actually been done.

We do know that all objectives will not bear the reduction of aperture without impairing their performance, but we should be very sorry to possess a one-inch objective which would not bear reduction to 16° without injury to the image—but more of this in our next. Would it not be possible for contributors to the J.R.M.S. to sign or initial their articles? Readers would then be able to observe any "change of front" which often takes place in the opinions of contributors.

VOLVOX AUREUS. WAX CELLS.—Mr. Thomas Whitelegge, of Ashton-under-Lyne, has sent us a goodly collection of this alga in fructification, he having discovered it in a pond near Ashton. He has also demonstrated to us a very simple method of making wax cells. A piece of glass tubing is first drawn out to a point so as to form a pipette, and this is filled with melted white wax. The slip upon which the cell is to be made is placed in the turntable, and while it is spinning, touched with the point of the wax pipette, previously heated so that the wax may flow out readily. A wax ring is thus made quite as easily as one of varnish, and if the ordinary pharmaceutical white wax be employed, it will adhere very tenaciously to the slide. It is obvious that many varieties of rings may be made by modifying the temperature of the wax or even by warming the slide, and as an operation of this kind generally requires some little practice in order to obtain the best results, a few failures at the outset should not discourage the operator from further attempts.

STAINING WITH ANILINE BROWN.—According to Henneguy all Infusoria may be stained when in the living state, by means of Bismarck Brown. Where *Paramœcium aurelia* was treated with an aqueous solution of coloring matter they assumed an intense yellow brown color, which first appeared in the vacuoles of the protoplasm and then invaded the protoplasm itself.

Small trout were placed in a solution of the above, and while they continued to swim actively about were stained the characteristic color. Some cress seeds were sown upon cotton, soaked in a strong solution of Bismarck Brown, when it was found that the vessels were stained a deep brown, up to their termination in the leaves.—*Rev. Internat. Sci. Biol.*

STARCHES.—A series of twenty-four sections of starch-bearing vegetables and starch granules has been sent out by Mr. A. C. Cole, F.R.M.S., for the use of botanical students. We have been favoured with a set of these preparations, which demonstrate very clearly the various forms of the starches, the manner in which they are borne in the plant, and show us clearly that very different means must be employed for preparing the various kinds in a state of purity.

There is a good section of the sweet flag, *Acorus calamus*, but the starch granules are small, and require a good low angle lens of high power to see them distinctly. The section of the root of Peony, *Pœonia officinalis*, show us how closely many of the starch granules are packed in their cells; but perhaps the best instance of this is found in the section of a grain of Maize, *Zea mais*, of the orchids there are two sections of the roots, showing the differences in the granules from these plants. There is the Spotted Orchid, *Orchis maculata*, with a large granule, somewhat similar to arrowroot, while the Butterfly Orchid, *Habernaria bifolia*, contains granules nearly circular, and but half the size of *O. maculata*. One of the most beautiful sections in the collection is that of the Geranium stem, and the Mandrake *(Atropa mandragora)* and Buttercup roots *(Ranuncnlus bulbosus)* are good also; but the triumph of the preparers' art is to be found in the section of Liquorice root, *Glycyrrhiza glabra*, where a complete unbroken section is exhibited of a diameter of three quarters of an inch. The section of Yam tuber, *Discorea satiova*, is a fine one, and shows many of the granules cut in two, while the section of a Green Pea, *Pisum sativum*, exhibits the large circular cells filled with mature and immature granules. The section of a grain of Wheat is an exceedingly interesting study. In one unbroken plate we have before the eye the whole structure of the grain, and this method of examining the starches commends itself to the microscopist as being fraught with interest, and giving him an insight into the cell-structure of the most important plants.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

H. S.—Unless you are fairly acquainted with chemical matters we strongly advise you to give up all idea of mounting in phosphorus; it is exceedingly inflammable, and of but limited application.

D. D.—A half-inch should show the markings upon *P. formosum*, except it be of very low angle. Is your method of illumination perfect?

H. H. — The Verification department is not discontinued; we have been too busy to attend to it fully during the past two months, and must ask a little indulgence. After July we must make an alteration in this department.

C. R. C.—Refer to Practical Microscopy. Cooke's Handbook would suit you we think.

D. B.—The fungus is *Macrosporium cheiranthi.*

J. C.—The aperture shutter may be had from Mr. Collins to fit the substage if you so require it. Take no notice of what is said, try it for yourself; we will lend you one for trial. Microscopy has often been retarded by the too implicit following of "bell-wethers."

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

WANTED. Paraboloid and Parabolic Reflector. Exchange splendid telescope, Photo-camera and ¼ plate lens, &c.—R. C. Pilling, Robins Nest, Blackburn.

STARCHES. Will exchange a large variety of starches and other slides for parasites, geological, or other good slides. —J. E. Fawcett, Rawdon, nr. Leeds.

EGGS OF SHEEP FLUKE in exchange for foraminifera or diatoms.—C. E. W., 31, Darley-street, Bradford, Yorkshire.

CORRESPONDENTS WANTED in all parts of the world to exchange microscopic slides or material. All communications answered.—F. L. Carter, 20, Trafalgar-st., Newcastle-on-Tyne.

SIX DOZEN micro. slides for exchange. Send list to John Alex. Ollard, F.R.M.S., Ye Hermitage, Forty Hill, Enfield.

STRAW BRISTLE MOULD will be sent on receipt of stamped addressed envelope to E. Holmes, 149, Essex-road, London.

WANTED diatomaceous deposits and dredgings from all parts of the world. Will be glad to hear from correspondents abroad.—T. E. Doeg, Evesham.

WOOD SECTIONS given in exchange for rare starches. Send list to the Editor, and, if mounted, state in what medium.

WANTED first-class botanical and geological slides, rock and bone sections; also double-stained vegetable tissues and other good objects. Offered in exchange anatomical and pathological preparations, a variety of well-mounted and interesting specimens.—F. R. Martin, Malvern House, Clevedon.

FISH SCALES—forty kinds, seeds forty kinds, eighteen kinds of Zoophytes unmounted, in exchange for well-mounted slides.—Send lists to B., 36, Windsor-terrace, Glasgow.

PLATE III.

Fig. 9.

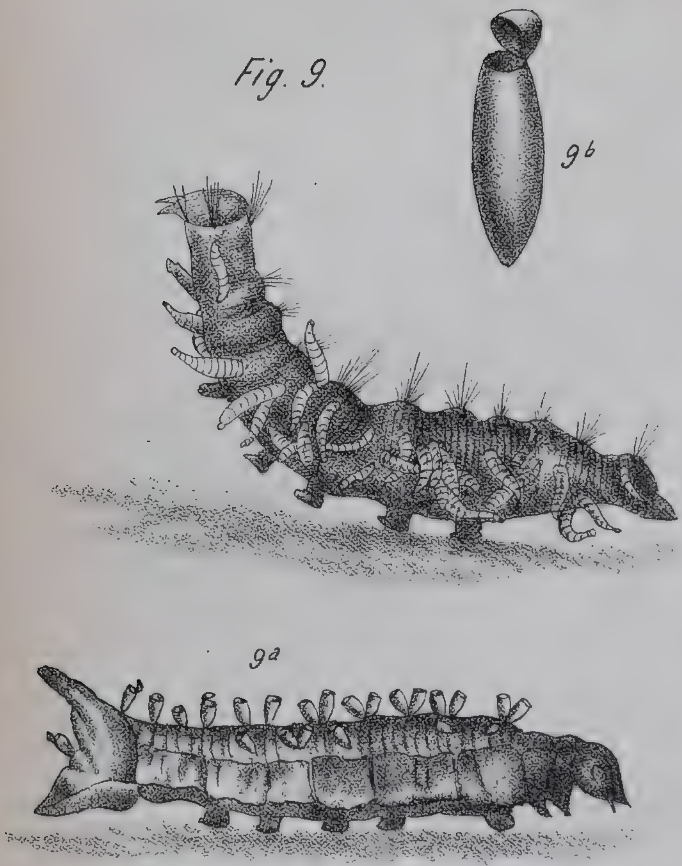


Fig. 10.

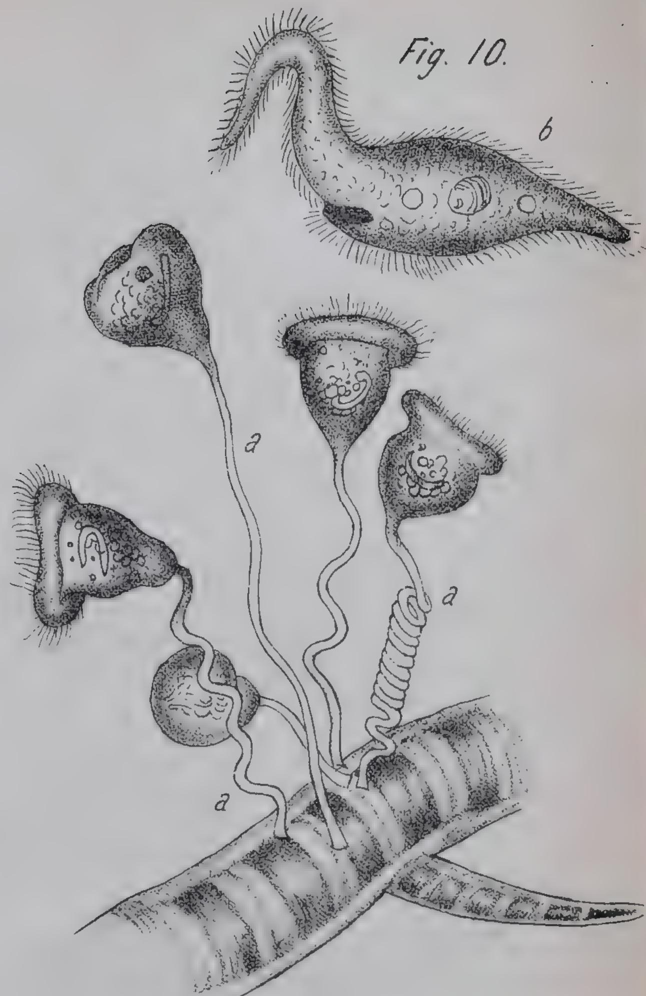


Fig. 11.

Fig. 12.

THE NORTHERN MICROSCOPIST.

No. 20. *AUGUST.* 1882.

LIFE-HISTORIES AND THEIR LESSONS.

BY REV. W. H. DALLINGER, F.R.S., F.R.M.S.

(Continued from page 177.)

BERKELEY also tells us that Achlya is an aquatic form of *Sporendonema muscæ;* that the filaments are devoid of septa, and that the tubes contain a colourless granular protoplasm, denser on the walls, and that there is an irregular spiral movement in anastomosing currents exhibiting the circulation of the cell contents, such as is met with in hairs of Tradescantia.

In truth, then, what has been presented to us as a remarkable transformation of the "protoplasm of a dead fly's leg" into this circulating protoplasm of a Saprolegnia, was neither true as an inference nor new as a fact, except to the gentleman who offered it as an evidence of the heterogenetic origin of living things. It is one of the commonest events of the autumn to see "dead flies on the window pane," and we need not wait even for this phœnomenon to get the *Achyla prolifera.* The aërial condition of the fungus need not precede it. Throw a few flies into water, and in a day or two many of them will be covered, in all probability, with Achlya.

In Plate II., Fig. 7, we see the manner of its growth upon the decaying leg of an insect. At *a* (out of its natural position on the thread, for the convenience of illustration) is seen the sexual mode of increase, *a* being the oogonium and *b c* the antheridia. The method of asexual reproduction is seen in the same Plate, Fig. 8, where the end of the thallus, *a*, becomes densely packed with spores; a septum is formed at the base *b*, and ultimately the whole centents are poured out from the tip, as at *c*, as minute ovate spores, having one or two delicate flagella, as seen in a more magnified spore at *d*, which, like Bacteria or Monads, have the power of free movement. Soon, however, they settle on a suitable and exciting substance, as the dead body of an insect, or the living body of a fish or newt, and rapidly germinate, as at *e*, *f*, *g*. The manner of cyclosis of the protoplasm in the tube of the thallus is seen at *h*.

It must be pointed out that want of knowledge of the life-history of this lowly form was the entire secret of its production as a case of Heterogenesis. The facts observed were correct enough; but the other links that made the chain of which they were only a part, were unknown to the observer; and this is a fruitful source of "fact," such as is constantly offered for a similar end. By such a method of enquiry and research, the potato disease might well have been taken as the "transmutation" of the protoplasm of the potato into its blight! Indeed, heterogenetically, this was a far better case, for here we have (living) protoplasm to get the fungus transmuted from. But in the other case only the proximate elements of the protoplasm of the dead fly. As it is, however, both Achlya and Peronospora are known to have definite histories, and to depend ultimately upon the production of what are the equivalents of genetic processes.

It would indeed, in the absence of accurate knowledge, be much more to the purpose to say that the mistletoe was the direct result of transmuted protoplasm from oak or apple tree that becomes its "host;" for verily it lives by the living matter provided for it. But the Botanist knows that the mistletoe grows from a fertilised seed. Not knowing the history of the Achlya, it is easy for the believer in Heterogenesis to take a blind leap over Nature's elaborate arrangements for its continuance and multiplication, and assume that it sprang, without a progenitor or a past, into direct existence from the protoplasm (?) of a dead fly!

This is not a new process of inference in the history of Biology. There was a time when every process that could not be explained as it was, was explained as it ought to be. It was gravely affirmed that ducks grew on trees, and elaborate drawings of the process are still in existence. We all know how hasty inference could account for the coming of the flesh-fly in the carcase of the dead sheep, by transformation. But gradually the illusiveness of this method of inference has become apparent. Biology to-day is as rigid a science as Physics in some of its methods; this precision has "laid" the ghost of Heterogenesis. Life-processes are no more capricious than processes of crystallisation. The laws of Biology are laws as much as those of Chemistry. The lowliest and minutest forms which we have studied have a known history repeated (subject to the secular processes of the Darwinian law) in all their successors. There is no sudden caprice; and therefore Heterogenists are fain to congregate about the fringe of vital forms where our knowledge of life-history is not complete, and where the minutest forms are found. We never hear of either crustacean or insect, however small, "transmuting." The explanation is easy. Whenever we know the history of a living form, although we know that in the process of ages it may slowly change, and give rise not only to varieties but to different "species" and genera, yet that its metamorphoses or developmental processes, as capable of observation in the life-time of a man, or a generation, will be as certain as the reactions of a metal or an acid.

The strange position taken up by Dr. Bastian, in his *Beginnings of Life*, has warped and rendered futile the character and results of the work of more than one earnest worker, desirous of using a microscope in the interests of Biological Science in this city, during the past few years. Many may contribute facts who may not be masters of the doctrines of a science, at least in microscopical work. But when their judgments are warped by the affirmation by an apparent "authority," that they are to expect to find Heterogenesis, which is "defined" as "the origination of living beings more or less complex in organisation from other living units, wholly different from themselves, and having no tendency to assume or revert to the parental type." *

This is, in brief, a sort of charter for the wholesale "explanation" of what we do not understand in the development of living forms, into a "fact" for Heterogenesis. There are caterpillars of large size that are found sometimes in England, but often in America, which are the "hosts" of scores of minute larvæ, which eat and grow upon the fat and non-vital parts of the host; in the majority of cases they at last attack the vital organs, kill the caterpillar, and then eating their way through the skin, as in Plate III., Fig. 9, and then weaving cocoons on the surface of their larval host, wait until they emerge from these as perfect flies. They do not, however, always kill their unwilling entertainer. Fig. 9 *a* is from a drawing, by an American observer, of the cocoons empty; and Fig. 9 *b* is a magnified cocoon.

Now, to deceive in this case is scarcely likely; we know, by the aid of popular literature, and in some instances of school boards, that this is the work of an Ichneumon fly. But a similar case amongst unknown microscopic forms might easily be translated into "palpable Heterogenesis."

Not less remarkable, as a suggestive illustration, is that terrible internal scourge of man himself, *Trichina spiralis*. Every muscle of the body of a trichinised man or animal may be literally crowded with the delicate coiled "worm" at rest in its cyst. If we did not know that it had a history which, happily, is more or less completely compassed, could the thoughtful and practised Biologist conclude that it was the result of the direct transformation of the

* Beginnings of Life, vol. i., p. 244.

muscular protoplasm into Trichinæ? Perhaps some might; this has been done; but the microscope has come to our aid, and made us masters of the cycle of its life. But again it must be asked, if something equivalent to this happened amongst the medley of minute and lowly organisms that accumulate in a live box, or a trough, with decaying animal or vegetable matter, would not the heterogenetic bias be ready to infer "transmutation?"

Even more remarkable still are the curious parasitic fungi which attack and kill the larvæ and pupæ of insects. In the comparatively common case of *Hepialus virescens*, the caterpillar buries itself in the earth, and instead of becoming an imago, is absolutely converted into a vegetable—a fungus. The interior of the larva is wholly occupied with a white fibrous mycelium, and up through the very soil in which it is buried grows a tall fungoid filament, literally rooted in the larva itself. *Torrubia Robertsii*, *T. militaris*, *T. spherocephala*, *T. entomorrhiza*, and others, are well-known varieties of this fungus. This is decidedly a better case for inferring the "transmutation" direct of animal protoplasm into vegetable form, than many of the reputed cases in the *Beginnings of Life*, and others presented in this and other of our local scientific societies, of the transformation of Euglenæ into Rotifers, or chlorophyll corpuscles into Paramæcia! But to patient effort it has been shown that these fungi have a definite biological cycle; that they arise in diffusable spores; and, within the terms of the known laws of Evolution, follow each generation the path of its predecessor as accurately as a sodium flame will give the same results to-day to the prisms and lenses of a spectroscope as it did under the same circumstances yesterday.

But from all this it will be seen that the danger in the case of the young and uninstructed student of pond life or putrefactive forms, is want of thoroughness, or hasty inference.

In the year 1870, I actually watched a Paramæcian hatch or come out of what appeared to all intents and purposes an encysted Vorticellan! The Vorticellan was the beautiful form known as *Convallaria*. The Paramæcian was *Amphileptus anser*. This seemed an actual case of Heterogenesis. I paused, was silent, worked and waited. It was not until 1872 that a repetition of the phenomena occurred; then it was rich in instruction.

A group of the *V. convallaria* was seen, as at *a*, *a*, *a*, Plate III., Fig. 10. Swimming in the trough were several *Amphilepti*, as in Fig. 10 *b*. Suddenly an Amphileptus sprang upon and seized the crown of a Vorticellan, as at 1 *a*, Plate iii., Fig. 11. This little organism was powerless to shake it off, in spite of darting up and down, swaying to and fro, and the rapid lashing of its circle of cilia. Gradually it became less active, and a sort of fusion was manifest, as in 11 *a*, which was more and more marked passing

PLATE IV.

Fig. 13.

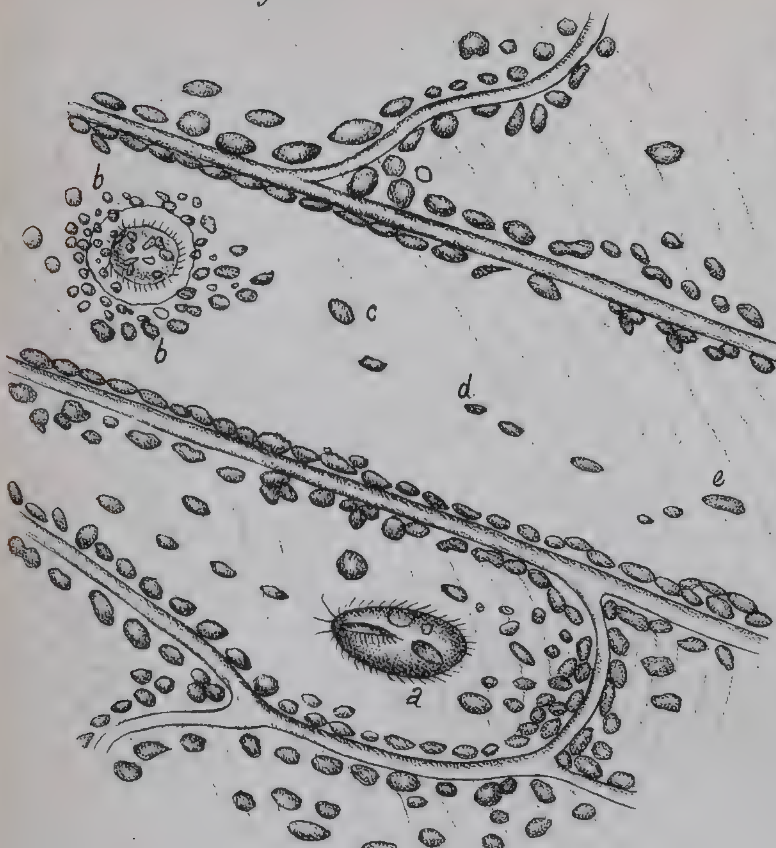


Fig. 14.

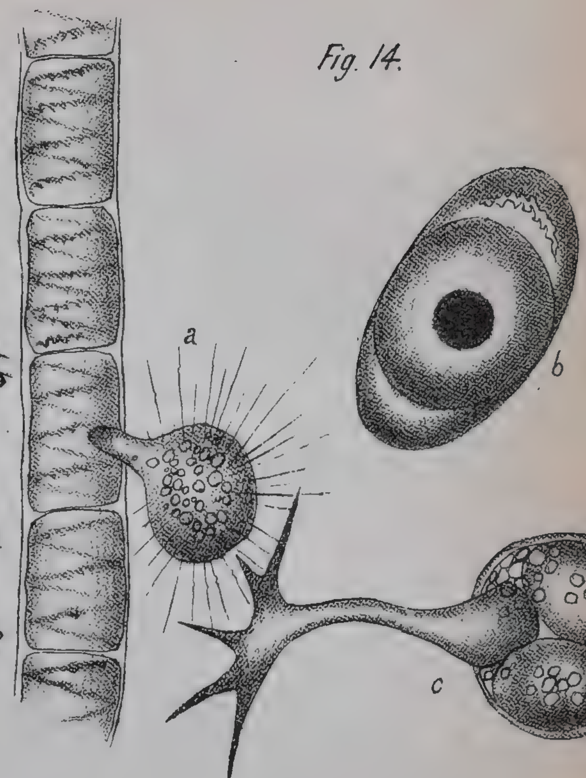


Fig. 15.

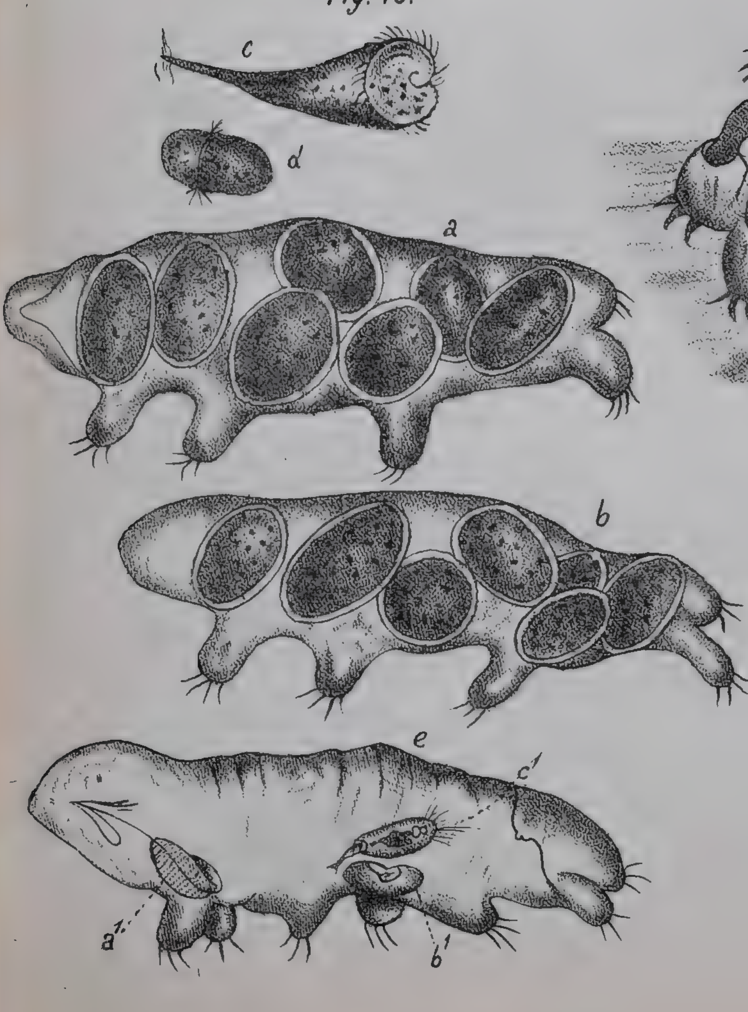


Fig. 16.

through the stages seen in III *a* and IV *a*, until at length it fell upon the alga to which it was attached, as seen in *b b*, Fig. 12. This was watched, and at length there escaped from it the living form, roughly drawn at *c*, which passed through the stage *d* into the proper form *a*, *A. anser*, shown at *e*. These drawings have been in my portfolio since August, 1872, when they were made, and I should almost entirely have forgotten it, but a friend, knowing of the incident, and reading Professor Huxley's *Anatomy of Invertebrated Animals*, just as it came out in 1877, called my attention to page 103, where we read, "Encystment, whether followed or not by division, is very common amongst all the ciliata, and a species of *Amphileptus* has been seen to swallow, or rather envelope, a stalked bell-animalcule, and then become encysted upon the stalk of its prey, just as *Vampyrella* becomes perched upon the stalk of the devoured *Gomphonema*." Thus an explanation of the seeming transmutation of Vorticellan and Paramæcian, and good evidence that it was not even uncommon, was forthcoming.

But amongst other illustrations of a similar kind, we were shown, recently, an instance of what it was contended was the emergence of a Paramæcian from chlorophyll granules in Nitella! The circulating granules in the decaying plant were said to have "become" an animal!

I can easily, from my own portfolio and that of others, produce similar instances. Fig. 13, Plate IV., shows some of the cells of a leaf of *Anacharis alsinastrum*, with their circulating chlorophyll granules. I have often seen, what is again and again recorded in treatises and monographs,—the presence of minute animals, as Paramæcia and Rotifers, within the cells of aquatic plants, as Vaucheria, Sphagnum, Nitella, and others. At *a* is an instance of this; the minute Paramæcian *Oxytrichia pellionella*, the 1-700 of an inch in length, was seen within the cell moving freely, and on being carefully followed was seen to "encyst," to become still and round in the midst of a cell, as at *b*. But we all know, who watch the cyclosis of particles within the cells of aquatic plants, that at times the granules get loose from the current, as at *c*, *d*, *e*, but as these flowed up they were stopped by the encysted animal, eventually covered, and at length, from the chlorophyll mound within the cell, an active Paramæcian wriggled and escaped, ultimately emerging altogether by the rupture of the cell-wall of the decaying leaf. The conjurer seems to take numberless eggs out of a burning candle. The mound of chlorophyl granules, taken as such, seems to change into a Paramæcian; in both cases it is not what it seems; it is something else to careful investigation.

It may be difficult to explain how these forms enter the cells of plants, but not more so than to explain how the spores of fungi enter eggs. Yet we know that this latter is true. But something may be learned from the observations of Cienkowski on *Vampyrella spirogyræ*, seen in Fig. 14; *a* is the mature form engaged in the work which distinguishes it, *i.e.*, boring into the cells of the spirogyra. It then withdraws its pseudopodia, is granular, and divides into three portions within a cell, *b*. These each escape, and become amœboid, as we see at *c*. Each of these again becomes at length encysted. Thus we have an amœba stage, a cell stage, a second amœba stage, and a final encysted stage.* This is not a perfectly worked out form, but it has none the less in this relation a suggestive history as to its penetration of vegetable cells.

The same caution is necessary in reference to the occasional appearance of the accidental "grouping of chlorophyll grains." Something may be learned from the history of *Pediastrum granulatum*, the mother cells extruding granules in colourless (and at first almost invisible) envelopes, in an irregular manner; but these granules afterwards arrange themselves in their hereditary order, and become as their predecessors. But much by way of cautious investigation must also be added. Indeed, the lesson throughout is caution. Some illustrations, indeed, as many in this Society will remember, were given us from that admirable observer, Mr. H. Carter, F.R.S. These observations, however, which are very far from parallel with those adduced in comparison here, were made over twenty years ago. But since that time Mr. Carter has corrected, by further observations, what he discovered to be erroneous in his earlier results, explaining the paradoxes by the presence of parasites with whose existence he had not been before acquainted.†

We can only assume that this correction of the facts was unknown to the author of the paper which we criticise. Even Louis Agassiz, if we are only to allow his earlier work to bear witness uncorrected by his later, could be quoted as strongly on the side of Heterogenesis. Thirty years ago he asserted that the Trichodina was a Medusa! "In the eggs of Hydra he had been able to trace all the forms from the segmented yolk to these parasites; the fresh-water Hydra is the polypoid form of Medusæ, while these parasites are the medusoid form."‡ Further, he says, "I have seen a Planarian lay eggs out of which a Paramæcium was born (!), which underwent all the changes these animals are known

* Cienkowski. *Beiträge zur Kenntniss der Monaden*. *Schultze Archiv. fur Microscopische Anatomie.* Bd. i., 1865.

† *Cf. Ann. of Nat. Hist.*, 2nd ser., vol. xix., p. 287, and *Ann. of Nat. Hist.*, 3rd ser., vol. viii., p. 289.

‡ *Proc. Boston Soc. of Nat. Hist.*, vol. iii., 1850, p. 354.

to undergo up to the time of their contraction into a chrysalis state, while *Opalina* is hatched from *Distoma* eggs."* And he further asserts that Colpoda and Paramecium "are the brood of Planariæ!" †

It is not difficult to explain these egregious errors of observation now. But it would be scarcely just to a distinguished, if philosophically narrow, Biologist, that these errors of the long past should be quoted as his latest judgments and most matured observations. It is not less a matter of moment that Mr. Carter's important emendations of his earlier observations should be noticed and receive their due weight.

I called attention some time ago to an interesting observation made on the Tardigrades.‡ It will be instructive to quote from this. "Most microscopists have at some time made the acquaintance with the water-bears of the ponds, and a good many have followed their development. Whoever has done the latter has fully convinced himself of the truth of the statements of Hölliker, Frey, Doyère, Kaufmann, and others, that the tardigrades in every instance produce large fecundated eggs, from which young, closely resembling the parents, emerge. Another feature of the tardigrades is the extreme hardness and toughness of their 'skin.' It is, in point of fact, speaking relatively to the Arthropoda, almost a 'shell.' This skin, it is also well known, is 'cast' by the creature, and it forms, in the case of the female, a shelter or protection for her eggs.

"Now, Dr. Bastian tells us that the power of reproduction in these forms is not limited to the 'rudimentary generative organ,' because 'Dr. Gros tells us that the dead tardigrades may ultimately be resolved into specimens of Actinophrys, Perammata, or Arcellinæ,' and that these products may at different times be either all of one kind or intermixed with each other and with young tardigrades! On the strength of this discovery we are presented with a drawing, which I reproduce. (Fig. 15 *a.*) The subscription which accompanies this is very suggestive. It runs thus, viz.: 'Seven large germs, into which the total internal substance of the parent has become resolved, each of them being capable of developing into a tardigrade.' Now, wherever there are plenty of tardigrades there will be found dead forms, with their internal structure unchanged, and others which are mere empty shells or skins. Some of these latter are, doubtless, 'cast skins,' but the dead water-bears, in a trough not very plentifully supplied with food, will soon be attacked by paramæcia; and although the

* *Essay on Classification*, Boston, 1857, p. 182.

† Lond. Ed., p. 112.

‡ *Popular Science Review*, vol. xv., 344.

aperture they make may not be clearly seen, they somehow get into the body of the animal and gradually devour all that is in it; and after cleaning it as thoroughly as ants will a small skeleton, leave it a hollow but perfect form. It is now open to the chapter of accidents, and it can be no matter for surprise that the minute eggs of aquatic creatures enter into it and hatch there. This can be easily illustrated. The Secretary of a local Microscopical Society has endeavoured to verify or substantiate some of the more marked cases presented by Dr. Bastian. But his method of examination is, of necessity, an interrupted one. He has frequently called my attention to curious cases of apparent 'transmutation,' and I have before me now some of his drawings of these taken from nature.

(To be continued.)

THE RELATION OF APERTURE AND POWER IN THE MICROSCOPE.

By Professor Abbe, Hon. F.R.M.S.

A paper read before the Royal Microscopical Society, 10th May, 1882.

I.—General Considerations as to Wide and Narrow Apertures.

THE question of the relative values of high and low apertures has been much obscured by the one-sidedness with which it has been treated. One party of microscopists—the "wide-aperturists"—having recognized that high apertures are capable of exhibiting minuter details than low apertures, conclude therefrom that all microscopical work must be done with very wide apertures, and that low-angled systems are worthless. Another party, relying upon the fact that there are many cases in which low or moderate apertures perform decidedly better than wide ones, generalize this experience and deny that there can be any essential benefit in very wide apertures, asserting that all observations, with the possible exception of resolving diatom striæ, can be done as well with low-angled objectives. The premises of both these views may be said to be true, but true under conditions only; and by disregarding these conditions both parties arrive at conclusions which are equally remote from a proper estimation of the requirements of scientific work with the Microscope. My view of the question * is based on the following considerations:—

* As some suggestion appears to have been made when the above paper was read as to my views having undergone a change, I beg to remind my readers that the views above explained are those which I have professed since 1873—the date of my first paper on the subject. My advocacy of wide apertures for minute objects appears to have been interpreted as an advocacy of wide apertures for all purposes—a misapprehension which I am at a loss to account for, as nothing I have ever said or written could justify any such a supposition.

All the catalogues of Mr. Zeiss issued since 1872 give practical evidence of this, as the objectives there specified (and stated to be constructed according to my principles and under my direction) include no low and medium powers, except with low or very moderate apertures.—E. A.

1. Every given degree of minuteness of microscopic detail requires a given aperture in order to obtain a complete (or perfect) image, *i.e.* an image which is a true enlarged projection of the structure, exhibiting all elements in their true form and arrangement. The minuter the dimensions of the elements the wider an aperture is necessary—the larger these dimensions the narrower an aperture is sufficient. Structures whose smallest elements are measured by considerable multiples of the wave-lengths of light are perfectly delineated with low or very moderate apertures, and their examination with wide apertures does not improve their recognition. On the other hand, if we are dealing with objects whose dimensions (or structural elements) are equal to a few wave-lengths only, even the widest apertures hitherto obtained will not afford complete or strictly true images, but will show these objects more or less incomplete or modified. This general principle holds good in regard to objects of every kind, regular or irregular, isolated particles or composite structures, because the physical conditions of microscopical delineation are always the same.

The obvious inference from this principle is that the widest possible apertures must be used for the observation of objects or structures of very minute dimensions, low and moderate apertures for relatively large objects.

It may perhaps be said that the objects of microscopical research do not justify such a distinction of large and minute, since the works of nature are always elaborated to the minutest details, all coarse objects being composed of smaller elements, and these of still smaller ones, &c. This is quite true in regard to the objects considered as natural things, but not as objects of scientific research. The interest of research is not always directed to the ultimate elements, but is as often confined to the consideration of the coarser parts, and in such cases the observer is not only allowed but sometimes compelled, to disregard everything which is not connected with the scientific aim of his investigation. To observe every object in nature throughout, from Alpha to Omega, is the privilege of *dilettante* microscopy only, which has no distinct aim. There are many lines of the most valuable scientific research (*e.g.*, the greatest part of all morphological investigations) which have not to deal with very minute things. This kind of work can be completely done with low or moderate apertures.

To recommend the application of wide-angled objectives for every branch of microscopy, as has been, in fact, done by excited wide-aperturists, is no more to be supported than it would be to recommend the use of a magnifier to a painter for inspecting the tree which he proposes to delineate.

According to what has just been said, the only benefit of greater aperture is that it is capable of delineating minuter things. Now minute dimensions require high amplifications in order that they may be enlarged to a visual angle sufficient for distinct vision. Low figures of amplification cannot render visible (at least not distinctly visible) details which are beyond a certain limit of minuteness. Even if they are delineated by the Microscope they would remain hidden to the eye for want of sufficient visual angle. It follows therefore that wide apertures will not be utilized unless at the same time there is a linear amplification of the image, at least sufficient for exhibiting to the eye the smallest dimensions which are within the reach of such an aperture. On the other hand, a high amplification will be useless if we have small apertures which delineate details of dimensions only capable of being distinctly seen in an image of much lower amplification. We have here an empty amplification, because there is nothing in the image which requires so much power for distinct recognition. In the first case (deficiency of power) the large aperture cannot show more than a smaller one; in the other case (deficiency of aperture), the high amplification shows no more than a lower would do. Consequently :—

> Wide apertures when high amplification is required; low or moderate apertures when low or moderate amplifications are sufficient or cannot be overstepped.

2. The utilization of a given aperture depends in principle on the amplification of the ultimate image which is projected by the entire Microscope to the observer's eye. Now one and the same amplification may be obtained in very different ways since it is the resultant of three distinct elements, (*a*) focal length of the objective, (*b*) focal length of the ocular, and (*c*) length of the tube. Any definite number of diameters (say 1000) can be obtained with a low power objective (say a 1-inch) as well, from a mere dioptrical point of view, as with a higher power (say ⅛-inch), by applying a sufficiently deep eye-piece and a sufficient length of the tube. It is, however, well known that there is a great difference in the optical qualities of images which are produced under these different conditions. Forcing a high amplification from a low-power objective is always connected with a considerable loss of sharpness of definition of the image, owing to the magnification of the residuary aberrations, which are inherent even in the most finished constructions. It is, therefore, a well-established practical rule that a certain amount of amplification requires a certain power of the objective—higher amplification a higher power (shorter focal length)—in order to obtain the image under those favourable conditions which are necessary for their full effectiveness. This considered, the inference of the foregoing paragraph may be expressed in these terms:—

> Wide apertures with objectives of short focal length; low and moderate apertures with objectives of low and moderate power.

As a detailed discussion of this subject will be found in the second part of this paper, it will be sufficient here to point out some notable facts of experience by way of example only.

With objectives of say 1 inch, and ½ inch, focal length, the lower and medium eye-pieces in use will yield 40-80 and 80-160 diameters only. In order to obtain 150 and 300 respectively, very deep oculars (or an extra length of the tube) would be required. So far now as such objectives are intended for the lower powers mentioned above, an aperture of about 0.15 (18°) in the case of the 1-inch, and of 0.3 (35°) in the case of the ½-inch, are at all events more than sufficient for showing every detail which can possibly be recognized by the eye under these amplifications, and therefore wider apertures are useless. In point of fact, no observer will see anything more or anything better with similar objectives of say 0.40 (48°) and 0.75 (96°) respectively, than with the narrower angles indicated above, as long as the low and medium oculars are in question only. These latter apertures would require for their full utilization, *i.e.* for convenient observation of the minuter details which are within their reach, amplifications of much more than 150 and 300 diameters. With well-made objectives of those apertures, such figures may be realized indeed, and details may be shown by means of deeper eye-pieces, which remain quite invisible with the lower angled systems; but no microscopist can deny the inferior quality of the images obtained in this way if compared to those of equal amplification, which are obtained with these same apertures when the objectives have double the power and the oculars the half only. Structures of so simple a composition as diatom striæ may perhaps be tolerably displayed under such forced amplifications of low-power objectives, but with objects of somewhat irregular and complicated structure the deterioration of the image attendant upon a considerable enlargement of the residuary spherical and chromatic aberrations by deep eye-pieces, becomes at once obvious even with the most finished objectives. In point of fact, no experienced histologist will ever use in ordinary work even an ocular amplification of the amount necessary for obtaining 100 diameters from a 1-inch objective or 200 from a ½-inch. He would be unwise if he troubled himself with inferior images whilst good images of the amplifications required could be obtained with equal, or even greater, convenience with objectives of the same apertures but half the focal length.

The above is an example of waste of aperture, or lack of useful power; waste of power and lack of aperture are exemplified by every objective of excessively short focal length, *e.g.* 1-50 inch. Such a lens, even if immersion, cannot be made with an aperture of much greater numerical value than 1.0, in consequence of the technical obstacles arising with such very short focal lengths. Now the limit of an aperture of that amount is entirely exhausted, at all events with a power of 1000 to 1200 diameters, inasmuch as nothing of the real attributes of an object can be seen with that aperture under a higher amplification, which could not be as well recognized under the lower. A 1-50, however, will yield 1500-2000 diameters with the lowest eye-pieces which are usually employed. The lowest attainable power is therefore an empty power already, and every useful amplification available with the aperture in question could be obtained under favourable conditions and with much less inconvenience by an objective of half the power, or even less.

3. The preceding shows that wide apertures can only be utilized in the observation of minute details, under high amplifications obtained with objectives of short focal length. Wide apertures are therefore useless when those conditions are not fulfilled, because in this case the same result could be obtained as well with low-angled systems. But as abundance, *primâ facie*, is no detriment, the foregoing considerations do not enforce any positive objection to the use of wide apertures for every kind of work. There are however other points of view from which it becomes obvious that the application of wider apertures than can be utilized is not merely superfluous but is a decided disadvantage, inasmuch as they prevent the utilization of some really valuable benefits which are the privilege of low and moderate apertures.

The first disadvantage results from the reduction of the depth of vision (or the "penetration" of the Microscope) which is connected with wide apertures. I have given in another place * a discussion of the circumstances on which penetration depends, and the formulæ which afford an approximate numerical estimation of the depth of vision in microscopic observation. These theoretical suggestions show (in accordance with the experience of practical microscopists) the reduction of penetration with increasing aperture under one and the same amplification, and especially when the amplification is not restricted to very small figures. Now there are many objects of microscopical research which do not require, and, indeed, do not even admit of high powers, but demand for effective investigation as much penetration as possible. This is always the case where the recognition of solid forms is of importance, and therefore a distinct (at least, a tolerably distinct) vision of different planes at once must be possible, whether the observation is assisted by stereoscopic devices or not. The greater part of all morphological work is of such a kind, and in this line of observation therefore a proper economy of aperture is of equal importance with economy of power.

Whenever the depth of the object under observation is not very restricted, and it is essential that the depth dimension shall be within the reach of direct observation, low and moderate powers cannot be overstepped, and no greater aperture should therefore be used than is required for the effectiveness of these powers—an excess in such a case is a real damage. High powers and correspondingly wide apertures are restricted to those observations which do not require any perceptible depth of vision, *i.e.* to two different cases (1) when the objects are quite flat or exceedingly thin; (2) when preparations of greater depth are sufficiently transparent to admit of an indirect recognition of their solid structure by means of successive optical sections through successive focussing of different planes. For the latter method of observation the loss of penetration with increasing power and aperture is no drawback, but rather an advantage, because it enhances the distinct separation of the sectional images at successive

* See this Journal, i. (1881) p. 689.

foci. A disregard of these natural restrictions in the use of wide apertures is obviously the origin of the opinion that aperture *per se* is antagonistic to good definition. It is quite true that there are many even very delicate objects which are much better seen under a given amplification with a system of very moderate than with one of very wide aperture, the former giving a clear view of the whole structure, the latter showing perhaps some distinct points, but as a whole veiled in haze. Provided, of course, that we have well-corrected objectives, the fault here is not on the part of the lens, but on the side of the object, which requires for proper recognition a greater range of depth than is reconcilable with a wide aperture. The theoretical suggestion which has been brought forward in support of the notion that different parts of the clear area of an objective produce dissimilar images, and that therefore the resultant image must show increasing confusion with increasing aperture, cannot apply to the delineation of a plane object. In a well-corrected objective the partial pictures received through the various parts of the aperture-area are always strictly similar so far as one plane of the object is concerned. The confusion suggested is nothing else but confusion of the images of different depths—lack of penetration, but not lack of "definition" in any reasonable sense of that term. Provided the objectives are properly corrected and the objects are fit for the delineation of an image, undisturbed by interfering confused images from other planes, the "defining power" of an objective is always greater with greater aperture for every kind of objects, inasmuch as under all circumstances the wider aperture admits of the utilization of higher amplification than can be obtained without perceptible loss of sharpness (with the same objects) by lower apertures.

There is therefore no drawback in principle to the use of a large aperture when the objects are suitable. But the considerations above lead to the conclusion:—

> Wide apertures (together with high powers) for those preparations only which do not require perceptible depth of vision, *i.e.* for exceedingly flat or thin objects, and for transparent objects which can be studied by optical sections. Moderate and low apertures when a wide range of penetration cannot be dispensed with.

4. There is still another point of view, and one of special practical importance, which shows the positive damage connected with the use of unnecessarily wide apertures. The increase of aperture is prejudicial to the ease and convenience of microscopical work in two essential respects.

1stly, It necessitates a progressive reduction of the working distance of the objective. Owing to the rapid increase of the anterior aberration with increasing obliquity of the marginal rays (particularly in the case of dry lenses), perfect correction of a system cannot be obtained unless the layer of low refraction between the object and the front lens (*i.e.* the working distance) is reduced to a certain fraction of the focal length of the system, which fraction is necessarily diminished in a rapid proportion as the aperture becomes greater and greater. Whilst there is no objection to retaining as working distance 7-10 of the focal length for an aperture of 30°, if the aperture is 60° not more than 3-10 can be allowed, and with an aperture of 116° really good correction is not reconcilable with a working distance exceeding 1-10 of the focal length. It is therefore an obvious disadvantage to use aperture angles of 60° and of 116°, when the power which is required or available can be obtained with 30° and 60° respectively.

2ndly, Increase of aperture is inseparable from a rapid increase of sensibility of the objectives for slight deviations from the conditions of perfect correction. The state of correction of an objective depends on the thickness of the refracting film between the radiant and the front lens, represented by the cover-glass and that portion of the preparation which is above the actual focus. This is a variable element independent of the objective itself. In order to avoid large aberrations which must result from the change of that element, its variation must either be confined to narrow limits or must be compensated for by a corresponding change in the objective. Now there is a great difference in regard to this requirement between the objectives of low and of wide aperture, in particular with the dry system. An objective of a few degrees is almost insensible, it may be focussed to the bottom of a trough of water without any loss of performance. With 30° differences in the cover-glasses within the usual limits are still inappreciable, and an object may be seen at the depth of a drop hanging on the under surface of a cover-glass. With 60° a deviation of the cover-glass from its standard thickness by not more than 0.1 mm., or a corresponding increase of the depth of the preparation above the actual focus, will introduce perceptible aberrations and a visible loss of definition if not compensated for. With an aperture exceeding 100° in a dry lens, the same result will arise from a change of thickness of 0.02 mm. only. To preserve always the best correction in such a system would necessitate a change of the correction-collar for almost every change of focus in the inspection of successive layers, unless the preparation is exceedingly thin.

So far as the necessity of obtaining a certain amount of amplification in an efficacious manner requires a certain aperture, the above-mentioned restrictions and difficulties in the proper management of the objectives cannot be avoided. But all restrictions in regard to the objects, and all the trouble taken in the adjustment of the objectives, is quite for nothing when the small result can be obtained with a lower aperture. If for the sake of convenience the precautions required in the use of wide-angled lenses should be disregarded in working with the lower powers of wide aperture, the performance of such lenses is always worse than that of much narrower apertures under the same amplification. The best wide-angled system, if not carefully adjusted when in use, is not better than a bad low-angled lens, for the tolerably sharp image, which could be still obtained through the central part of the aperture alone (even under the imperfect state of correction) is disturbed by the coarse dissipation of light from the ineffective marginal parts of the aperture.

The amateur who likes the Microscope for his amusement may not much object to some extra trouble connected with the use of wide-angled low-power lenses, which he admires as brilliant specimens of optical art. For those, however, who work with the Microscope, the economy of labour to which they are obliged will be expressed by the rule:—

> Never use wider apertures than are necessary for the effectiveness of the power, because excess of aperture is always waste of time and labour.

5. A few remarks about another point of practical interest. By those who plead in favour of large apertures in all cases, it has been sometimes suggested as a rational plan for reconciling opposite demands, to have all objectives constructed with relatively wide angles, and to reduce them by stops or diaphragms when smaller angles are desired. The greater penetration and insensibility of the low apertures may of course be attained thereby: but nevertheless this device is only a makeshift, and the result is inferior to that obtained by objectives originally arranged for a lower aperture. It is not merely that the stops cannot increase the working distance (which will always remain at the point corresponding to the full aperture of the lens), but that the low-angled lens which is made out of a good wide-angled one by means of a stop, is in optical respects a relatively bad objective—not nearly as well corrected as the same power would be if carefully adjusted for the lower angle. The reason will be readily understood from the following consideration.

The best correction of an objective of given aperture depends on the proper distribution of a certain amount of residuary aberration, which cannot be eliminated with our present means. The greater the aperture the more aberration must be intentionally left at the central part of the system in order to prevent an obnoxious accumulation in the marginal zone. It is obvious, therefore, that with an aperture-angle of say 90° the inmost cone of 45° cannot be so well corrected as it might be if the marginal zone could be left out of account. The effect is by no means inconsiderable, particularly in regard to the colour corrections. Owing to the chromatic difference of the spherical aberration the central portion of a somewhat wide aperture must always, even in a well-arranged objective, be perceptibly under-corrected chromatically, and in using this central part alone (the compensating influence of the over-corrected marginal zone being done away with), we have the performance of an inferior lens. In point of fact, no intelligent optician would ever make an objective of 30° aperture on the same formula as one of 60°, or one of 60° on the same formula as another of 100°, though this could be done by merely reducing the clear diameter of the lenses.

There cannot, therefore, be a reconciliation between the pleasure of exhibiting mere optical accomplishment and the interests of the working microscopist. Bad lenses will certainly not meet the demand for low and medium powers affording the utmost possible economy of time and labour in scientific work. This can be done only by systems in which all advantages attendant upon the lower apertures are fully realized by constructions specially aiming at the best which can be obtained under the actual conditions of the case.

The progressive increase of aperture in the higher powers, formally within the capabilities of the dry system, and at a later period by the development of the immersion method, is, without any reasonable doubt, the most important feature of the modern advance of microscopical optics. It has rendered possible the successful extension of microscopical research to minuter and minuter objects, which otherwise would have been impossible by the ineffectiveness of all increase of amplification beyond certain low figures. The appreciation of that progress and the recognition of its true basis has led to a tendency to increase more and more the aperture of every kind of objectives. The fact has been disregarded that it is an entirely different thing whether the object is to promote the performance of the Microscope in the whole at the limits of its power, or to promote its performance for aims beyond these limits. The opinion has thus arisen that what is a benefit for one kind of lenses must also be a benefit for every other kind. Objectives of low and medium powers (1-inch to ¼-inch) of 15° to 60° are proclaimed at this time by many microscopists as old-fashioned and worthless things; 45° to 100°, or even 60° to 140°, are wanted for the same powers. Now as from a purely technical point of view, it is an accomplishment when the delineating power of an objective cannot be exhausted even with the deepest eye-pieces, opticians (notwithstanding the total bootlessness of such a super-abundance) of course take pleasure in making such "superior" lenses, and the natural consequence is that the lower apertures required for useful scientific research are likely to be esteemed as second-rate work, no longer worthy of high technical art.

This opinion is a fatal mistake, and its practical effect, if not counteracted, will be a decided retrogradation of microscopical optics. Nobody, of course, can have the least objection to the construction of lenses of any description whatever for the personal pleasure of this or that microscopist. Strong opposition should, however, be made against all tendencies of captivating microscopical optics, in favour of such predilections, at the cost of the general usefulness of the instrument.

Scientific work with the Microscope will always require not only high-power objectives of the widest attainable apertures, but also carefully finished lower powers of small and very moderate apertures.

From the Journal of the Royal Microscopical Society.

PROF. ABBE'S PAPER ON THE RELATION OF APERTURE AND POWER IN THE MICROSCOPE.

WE announced in the last number our intention to give an abstract of Prof. Abbe's paper, but finding it could not be usefully *abstracted*, it is presented to our readers *in extenso.*

We do not agree with some of the conclusions, especially those in which it is stated that two objectives of the same power but different apertures are necessary; nor with the statement that wide apertures by being cut down produce bad objectives; but as the proof of the pudding is in the eating thereof, we intend to present our readers next month with a series of photographs to prove the position we have taken up, and to show that low power objectives of wide aperture (up to a certain limit) are not only necessary, but are the best appliances with which to conduct microscopical research.

With the higher powers we do not differ much from Prof. Abbe's views, and any one who has studied bacteria under an eighth of 110° air-angle, and again under a fifteenth of 110° water-angle, will be ready to admit the superiority of the pictures yielded by the latter.

What we shall argue for will be two-inch objectives of 20° air-angle, one-inch of 35° and the half-inch of 66°. Something may be said regarding the quarter-inch and eighths, but the lower powers will be used to demonstrate that the position we have taken up is a correct one.

In this connection we have no wish to discourage the purchase of low-angle lenses by amateurs, but we hold that every instrument used in scientific research should be the best of its kind, and every device not calculated to produce a correct picture of an object—to tell the truth, the *whole* truth, and nothing but the truth—should be discarded, except when used for purposes of amusement, or for observations by no means critical.

We think Prof. Abbe has been exceedingly unfortunate in his selection of a *simile* when he states, "To recommend the application of wide-angled objectives for every branch of microscopy, as has been, in fact, done by excited wide-aperturists, is no more to be supported than it would be to recommend the use of a magnifier to a painter for inspecting the tree which he proposes to delineate." We may be singular in our tastes, but we certainly prefer to see a tree delineated with rugged bark, enlivened with natural patches of orange-yellow and olive-green, betokening the presence of lichens, and the dark-green of mosses, *the details painted in;* instead of a broad wash of colour, putting one more in mind of a green or brown fence, without any detail, and such is the difference when two objectives of half-inch power, one of 35° and the other of 66° are worked over a shell of *Pleurosigma formosum.*

HOW TO FOUND A LOCAL MICROSCOPICAL SOCIETY.

IN the fall of last year, and also at the commencement of the present, we received several enquiries upon the above subject from correspondents wishful to start microscopical work in their respective towns. They wished to be informed of the *modus operandi* to be gone through in order to successfully launch a Society and give it a permanent existence. We wrote advising that the subject should be postponed until a convenient season in this year: that period has now arrived, and a few words upon the subject may lighten the labours of those who wish to devote their energies to the foundation of a local Microscopical Society.

In the first place, an energetic Secretary must be found, and this selection requires very delicate management. A Secretary should be fairly well known in his district, a good microscopist, and his occupation should be approximately regular in order that "pressing engagements" do not interfere with his attendance at meetings.

The President (and we perhaps should have mentioned him first) should be chosen, as much for his social position as for his scientific worth. If both qualifications can be secured, so much the better, otherwise it will often be found that the former possesses more attraction, and a good, genial President, a good business man, will be more likely to lay a good foundation for the Society than a crotchety scientist, whose sole aim is to air his views and to impress upon the members that there is nothing new under the sun, at least to himself.

If the President be wise he will leave most of the general work to the Secretary, reserving to himself the task of giving aid on momentous occasions, and friendly advice at all times. In many Societies it is too much to expect the President to attend every meeting, and therefore provision must be made in the shape of Vice-Presidents, for a chairman on every occasion when the President is absent.

Four Vice-Presidents are sufficient,—neither more nor less should be chosen,—and they should be as carefully selected as the President. Let it not be forgotten that although it may be an honour to the individual to be selected, yet the welfare of the Society is the object of primary importance, and men should be chosen, not for their own aggrandisement, but to set a good example to other members of the Society, to smooth over many matters which are continually cropping up at meetings, to say a kindly word to members who have been at some trouble in bringing forward subjects at meetings, and to aid generally in pecuniary matters, or by the influence of their position.

Then there are the Committee-men and Officers to be thought of,—they should all be good business men, and the best microscopists the neighbourhood possesses. They should not be selected for the simple reason that they possess miscroscopes, but because they know how to use them, and for the aid they may be supposed to render in the several branches of Natural History.

It is a great mistake to be lax in these selections, or to assume that because one has the classical authors at his fingers-end he is necessarily a good microscopist. The Council, as a body, should be an honour to the Society, and should contain the most important members of the district within it. If this be accomplished, little difficulty will be experienced in keeping up its status; but when party feeling is rampant, and every other member becomes infatuated with an idea that he should be President, the Society will suffer by the division of interests which should be consolidated.

A Society should endeavour to found and maintain a reference library, and possess a cabinet of slides which may be consulted. This renders a Librarian and Curator necessary, and careful appointments should be made.

As to Rules, these should be very well considered. Those of the Manchester Microscopical Society may serve as a guide in this direction, and therefore they are inserted.

I.

The Society shall be known as the MANCHESTER MICROSCOPICAL SOCIETY.

II.

The objects of the Society shall be to associate its members for mutual assistance in Microscopical matters, to promote accurate working with the Microscope, to hold meetings at which papers may be read and discussions take place thereon, to organise out-door excursions, to form a library of Microscopical literature for the use of the members, to promote the exchange of slides and all other acts which may be conducive to the welfare and advancement of the Society.

III.

The business of the Society shall be conducted by a Council consisting of a President, four Vice-Presidents, Treasurer, Librarian, Curator, and Secretary, and ten members of Committee, all of whom shall be honorary: seven shall form a quorum. All the members of Council shall retire annually, but shall be eligible for re-election except in the case of those members of Committee who have attended less than two-thirds the number of Committee meetings, in which case they shall not be eligible for re-election for at least one year after their retirement.

IV.

At the December ordinary meeting in each year the President, or failing him the Chairman, shall invite the members to nominate candidates to form the new Council, informing them at the same time of those members who are not eligible for re-election. Each candidate shall be nominated (with his consent) by at least two members of the Society. Such nominations must be in writing and be delivered to the Secretary on or before the January ordinary meeting. The list of nominations shall then be printed as a ballot paper and sent to each member of the Society at least fourteen days before the Annual General Meeting. If no nominations are made by the members, or the nominations are not sufficient, the Council shall nominate the requisite number to fill the posts.

V.

That every candidate for membership, whether lady or gentleman, must be proposed and seconded at an ordinary meeting, and voted for at the next; that a majority of two-thirds of the members present at such meeting shall be necessary for election; and that on payment of the subscription, such member shall be entitled to the privileges of the Society.

VI.

The Secretary shall, in December of each year, write to each member of the Society whose subscription is in arrear, requesting immediate payment, when (if his request be not complied with before the end of the following January) the Council shall prepare a list of the names and addresses of such members, which shall be read out at the Annual General Meeting, and the persons dealt with as the majority of members present think fit.

VII.

That the Annual Subscription be five shillings—payable in advance, and due on the first of January in each year; but any member joining after Midsummer shall, for that year, be liable for half the subscription only.

There shall be an entrance fee of five shillings so soon as the Council deem fit to impose it.

A voluntary fund shall be formed for the purchase of books, specimens, instruments, &c., to which the members are invited to subscribe.

VIII.

The following Meetings shall be held by the Society:—

(a.) Council Meetings, convened by circular by the Secretary, as instructed by the Committee, at times most convenient to the majority.

(b.) Ordinary Meetings of the members to be held on the first Thursday in each month, commencing at 7 p.m. and close not later than 10 p.m.

(c.) Annual General Meetings to be held on the last Thursday in February in each year; and

(d.) All other meetings to be called Special General Meetings.

IX.

The Annual General Meeting shall be convened by circular, and held on the last Thursday in February in each year, when the minutes of the last Annual Meeting shall be read, together with a report of the proceedings of the past year, the Treasurer's audited accounts submitted, the Officers for the ensuing year elected by ballot amongst the members present, and other business relating to the general interests of the Society transacted. The members must vote personally: no proxies will be allowed. The Auditors and Scrutators shall be appointed by a majority of votes at the Annual General Meeting.

X.

That at all ordinary meetings the following be the order of business:—The minutes of the last meeting shall be read and confirmed; new members proposed or elected; communications made (if any); papers read and discussed;—after which the meeting shall resolve itself into a conversazione.

XI.

That a record be kept by the Secretary of all the proceedings of the Society, and that this, together with a list of the members and their addresses, be open to the inspection of any member of the Society.

XII.

That any member may introduce a friend to any ordinary meeting; but no visitor shall be allowed to be present at more than two meetings in a session.

XIII.

That the Council for the time being be the nominal custodian of the property and effects of the Society, and be empowered to invest the funds thereof in any way the majority think fit for the general welfare of the Society.

XIV.

That honorary members shall be admissible, among whom may be included persons distinguished for their attainments in Microscopy, and that such honorary members shall be nominated by the Committee, elected by a majority at a General Meeting, and have all the privileges of ordinary members, except that of voting.

XV.

Special General Meetings may be convened at any time by the Hon. Sec., on receipt of a requisition signed by at least 20 members of the Society, by sending a notice to each member of the Society, stating the object of the meeting, at least 14 days before the proposed meeting is to take place. Resolutions passed by a majority of members at these meetings are to be considered as being passed by a majority of the Society.

XVI.

The Council shall have power to enact Bye-laws for the successful working of the Library, Slide-Cabinet, and such other sections which are from time to time established. Such Bye-laws shall have the full power of Rules immediately after their enactment; but they must be brought up for sanction at the ensuing Annual General Meeting.

XVII.

That no alteration be made in these Rules except at the Annual General Meeting or at a Special General Meeting called for that purpose. Notice of such alterations shall be sent to each member of the Society in writing, at least one month before the meeting at which the alteration will be proposed.

A low subscription is advised, a high one is only allowable when the Society publishes its own "Transactions;" it is, however, doubtful how far this step is a wise policy, and it should be well considered by the Council of every Society whether it would not be better to pay the cost of illustrating their papers in a journal such as The Northern Microscopist, rather than to spend more money in issuing a non-illustrated one. A low subscription brings in a large army of workers, who have perhaps neither the means nor the inclination to pay a high fee; and we take it that the chief aim of a Microscopical Society is the diffusion of knowledge, and not to form a select gathering of a monied few.

While on this subject, just a word of exhortation to the heads of Societies. Do not keep aloof from the younger and less favoured members; remember that the success of the Society, the general microscopical training, and the polish, so to speak, of the individual member depends upon the harmony kept up within its walls. We have always found less favoured microscopists very grateful for help and information, and, on the other hand, it is impossible to come in contact even with students without learning something new, and therefore all are benefited. In the North there is nothing to find fault with on this score,—there is a certain feeling of scientific equality which smooths over many a difficulty; but in many parts of the South, where microscopical societies should flourish more than they do at present, there is more reserve, and the different sections hold aloof from each other, as if one was not comfortable in the other's presence. Such feelings are detrimental to the welfare of any Society.

Now, a word to our correspondents—"How to found a local Microscopical Society." An informal meeting of those who consider it desirable that a microscopical society be established should be held, and there the probable success of the undertaking should be freely discussed; the President and Hon. Secretary should be named, and asked if they would accept office if elected. A formal meeting should then be called by circular and advertisement, and held in some public room, "of all gentlemen interested in the formation of a Microscopical Society for the town of ———," and in the interim those present at the informal meeting should wisely consider who should be proposed as Vice-Presidents and Committee, getting their consent also for nomination.

During the first year, and especially at the first election, it is inadvisable—nay, decidedly impolitic—to have more nominations than there are vacancies to fill. By arranging this quietly before the meeting, no petty jealousies are excited, and the Society is bound to travel more smoothly. If care has been exercised in the selection of the Council, and a good, honest list prepared, it may be depended on to pass; but if, on the contrary, it has not been carefully selected, there will be endless discussion and annoyance.

At the opening of the meeting, the Chairman sets forth the object for which the gentlemen have been called together, after which the following resolutions may be put forthwith :—

1. That it is desirable a Microscopical and Natural History Society should be established for the town of ——.

2. That the Society be called The —— Microscopical Society.

3. That all members signing the memorandum lying upon the table be admitted original members of the Society without the payment of an entrance fee.

4. That the following members be elected as members of the first Council, *viz.*, President, four Vice-Presidents, twelve members of Committee, Treasurer, Librarian, Curator, and Hon. Sec.

5. That a series of Rules be drafted by the Council, such draft to be in the hands of the members on or before the first monthly meeting, when they shall be brought up for amendment or adoption.

6. That the meetings of the Society be held once in each month, at such time and place as may be decided upon by the Council.

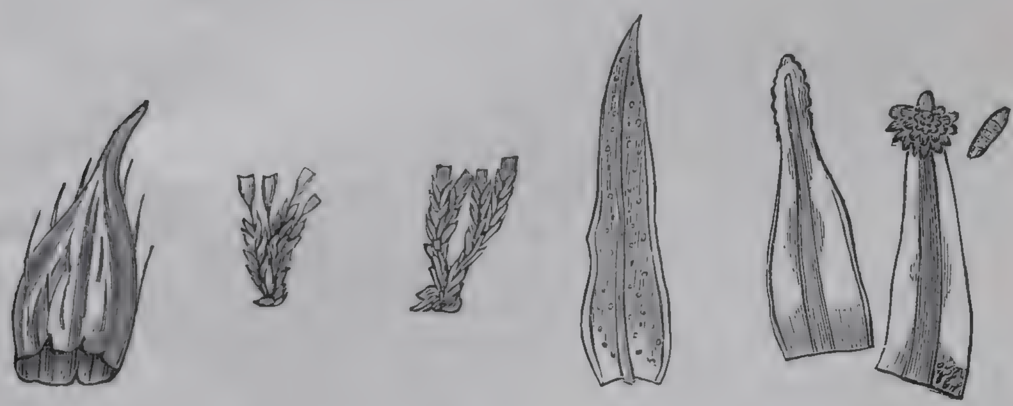
After these resolutions have been carried, the President declares the Society in existence, makes a few remarks upon the value of a good knowledge of Microscopy, and adjourns the meeting to some previously decided date, at which he delivers his inaugural address; the Committee, in the meantime, taking steps to ensure a good attendance, and finding subjects to amuse and instruct those present, either by means of short lectures, illustrated by diagrams, or sciopticon, or by the holding of a Soiree, where many microscopes display such objects as are generally entertaining.

NOTES ON MOSSES.

AS we are now in the midst of the holiday season it will perhaps be appropriate to mention one or two of the happy hunting grounds for the Muscologist.

Commencing near home, we have first of all Marple and Dan Bank, then Staley Brushes, where permission to ramble up the stream will have to be procured from any of the Ashton or Stalybridge Waterworks Committee.

From Buxton to Miller's Dale, for variety of species, will prove one of the most successful; over one hundred different species being collected during a day's ramble in that neighbourhood. The sandhills at Southport, however, while quite as rich, boast a greater number of the rarer kinds, being peculiar in this respect, as many Mosses are found amongst these sandhills which are found nowhere else in Britain, except in Cornwall, or on the well-known Bens of Scotland.



Figs. 10. 11. 12. 13. 14.

To those who are making Wales their summer resort, the Conway valley and the neighbourhoods of Dolgelly and Barmouth will prove especially fruitful and interesting; but to those who have the time, and also that important factor, the means, Scotland is the grand pilgrimage for all true lovers of this beautiful little plant —Ben Lawers being a veritable "Mecha" in this respect. Of the six hundred British species, over three hundred and fifty are found on this mountain, of which twenty are found nowhere else in Britain.

Of the Mosses in fruit this month, the Orthotrica, or Bristle-mosses, claim our attention, as many of the rarer species of this genus as *Sturmii*, *stramineum*, *speciosum*, *Lyellii*, and *Ludwigii* can now be searched for. Allied to the Grimmias they are very similar in appearance, being perennial and growing in round tufts of a dark-brown—almost black colour; they are termed bristle-mosses from the character of its calyptra, Fig. 10.

Stems from ¼-inch to 1-inch in length, leaves oblong-lanceolate generally, capsules pear-shaped or elliptical, and either exserted as in *O. saxatile* (Fig. 11), or immersed in the leaves as in *O. cupulatum*, Fig. 12. This distinction dividing the genus into two broad groups.

They are found on trees or rocks and walls, never on earth—the fruit ripening exactly twelve months from the first appearance of the flower. Peristome, in one or two cases absent, is either single or double of 32 teeth connected so as to seem 16.

A common species is *O. affine*, the common wood bristle-moss, capsule oblong with narrow striæ and somewhat exserted; leaves spreading oblong-lanceolate; margin revolute and slightly undulate, strongly papillose or with bluntish prominences on both sides, Fig. 13.

The following species may also be mentioned: *O. rupestre*, *O. anomalum*, *U. crispum*, *U. Hutchinsæ*, and *U. phyllanthum.*

The last named, the frizzled bristle-moss, is found near the sea, but fruit not known; the nerve of the leaf extending to or beyond the apex where it is generally covered with gemmæ, Fig. 14.

Many of the Dicranaceæ may be gathered this month, as also many of the Bryums; the more common species being *D. scoparium* and *D. majus*, found on shady banks in woods, and *B. pallescens*, on rocks and walls. The following are more rare: *D. Starkii*, *D. falcatum*, *D. Blyttii*, *D. Scottianum*, and *D. fuscescens* found on Alpine rocks, while *D. squarrosum* frequents wet mountainous places, but it is rare in fruit. *B. latifolium* and *B. uliginosum* are met with in boggy places, whilst rocks and walls suit *B. acuminatum*, *B. polymorphum*, *B. elongatum*, and *Z. julaceum.* *Z. demissum* is a very rare species, and *B. Warneum* is only found at Southport and in Scotland. *Mnium stellare*, always reported as not fruiting in Britain, has been found in fruit in Derbyshire during the last two months by Mr. G. A. Holt, of Manchester.

A very marked genus is the Encalyptas, or extinguisher mosses, from the calyptra completely enveloping the capsule.

Belonging to the group Splachnaceæ is a very interesting moss in fruit this month, *Œdipodium Griffithianum.*

It was first found on Ingleborough in Yorkshire, and subsequently on Ben Lawers, Ben Nevis, Ben Cruachan, and other mountains in Scotland. Wilson says it is confined to Britain, and it is stated that Professor Schimper, the author of the *Bryologia Europæa*, paid a special visit to England, to personally gather this and other mosses. An exceedingly fine collection of specimens, examined and named by Professor Shimper, was recently presented to the Manchester Free Reference Library by Mr. John Windsor. There are also in the library collections of Mosses made by Messrs. Nowell, Buxton, and Hobson.

Of the Hypnums, or Feather Mosses, the most noticeable is

Hypnum giganteum, found fruiting this month on Wybunbury Bog; it is also found, but in a barren condition on Hale Moss.

It is dioicous with densely primate erect thick stems, often a foot long; the leaves are broadly cordate-ovate and strongly nerved to apex; capsules oblong-cylindrical, horizontal on a long seta, lid mammillate.

On shady rocks may be gathered *H. demissum*, *H. pulchellum* and *H. denticulatum;* limestone rocks, *H. delicatulum* and *H. confervoides*, and in woods, *H. undulatum* and *H. crista-castrensis*.

WILLIAM STANLEY.

OUR BOOK SHELF.

Micro-Fungi: when and where to find them. BY THOS. BRITTAIN. Manchester: Abel Heywood & Son.

This interesting little work, published at the modest price of one shilling, will be welcomed by many a field naturalist, who up to the present time has been without an inexpensive work on micro-fungi to aid him in his rambles. To the student, such a guide book is invaluable, and as Mr. Brittain is well known as a collector of micro-fungi, and his knowledge of localities so extensive, especially in the neighbourhood of Manchester and Buxton, that no words of ours are necessary to recommend it.

The work had its origin in the papers contributed to THE NORTHERN MICROSCOPIST by Mr. Brittain; some of them have been revised, and an appendix of some value to the student has been added.

A Bibliography of the Microscope and Micrographic Studies, being a catalogue of books and papers in the library of Julien Deby, F.R.M.S., &c., &c. Part III.

Mr. Deby in the preface of this admirably printed catalogue writes, "It is hoped that the present catalogue of books and papers, prepared for my personal convenience, may also prove of some utility to Microscopical friends.

Considerable labour has been involved in its preparation, so as to make it not only a list of books in my own library, but by the addition of the 'Desiderata' as complete a Bibliography as possible.

Part III., comprising the literature of the Diatomaceæ, for which I have had the good fortune of securing the active co-operation of Mr. F. Kitton, F.R.M.S., is printed in advance of Parts I. and II., which will contain similar lists of the works relating to the microscope proper, the Protozoa, the Desmidiæ, and to some other branches of Natural Science. These are nearly completed, and will follow promptly.

This catalogue is intended for private distribution, and the number of copies is necessarily very limited. I have, however, reserved fifty copies for gratuitous presentation to such Microscopical Societies as may make early application through their respective Secretaries." Mr. Julien Deby's address is 75, Holland Road, Kensington, London, W.—Ed.

The Journal of the Postal Microscopical Society. No. 2. London: W. P. Collins.

This periodical in its second issue is fully as interesting as the first number. There is much that is valuable in it, and very readable is "An Hour at the Microscope" by Mr. Tuffen West. We must however take exception to the instructions given for photomicrography, except it be the sentence "the best and quickest way * * would be to go to a photographer and take a few lessons" which we fully endorse so far as regards developing plates.

Our advice is always, "do not purchase lenses specially corrected for photography—ordinary lenses will do quite as well." We do not agree, either, in instructing the amateur to use magnesium light for such low powers as the one inch and half inch, an ordinary argand gas lamp will do all that is required. Only yesterday we obtained a very good picture of Polycistina × 65 diameters with the inch objective and A eyepiece, the slide being illuminated with Wenham's paraboloid. An exposure of two minutes was required, while when the C eyepiece was substituted for the A, giving thereby 130 diameters, four minutes was found necessary. What more could the amateur require?

It is well to put on record here, that some lenses require to be *approached* the slide in order to correct for actinic focus. There is much in the article, however, that is interesting, and the sentence, "the majority of amateurs expose dry plates too long," should be always borne in mind.

Studies in Microscopical Science. Edited by A. C. Cole, F.R.M.S. London: Ballière, Tindall, & Cox.

Numbers 7, 8, 9, and 10 of this weekly periodical are now before us, and the microscopist must be hypercritical indeed if he be not pleased with the result of Mr. Cole's work. No. 7 is devoted to a description of the Spinal Cord of Cat: the etymology is well defined, and a good description given of the Megascopic characters of the Spinal Cord, its microscopical character and blood vessels. Finally, there are six methods of preparation given, and a bibliography relating to the subject. No. 8 is devoted to the bracken fern *(Pteris aquilina)*. No. 9 to a section of the Human Liver; while No. 10 gives a clear account of the thallus of the sea-weed *Fucus vesiculosus*, or bladder-wrack. The chromo-lithographs are really the best of the kind that have hitherto appeared. Messrs. Watson & Son have now a claim to be considered perfect delineators of microscopic objects. None the less perfect are the slides accompanying the periodical, and we strongly hope Mr. Cole will meet with such encouragement as to cause him to look upon his undertaking as a permanent work.

We have also received the *Report and Proceedings of the Manchester Scientific Students' Association for the year 1881*, containing much interesting matter; the *Proceedings of the Liverpool Field Naturalists Club for the year 1881-82*, shewing that that Society is doing a great deal of useful work, and of which the President's address on Animal Adornments, may be read with profit; and the April and May *Transactions of the Hertfordshire Natural History Society*, which complete their yearly volume, and contain reports of field meetings and general society business.

TO SECRETARIES OF SOCIETIES.

In view of the constantly increasing pressure upon our columns, we find it impossible to give such full and complete lists of objects shown at the Ordinary Meetings and Soirees of Societies, as we hitherto have done.

We do not wish all lists expunged from reports, but that there should be some method in enumeration is evinced by the numerous letters we have received during the last six months, to the effect that in the opinion of our correspondents, many of these lists are of but little use. Our own views coincide completely with those of our correspondents. We had long been of opinion that the lists of objects might be cut down with advantage, but wished for twelve months at least, to provide a permanent record, useful to young Societies and to those wishful to exhibit at Soirees. We have done this, and therefore ask the Secretaries of Societies to aid us in making their lists as interesting as possible, confining it to objects shown to illustrate papers or other communications, new apparatus, and to *rare* specimens met with in the district.

NOTICES OF MEETINGS.

BOLTON MICROSCOPICAL SOCIETY.—This Society made its first ramble during the summer recess on Saturday last. Taking the 2.50 train to Atherton, the members were conducted by Messrs. Midgley and Shipperbottom to the various ponds and ditches which abound between there and Chequerbent. In a pond found soon after leaving the station, the larva of the great water-beetle *(Dytiscus marginalis)*, and the beautiful building rotifer *(Melicerta ringens)* attached to the pond weeds was discovered and transferred to bottles or tubes of the members. In the same pond was seen the great newt *(Triton cristatus)*, and several tadpoles of it were secured for aquaria. The common hydra *(Hydra vulgaris)* had here a happy existence amongst an abundance of water fleas, cyclops, &c. A little further on in the fields a pond was reached which proved a fruitful source of interest. The surface is just now adorned with the somewhat rare water lily *(Nuphar lutea)*, which Mr. Midgley described in detail, explaining the utility of the air cavities being larger in the peduncles than in the petioles; the existence of stellate crystals of lime in the structure of the plant, with other interesting lore in connection with it. Here they found that wonderful rolling plant, the *Volvox globator*, in abundance; and, by means of Mr. Shipperbottom's collecting apparatus vast numbers of these beautiful desmids were procured. Attached to some duckweeds were found the tree vorticella *Carchesium polypinum* and other infusoria. A grand polype *(Plumatella repens)* was also found. The pond seemed full of life, whilst around its banks the botanically minded amongst them had a variety of plants seldom met with in this part of the county. From this pond they wended their way through the fields across the railway, where in one of the ponds along Clegg-lane, Mr. Shipperbottom found the phantom larva, an object of great transparency, in which the nervous system was afterwards well shown under the microscope. In another pond was found a patch of the water buttercup *(Ranunculus aquatilis)* in full flower, forming a pretty sight as it floats on the surface. The double foliage was noticed as well as the reason of the submerged leaves being so multifid, and the floating ones trifid. Another dip brought out the flagiliate infusorian *(Euglena viridis)*. In another pond was growing the stately yellow flag *(Iris pseudacorus)*, a spike of which was plucked and the position of the anthers in relation to the stigmas of the flower pointed out. Many other wonders in pond life were met with, which we are sure will furnish ample material for study for many a day to come.

MANCHESTER MICROSCOPICAL SOCIETY.—The above Society's excursion to Ashley for Castle Mill, announced for Saturday, July 8th, under the leadership of Mr. Graham, took place notwithstanding the threatening character of the weather, which however had an influence on the numbers present, only seventeen joining; but they were apparently of the right stamp, enthusiastic as to the business in hand, therefore pretty indifferent as to the behaviour of the elements. It was well such composed the party, for hardly had Ashley been left behind, when a thunderstorm broke, with heavy downpour for nearly half-an-hour. Shortly afterwards the ponds in the neighbourhood of Castle Mill, wherein grows the Bladder-wort, *Utricularia vulgaris*, were reached, and all were soon actively engaged in securing specimens, of which there was no lack; but the plant was hardly in a satisfactory condition, either for the herbarium or microscopic preparations, it having passed its prime and assumed a brownish hue, the bladders being dark with the remains of the insects their remorseless trap doors have closed upon. It proved, however, to be rich with *Floscularia*, *Stephanoceros*, *Melicerta* and numerous other microscopic treats.

From the ponds there were also obtained vast numbers of *Entomostraca*, evidently of the family *Diaptomidæ*, although not agreeing in all respects with any one of the three genera of that family described in Baird's work.

After a lengthy stay at the ponds in question, the party proceeded by field paths to Morley, and then on to Lindow Common, where they added to the spoils *Polytrichum piliferum*, in fine condition of fruit; *Sphagnum cuspidatum*, *var. plumosum*, *Colypogeia*, *Trichomanes*, and *Gymnocolea inflata*, as well as the Sundew *Drosera rotundifolia*, the other insectivorous plant the expedition had in view to obtain.

The two insectivorous plants gathered derive, according to the late Dr. Darwin, benefits from the insects, each by a different method; for while the Sundew actually digests the animals entrapped, the Bladder-wort but absorbs the products of decay of the organisms it entombs in the bladders.

The wealth of wild flowers was most profuse; but in passing through Morley Meadows, by the left bank of the river Bollin, a magnificent spectacle was presented, for there, in an opening in the wood, were hundreds of the common Fox-glove, *Digitalis purpurea*, from three to five feet in height; and though thunderstorm number two was raging, the party levied tribute, reaching Wilmslow in time to catch the 6.15 train for Manchester.

On Saturday, May 27th, a few members of the Microscopical Society, under the leadership of Mr. Sington, rambled in the fields between Heaton Moor and Burnage, pond hunting and botanizing.

Among the pond-life found were *Melicerta ringens*, a number of larvæ, including those of the Ephemeridæ; Hydra, Stentors and *Volvox globator;* several varieties of Desmids and Water Scorpions, various entomostraca, the spawn of as well as full grown tritons, newts and sailor beetles. A number of Dragon flies just commencing the imago stage of their existence were also caught.

The district is not a good one for Mosses, but *Hypnum serpens* and several species of Bryum and Mnium were found.

MANCHESTER MICROSCOPICAL SOCIETY.—At the ordinary meeting in July the attendance was thin, many of the members having accepted invitations to be present at the Soirèe, given by the Society of Chemical Industry, at the Owens College.

Mr. Miles read a short paper "On the Optical performance of Objectives," with special reference to Professor Abbe's recent paper "On the Relation of Aperture and Power in the Microscope." The discussion on this paper was deferred to the September meeting.

The ramble of the members on the 17th June was next reported upon by Mr. Brittain, the conductor. The romantic Buxton valley, from Buxton to Millers Dale was truly a happy hunting ground on the occasion. The weather and the flora were equally charming, and many good gatherings of interesting specimens of micro-fungi, mosses, &c., were collected for future microscopic examination on quiet evenings at home: amongst the former many specimens were found in excellent condition. The favourite common Colts-foot cluster cup was in great plenty: some of the party now for the first time saw it in its natural condition, and are not likely to forget this their first day of a successful hunt. Soon afterwards the luxurious *Epilobium hirsutum* attracted the notice of the conductor, for upon the leaves of this plant another cluster cup was now due. On examination it was found upon a large number of the leaves, and in great plenty, as also in beautiful condition; it is known as *Æcidium epilobii*. A small quantity of the Rose rust, *Lecythea rosæ*, was met with, and a solitary specimen of the Sorrel smut, *Ustilago Kuhniana*. This fungus fixes itself upon the floral organs chiefly, and quickly destroys them. It is found sometimes upon the stalks of the plant, but in smaller quantity. The white fungus, *Cystopus candidus*, which sometimes spots over the leaves of the common cabbage, like dabs of whitewash, was found upon the Shepherd's Purse. It is very common upon the latter plant. The Corn rust, *Trichobasis rubigo-vera*, was met with on grass in moderate quantity.

Amongst the results of the ramble which will leave the most lasting impression was the Butter-wort; so called from the sticky nature of its leaves. It is known also as the Snowdon violet. It was in full flower, and a large number of the leaves of the plant had caught and held in their fatal grip a countless number of unfortunate insects. This is one of those insectivorous plants upon which Dr. Charles Darwin made some hundreds of experiments, the record of which forms one of the most charming chapters of his remarkable book on Insectivorous Plants.

In reporting on the Mosses gathered Mr. Stanley said we cannot all be Moss students, but it is as well that we should be occasionally reminded, not only of the important part that Mosses fill in the economy of Nature as the precursors of higher vegetation, but also of their value in filling in and making complete the beauty of Nature's pictures.

For how different, even to the most ordinary observer, would the various spots appear in our ramble from Buxton to Millers Dale, if we could imagine that each boulder, bank and wall was suddenly bereft of every particle of Moss; their bare and rugged appearance affording no relief to the more prominent features of the landscape. This thought was suggested by the beautiful appearance of the wall tops on the left side of the road in Ashwood Dale; being covered for yards together by the bright yellow-green leaves and stems of the Silky Feather Moss, *Homalothecium sericium*, mixed here and there with almost black patches of the bristle Mosses, *Orthotricum saxatile*, and *cupulatum*.

Of the many favourable spots around Manchester for the Muscologist this district is perhaps the richest in variety of species; although the sandhills at Southport possess a greater number of the more rare mosses.

The genus Orthotricum is named bristle-moss from the hairs on the calyptra being quite erect; while the Polytrichaceæ, or hair-mosses, besides being very large in habit, have their calyptras covered with hairs like a shaggy coat.

The stems of the Orthotricums are from ¼-inch to 1-inch in length, and the leaves are mostly ovate-lanceolate; the species *saxatile* being known from capulatum by its capsule not being immersed in the leaves, and having eight striæ very prominent when dry. Allied to Orthotricum is the genus Grimmia, named from Dr. Grimm, a German botanist, two species of which were gathered —*Grimmia apocarpa* and *Grimmia pulvinata*, the grey-cushioned Grimmia, found abundantly on wall tops and rocks, and justifying this appelation by the beautifully circular cushions formed by the short branches and hair-tipped foliage.

Of the 126 generic names of British Mosses, fully three-fourths are derived from Greek roots, with reference to marked features of the capsule and peristome; hence the attempt to establish an artificial classification from the peristome, which has proved of no avail, for along with others, this genus Orthotricum has both single and double peristomes, and in one or two intances is without peristome. Its general features, however, are so constant and well marked, that there is no mistaking the genus when once recognized. Another species *O. affine* was collected, but without fruit. Of the remaining generic names four—Tortula, Funaria, Fissidens and Fontinalis—are from the Latin; and the rest are named after various cryptogamic authorities.

Four species of Tortula or Barbula were gathered. The wall-screw moss, *Tortula muralis*, common on almost every wall, and known from the leaf, having its margin thickened, and its nerve extended beyond the apex into a very long hair point, almost as long as the leaf itself. *T. rigidula*, the lesser rigid Screw Moss, *T. recurvifolia*, recurved leaf, and *T. tortuosa*, curly-leaved Screw Moss. This genus, named from tortus twisted, is very distinct and easily known from the twisted character of its peristome. In the same family of Pottiaceæ are *Didymodon rubellus*, *Trichostomum mutabile*, and *Ceratadon purpureus*.

The same afternoon, *Seligeria tristicha* and *Hypnum commutatum*, two rare species, were collected near Millers Dale by one of our members, Mr. Cash, who has kindly given me specimens for exhibition this evening.

One of the beardless Mosses, *Gymnostomum calcareum*, is found near Buxton, as also *Zygodon viridissimus*, variety rupestris.

These are developed by means of gemmæ, not fruiting in England. Specimens were also gathered of *Encalypta streptocarpa*, the extinguisher-moss, from its calyptra entirely enveloping the capsule. This is very rarely found in fruit.

Funaria calcarea and *hygrometrica*, and *Bryum capillare* and *cæspiticium*. These are common Mosses found almost everywhere.

Cinclidotus fontinaloides, the lesser water moss, *Neckera crispa*, or crisped leaved Neckera. The genus is named after Necker, a celebrated German botanist, who denied the existence of sexes in mosses.

Of the Hypnums, or Feather Mosses, were gathered *Thamium alopecurum*, *Eurhynchium crassinervium*, and *E. Swartzii*, *Amblystegium serpens* in nice fruit, *Hypnum palustre* var *subsphærocarpon*, *H. stellatum* var *protensum* and *H. triquetrium*.

Not many Hepatics were found, as the time was altogether too short for a proper search; but I may mention *Conocephalus conicus*, the cone-fruited Liver-wort; *Asterella hemisphærica*, the hemispherical Liver-wort; *Frullania dilitata*, the tubercled Scale Moss, and from the whole surface of the calyx being covered with minute fleshy tubercles; and *Lophocolea bidentata*, the two-toothed Scale Moss.

A word may not be out of place as to preparing Mosses for the herbarium. Remove the loose and coarse dirt, and then wash well under the tap, being careful not to damage the capsules. After shaking as much water as possible from them, lay them on a tray to dry; in four or five days they will be ready to arrange in packets, and label with the proper name and number as per London Catalogue—the locality and name of collector should also be noted. Then place in a larger fold with the name of the genus attached.

Might I be allowed to suggest that these rambles could be made of permanent value to the Society, if complete lists of the objects gathered were handed in to the librarian to be catalogued, so that an official register might be made for the benefit of the members, showing when and where to find the various objects of Microscopical interest in and around Manchester.

Mr. Hyde then followed with a description of the following plants and ferns gathered in the Dale. The following had been mounted for display :—

1—*Asplenium ruta-muraria.*
2—*Polypodium calcareum.*
3—*Cystopteris fragilis.*
4—*Helianthemum vulgáre.*
5—*Geum rivale.*
6—*Hippocrepis comosa.*
7—*Poterium Sanguisorba.*
8—*Saxifragæ tridactylites.*
9— *Do. Hypnoides.*
10—*Listera ovata.*
11—*Anthyllis Vulneraria.*
12—*Fragaria vesca.*
13—*Pyrus Aria.*

Messrs. Graham and Furnival devoted their attention chiefly to Photography, and succeeded in procuring good negatives of portions of the romantic scenery in the Dale.

MANCHESTER CRYPTOGAMIC SOCIETY.—At the meeting, July 17th, Mr. Thos. Brittain, F.R.M.S., in the chair, Mr. S. Ashton brought some fern ponds for identification. These came originally from Jersey, and proved to be a finely divided form of *Asplenium lanceolatum*.

Mr. Stanley exhibited a number of Hepatics he had recently gathered in Derbyshire.

Mr. W. H. Pearson read a few notes on *Conocephalus conicus* and *Preissia commutata* and exhibited specimens. The latter species had recently been collected by Mrs. Perrin in Cheadle, and by Mr. Holt, near Buxton. This rather widely distributed species is not recorded for Derbyshire in the London

Catalogue. Mr. Pearson also exhibited specimens of *Mylia Taylori* with *colesules* collected by Mr. Geo. Stabler in Mardale.

Mr. J. W. Atkinson exhibited specimens of micro-fungus *Nectria mammoideæ*, a recent species not described in Cooke's Handbook. The specimens had been found on the dead stems of the Furze at Bowness, Windermere, May, 1882.

NOTES AND QUERIES.

Pond Life.—It may interest some Northern Microscopists to know that very fine specimens of *Melicerta ringens* may be found in great abundance in Germine Lake, at the foot of the Hambleton Hills, about five miles from Thirsk. It will be found on *Myriophyllum spicatum*, on the east side of the lake.

J. Nookthrop.

Influence of Temperature.—The temperature which seems most favourable to the bacterium of the disease called *charbon*, is that of mammalia (37°C.). Birds, having a higher temperature (about 42°), do not take the diseases under ordinary conditions. M. Pasteur, however, has developed it in fowls by lowering the temperature (keeping the feet in cold water). M. Gibier has now experimented with frogs, and finds that they "do not suffer after inoculation in the normal state; but if kept, after being inoculated, in water at about 37°, they may take the disease (five out of twenty did—most of the others died soon after immersion). The bacteria developed were remarkable for their great length, and this is attributed to the slowness of the circulation.

The Schoolmaster Abroad Again.—The *Manchester Evening News* of July 5th contained the following:—

Mr. Batty said he should like to know from the chairman of the Waterworks Committee what was the cause of the water supplied by the Corporation smelling and tasting very disagreeably at times. He knew one family in his neighbourhood who were, with one exception, water drinkers, yet they had been compelled by the bad state of the water to drink other liquids. (Cries of "Shame!" followed by laughter.)

Mr. Alderman Patteson stated that the complaints were from people using the water coming from the Gorton reservoir. The committee were now taking the sludge out of that reservoir and putting lime into it, but why the water should have smelt so badly the committee could not make out. They had been greatly bothered by the matter. The opinion of a scientific man had been obtained, who stated that the water was not injurious; nevertheless there were minute animal matters in the water which puzzled the committee as to how they got there.

We would recommend the worthy Alderman to join the Manchester Microscopical Society; perhaps it would do the whole committee good to become members.—Ed.

Killing and Preserving Insects.—"On page 163 of the *Northern Microscopist* for June, 1882, a correspondent asks 'what is the best and most humane way of killing insects, &c., so as not to damage them or render them unfit for either dissecting or mounting?'"

The question called to my mind an article which I read in the *American Monthly Microscopical Journal*, Vol. I., No. 9, entitled "Carbolic Acid in Balsam Mounting," by C. M. Vorce, which, I think, will give the necessary information, and perhaps be of some value to your readers.

I have tried this process with most excellent results in mounting and in the examination of insects, &c. The acid I use is the pure crystallized, with just sufficient water added to keep it fluid; this can be obtained of any chemist. My mode of procedure is this:—Place a drop of the acid on a slide, and drop into it the living insect; it will be seen to struggle for a second or two, then the limbs, wings, and tongue become extended; it then becomes beautifully clear and transparent. The acid should now be drained away, a drop of balsam put on, the cover applied, and the slide finished in the usual manner. Or the insects, flies, &c., may be dropped into a small wide-mouthed bottle filled with the acid, and be examined or mounted at leisure. I agree with Mr. Vorce in saying that I can discover no difference between the effects of immersion for a few minutes, and immersion for weeks.

The advantages claimed for this method is the speed with which the result is obtained,—almost instantaneous death of the insect, and that the acid does not stiffen or harden the object, but it remains perfectly flexible for a long time, so that the object may be arranged so as to display its features to the best advantage.

Wapakoneta, Ohio. G. W. Vickers, M.D.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to the Editor, Mr. George E. Davis, Dagmar Villa, Heaton Chapel, Stockport; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

D. A. C. — Mount the object in Balsam and Benzol. Starches mounted in this medium are only useful as polariscope objects.

H. H.—We do not know anything of the publication you mention. The aperture shutter *is* useful; we hope to prove it next month.

D. V. B.—We shall be glad to verify your objectives if you will send them to us next week.

C. A. R.—Yes. By all means go to a professional photographer; he will be able to aid you in manipulative matters, but not in the arrangement of your objects or their illumination.

H. R. C.—Your Lichen is *Collema pulposum*, and the Moss *Tetraphis pellucida*.

H. P.—We are glad you are satisfied with Bulloch's "Biological Stand." We note you say "I consider it far better value than any English student's stand which I have seen."

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

WANTED. Paraboloid and Parabolic Reflector. Exchange splendid telescope, Photo-camera and ¼ plate lens, &c.—R. C. Pilling, Robins Nest, Blackburn.

STARCHES. Will exchange a large variety of starches and other slides for parasites, geological, or other good slides. —J. E. Fawcett, Rawdon, nr. Leeds.

EGGS OF SHEEP FLUKE in exchange for foraminifera or diatoms.—C. E. W., 31, Darley-street, Bradford, Yorkshire.

CORRESPONDENTS WANTED in all parts of the world to exchange microscopic slides or material. All communications answered.—F. L. Carter, 20, Trafalgar-st., Newcastle-on-Tyne.

SIX DOZEN micro. slides for exchange. Send list to John Alex. Ollard, F.R.M.S., Ye Hermitage, Forty Hill, Enfield.

STRAW BRISTLE MOULD will be sent on receipt of stamped addressed envelope to E. Holmes, 149, Essex-road, London.

WANTED diatomaceous deposits and dredgings from all parts of the world. Will be glad to hear from correspondents abroad.—T. E. Doeg, Evesham.

WOOD SECTIONS given in exchange for rare starches. Send list to the Editor, and, if mounted, state in what medium.

WANTED first-class botanical and geological slides, rock and bone sections; also double-stained vegetable tissues and other good objects. Offered in exchange anatomical and pathological preparations, a variety of well-mounted and interesting specimens.—F. R. Martin, Malvern House, Clevedon.

FISH SCALES—forty kinds, seeds forty kinds, eighteen kinds of Zoophytes unmounted, in exchange for well-mounted slides.—Send lists to B., 36, Windsor-terrace, Glasgow.

THE NORTHERN MICROSCOPIST.

No. 21. *SEPTEMBER.* 1882.

A PLEA FOR WIDE APERTURES.

A reply to Prof. Abbe's paper "On the Relation of Aperture and Power in the Microscope."

IN the following remarks we shall consider the microscope solely as an aid to vision in the prosecution of research, assisting the observer by presenting to his eye a true but magnified image of some minute particle or organism, that he can behold it as in its natural condition, and study its character and details with facility.

It is well to keep this view steadily before us, as the above is the main purpose for which the instrument is constructed, and all other considerations are subordinate to it. As the revelations of the microscope are assuming a more important position every day, as observations are recorded in many journals, and as the inferences drawn by the student of to-day will serve to guide or misguide the men of to-morrow, it becomes of vital importance that the optical portion of the instrument shall not lend a hand in passing down to posterity distorted and hazy approximations of the truth.

For the purposes of scientific work we are about to argue (within certain well defined limits) for wide apertures only, and would strongly advise the young beginner who is making any department of Natural History his study to purchase his objectives, of apertures as nearly as he can afford, to those which we shall recommend. Not—be it understood—that we wish to discourage any student who is obliged to select cheaper lenses. He will find in these a magazine of power sufficient to satisfy all his early requirements, and as the differences between lenses of fair and excellent qualities are matters which require a fine judgment and great practical knowledge for their decision, a student might very possibly perceive no difference between an objective costing eighteen shillings and a well corrected wide aperture lens costing fifty shillings. Indeed, he might think the former the better one of the two, despite the opinions of experts who know how to take all matters into consideration, and we would therefore advise the advocates of the superiority of *third class objectives* to waive their objections to better ones, until they are able to maintain their position both practically and theoretically.

We would like to see every research annotated with the *exact* focal length and aperture of each objective employed; the length of tube and the quality of the eyepieces, factors too often left entirely out of consideration.

It has been thought necessary to state the foregoing as we have lately heard it expressed as our view, that without a student is able to purchase the very widest aperture lens obtainable he had better refrain from becoming a microscopist. We are sorry to have been so completely misunderstood: a great deal of very useful work can be done, and, in fact, has been done, with lenses of very low air angle. What we principally object to is that third rate objectives, *advertised and sold as such*, should be paraded before the microscopical tyro as being of equal quality with, if not even better than, the first class well corrected objectives of the same makers.

Of course some of these remarks do not apply to Prof. Abbe's paper; the small aperture lenses which he there recommends are not those constructed with low prime cost as the principal object; but good well-corrected objectives constructed on a formula calculated to yield a maximum amount of penetration with great working distance.

This leads us to take into consideration Prof. Abbe's paper, read before the members of the Royal Microscopical Society on March 10th of the present year, and which may be found printed *in extenso* on page 204 *et seq.* of this Journal. We may say in this connection that this criticism has been forced upon us by the publication of opinions not founded on facts, not demonstrated either diagrammatically or mathematically, but supported by general statements only, so that each reader of Prof. Abbe's paper will deem it only reasonable that he should be allowed to interpret the inferences after his own fashion.

Since this paper was written, and the photographs prepared, a second paper by Professor Abbe has appeared, and may be found in the August number of the Royal Microscopical Society's Journal. With many points in the first paper we were in agreement; we have always used and advised to be used relatively low angles for small amplifications and wide apertures for high amplifications; but as our readers will plainly see the matter is one of degree, and it is only when we come to discuss how these amplifications with their various apertures shall be constructed and applied in practice, that we find ourselves so completely at variance with the views of Prof. Abbe.

There is much in the paper, already mentioned, to interest both the student and the professed microscopist, the inferences so generally stated and defined, are perhaps the weakest points in the communication, and it would have been much better had reasons been given, *on a histological basis*, for the selection of certain apertures for definite focal lengths, and the various researches in detail, for which these apertures and amplifications were found most useful. It is true that in his second paper Prof. Abbe gives the amplifications necessary to utilize each "aperture," but the latitude allowed by the table, taken with the fact that the figures do not at all agree with his views as carried into practical effect by his brother-in-law, Zeiss, is the best argument for its total rejection.

Having these views before us, and agreeing in great part with them, we have three main questions, differences of opinion, to occupy our attention.

1. Are apertures, wider than those Prof. Abbe has indicated in his second paper, more useful than narrow ones, and why?

2. Can apertures be reduced by means of a diaphragm (fixed or otherwise) without spoiling the performance of the objective? and

3. Can penetration and long working distance be secured from a series of wide aperture objectives?

Now, if we return to the first question, referring on our way to Prof. Abbe's paper, we shall find that the latitude he allows in the amplifications for each definite aperture stultifies any attempt to fix within a few degrees what the definite angle should be for a specified objective. On page 462* he writes, "It may be inferred from this example, in accordance with many similar facts, that satisfactory observation requires that the smallest detail of the microscopical image shall be displayed under a visual angle of not less than 2′ and not more than 4′ approximately: angles which correspond very nearly to the amplifications 300 and 600 for dimensions of 0·5 μ.

This is for an aperture of 0.6 (73°.6 in air), which shows the striæ on *P. angulatum*, but nothing more, and is intended to illustrate what "empty amplification" is (*i.e.* the point at which enlargement of the image opens out no new detail). But why should there be any "empty amplification?" or, in other words, why should not the chance of it be reduced to a minimum? Why should not the objective be capable of showing out detail with each increment of ocular so long as the quality of the image is preserved, the working distance regarded, the aperture capable of being reduced when desired, and penetration possible with suitable manipulation.

To say that the microscopical image shall be displayed under a

*J.R.M.S.

visual angle of not less than 2′ nor more than 4′ for a dimension of 0.5 μ means that the aperture of 0.6 (73°.6) may be applied to $\frac{1}{6}$th objective or to a $\frac{1}{12}$th to discover the same details in the image, or, arguing conversely, that the limit for a one-twelfth may be between 1.15 aperture as laid down in column 4, page 463*, and 0·6 as set forth in the fifth column in the same page. And so if we take the half-inch objective, which gives us, upon the English tube, an amplification of 100 diameters, we shall see that the aperture may vary according to the needs of "different individuals"† from 0·20 (23°) if 2′ of visual angle only are required, to 0.10 (11°.5 in air) if 4′ are necessary. Now the limits, as laid down in the table—of 23° on the one hand and 11°.5 on the other—for a half-inch objective when used upon an English tube, will no doubt be regarded by all microscopists as far too low. If, however, they have a leaning towards these figures let them get an objective constructed, a half-inch of 23°, and with it follow us in our remarks.

Prof. Abbe tells us in his first paper (NORTHERN MICROSCOPIST, p. 207, line 19) that abundance of aperture is *primâ facie* of no detriment except so far as it affects penetration and ease of working; too large an aperture for the amplifying power of an objective is called "waste," and too small a one "empty amplification." Now if there be two faults in an objective, it is easy to conceive that the "waste of aperture" or "lack of useful power" is the least serious. Prof. Abbe tells us that in this case, details may be actually present in the image, but would not be visible to the eye for want of sufficient amplification. This is really the case; but as the necessary amplification can easily be obtained by using a deeper ocular, this objection must break down if we are able to prove that as good an image is thus obtainable as by using a higher power and a shallower eyepiece. The fault of "empty amplification" (the aperture too low in proportion to the magnifying power) cannot be remedied by the application of any appliance, the amount of light admitted will always be feeble, the definition poor, and such objectives will never stand deep eyepieces for the simple reason that they only increase the size of an imperfect image. If abundance of aperture is *primâ facie* of no detriment, the opposition to wider apertures, than those Prof. Abbe has laid down, must cease, if we are able to prove that any advantages are obtained by their use, independently of those appertaining to resolution. The *defining power* of an objective is perhaps its most important feature; is it not the quality *par excellence* which distinguishes it, and which has an important bearing upon all its other qualities? Prof. Abbe tells us (NORTHERN MICROSCOPIST, p. 208, line 18), "Provided the objectives are properly corrected and the

*J.R.M.S. †J.R.M.S., p. 462, line 25.

objects are fit for the delineation of an image, undisturbed by confused images from other planes, the 'defining power' of an objective is always greater with greater aperture for every kind of object, inasmuch as under all circumstances the wider aperture admits of the utilization of higher amplifications [oculars! Ed.] than can be obtained without perceptible loss of sharpness (with the same objects) by lower apertures."

This is a great admission, and helps our case wonderfully; let us now turn to the opinions of the Editors of the Journal of the Royal Microscopical Society:—In vol. I. series II. of the Journal, p. 709, in a review of "The Microscope and its Revelations" may be found the following:—"The wider the aperture of an objective the greater the technical skill which is required on the part of the practical optician; but the notion that as the aperture of an objective is increased, its defining power must necessarily, either on theoretical or practical grounds be impaired happily belongs to a closed chapter of microscopy." Prof. Abbe lays stress upon the fact that the objects are to be "fit for the delineation of the image," and this is too often overlooked; objectives are often blamed on account of the unsuitability of the preparation or the clumsiness of the operator and his methods of illumination.

Dr. Goring pointed out years ago that "defining power" depended upon the comparative destitution of aberration, and if defining power increases (in well corrected objectives) with increase of aperture, the wider angles must be the better lenses, and more free from aberrations. We need not dilate upon this question, as the quotations above will be enough for our readers, especially if we add a quotation or two from Dr. Carpenter's work upon the Microscope. "If he (the microscopist) be engaged upon difficult Biological investigations, he will do well to make perfect definition his *sine quâ non*, and to be content with the largest angle that can be obtained without a sacrifice of this."

On page 198, when speaking of apertures, he says:—"If the aperture be too small the image will be dark; but if it be too large details are brought into view (such as the separateness of the particles of the vermilion injection) which it is of no advantage to see." There is another way of looking at this question, and we ask:—If the aperture is so small that it conceals the fact that particles of vermilion are contained in the vessels, is it not likely that it also hides the structural elements for which the histologist is searching?

With this question of definition we must consider the power to stand deep eyepieces. Now we think it will be universally conceded that wide apertures will stand deeper eyepieces than small angles, and for two reasons: in the first place there is greater illumination of the field, and secondly the wider the aperture the more oculars will the objective stand before increase of amplification ceases to open out fresh detail. In the first case increase of illumination, with wide apertures, is very apparent, a half-inch of 90° would admit twice the amount of light that one of 60° would pass, the illumination depending upon the square of the numerical aperture. This fact has been proved to us over and over again during experiments on photo-micrography; an instance will illustrate it. Several weeks ago, the photographs on Plate IVa. were taken; now the object remaining upon the stage and the illumination (an Argand gas lamp) unaltered, it was found that 4 minutes exposure was required with Tolles one-inch objective of 35° combined with the C eyepiece, and 5.5 minutes with a Zeiss B of 40° (really 38°) and the A ocular to obtain pictures of the same intensity. The amplification was 128 diameters in each case, and both plates were developed in the same bath.

In the second case, the excess of aperture often comes in useful during practical work. One sometimes perceives in the field some object, or some minute structure not easily recognisable with the existing amplification—if there is no aperture to spare, a higher power eyepiece will be of but little use, the imperfect image will be magnified; and but little idea will be gained of its true character. If, on the other hand, the aperture is not fully utilized by the shallowest ocular, deeper ones will continue to develop detail and be equivalent to working with a higher power objective of wider aperture. Let it be borne in mind, however, we are not attempting to argue for the use of excessively deep eyepieces, except for the purposes of testing objectives, or for numerical apertures exceeding 1.0. It is our opinion that the 2″ (A), the 1″ (C), and the ″½ (D) oculars are the most useful, and any objective to be employed in research should be capable of use with the half-inch eyepiece without the definition of being impaired. By this means, as we shall show hereafter, any degree of penetration and long working distance may be secured with objectives of wide aperture.

Prof. Abbe has shown us in his paper of last year that under certain conditions wide apertures are more likely to afford us a correct image of objects than lower angles, and the *P. angulatum* illustration on p. 462* is a strict confirmation of this view.

Now, in considering the relationship which should exist between aperture and power in the microscope, *working distance* is one of the items not to be overlooked, and in a regular series of objectives all apertures should be possible for practical amplifications (within reasonable practical limits): it is certainly incorrect, as a principle, to increase the aperture of an objective in order that it may stand a deeper eyepiece, if at the same time any appreciable amount of

* J.R.M.S., August, 1881.

working distance be lost. We can readily explain our views by citing several cases in point.

The longest working distance in a half-inch objective with which we are acquainted is 0.25 inch, with an air angle of 39°. Let us take this as our standard (but, perhaps, these figures can be improved upon), and in doing so assume that it is advisable to stop enlarging the angle of the one-inch objective directly the working distance runs level with 0.25 inch.

By using this argument, it will be seen that it is possible to manufacture lenses with too wide an aperture. In the work, "How to see with the Microscope," by Dr. J. E. Smith, a Spencer inch of 50° is stated to have a working distance of 0.13 inch, about half the distance of that of the half-inch of 39°. But a half-inch of 50° could be made with a longer working distance than 0.13 inch, therefore we do not see what has been gained by enlarging the aperture thus far.

We happen to possess a fine Tolles one-inch of 34°, made specially for us; it has a working distance of 0.39 inch, and we have found 0.4 inch to be the usual working distance for nominal inch objectives of 30°. Again, the longest working distance possessed by any well connected quarter-inch, which has passed through our hands, has been 0.10 inch for 41° and Zeiss C ($\frac{1}{4}$ inch) of 50° had a working distance of 0.06.

Now, if it is held that the quarter-inch of 50° is a useful objective for the anatomist or histologist, it is clear that there would be no advantage in reducing the working distance of the half-inch below 0.06; on the other hand, there is an advantage in increasing the angle until the working distance is reduced to 0.10 inch.

The quarter-inch of 130° may be made with a working distance of 0.02 inch, and the one tenth of 140° air angle, with a working distance of 0.01 inch, is also common, but as we are only taking the lower powers into consideration, the higher amplifications will not be more than noticed.

For lower powers than the inch we see no reason why the apertures should not be considerably increased, as for all of them there would be sufficient room for top illumination or for working through a moderately thick trough. Of course, with the 2″, we are stopped at about 20° by the diameter of the Society screw, but this has been remedied by the introduction of the "Butterfield," or Broad Guage screw.

The above are our views, and we hold that the possession of a set of objectives, a two-inch of 20°, or even more; a one-inch of 35°, or even 40°, if the working distance of 0.40 inch can be preserved; and a half-inch of 66° or 70°, so as to give a working distance of 0.10—0.12; with a quarter-inch of 100°, and higher powers as necessary, will enable all kinds of work to be performed without going to the expense of two objectives of different apertures, but only yielding the same amplification. These are the apertures we consider more useful than those advised by Prof. Abbe, and we have given our reasons why.

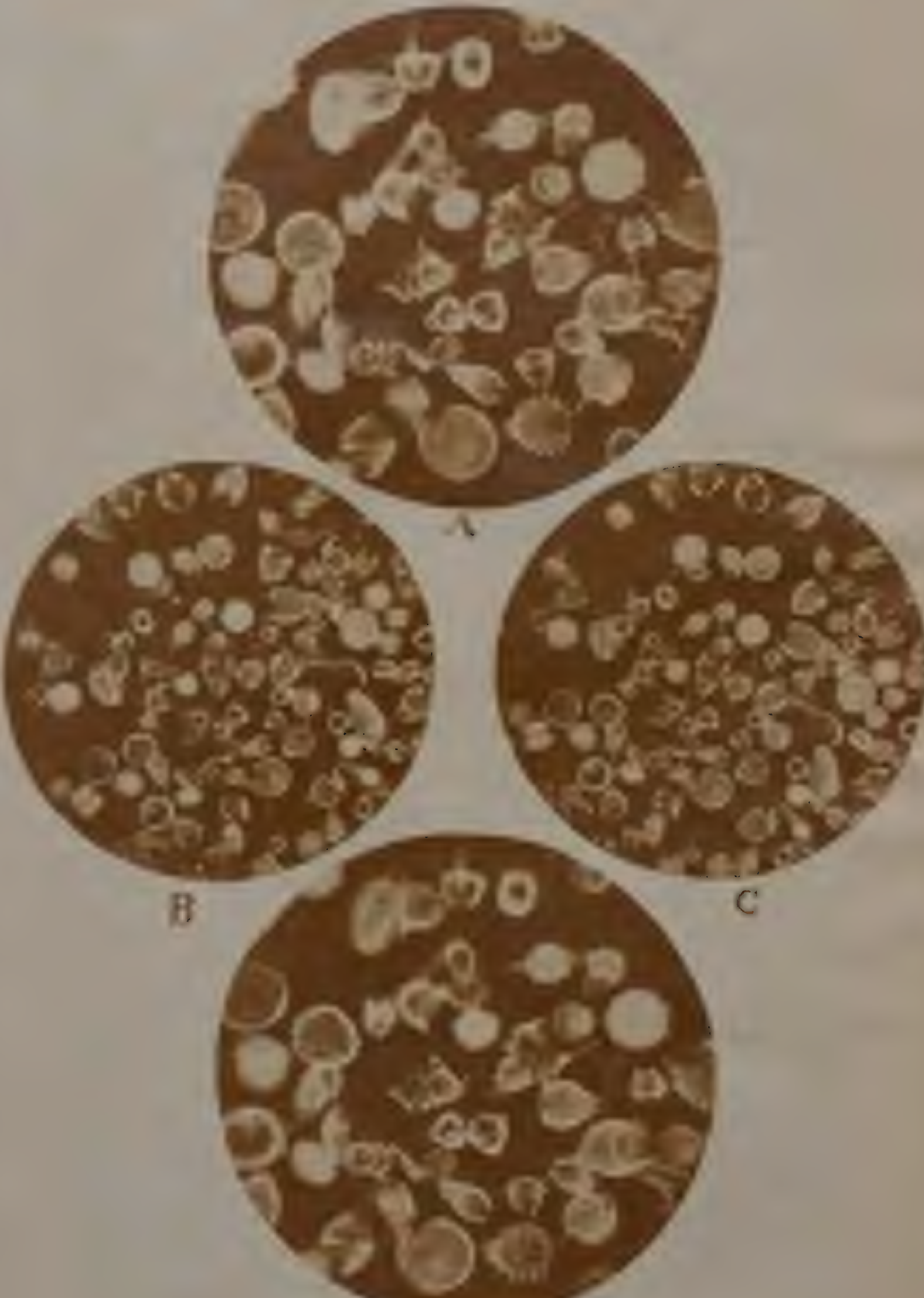
In our reply to the next question, Can apertures be reduced by means of a diaphragm without spoiling the performance of the objective? we must say that our experience is totally opposed to the statements of Prof. Abbe, and the echoes proceeding from the Editors of the Journal of the Royal Microscopical Society. If they had said *some objectives* will not bear this reduction, we could have said, Yea, verily! as the first objectives we tried to reduce in this manner gave extremely unsatisfactory results. Will Prof. Abbe, or any of his disciples in London, give us a diagram illustrating the distribution of the residuary aberrations in a one-inch objective, say of 35°, corrected, so that it will not break down under a ½ eye-piece, and show us *how* it *must* happen that cutting off the peripheral rays transforms a good into a relatively bad objective.

M. Zeiss, in his catalogue, states most distinctly "the object glasses are constructed according to the formulas of Prof. Abbe, of Jena," and we are to imagine that these lenses will not bear reduction; those we have tried will not, and so Prof. Abbe is correct here; but those of Tolles, Beck, Ross, and Wray, with which we have principally experimented, stand the reduction wonderfully well.

Perhaps our readers will say it is not enough to make a mere assertion. We have anticipated this, and wish to demonstrate the fact. Upon the page of photographs accompanying this number may be seen two circles B and C; the latter picture was taken with a specially constructed and well corrected one-inch objective of 16° air angle with the A eyepiece, while the former (B) was taken with the Tolles inch of 35° *cut down to 16° by means of the iris aperture shutter*, with the A ocular, the amplification remaining the same in both cases, *viz.*, 65 diameters.

Our readers will now be able to judge whether cutting down the aperture of a good objective spoils it. For our own part we see but little difference in the quality of the two pictures, but where the difference is, that taken with Tolles' objective has the superiority, the picture appeared more "solid" with a greater sense of relief under the microscope, and this appearance has been faithfully reproduced in the print. We have chosen Polycistina for our subject, as a preparation of considerable depth; diatoms would perhaps have suited our purpose better as giving a picture more pleasing to the eye, but we wished specially to avoid thin flat preparations for the purposes of this demonstration.

Perhaps it would be impossible to reduce the aperture of a one-sixth of 178° air angle so that it might do duty as an objective of



A

B

C

D

60°, but such differences we have never attempted and so cannot say whether they are possible or not, or even whether any one would be likely to attempt such reductions in actual practice; but we do know that our 2″ of 20° will bear reducing to 12°, the one-inch of 35° can be reduced to 16°, the half-inch of 66° to 35°, and the ¼ inch of 120° to 70° by means of the aperture shutter with advantage whenever penetration is desired, though we are strongly of opinion that the method to be presently described is better for many purposes, especially when working distance is required to be increased.

It only remains now to answer the third question :—Can "penetration" and long working distance be secured from a series of objectives of wide aperture? The opponents to deep eyepiecing object to this operation as bad, resulting in bad definition, loss of light, and other evils. This shows us clearly that those experimenters were either possessed of badly corrected objectives, or employed too-deep eyepieces to objectives of low angle, and no doubt the evils they complained of were apparent. We have, however, shown that the Tolles inch admitted more light when used with the C eyepiece than the Zeiss B with the A eyepiece, the amplifications being 128 (diameters) in each case, the objection that there is loss of light must therefore be abandoned. Prof. Abbe next tells us (NORTHERN MICROSCOPIST, p. 206, line 11), "Forcing a high amplification from a low-power objective is always connected with a considerable loss of sharpness of definition." We do not appear to be favoured with the exact definition of "high amplification," but may form an opinion as on the same page, line 50, it is stated "No experienced histologist will ever use in ordinary work even, an ocular amplification of the amount necessary for obtaining 100 diameters from a one-inch objective or 200 from a half-inch." To which we add, that no histologist ever will, except foolishly, so long as low powers of small aperture are in his cabinet, for the simple reason that he will lose both light and definition.

That definition is not impaired by forcing 128 diameters from Tolles inch objective is proved by the photographs A and D. The slide was viewed with Ross and Co.'s A eyepiece, and the Zeiss B of 40°; Tolles inch was then substituted in combination with Ross C eyepiece, and the slide viewed again: when the best focus for the whole field was obtained, it was found that the largest circle upon the much broken Podocyrtis, near the centre, was exactly at the sharpest point, and a turn either way of the fine adjustment rendered it less sharp; photographs were then taken, the object being to secure perfect sharpness for this circle.

The reader will see the results, they require no comment; even with the C eyepiece the picture yielded by the Tolles lens has better definition, more penetration, and a flatter field than the other picture.

We have now possibly overcome the objection that no one would force 100 diameters from an inch objective when he could get a better picture from a half-inch, and, therefore, may now consider the best way to obtain penetration and long working distance from wide aperture objectives.

Both oculars and objectives must be used with intelligence, and the question often crops up during an investigation, which shall be used to get a certain amplification, say of 100 diameters, the half-inch and the A eyepiece or the one-inch and the C ocular?

The answer to such a question must depend upon two circumstances—the working distance required, and the necessary angle. Is penetration required? If so, the aperture must be small, or, is the preparation flat and thin, and resolution rather than depth of focus necessary? If this be the case use wide apertures.

Now let us illustrate the case by the half-inch objective. There are many lenses of this power in use possessing an aperture of 40°, used especially for the study of Foraminifera, Polycistina, and such like solid objects. Now we argue that the half-inch of 40° is entirely unnecessary; a better image with more penetration, more light, and better definition may be secured by using the one-inch of 35° and the C eyepiece, and thus giving considerably more working distance than could ever be obtained from a half-inch. In taking pictures A and D the amplifications were 128 in each case, the working distance in A was 0.38 inch, while that of D was only 0.14 inch.

If a small aperture is needed, and working distance not a *sine quâ non*, the aperture may be reduced by means of the iris shutter as has been shown by pictures B and C, and we hope to have practically demonstrated the untenable position taken up by Prof. Abbe and his colleagues, the Editors of the Journal of the Royal Microscopical Society, by the accomplishment of that which they have been pleased to state was impossible.

There is yet another point to be considered. Prof. Abbe raises an objection to wide apertures on account of the trouble the cover adjustment entails. We have never found any difficulty in making this adjustment quickly, and we are of opinion that it should be more studied than it is, for it is a lamentable fact that students know practically nothing as to how the adjustments should be made even after passing through a Biological laboratory, where they should be taught something concerning the manipulations of the instrument.

We have now replied to the several objections raised against wide apertures, we have found much benefit ourselves in finally selecting objectives of the apertures here indicated, and if we have assisted any of our readers in this somewhat intricate and obscure question we shall consider we have not written in vain.

"THE NORTHERN MICROSCOPIST" VERIFICATION DEPARTMENT.

EXPLANATIONS.—Columns *a* and *b* give the denomination of the objective as issued by the maker. The column *c* shows the actual distance between the upper surface of the covering glass and the front of the objective, when used over a slide of *Amphipleura pellucida*, the frustules being mounted dry, on a cover suitable for observation with a one-twenty-fifth dry objective, and used in a ten inch tube. The column *d* gives the actual focal length of the objective determined by Cross' formula $\frac{n\,l}{(n+1)^2}$ where l = the distance between the two micrometers and n = the amplification at this distance.

The eyepiece used is a Ross A, with a diaphragm aperture of 0·75 inch, and yielding approximately an amplification of 5 diameters.

Column *e* contains the results of the aperture measurements by Professor Abbe's Apertometer; they are the mean of several, but the individual measurements scarcely differ from each other. Column *f* is calculated from the numbers in column *e*.

REGISTER NUMBER.	SOLD AS				REAL APERTURE.		REMARKS.
	a Inch.	*b* Air-angle or Aperture.	*c* Working Distance. Inches.	*d* $\frac{n\,l}{(n+1)^2}$	*e* Numerical.	*f* Air-angle.	
Number 103.........	2″	12°	1.32	1.60	.12	14	We beg to call the attention of our readers to the change of rules in this department. See page 240.
" 104.........	1″	... ...	.74	.76	.14	16	
" 105.........	¼″	... ...	.02	.19	.76	100	
" 106.........	¼″	... ...	.04	.19	.54	66	
" 107.........	″1/10	150°	.03	.113	.87	122°	
" 108.........	E	... ...	.01	.107	.86	120°	
" 109.........	2″	... ...	1.18	1.50	.155	18°	
" 110.........	B	40°	.14	.416	.325	38°	
" 111.........	½″	80°	.05	.36	.67	84°	
" 112.........	¼″	135°	.02	.20	.95	144°	
" 113.........	¼″	... ...	.015	.212	.92	134°	

OUR VERIFICATION DEPARTMENT.

FOR several months up to this date, pressure of business has compelled us to return objectives, sent into this department, unmeasured. We are now able to resume the work, but would call the attention of our readers to some slight changes in the conditions under which we undertake the verification.

Hitherto we have charged a fee or eighteen-pence for each objective; we now propose to charge one shilling when the objective is without collar adjustment, and one shilling also for each series of measurements when the objective has a collar adjustment. In this latter case correspondents can have the measurements made at any *one* specified position of the collar, but if no mention is made of this, measurements will be made at the two extremes. The column denoting magnifying power has been omitted, it can, however be easily calculated from column *d*.

THE CRAY FISH.

AS it is probably the privilege of comparatively few persons to see a cray fish cast its shell, a brief description of a case which recently came under observation may be of interest. First of all the carapace, or bony covering of the head and thorax, seemed to break away from its connection with the envelope of the abdomen. The animal then stretched itself stiffly upon its left side on the shingle at the bottom of the aquarium, and proceeded to curl itself round, by which action the carapace above mentioned was brought well over the head, and the eyes were completely hidden from sight. At this stage it became evident that the abdomen also was beginning to recede from its case, and thus the process of "moving" went on simultaneously in both parts of the body, the swimmerets, ambulatory limbs, chelæ, antennæ, etc., all coming out perfect, the last-named, especially, being drawn out with the greatest ease as we might imagine a very flexible sword to be drawn from its sheath in an inconvenient position. When nothing but the extremities were left in the shell the animal gave a convulsive wriggle—the first symptom of impatience that it had betrayed—which set it completely free from its late tenement. After a few more wriggles, apparently to convince itself of the reality of what had just taken place, it relapsed into its normal condition of meditative apathy. The new shell was considerably darker than the old one, but soon toned down to the same hue. The original covering was taken out of the water and preserved in spirit; within two hours of its immersion its colour had changed from dark brown to a beautiful orange red. A. R. D.

NOTES ON MOSSES.

WE have all noticed the rich green velvet on damp walls and other moist situations, due to the confervoid shoots of the first growth of Mosses after germination of the spores. All Mosses have this Protothallus or Protonema, from which the perfect plants spring, as in other cryptogams, and which disappear after full development of the fruit.

In this young condition the refractive cells of the Cavern Moss, *Schistostega pennata*, illumes the dark recesses of sandstone caves, in which it loves to grow, with a brilliant golden-green light. Frodsham is a well known locality for this Moss, and it is not infrequent in Lancashire, Staffordshire, Derbyshire, and Nottinghamshire.

The duration of these confervoid filaments varies much in different Mosses; the leaves being produced in about three weeks in Funaria, Gymnostomum and some Brya; while in some Polytrichums they do not appear for two or four months.

The confervoid filaments are almost always present in many of the Ephemerums and Phascums, Earth-Mosses; the most minute of the British Mosses.

Fig. 15.

These genera belong to the terminal fruited division, whose capsules are without a deciduous lid and burst irregularly, and are annual, almost stemless and slightly branched plants, growing on newly exposed soil, and having lanceolate leaves in eight rows, nerved entire or serrated, with large cellules; Monoicous. *Ephem-*

crum serratum fruits both in the spring and autumn, and while so minute as to require great care to detect it amongst the Mosses, is known by its deep velvety-green colour and fine reddish purple of the capsules. The leaves are exceptional, being stemless and nerveless; serrated and connivent; capsule large roundish-ovate, and subsessile. Found at Marple. Fig. 15.

Equally small is *Phascum sessile*, the sessile-fruited Earth-Moss, being about $\frac{1}{16}$ inch in height. It is even less conspicuous than *P. serratum*, and is found on clay and chalky heaths; rare, with leaves narrower and rigid, cellules smaller. Another rare species is *Ephemerella recurvifolia*, found on heaths and fallows, and having erect, frequently recurved leaves, toothed at the apex, with a strong excurrent nerve.

Of the mature plants without confervoid shoots the most noticeable is *Microbryum Flœrkeanum*, being only $\frac{1}{20}$ inch in height. The leaves are broadly ovate, tapering to a point with reflexed margins. It is found on clay or chalky fields, and is rare.

The other autumn-fruited Phascums are *P. muticum*, the common dwarf Earth-Moss, found on moist banks and fallows; *P. patens*, the spreading Earth-Moss, clay banks and fields; *P. nitidum*, the delicate Earth-Moss, moist banks; and *P. rostellatum*, the beaked Earth-Moss, in dried beds of pools, &c.

Having capsules with a deciduous lid, but without peristome, is the genus Gymnostomum, or Beardless-Moss, from γυμνος, naked, and στομα, mouth. It is distinguished by its oval capsules, dimidiate calyptra and lid with an oblique beak; leaves of close firm texture and small dense areolæ.

The slender Beardless-Moss, *Gymnostomum tenue*, found on sandstone rocks and walls, has tufted stems with tongue-shaped leaves nerved nearly to the apex; while more generally distributed on moist Alpine and sub-Alpine rocks are *G. rupestre*, the rock Gymnostomum, and *G. curvirostrum*, the curve-beaked Gymnostomum. In Lancashire and Cheshire is found on clay-fields and banks, *G. squarrosum*, the spreading-leaved Gymnostomum; the only other habitats for this Moss being the Isle of Wight and the South-Eastern counties; while near Buxton there grows plentifully, although not in fruit, *G. calcareum*, one of the excluded species of the London catalogue.

Abundant on the summits of the higher mountains of Scotland is *Zygodon Lapponicus*, the Lapland Yoke-Moss. It has also been found on Snowdon, and only bears fruit at high altitudes, growing in the crevices of rocks. Being without peristome it has been classed by some writers amongst the Gymnostomums. In mild situations it is barren, and in this state *Zygodon Mougeotii* is found frequently with it.

A minute and rare Moss found on sandstone rocks is *Anodus*

Donianus, Don's Bristle-Moss, having bristle-like leaves very minutely toothed; capsules cup-shaped with a wide mouth.

Of the Dicranaceæ in fruit this month may be mentioned *Dicranum longifolium*, found only on Ben Lawers and adjacent peaks; leaves long, falcate, secund, with a slender nerve, margin and back serrate at apex.

Equally rare on turfy bogs in Lancashire and Yorkshire is *Dicranum Schraderi*, with leaves sub-secund and rather obtuse, toothed on margin and keel; sub-papillose at back near apex; capsules oval-oblong incurved; lid rostrate.

Fig. 16.

Pretty generally distributed throughout Great Britain, on marshy places and moist banks, is *Dicranum palustre*, the marsh Dicranum. The stems are three to four inches in length, branched, and almost all reaching to the same height; the leaves are sub-secund, linear-lanceolate and undulate; nerve narrow, not reaching to apex, which is serrate; capsules sub-erect, slightly curved, and striate. Var. β *juniperifolium*, has shorter, wider, and more rigid leaves, while γ *polycladium* has small imbricated leaves.

Growing on shady mountainous rocks at Greenfield, and generally throughout Britain, although not recorded for Lancashire, Cheshire, or Derbyshire, is *Diphyscium foliosum*, the Leafy Buxbaumia: distinguished by its curious plicate membrane forming the peristome: stem short; cauline leaves ligulate; perichætial leaves much larger and broadly-lanceolate, with a nerve running out into a stout hair, laciniate at the top. Fig. 16. Like *Tetradontium Brownianum* it is often found with its growth downwards.

Two small and rare species of the Thread-Mosses are found at Southport, *Bryum Marrattii* and *Bryum calophyllum*; and another of the Bryaceæ fruiting in September, and rare, is *Webera Ludwigii*, collected on the Scotch mountains and also on Snowdon. It has several sets of shoots rising one above the other according to the years in which they have been produced, only the last series being green, the others being in most cases darkened by snow water.

Fig. 17.

Also on the Scotch summits, not lower than 3,000 feet, is the conical Mouth-Moss, *Conostomum boreale*, so called from the teeth of the peristome forming a cone by their union at the summit. It is placed next to the Bartramias, greatly resembling in appearance the Fountain Apple-Moss, *Philonotis fontana*. The genus Bartramia, named in honour of John Bartram, an American botanist and traveller, has a terminal seta and sub-globose capsule with double peristome; calyptra dimidiate. An interesting species belonging to this group is *Brentella arcuata*, the curved-stalked Apple-Moss, being almost entirely confined to the British Isles. Found rarely in fruit on waterfalls and rocks in sub-Alpine districts, its leaves, from a broad sheathing base, are ovate-lanceolate, serrulate and spreading.

A very rare species on shady banks and mountains in Cornwall and North Wales is *Philonotis rigida*, the Rigid Apple-Moss.

In the Pleurocarpus, lateral-fruited, division of Mosses two very common species, although not so common in fruit, may be mentioned. *Hypnum rutabulum*, the common rough-stalked Feather-Moss: this may be regarded as the commonest of the British Mosses; growing everywhere on banks, walls and trees, and equally common throughout Europe and North America. It fruits both in the spring and the autumn, and takes its name from its very rough fruit-stalk (seta), the capsules of which are ovate-oblong, arcuate, and nodding (cernuous); leaves ovate, concave, acuminate, and serrulate, thinly nerved above half-way. Fig. 17.

Hypnum populeum; the Matted Feather-Moss, an equally common species on stones, in shady situations, and greeting the eye by every wayside. The stems are creeping and sub-pinnate; leaves narrowly ovate-lanceolate, tapering to a long serrulate point, margin reflexed, nerved to apex.

Not so common as these two, but generally distributed throughout Britain, and found on stones by rivulets in shady woods, and sometimes in the water, is *Hypnum rivulare*, the river rough-stalked Feather-Moss, with deltoid-ovate leaves, gradually tapering and serrate, and only nerved above half way. Also fruiting in this month are *Hypnum chrysophyllum*, the golden-leaved Feather-Moss, fallow ground, chalk hills, etc., and *Hylocomium Oakesii*, Oake's Feather-Moss, only found on alpine rocks in the Eastern and Western Highlands.

Very rare and local are *Leskea apiculata* (Myurella) found on moist rocky ground on Ben Lawers, and *Leskea micans* (Hypnum), on shady rocks in the South of Ireland. A little less rare are *Leskia moniliformis* (Myurella lulacea), *Leskea polyantha* and *Leskea subrufa*, the last not fruiting in Britain.

WILLIAM STANLEY.

NOTE ON THE SCHWENDENERIAN THEORY OF LICHENS.

BY R. B. CROFT, R.N., F.L.S., F.R.M.S.

I CANNOT better describe the theory as to the nature of lichens which is variously styled "The Algo-Lichen Hypothesis," the "Dual-Lichen Hypothesis," and the Schwendenerian Theory of Lichens, than by quoting the commencement of a paper by the Rev. W. A. Leighton in 'Grevillea' (vol. ii, p. 122), in which periodical will also be found the arguments for and against the said theory.

Mr. Leighton says: "Much attention has been of late devoted, and is still devoted to the subject of the gonidia of lichens. Two theories or opinions have sprung from these researches, which are respectively supported by great and learned savans. Those whose studies are chiefly physiological maintain that the filamentous tissue of the thallus of lichens is a fungus which grows parasitically on an alga, which it envelopes and carries on with it in its growth so as to constitute the gonidia. On the other hand, true lichenologists, whilst admitting the apparent similarity of gonidia to certain algæ, do not consider them as such, but as special organs of multiplication or propagation of lichens."

Although Professor Schwendener propounded this theory in 1869, and although many experiments have been made by various observers to test its truth, opinion still is divided. Sachs, in his 'Text-Book of Botany' (p. 262), says: "There can no longer be any doubt that the lichens are true fungi of the section Ascomycetes, but distinguished by a singular parasitism. Their hosts are algæ which grow normally in damp places but not in water." As many introductory works on botany are founded on Sachs' work, this is repeated, learnt, and believed by many; while on the other hand Dr. Nylander, admittedly the greatest Lichenologist of the age, terms the hypothesis "absurd," and Dr. M. C. Cook classes together the advocates of the theories of Table-turning, Tichborne, and Schwendener.

About three years ago I made my first attempt to build a lichen, or rather I found in a small phial that which advocates of the Schwendenerian theory would have no doubt claimed as such; and as I have just repeated the experiment with the same result, I will briefly describe the *modus operandi*, in the hope that other members may by their observations throw further light on the subject.

I placed a gathering of *Protococcus pluvialis** in a small phial in perfect darkness, and after some time found that mixed with the *Protococcus*-cells there were fragments of what appeared to be the mycelium of a fungus. After a further deprivation of light for some time, I found that the mycelium had greatly increased in quantity, and that it surrounded and imprisoned the perfectly healthy still cells of the *Protococcus*.

In this condition you will see it under my microscope this evening. At the October meeting of this Society I showed the *Protococcus*, then freshly gathered, when many of the cells were motile, now they are all stationary, though a few retain the hyaline

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* In both cases the *Protococcus* was from a cast-iron shell at the base of a fountain in the garden of Mr. C. W. Nunn, of Hertford. Mr. Nunn has had this *Protococcus* under observation for several years, and considers it to be a distinct red variety.

envelope. You will observe that all or nearly all the cells are red, and that although under a high power (700 diameters) no connexion with the fungus can be perceived. Therefore we have what the advocates of the theory declare a lichen to be, viz., an alga surrounded and imprisoned by a fungus, only it is in water instead of air. Probably further study would prove that the presence of the fungus was accidental, and that though the *Protococcus* is apparently healthy, it is not increasing by either of its known methods of growth. As this inquiry can be easily prosecuted by any one possessing a microscope with a $\frac{1}{4}$-inch objective, I hope some of you will try the exceedingly simple experiment detailed above, and if you can get as far as I have got, that you will endeavour to induce the dual growth to flourish in air as well as water. I would also suggest that one phial be kept in the light and another in the dark, in order that we may find out whether that has anything to do with the fungal growth, or whether it is only a coincidence.—*Trans. Herts. Nat. Hist. Soc.*

ON A SPECIES OF CHÆTOSPIRA FOUND AT HODDESDON.

By F. W. Phillips.

AT the meeting held here in March, 1880, Mr. Henry Warner drew a rough sketch of an animalcule, and told me that he had found it many years ago in a pond at the Woodlands, Hoddesdon, but had never been able to identify it. .I saw at once that it corresponded with the drawing of *Chætospira Mülleri* given in the last edition of Pritchard's 'Infusoria.' I had met with it about two years before, but unfortunately had given but little attention to it. I did not find it again until last October, and it was under the following circumstances. In July I placed in a polype-trough what I judged to be the empty cœnœcium of a Polyzoon, and some *Paludicellæ*, obtained from the same pond, leaving them there in the hope that statoblasts might be deposited; about a month after I sent the trough and contents to Mr. Isaac Robinson. While it was in his possession some creature laid a number of eggs against the glass, and attention was from time to time directed to their development. One day Mr. Robinson reported the appearance of a strange creature adherent to this egg-case, which was now empty. The description of its movements convinced me that it was no other than the rather rare *Chætospira;* and on examining it, I found that it was so. The animalcule, which was extremely small, had built its tube or sheath in one of the depressions of the empty egg-case. Unfortunately the glass of the polype-trough was too thick to use the $\frac{1}{5}$-inch objective, therefore we used the $\frac{1}{4}$-inch objective and D eyepiece; a power which was insufficient to enable me to make an elaborate investigation. I have the creature still by me, but it is either dead, or encysted, as it has for some time past refused to come out of its tube. The genus appears to be so little known that it would perhaps be advisable to quote Prichard's description.

Family *Vorticellina*. "Genus *Chætospira* (Lachmann).—The surface generally covered with cilia, like the genus *Stentor*, from which it is distinguished by having that part of the parenchyma of the body which bears the ciliary spiral and the anus (which in all the Stentorinæ lies on the dorsal surface of the body, close under the ciliary spiral, and not in a common pit with the mouth) drawn out into a thin process. This process is narrow and bacillar; the series of cilia commences at its free extremity, and only forms a spiral when in action, by the rolling-up of the lamina. The process bears the anus. The animalcules inhabit a sheath or tube, of a mucilaginous or even horny density." The genus was first described in 1856 by Mr. Lachmann, who found the two species of which it consists in fresh water near Berlin. They are described by Prichard as follows:—

"*Chætospira Mülleri*.—Slender. The first cilia of the series upon the process are somewhat, but not remarkably longer and stronger than the rest; when rolled up, the ciliated bacillar process forms more than one turn of a spiral. Sheath flask-shaped and horny. Hitherto found only in the open cells of torn leaves of *Lemna trisulca*, growing in fresh water near Berlin."

"*Chætospira mucicola*.—Enclosing tube mucous in consistence; animalcule shorter and more compressed; the rolled-up ciliary process does not form a complete turn of a spiral; the first cilia are considerably larger than the rest, the first one especially being nearly twice as long as most of the others."

The animalcule we found does not altogether agree with either of these descriptions. It has, like *Chætospira Mülleri*, a horny sheath, to which are attached a great number of brown granular particles, as though they had been cemented to it. The case is not imbedded in, but built outside the cellular substance to which it adheres. The ciliary process resembles *C. mucicola* in not making a complete turn of a spiral. At the extremity of the process there appeared to be a small projection as though it had a slight tendency to be bilobed, like the allied genus *Freia*, but the animalcule maintained a very awkward position all the time we watched, so that it was impossible to get a clear view of it: therefore it is just possible that this appearance was due to a distorted view of the long terminal cilium characterising *C. mucicola*. On giving the stage of the microscope a sharp tap it would quickly withdraw within its tube, after the manner of *Vaginicola* and other sheathed animalcules; as soon as its alarm subsided, the process would be slowly extruded in a straight line, and then with a rapid and peculiar scythe-like motion it would be swung round into the spiral form. The movements of the cilia very much resemble those of *Stentor*, but have rather more of a vibratile character.

The only notices I can find of the occurrence of *Chætospira Mülleri* in England are, firstly in a paper by Mr. J. G. Tatem, read at the Quekett Club, March 27th, 1868, wherein he records it for the first time as a British species: secondly, in an article in 'Science Gossip,' July, 1868, by Mr. F. C. S. Roper, who states that he found it on the 28th of May, 1851, on Snaresbrook Common, which was five years prior to its having been described by Mr. Lachmann, and that he sent drawings of it to several naturalists, but none of them were able to identify it. Possibly the animalcule may not be so very rare, but its small size and extreme timidity or sensitiveness, which causes it to retire with the slightest shaking, is probably the cause of its being over-looked.

Since making the above notes, I have this morning had the good fortune to find another specimen quite close to the former; the sheath, which is imbedded in the cellular structure of the egg-case, is lageniform in shape, with a rather long narrow neck; it is almost identical with Mr. Tatem's figure, and the spiral makes two turns, thus determining it to be *Chætospira Mülleri*. The true species has therefore been found as well as the apparent variety.—*Trans. Herts. Nat. Hist. Soc.*

ON THE OCCURRENCE OF RED SNOW IN HERTFORDSHIRE.

By R. B. Croft, R.N., F.L.S., F.R.M.S.

On the return of Captain Ross's expedition from the Arctic regions in 1819, red snow, which had been found extending over a range of cliffs on the shore of Baffin's Bay, in some cases 12 feet deep, was in its melted state subjected to careful examination, and was pronounced by the eminent botanist, Robert Brown, to contain a unicellular plant of the order Algæ, an opinion since confirmed by Greville and others, and now generally adopted, the plant being known by several names, amongst which that of *Protococcus nivalis*, given to it by Agardh, and *Palmella nivalis* given to it by Sir William Hooker, are most usually accepted. The following is a description by the authors of the 'Micrographic Dictionary' of the organism in red snow brought home by Captain Parry, R.N.:—" Frond, an indefinite gelatinous mass, densely filled with spherical cells, about 1-1200th part of an inch in diameter; cells with a distinct membrane, their contents consisting of numerous tolerably equal granules, red or green. Between the large cells lie patches of minute red granules, apparently discharged from the large cells. Bauer and Greville both describe this as the mode of propagation of the plant; but it is probable that the cells also increase by division when actively vegetating."

In a very pleasant little book called 'Footprints from the Page of Nature' I find the following: "If we place a portion of the snow coloured with this plant upon a piece of white paper and allow it to melt and evaporate, we find a residuum of granules just sufficient to give a faint crimson tinge to the paper. Placed under the microscope, these granules resolve themselves into spherical purple cells, from the 1,000th to the 3,000th part of an inch in diameter; each of these cells has an opening surrounded by serrated or indented lines, whose smallest diameter measures only the 1-5,000th part of an inch."

The same author says, further on: "The actinic power of the solar light, aided by some peculiar, and as yet unknown property belonging to the natural whiteness of the snow itself, is highly essential in the production of the beautiful crimson or rose colour by which the red snow is distinguished; but this colour gradually changes to green when secluded from the direct action of light and developed on dark or opaque objects."

Although the above is, as I have said, the generally accepted theory of red snow, yet examinations of red snow made near Grimsel, in Switzerland, in 1839, at the Glacier of Aar, in 1840, and other places, led Mr. Shuttleworth and Professor Agassiz* to conclude that the discolouration was due to an immense number of moving animalcules of various shapes and sizes, and to globules which were supposed to be the ova of *Philodina roseola*.

Professor Meyen† remarks that *Euglena sanguinea* and *Euglena viridis*, which greatly resemble *Protococcus*,‡ are the cause of the red and green snow which has been described by Martius, a naturalist, who had accompanied a French expedition to Spitzbergen. In this case also globules are mentioned.

From these researches it is evident that it is not proved that red snow is dependent on one form of organic existence, but that many species both of plants and animals may contribute to its production.

Having thus briefly noticed all that I can discover about red snow, I will give a short account of some that I found on the 28th

* 'Ann. Nat. Hist.,' Aug., 1841. † 'Ann. Nat. Hist.,' Aug., 1848.

‡ See Cohn's Memoir "On the Natural History of *Protococcus pluvialis*" in 'Botanical and Physiological Memoirs' (Kay Society, 1853).

of January. On the afternoon of that day, which was the first of decided thaw after the recent long and memorable frost, I noticed under the upper layer of ice on a large pond in my garden sheets of snow of a dark red colour; and as the position, condition of snow, etc., may be of important assistance to future searchers, I shall describe them at some length. The pond had been frozen for more than a fortnight (on the 15th we were skating on it). On the 18th came the violent snowstorm and gale, which covered the pond with nearly a foot of drift snow. On the 26th a man was employed clearing the snow off the pond, but the lower layer (about four inches thick) had apparently partly melted and frozen again; therefore the snow was only cleared away to the surface of this frozen layer, which I shall call frozen snow, to distinguish it from the true ice underneath.

On noticing the deep red colour which appeared to be above or in the true ice, I dug holes in the frozen snow and found that where it rested on the ice it was a deep rose colour; the water, which owing to the rapid thaw quickly filled the holes, became also rose-coloured, looking from a short distance like pools of blood. I collected a vase of the melting snow, which owing to its small quantity and the difference of background looked a lighter pink. On rapidly baling the water out of one of the holes, I noticed the ice beneath to be full of bright red specks like so many rubies. I cut several pieces out, and placed them in a separate vessel for examination. The water in the vases (at first a decided pink), gradually became paler and paler, and at the end of ten days the colour had entirely gone.

Microscopic examination of the melting snow showed frond-like patches of green matter, among which were many *Euglenæ*, apparently *Euglena acus* (I could in no case see any flagellum). Round green cells, which I took to be the resting form of the same *Euglena*, and a very great number of yeast-like bodies, although they appeared in the microscope to be hyaline, were in my opinion the cause of the red colour. These bodies I take to be the "globules" of Meyen. As far as I could see, then and since, there was no *Protococcus*, or to speak more exactly, no body resembling *Protococcus* which might not have been some stage in the life of the *Euglena*.

I sent three specimens of the melted snow to Mr. Saville Kent, the talented author of 'A Manual of the Infusoria,' one taken from the bottom of my vase with a good deal of sediment, one taken from the surface, and the third with the sediment from the vase containing the pieces of solid ice, which you will remember I spoke of as being full of bright red specks. Mr. Kent tells me that the contents of the three phials are identical; that the green frond-like masses are decaying masses of *Euglenæ*, probably suddenly frozen, that the *Euglena* is *Euglena acus*, that he can detect *Protococcus*, and that the yeast-like bodies may be an abnormal form of that plant. Mr. Bolton, of Birmingham, and my co-secretary, Mr. Hopkinson, who have examined the melted snow, both say that it contains *Protococcus*, so that I am alone in my opinion that it is not present. I think with regard to the yeast-like bodies we may come to the conclusion that they are not yeast; therefore the question arises, What are these bodies? Mr. Kent's suggestion that they are an abnormal form of *Protococcus* leads to an important train of thought; for may not *Protococcus* always assume this form when it colours snow red. But I venture to suggest that, considering the extraordinary resemblance between the plant *Protococcus* and the animal *Euglena*,* they may be a form of *Euglena;* and although I only throw out this as a possibility, yet my idea is strengthened by the fact that some years ago, while studying the *Euglenæ*, I found that during one portion of their life they assumed forms which I described in my note-book as "closely resembling the *torula* of the yeast plant."—*Trans. Herts. Nat. Hist. Soc.*

POND LIFE AT BRAMHALL.

THE Manchester Microscopical Society had its ramble on Saturday, July 29th, in the neighbourhood of Bramhall, under the leadership of Mr. William Stanley.

Alighting at Davenport station the party wended their way to a large pond at Charlestown, called Long Pitts, which they found swarming with Entomostraca, and round the edges of which were gathered the Forget-me-not, and the White water Bed-straw, with tufts here and there of the Fox-glove and Great hairy Willow-herb.

The fineness of the weather caused everything to appear at its brightest, and not the least factor in the enjoyment of the scenery around was the beautiful fragrance of the sweet-scented vernal grass in the newly cut hay on every side.

Turning to the left the brook was followed past the *New Farm*, and, crossing Bramhall brook at the bridge below the Hall, the wood was skirted until the fields above the Hall were reached, when to the right of Great Reddish wood a pond was found covered with the Water Lily, and specially rich in the objects of our search.

Life is always an interesting and fascinating study, particularly

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* See Cohn's Memoir, previously referred to, for an account of this resemblance.

minute pond-life such as the Polyzoa, Infusoria, and Rotifera, for with the aid of the microscope we are enabled, from the transparent nature of their organs, to trace their development from the very commencement of their existence; and thereby solve some of the important Biological problems pertaining to the life of the highest organisms.

Cyclops quadricornis and Daphnia pulex, two entomostraca found in every pond nearly all the year round, well illustrate the immense fecundity of these minute animals, for we are told that according to a computation by Irvine from data ascertained by actual observation, a single fertilized female of the common Cyclops may be the progenitor in one year of over "four thousand million" young.

The genus Cyclops receives its name from possessing only a single eye or cluster of ocelli; the Daphniæ and most other entomostraca having the same character. Their motion through the water consists of a series of jerks caused by striking the water with their tails, feet, and antennæ.

The feet and tail of the Cyclops are adorned with plumose tufts, and it is a very voracious creature, feeding on other minute animals and even on its own young; while the Daphnia derives its sustenance from particles of vegetable substances.

Among aquatic insects were Notonecta and the larvæ of the Agrionidæ; a family of Dragon-flies, as well as Dytiscus in both the larval and mature forms. The more important finds were, however, the following. The Phantom Larva, *Corethra plumicornis*, was caught by the hundred, and its pupa by the dozen. This larva of a dipterous insect is peculiarly interesting to microscopists on account of its wonderful transparency, which enables its anatomy to be studied without dissection. Its most remarkable internal feature is the kidney-shaped air-sacs, two of which are situated in the second and two in the ninth segment of the body. They are spotted with oval cells of black pigment, which gives them a most beautiful appearance when properly illuminated. The larva is destitute of the longitudinal trachea found on other larvæ, but in the pupal state the air sacs disappear, and tracheal trunks are developed.

The nymphs of two genera of the Ephemeridæ were also found, Clöeon and Heptagenia. The former is recognized by the external gills of the first six abdominal segments being composed of double plates; the seventh pair being single. The latter is known by the gills on the first six segments being formed of single plates, to the roots of which are attached bundles of threads, the analogues of perfect gills. The two nymphs differ also in their mode of locomotion. Clöeon swims by sudden jerks of the abdomen, whereas Heptagenia is generally found creeping or running along the ground. They both lose the central filament of the tail on assuming the winged state; Clöeon having two and Heptagenia four wings. Amongst the winged insects found the most noticeable was the White Plume Moth, *Pterophorus pentadactylus*, in which the wings are divided into plumes, the microscopic arrangement of the scales being worthy of notice. W. S.

VISIT TO THE WESSENDEN VALLEY.

THE Stalybridge Microscopical Society, which meets once a month for outdoor rambles in summer and for indoor meetings in winter, had an excursion on Saturday, July 15th, to the Wessenden Valley, in conjunction with the Ashton Biological Society and under the leadership of Mr. John Whitehead. It being the feast of St. Swithin, in the early part of the day the clouds did their utmost to celebrate the occasion, the rain descending in torrents until noon, but by the time the party reached Marsden the weather was all that could be desired. The sun shone brilliantly, and, aided by a pleasant breeze, the ground soon dried, making botanising very enjoyable. On entering the Wessenden Valley, the party were much pleased to see many acres profusely covered with the beautiful grass *Aira flexuosa* in full perfection. After passing the last gate that is placed across the cart road, the party made for the stream, when the work of the day began, the result of which was a rich collection of botanical specimens. Those most deserving of notice were as follows:—

Grasses: *Aira flexuosa; Agrostis canina.*

Sedges: *C. pallescens; C. binervis; C. lævigata.*

Mosses: *Atrichum crispum; Dicranella squarrosa; Oligotrichum hercynicum; Plagiothecium Borrerianum; Sphagnum squarrosum; Sphagnum subsecundum* v. *contortum.* It is worthy of note that *Atrichum crispum*, which was found with abundance of male flowers, is not known to bear fruit nearer to Manchester than New Jersey, U.S.A.

Liverwort: *Scapania undulata.*

Flowering Plants: *Campanula hederacea; Melampyrum pratense; Myosotis repens; Narthecium ossifragum; Ranunculus flammula* v. *pseudo reptans.*

The crowberry, *Empetrum nigrum*, was found in fruit. The ferns, some of them rare in this district, were observed but not uprooted. The cascade, which was full of water from the recent rain, was visited, and after tea at Marsden the party left by the 7·30 p.m. train, to resume the business of the excursion at the Mechanics' Institution, Ashton, on Monday evening, when the principal finds of the day, as enumerated above, were discussed.

PARMELIA PARIETINA.

OF the few Lichens which are within easy reach of the Manchester Microscopist the *Parmelia parietina* is the one which is most plentiful and the most easily found. It grows upon the trunks of trees, and upon stone walls, as also upon rocks in the Buxton valley, and other surrounding hills in great plenty; but chiefly in damp situations, for it requires a large amount of moisture for its healthy development. The colour of the plant is of a greenish yellow, the yellow deepening frequently in the direction of orange. It forms a conspicuous and beautiful object wherever it may be found, but especially so if upon the limestone rocks. The contrast of colour betwixt the plant and the white of the limestone has a charming effect. This lichen is not only plentiful in the district I have indicated, but it is found in all other similar districts throughout the entire kingdom.

As a microscopic object it is exceedingly interesting; it is a Gymnocarpus lichen, and if a very thin section be obtained of the fruit vessel—the apothecium—the asci will be seen *in situ*, each ascus containing eight minute sporidia. In dry weather it is difficult to remove it from its native home, and will break into fragments if roughly handled; after a shower of rain it may be removed without the slightest difficulty. On examination of the section the student will find in the water or other fluid he may use a large number of small floating green bodies. These are gonidia, and are found in all lichens. They never exist in fungi, and thus form a test by which the two may be known.

THOMAS BRITTAIN.

NOTES AND QUERIES.

OSMIC ACID MOUNTING.—At the August meeting of the Manchester Microscopical Society, Mr. J. T. Fleming called our attention to a slide of *Volvox globator*, mounted in Osmic Acid. It was a very successful preparation, but time alone will show whether the slide is a permanent one.

MACROPIS LABIATA.—I have been fortunate in obtaining a good series of both males and females of this insect—the rarest of our

British bees, which hitherto has only been taken singly in the New Forest. At Weybridge a male was caught on July 4th, 1842. Mr. Bridgman has taken them at Norwich a few years ago.

I found them flying very swiftly along the banks of the Basingstoke Canal, and frequenting the flowers of the great yellow loosestrife, *Lysimachia vulgaris*. FRED. ENOCK.

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY. —In the Report and Transactions of this Society for 1881, just published, we have the President's address, the annual reports of the Secretaries, Curator, Librarian, and Treasurer, with a great deal of interesting matter in the shape of papers read before the Society, and occupying the last 38 pages of the book. Though well pleased on the whole with the production, we feel bound to call attention to a few points where a little more care might have been shewn with advantage. When the Rev. M. J. Berkeley is elected a corresponding member of the Society as a tribute to his high scientific attainments, why should he be refused that title which of all others a scientific man is proud of having gained? Do not the Editors know that the Rev. M. J. Berkeley, M.A., F.L.S., is also a Fellow of the Royal Society? We would suggest that they re-read their list of members.

Among the list of donations the treatment accorded to the *Northern Microscopist* last year has been repeated, and it is again conspicuous by its absence. As we have sent a copy of the Journal from its commencement to "The Library" of the Society, surely an acknowledgment might have been expected.

We are sorry to hear from the Committee's report that there is a considerable falling off in the circulation of the "Midland Naturalist," and this principally in Birmingham and the district. We also read, "The Committee acknowledge gratefully the valuable services given to the 'Midland Naturalist' by the Editors, and will gravely consider during the year the best means of setting the publication on a firm and successful basis." As the falling off referred to above is chiefly in the Midlands, the reason must be either that such a journal is not required, or else that it does not meet the wants of the district. In either case, it behoves the Society to act with discrimination, as subsidising a journal that is not required means an absolute loss of capital which a reference to the treasurer's report shews would be very unwise.

STUDIES IN MICROSCOPICAL SCIENCE.—Nos. 11, 12, 13, 14, and 15 of this paper have come to hand since our last notice. In the first is illustrated a single lobule of the liver of a cat, the hepatic vein having been injected red and the portal vein blue. The methods of preparation are given at some length and are peculiarly interesting. No. 12 is devoted to the T. V. Section of a leaf, the *Rhododendron ponticum*, and we consider that on the whole this is the best plate Messrs. Watson have turned out. It is exceedingly natural, and represents truly what is seen under the microscope. No. 13 treats of the Human Kidney. No. 14, a section of the leaf of the Coltsfoot (*Tussilago Farfara*) with *Œcidium compositarum* var. *tussilaginis in situ*. The slides accompanying the paper show the cup-like character of the fungus in all its details, very well indeed. The last number gives an illustration of a horizontal section of the papillary portion of human kidney, with full descriptions.

Lepisma Saccharina.—Prof. A. Liversedge writes to the Royal Microscopical Society to confirm the description of a bookworm which is given by Hooke in his Micrographia of 1665, but has been ridiculed by Blade in his "Enemies of Books" (1881). The insect in question (*Lepisma saccharina*) is found in New South Wales, and other of the warmer parts of Australia, and is known as the silver fish. It is very destructive to books and papers, especially when the latter are loose, and access to the different portions is easy. Labels seem to have a special attraction, and the Professor encloses some specimens which have been written about fifteen months, but rendered entirely useless by the ravages of the Lepisma. He suggests that the labels should be saturated with a poison previous to use. The writer says it may be that the Lepisma preys upon the pseudo scorpions (*chelifer*) which are always found in the same neighbourhood, but he does not think this is the case.

Chemical Composition of Moulds.—We learn from the Journ. of Pract. Chem. xxiii. (1881) pp. 412-21, that a growth of pure, *Aspergillus*, *Mucor*, and *Penicillium*, has been obtained by N. Sieber, who rendered the fluid selected for the purpose unsuitable for the growth of Schizomycetes by having free phosphoric acid present. From the alcohol and ether extract, small crystals of an as yet unknown substance were obtained, but the extract itself consisted entirely of albumen and cellulose, nor was the allumenoid present in the form of mycoprotein.

Morphology and Genetic Relationship of Pathogenous Bacteria.—Dr. F. Haberkorn has published in the Bot. Centralb. x. (1882) pp. 100-6, the results of his investigations in this direction. He says that spherobacteria, microbacteria, desmobacteria, and spirobacteria are not, as Cohn would have them, four distinct tribes, but all forms of one genus. In the case of malaria, typhus and acute contagium bacteria, pleomorphy, and a definite alternation of generations occur in the history and development, which is the same for all these species, though the bacterium in each disease, as also in typhoid, is perfectly distinct. The size, colour, habits, movements and metastasis, together with the general conditions of their existence, serve to distinguish the different species.

FLUID FOR HOMOGENEOUS IMMERSION.—Some recent experiments of Prof. Abbé (see Bot. Centralbl. x. (1882) pp. 224-5) with pure cedar oil have resulted in the formation of a fluid which Dr. L. Dippel considers perfect for its purpose. The pure oil is spread out so as to present as large a surface as possible to the action of the light and air. When thus treated, it gains the consistency of castor-oil, and while its refractive index is raised to 1.518-20 it undergoes no increase in dispersive power. The refractive index can be reduced if desired by adding olive or castor oil.

CHEMICAL DIFFERENCE BETWEEN DEAD AND LIVING PROTOPLASM.—Dr. O. LOEW is still working at this point, and has executed photographs to shew the difference between the action of dead and living cells upon a weak solution of silver nitrate. It will be remembered, perhaps, that some time ago he elaborated a theory according to which protoplasm consists of certain aldehydes, and its life depends upon the possibility of inter-molecular action between them. Some of the experiments made for the purpose of establishing the theory were extremely interesting. The filamentous Algæ, *Spirogyra* and *Zygnema*, after twelve hours immersion in a solution of silver nitrate, of one part in a hundred thousand, were black with the reduced silver. Algæ killed before immersion give no trace of the reaction. It was found that the Algæ survived a temperature of 35° C, but not 50° C. Immersion in solutions of veratrin and acetate of quinine did not destroy the reducing power of the filaments. The experiments were not confined to Algæ, but extended to other plants. *Cladophora*, the Moulds, Schizomycetes, the Diatomaceæ, and others, gave results generally resembling one another but differing in detail. The reducing properties above described are shared by the highly organised vegetable tissues, and in some instances—as with a few of the Infusoria—by animals.

MAKING DRAWINGS OF MICROSCOPIC OBJECTS.—But it will probably be asked why I did not kill my object before drawing it? I answer that I could never make a drawing to my mind from a dead aquatic larva or insect . . . to say nothing of the fact that a dead aquatic insect so loses the peculiar distinctive character derived from its favourite attitude and position, that though the component parts might in some instances be correctly given, the *tout ensemble* would be scarcely recognised. *Dr. Goring, 1845.*

Microscopical Cement.—A few of our readers would perhaps be glad to know of a cheap cement for mending cells, and for preventing running in of the finishing varnish. Let them procure some "patent knotting" from the oil and colour stores, and expose it a little while to the air, until it has become of the proper consistency. It makes an admirable cement.—A. R. D.

The Vertical Position of Microscopes.—I do not like this position at all. It should, I think, be only used with bodies which must be confined to the stage by their gravity alone, which case may sometimes occur; but I have made most ample provision for presenting all sorts of objects in any position without regard to their gravitation, by means of the aquatic wet and dry boxes and the slide holder, &c. I think that the practice of *poring downwards* (the ordinary way of observation with microscopists of the old school) is peculiarly detrimental to the head and eyes, having a great tendency to determine the blood to them. We never hear of astronomers, who are perpetually looking upwards, having their sight injured, like observers with microscopes, though they have to look, if possible, still more steadfastly and intently than the latter, with the highest powers.—*Dr. Goring, in* Pritchard's *Microscopic Illustrations.*

NOTICES TO CORRESPONDENTS.

All communications should be addressed to Mr. George E. Davis, The Willows, Fallowfield, Manchester; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

B. B.—There are several additions to the second edition.

B. A. C.—We shall be glad to receive the photographs. An article on injecting is in course of preparation, and when it does appear, will be well illustrated.

C. S.—Thanks for your kindly criticism, if you can send us proofs of your assertions so much the better.

J. C.—The preparations from the source you name do not always show the structure they should show; we have come to the conclusion that most of the slides are got up for show, more than practical utility.

H. Z.—We shall now be glad to verify your objectives, but please notice the new regulations.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

FUNGI. Wanted, correspondents with some knowledge of fungi, also books upon the subject, especially Berkeley's British Fungology and the parts which have appeared of Cooke's Illustrations of British Fungi.—J. R. Strood Green, Billinghurst.

SEA WEEDS offered, specimens of foreign genera; wanted, British. Lists on application.—R. Wood, Westward, Wigton.

MOSSES AND LICHENS in exchange for mosses, flowering plants, or fossils. Lists exchanged.—E. H. Starling, 146, Alexandra Road, London, N.W.

CABINET. For exchange; a cabinet to hold five or six hundred slides. Microscope, condenser, micro-material, &c., &c.—F. S. Lyddon, 2, Oakland Villas, Redlands, Bristol.

EXCHANGE. For well mounted slides will exchange pig parasites (*Hæmatopinus suis*) and others. Send list.—J. E. Fawcett, Rawdon, near Leeds.

DIATOMS (mounted and named) wanted in exchange for shells, fossils, &c.—P. Mason, 6, Park Lane, Piccadilly, London.

DESIGN AND WORK. Will exchange five volumes of "Design and Work" for works treating on the microscope, or for microscopic apparatus. — L. Francis, 20, Frogmore Street, Abergavenny.

DIATOM. Slide of *Gomphonema geminatum* in exchange for any interesting object.—A. W. Griffin, Saville Row, Bath.

APPARATUS. A one-eighth objective by Smith and Beck, and a two-thirds by Baker, for five pounds. Warranted perfect.—Rev. R. Browne, 120, Inverness Terrace, Bayswater, London, W.

MISCELLANEOUS SLIDES. Lists for exchange may be had on application to JUNIUS, care of the Editor.

XENODOCHUS CARBONARIUS. Mounted slides of this fungus for exchange. Send lists, botanical preferred. —A. Norris, Urmston, Manchester.

WANTED. A polariscope, camera lucida, and Lieberkühn. Can offer in exchange small entomological cabinet of six drawers, a drying house for setting lepidoptera, the Entomologist and Science Gossip of 1878 to that date, also a good guitar of Dutch make. —J. P. Hiller, 38, Hornsey Street, Holloway, London, N.

PLATE V.

Fig. 17.

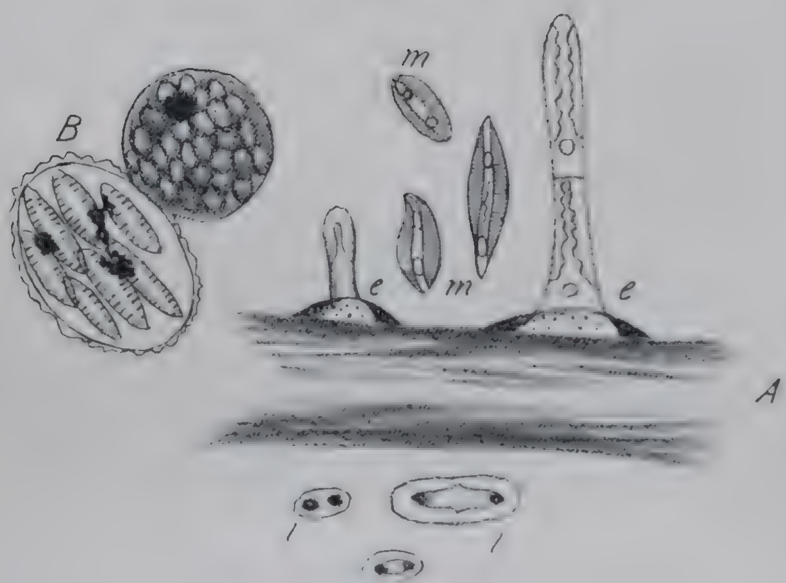
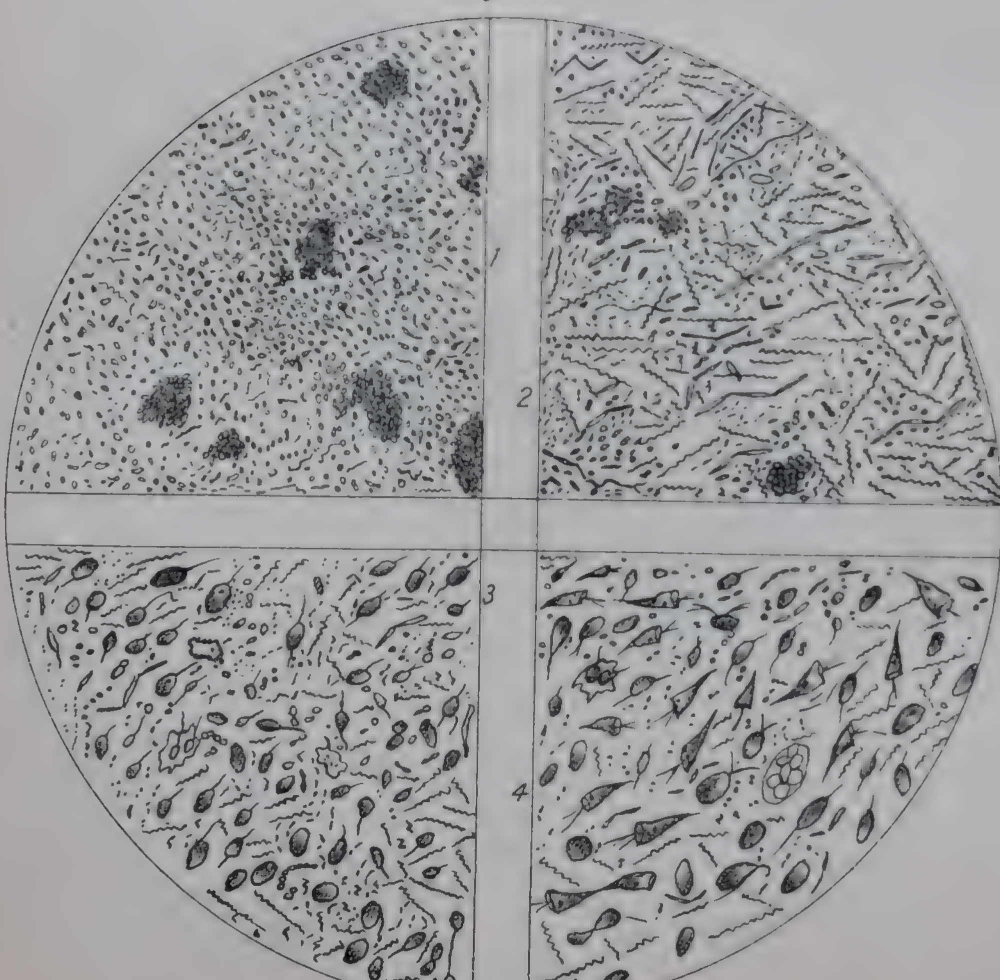


Fig. 18.



The Northern Microscopist,

AND

Microscopical News.

No. 22. *OCTOBER.* 1882.

LIFE-HISTORIES AND THEIR LESSONS.

By Rev. W. H. Dallinger, F.R.S., F.R.M.S.

(Concluded from page 204.)

IN 15 *b* I reproduce one which it will be seen is extremely like the one figured by Dr. Bastian (Fig. 15 *a*), which it must be remembered, he affirms, on the assurance of Gros, was full of germs by the resolution of its internal substance; and that each of the germs was 'capable of developing into a tardigrade. But, fortunately, the germs were not left to their capabilities; they were suspiciously followed out, and they became *Stentor cæruleus!* As drawn, after hatching, they are presented in the attached or fixed state at 15 *c*, and in the swimming condition at 15 *d*. Clearly, the eggs of the stentor had got into the dead hollow body of the tardigrade and developed there!

"That this inference is a correct one I have repeatedly verified, and at Fig. 15 *e* give an additional instance in proof. This is the hollow, perfectly transparent skin of a tardigrade. Nothing has been left within but the hard retractile tube and 'gizzard,' and these, as seen at a^1, have fallen from their true position. At b^1 a small oval body was seen perfectly, and watched, and eventually the small rotifer, c^1—probably *Monura dulcis*—emerged from it, and at length escaped from the skin of the tardigrade altogether. Surely it is unsatisfactory science to consider a phenomenon like this 'heterogenesis,' and to label it 'homogenetic pangenesis in tardigrades!'"

Now, since the publication of this paper, I have received evidence of many similar instances. In Fig. 16 *a*, I give one. I received from Devon some little time since a jar of water and vegetable matter from a bog. It was, as it was reported to be, plentifully peopled with tardigrades and the rotifer known as *Callidina elegans.* It was by no means difficult to find the cast or empty "skins" of tardigrades. *a* is one of these which was found on the fourth day after the water and "weed" had been put into a "trough." It was seen first in the state figured. The eggs within the empty body are manifestly the eggs of the Callidina; but this in the sequel was not a matter of mere conviction, but became a demonstrated fact, when from one of the eggs the form seen in *b* emerged and mingled with its fellows. The other eggs never produced anything, probably having been injured. They simply decayed and broke up. Then it became manifest that Dr. Bastian's curious assumption of the heterogenesis of the tardigrade's body substance into eggs, because eggs appeared in and filled that "body," is refuted by many observations, and the cause of the appearance of Stentor, Rotifer, and other eggs within the carapaces of Tardigrades is explained by the observations of many.

But it is still more curious to find that such absolute refutations as have been given by experts in their own several departments of biological research, of the *assumed* instances of Heterogenesis, published in the *Beginnings of Life*, have not in all minds suggested the need, in observation, of the extremest caution. How serious the resulting errors are, in only one direction, has been shown plainly by Prof. H. L. Smith,* of America, whose competence to write critically on the subject of Diatomaceæ will not be disputed. He has given an absolutely destructive detailed criticism of every important instance of the reputed transmutation of something else into Diatoms which Dr. Bastian has presented, and brings out clearly the mistake of attempting to infer the "heterogenetic" origin of vital forms of whose ascertained history the observer was ignorant. Professor Smith says, "I have probably witnessed more of the phenomena of conjugation and growth than any other person, and can affirm, without fear of being disproved, that . . . any kind of transformation of Pediastreæ or Desmids into Diatoms never has happened—nay more, never will happen." "I look," he continues, "more particularly to the evolution of Diatoms, fully convinced, however, that the errors of misinterpreting what he (Dr. Bastian) saw are quite as great with the Desmids as with the Diatoms." For example, Fig. 17, Plate V., is a reproduction of one of Dr. Bastian's figures, which he declares represents, at *c c*, the "heterogenetic" origin of Diatoms from the Cladophora filament A. Professor Smith says, poor as the cut is, we easily recognise the "pedunculated diatoms" as "*Acanthes exilis* in its normal condition!" In fact, it constantly grows naturally thus on Cladophora, Vaucheria, and other algæ. But, because Dr. Bastian was not aware of this, he took the observation as a fine illustration—which in view of the facts we have no objection to admit—of

* Archebiosis and Heterogenesis. *The Lens*, Jan., 1873, and *Quart. Jour. Micro. Science*, vol. xiii., p. 357, and note by Mr. Archer, *ibid.*

Heterogenesis. Whereas, "if it had been allowed to live it would have continued the process of self-division, until finally . . . a new sporangium would have formed the commencement of a new series." Again, Dr. Bastian affirms the small forms figured at *l l* (Fig. 17), are algoid vesicles budded off from Vaucheria, and that they "gradually become converted into different kinds of diatoms." And further, "these bodies increase in size, and it soon became obvious that they were young Naviculæ (*l l*); the exact pattern assumed in the early stages is subject to much variation, and several different Diatoms seemed to be produced corresponding to these initial forms, *m m*." (Fig. 17.) "This," says Professor Smith, "would be wonderful if true; but not only is there no evidence that actual diatoms did come from the vesicles of Vaucheria, but any one familiar with the observation of living diatoms can tell where they did come from . . . They were in the gathering . . . and made their appearance out of the *débris* . . . as we know they will do under the influence of light . . . But, besides, diatoms do not grow by increase of size; there are no such things as broods of young frustules . . . The late Dr. Greville . . . fully agreed with me in this." Further, Fig. B, Plate V., is a copy of another illustration given in the *Beginnings of Life*. It is declared to represent the "resolution of Euglena into diatoms." It is said concerning it that "the whole of the contents of an Euglena seemed to have been resolved into distinctly striated Naviculæ . . . Although the earlier stages of the transformation were not seen (!), I have no doubt that the diatoms originated in this way." Upon this Prof. Smith observes: "He (Dr. Bastian) is more easily satisfied that an Euglena can transform into a diatom, which possesses a wonderful silicious and beautifully sculptured epiderm, than he is that bacteria come from air-germs," and then he clearly shows that the group of Naviculæ, seen in Fig. B, are simply a group that were devoured, and their protoplasm digested by an amœba. They constantly are ejected in this way from the body of the amœba, after the nutrition has been abstracted, and look like an encysted mass with an envelope complete; and even when treated with acids, although the envelope disappears, the frustules still adhere. And Professor Smith has "slides as well as materials, showing this in abundance." All this, it may be presumed, is capable of suggesting two things: 1. The danger of attempting to discover new modes of "genesis" until we have made ourselves acquainted with the old ones; and 2. That "Heterogenesis" is not even a scientific hypothesis, for the "facts" on which it is founded have not received scientific investigation.* But the caution suggested by all

* "Heterogenesis." *Popular Science Review*, vol. xv., 346.

this is evidently not in every case a prophylactic; although it certainly has been so in the case of a great majority of working Biologists, whether amateur or professional. But we have few of us, probably, been called before to witness so remarkable an alleged evidence of the nature, persistence, and transmutable power of "Protoplasm" as was brought before us a little while ago, in which we were called on to consider an illustration of the emergence of lowly living organisms from what was declared to be transmuted "protoplasm of sawdust!" It was gravely asserted that wood saw-dust contained protoplasm; and that this, which it had inherited from the tree of which it was a part, had the power heterogenetically to become—living organisms. The proof was that bacterial and monadic forms had been found in an infusion of which the sawdust was the essential ingredient! and it was supposed to be the more remarkable, from the fact that the sawdust had been prepared from wood which had constituted a pile of an old lake dwelling. It consequently had an antiquity, as dead wood, which might be greater than that of the historic antiquity of man in Europe, and, for aught we really can determine, greater than chronological antiquity of man upon the earth. Yet, although it is a piece torn from a dead tree of such a vast period since, it is supposed to contain—protoplasm—the life-stuff that gave the tree from which it was riven, its vital and physical characteristics—in its living entirety? and that this "protoplasm" had the power to change itself into separate and specialised living forms!

The grounds of this bizarre and incongruous "inference" are simply that living forms appeared in the sawdust infusion! which is no more and no less than every practical Biologist would expect. Anything that will carry "germs" or desiccated septic organisms into water that favours, renders possible, or indicates a putrefactive state, will rapidly give rise to putrefactive organisms. The "sawdust" from this lake dwelling pile had been saturated for thousands of years with the water of the lake. It doubtless contained germs of life in various forms. But unless it were, in the form of minute broken particles, introduced into a vessel in such a way as to have no contact with the outer air, and to be hermetically enclosed in sterilised water, it would be impossible to discover even what these germs, contained in this saturated wood, were. But when the wood is sawn into "sawdust," without precaution, and put into an ordinary "live-box" for study, what could we expect but living products? They must be there, as the experience of the practical Biologist has everywhere shown. Some of them would have been there equally if it had been bone-dust or stone-dust that had been there instead of sawdust. But to argue that such living things are the outcome of the "transmuted protoplasm" of the said "dust," is either to ignore, or to be unacquainted with, all the elements which constitute our recent knowledge of minute life, and all the facts which have enabled recent science to formulate the magnificent generalisation which finds in protoplasm the physical basis of life.

I have in my possession some fragments of a wooden hutch which was used by me for many years as a shelter for offensive putrefactions, from which septic organisms of various kinds were derived for study. A month ago I sawed and filed some of this, and placed it with minute broken fragments of the same wood into a vessel with water, and a little of Cohn's nutritive fluid, which was kept at a temperature of 62° F. In Plate V., Fig. 18 *a*, I show the result of the examination of a minute drop of the surface film after four days, where the earliest forms of Bacteria are in vast abundance, and in the drop were intensely active.* At 2 the same fluid is seen more generally examined four days after, when *Bacillus lineola*, *B. ulna*, and even *Spirillum volutans* struggle with *B. termo*, and prevail; and a few early developments of monads appear. In the quadrants 3 and 4 the general result of examination on the twelfth and sixteenth day are manifest, and all these forms were the common forms upon which, at the time, this outdoor cupboard was employed for the protection of the infusions on which Dr. Drysdale and myself were at work. It was simply evidence of what has been often given before, that the germs of the putrefactive organisms can persist in air undeveloped; but on entering a suitable fluid, are at once stimulated into development and increase. The wood of the cupboard was charged with germs. These were the germs of forms whose life-histories in many cases were known. They succeeded each other in time; they did not all appear together; but this, so far as we at present know, is dependent upon the condition of the fluid as superinduced by the forms that have gone before. Certain it is that their life-cycles are independent of each other. The monads are no more "transmutations" of the bacteria, than the graylings and trout of the Upper Thames are "transmutations" of its sticklebacks and minnows. It will complete the evidence which I have sought to give as to the need of caution in relation to hasty inference in the study of the minuter forms of life, if I take a case of its wise exercise from no older a source than the *Quarterly Journal of Microscopical Science* for April of this year (1880). It is furnished by Mr. Siddall in a paper "On Shepheardella, an undescribed type of Marine Rhizophoda."† It is a curious marine organism, seen in Fig. 1, Plate VI., which Mr. Siddall points out has a similarity of external form with the *Gregarina gigantea* of Van Beneden. But the ob-

* Only a quadrant of the "field" in each case is shown.

† Page 129, *et seq.*

servations made, although of great interest and value, were not, on account of fewness of specimens and, probably, want of knowledge of the life-conditions of the animal, competent to even indicate its life-history. Yet, to an observer in quest of support for a theory, there was much that was curious and "suggestive." In fact, the organism was simply seen in the main to break up into amœboid and actinophrys-like masses of protoplasm. Fig. 2 is a form of Fig. 1, in the first stage of "breaking up," where, indeed, in the course of time, changes had been superinduced in the normal organism. In one instance, in about five days, one in an apparently healthy state had passed from the normal condition (Fig. 1) into that seen in Fig. 3, which was a merely spherical shape with constrictions. In two and a half hours more it had again assumed the form shown in Fig. 2, and by the end of less than two days more it had broken into four parts, as in Fig. 4, which poured out anastomosing sarcode, as in Fig. 5, but this ultimately contracted into one principal mass; and from this, minute amœboid particles, and actinophrys-like bodies, as seen in Figs. 7, 8, which really were offshoots of the sarcode of the mass, as seen in Fig. 6.

Even this too brief summary of the results obtained by these observations show how interesting they are, and lead to a desire for their early re-prosecution and completion. But in their present form, does their author endeavour to establish the doctrine of transformations by showing that Shepheardella becomes amœba and actinophrys? No; but he, as a careful naturalist, says, "From the foregoing account it will be gathered that little beyond the dissolution of Shepheardella into amœboid particles has yet been quite satisfactorily traced. No attempt at fission, encystation, or anything approaching to either, and no development of special reproductive bodies . . . has yet been observed. The loss of the specimen possessing three nuclei was a matter of much regret, as I had hoped, judging from what has been noticed in other simple organisms having more than one nucleus, that it might ultimately divide into three distinct individuals, and, by so doing, give conclusive evidence of at least one process of reproduction. As it at present stands, the life-history of Shepheardella may be looked upon as a chain, a few links of which are here presented, the major portion being still missing."*

In conclusion, let it be remembered that the facts of nature are the only court of final appeal in science. Theories must always be either destroyed and cast away, or immortalised, by facts alone. Twenty years in the future will doubtless do for scientific knowledge in all directions what twenty years in the past have done—that is, modify much that is now rigidly held. But the broader

* *Quarterly Journal of Microscopical Science*, p. 137.

the basis of fact on which a scientific generalisation is established, the less the probability of its being supplanted or even modified by succeeding facts. The scientific mind should, and would, find no difficulty in receiving Heterogenesis if it represented a fact in nature. But with the vast area of facts that absolutely oppose it, as definitely settled as the specific gravity of gold; and with the crude and undigested "evidence" brought by its advocates in its favour, we may scarcely anticipate that uncertainty or caprice in vital development, or a new power in "protoplasm" to disregard its inherited tendencies, will be amongst the facts that will make the light of human knowledge brighter in the years to come. In their obedience to law, every realm of nature is at one. But in the realm of life, the obedience is the most intense, because demonstrably subject to the highest and most wide-reaching of all laws—Evolution.

NOTES ON MOSSES.

OCTOBER.

IN part five of the British Flora, Dr. Braithwaite says, "Of the immense family of the Dicranaceæ or Fork Mosses, numbering nearly 600 species, and distributed throughout the world at all altitudes, only one, Trematodonteæ, of the six sub-families, into which the European species are arranged, is not found in Great Britain; although represented on the Continent by three species of the genus Trematadon, and three of the genus Bruchia, one of which, *B. palustris*, may possibly occur here." The classification of the sub-families is based upon Professor Lindberg's admirable work (1878), and comprises, 1. Ditricheæ; 2. Dicranelleæ; 3. Seligerieæ; 4. Dicraneæ; 5. Onsophoreæ. It is noticeable that the list of Mosses appended to Sir John Franklin's "Journey to the Polar Seas," consists of British Mosses, amongst which are the Fork Mosses.

Inhabiting the ground, and also rocks, sometimes trunks of trees, the plants vary from minute to very tall, with leaves broadly lanceolate to subulate, smooth and nerved.

Capsule erect or drooping (cernuous); peristome of 16 teeth, cleft half-way or sometimes to the base into two lanceolate legs. Lid large and usually beaked (rostrate); calyptra large, dimidiate, irregular.

The genus Dicranella is distinguished in a great measure from Dicranum (see July notes, p. 182) by the absence of larger pellucid or coloured cells at the basal angles of the leaf; also the name, diminutive of Dicranum, indicating their smaller character.

Five of the species fruiting about this time are not common, viz., *D. crispa*, *D. Schreberi*, *D. rufescens*, *D. subulata*, and *D. curvata*. *D. crispa*, the curled-leaved Fork Moss, from its crisped state when dry, is found on moist banks and sandy soil, growing in patches, of a pale green colour; stems short, not ½ inch high; leaves widely spreading, subulate or almost bristly (setaceous), wavy, glossy and predominant nerve; capsule oval, erect on a reddish fruitstalk, of regular form and furrowed when dry. Ashley, near Bowdon (Wild). The fruit seems to be very persistent, having been gathered at Handforth in February, by Mr. Cash. Fig. 18. *D. Schreberi*, Schreber's Fork Moss, is a miniature resemblance

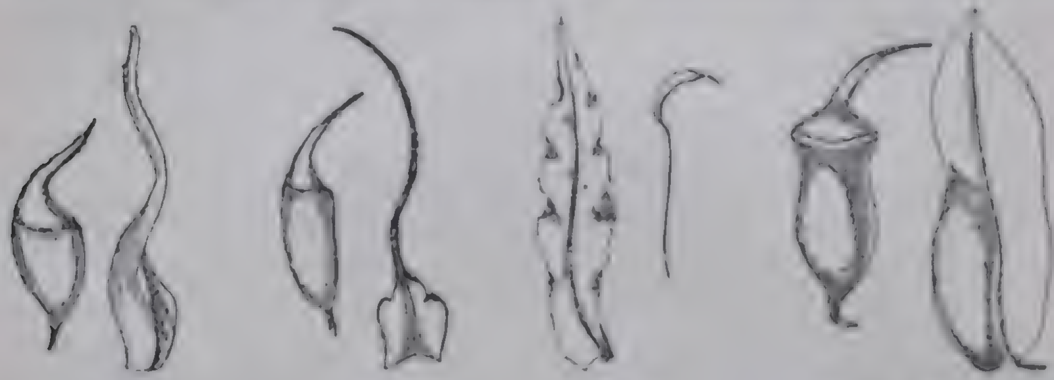


Fig. 18. Fig. 19. Fig. 20. Fig. 21.

of *D. squarrosa*, differing only in the narrower leaves, which more suddenly dilate and are sheathing below. Found near Irlam (Wilson), also at Ashley, with the variety *D. elata* (Wild). A rare Moss is *D. subulata*, the Awl-leaved Fork Moss; Sailors-shore, near Radcliffe (Wild); and extremely rare, *D. curvata*, Llanberis (Wilson).

A very elegant Moss, found on moist banks, chiefly in sandy soil, and not rare in the neighbourhood of Manchester, is *D. rufescens*, the Reddish Fork Moss. It is similar in habit to *D. varia*, but known by the pale reddish hue of the whole plant, and by the oppositely twisted fruitstalk. Stems bright red; leaves pellucid and loosely cellular, with plain margins, obscurely toothed. Capsule smooth, erect, reddish, with a short neck. Teeth of peristome closely barred.

One of the commonest species of the genus is *D. varia*, the variable Fork Moss, found from October to February, on damp clay fields, banks of ditches, and sometimes on rocks. Several forms, differing in size and tint, may be found growing together in one tuft.

The normal form is of a yellowish green colour, short and cæs-

PLATE VI.

pitose. Leaves erecto-patent, rarely sub-secund, gradually lanceolate-subulate, sub-denticulate at apex, margin reflexed, nerve slight excurrent. Capsule, ovate and cernuous; lid large, with short beak; seta-twisted to the right. Dioicous. Male plants smaller, with ovate-subulate bract. A variety, β *fallax* (Wilson) or *tenuifolium* (Bruch), has the leaves more distant, thinner, and narrower, with laxer cells and a paler and thinner capsule.—Cotterill Clough (Wild); whilst var. γ. *tenellum* (Schimp) has slender falcato-secund leaves, and var. δ. *callistomum* is distinguished by its scarcely secund-leaves and erect obovate capsules. Castle Mill (Wild).

Another very common species of this genus is *D. heteromalla*, the Silky-leaved Fork Moss, Fig. 19, growing in extensive silky patches on moist banks, roads, and sandstone rocks, and fruiting from November to March, Leaves are crowded, secund, lanceolate-setaceous or bristly, and slightly dentate at the apex; nerve prodominant; capsule obovate, cernuous, very often bent backwards, and when empty and dry obliquely furrowed, by which character, and by the pale fruitstalk, it may always be recognized. Dr. Braithwaite gives three varieties of this species; *b. stricta*, with leaves straight, erecto-patent, seta-elongated; *c. interrupta*, stems taller and more branched, leaves patent or falcato-secund; and *d. sericea*, growing in small, bright, green silky tufts, with leaves soft, longer, and narrower.

Allied to the preceding, and growing on wet rocks and stones, in shady rivulets, in all the mountainous cloughs round Manchester is *Dichodontium pellucidum*, the Transparent Fork Moss, with two varieties, *serratum*, Turton near Bolton (Wild), and *compactum*. More nearly approaching the Dicranums in habit is *Dicranodontium longirostrum*, the Beaked Swan-neck Moss, found in mountainous woods; rare. Stirrup Wood (Wild).

Four Mosses, *Didymodon rubellus*, the reddish Didymodon; *D. cylindricus*, the slender-fruited Didymodon; *Trichostomum homomallum*, the curved-leaved, and *T. tortile*, the twisted Trichostomums, belong to the same family as the Tortulas. The first is not unfrequent on shady walls and rocks. The reddish hue of the lower leaves, from which it derives its name, serves to distinguish it from other species greatly resembling it.

The rare *D. cylindricus* is found on damp, shady rocks. The fruit, which is rarer, is erect, narrow, and cylindrical. Dolgelly (Whitehead, Holt), Barmouth (Wild, Holt). Also rare on sandy banks and quarries, is *T. tortile*, named from the slightly twisted character of the leaves when dry.

On Kinder Scout (Holt, Whitehead), Derwentwater (Cash), about Snowdon, and on the Scotch mountains is *Grimmia Doniana*, Don's Grimmia, after Mr. G. Don. Growing in small, round, hoary tufts on rocks and walls, with stems seldom above $\frac{1}{4}$ inch long; it fruits both in March and October. The leaves are erecto-patent and narrowly lanceolate, gradually tapering into transparent (diaphanous) hair-points; margins plane; capsule pale, erect; oval-oblong and partly exserted; lid short, conical, obtuse; teeth of the peristome entire. Monoicous.

A more rare species, although larger, is *G. ovata*, the oval-fruited Grimmia, known from the last by the leaf margins being recurved below, also by its reddish brown capsules and rostellate lid.

Very rare, with blackish glossy leaves is *G. atrata*, the black-tufted Grimmia. Found on Snowdon and Glen Callater.

Another species, rare in fruit, is *G. funalis*, the Spiral-leaved Grimmia. Ben Lawers (Whitehead, Holt).

The genus Grimmia is named in honour of Grimm, a German botanist; sub-order Grimmiaceæ, Perennial acrocarpous Mosses, growing in tufts upon rocks, walls, and stones; with lanceolate leaves, immersed capsule and conico-mitriform calyptras; peristome single, with 16 equidistant teeth.

Belonging to the family of Hair Mosses, Polytrichaceæ, two genera, Atrichum and Pogonatum, are in fruit this month. Atrichum, α,θριξ, without hairs, is in habit intermediate between Polytrichum and Mnium, and in the leaves and form of the flowers resembles *Mnium undulatum*, but is known from Mnium by the acute papillose character of the leaves.

The calyptra is almost destitute of hairs, being spinulose at the apex only; peristome single, of 32 teeth.

A. undulatum, the Wavy-leaved Hair Moss, although a very elegant moss, is a common one, and one of the first to attract the moss student. Found in grassy, shady places, on soil only, it has long ligulate-lanceolate leaves, undulated in the margin and sharply toothed; capsule cylindrical curved; lid with a long curved beak. Monoicous. Fig. 20.

In Britain, the male and barren plants only of *A. crispum* are found amongst the stones and grass beside streams, and although common round Manchester, principally on the millstone grit, the only recorded counties for this Moss are Lancashire, Cheshire, Yorkshire, Carmarthen, and Devon. The fertile plant has only been found in North America. The two remaining species are *A. angustatum*, rare, and *A. tenellum*, of doubtful nature.

More showy plants than the preceding, and distinguished from them by the hairy calyptra, and by the more rigid, densely lamellated (covered with small plates) sheathing leaves is the genus. Pogonatum from πωγων, a beard; easily separated from Polytrichum by the rounded—not angular capsule, destitute of an apophysis. (See July notes, p. 183.) *P. nanum*, the Dwarf Hair Moss frequents moist shady sandy banks, and has lanceolate leaves with a sheathing base, minutely toothed at the apex; capsule roundish, reddish-brown, wide mouthed when dry. Delamere (Cash Holt.) Its columella is cylindrical, not winged, distinguishing it from *P. aloides*, the aloe-leaved Hair Moss, whose columella is four-winged; the capsule ovate-oblong with conico-rostellate lid; calyptra covered with whitish hairs. Common round Manchester.

P. urnigerum, the Urn-fruited Hair Moss, is principally found on mountainous banks and sides of streams, growing in pale, glaucous green patches. Stems 1-4 inches high, branched above, reddish below. Leaves erect when dry; lanceolate, acute, serrated; lamellœ suddenly thickened at the edges; capsule erect, subcylindrical, regular, granulated on the surface; lid convex, rostrate. Wilson says: "This species may in general be known by the foliage being glaucous above and reddish below, and by the neat cylindrical capsules. Delamere (Cash, Wild, Holt.)

The only remaining species of this genus, which are all dioicous, is *P. alpinum*, the Alpine Hair Moss, found fruiting in June in sub-alpine regions. Leaves linear-lanceolate, concave, sharply serrated, and spinulose at the back; capsule roundish, dark olive brown, blackish when old; teeth of the peristome short, pale and narrow; lid with a long beak. Fo. Edge, near Bury (Perceval.)

One of the prettiest, as well as one of the commonest mosses in fruit this month is *Bryum argenteum*, the silvery Thread-Moss, found everywhere on roofs and walls, on the ground, by way-sides, &c. This little moss is sure to have attracted the attention of every passer-by during the last few months growing in white silvery patches at the base of walls and houses, wherever the slightest trace of earth and damp could be found; in fact so general is this harbinger of vegetation that it forms one of the five discovered by Dr. Hooker at the Ultima Thule of Antarctic vegetation, Cockburn Island, lat. 60°. 24′. S. The stems are ¼—1 inch long, slender and fragile. Leaves imbricate, broadly ovate, mostly with a short point (apiculate), concave, entire, nerve ceasing considerably below the apex. Fruit-stalk about half-an-inch long, rather suddenly bent near its junction with the capsule, which is oval-oblong, its neck not tapering, but abruptly passing into the fruit-stalk of a purplish or reddish colour when ripe. Lid convex, obscurely pointed. Dioicous. Two varieties are given by Schimper, viz., *b. majus:* Stems longer, leaves greenish without points, and *c. lanatum*, smaller leaves with long points, without chlorophyll; silvery white; peculiar to warm climates.

Resembling *B. argenteum* in aspect, but longer, and always with a considerable tinge of red is *Zieria julacea;* the Zierian Thread Moss, found in the crevices of mountainous rocks—Bowness (Atkinson).

A very minute and rare moss, growing in small patches, not ½-inch in height, on turfy soil, is *Bartramidula Wilsoni*, the beardless dwarf Apple Moss. One of the most beautiful and delicate of mosses, it is remarkable for its pale pink globular, drooping capsules without peristome. Found in Ireland, Scotland, and Wales. Cwm Bychan (Wilson, Perceval, Salway.)

Connecting the Acrocarpous with the Pleurocarpous Mosses, are a few genera, termed Cladocarpi, of which the principal is the Fissidentaceæ, or Flat Fork Mosses. In ten species the capsule is terminal, while in the four remaining it is lateral, arising from a short fertile branch (ramulus); the possession, however, of a distinct vaginula, the sheath round the base of the fruit-stalk (seta), removes them from the pleurocarpous group. The anomalous structure of the leaf at once distinguishes it as a separate family amongst the moss flora, the leaves being in two rows, alternate and inserted vertically, each with a median nerve; united to which for a greater or less extent is a second series of stipules, which, with the upper half of the leaf base, sheathe the stem.

They are plants very variable in size, with stems from ½ inch to 12 inches long, simple or branched, complanate; capsule symmetric or obliquely incurved, narrowed at base; calyptra hooded (cucultate); peristome of 16 teeth, cleft half way or more into two rough subulate segments, transversely barred, deep red.

Named from the Latin *fissus*, split and *dens*, a tooth; the species are distributed through all the tropical and temperate regions of the globe, and are found on wet banks and rocks, sometimes trunks of trees. One of the lateral fruited species is *F. adiantoides;* the marsh Flat Fork Moss; common round Manchester on wet shady rocks, having stems 1—2 inches in length, but varying considerably in size and colour according to the locality. The leaves are oblong-lanceolate; acute, serrulate above; capsule ovate; lid long beaked. Dioicous. Fig. 21.

An extremely fine moss of this group, although not fruiting in Britain, is *F. polyphyllus*, having stems 5—12 inches in length; leaves nearly twice as long as the preceding, of finer texture, glossy; oblong-lanceolate, entire and nerved to apex. Pont Aberglaslyn (Cash, Cunliffe.)

Of the terminal fruited species there are four in fruit about this time. *F. osmundoides*, the Alpine Flat Fork Moss. Leaves crowded, ovate-lanceolate; not bordered, with large cells; nerve ceasing below apex; capsule sub-erect, small; oval-oblong; lid rostrate; calyptra mitriform, on wet rocks. Staleybrushes (Stanley, Wild.)

F. pusillus. Stems short; leaves erect, acute; narrow; nerved to apex; capsules sub-erect; peristome immersed. Sandstone rocks. Ashley Mill, Bowden, and Clitheroe. (Hunt.)

F. crassipes. Stems ¼—¾-inch, plants more robust; leaves larger, broader; capsules obovate-roundish on a short seta; erect. Oxford (Boswell.) Tynygroes (Holt, Wild.)

F. viridulus. The green Flat Fork Moss; plants very small; simple; leaves lanceolate, bordered, entire, acute; nerved to apex; capsule erect, oval-oblong; lid conico-acuminate. Banks and rocks. Barmouth (Rogers.)

Pleurocarpous Mosses. On trees, walls, rocks, &c., but not common in fruit is *Leucodon sciuroides*, the squirrel-tail Leucodon. Patterdale (Cash); also common in the same localities, *Isothecium myurum*, the blunt-leaved Frond Moss. Bowness (Atkinson.)

A handsome Moss, not common in fruit, is *Climacium dendroides*, the Marsh Tree Moss. Stems 2 or 3 inches high, much branched at the summit; branches nearly an inch long; leaves ovate-lanceolate; spreading, serrulate at the apex; capsule oval-oblong. In boggy or marshy places. Knutsford (Whitehead), Stirrup Wood (Cunliffe.)

A peculiar Moss, with fœtid odour when moist, is *Cylindrothecium concinnum* or Montagnei, the Cylinder Moss. The capsule is erect, cylindrical, on a long seta, and with a blunt lid; but the fruit is not found in Britain. Hills, chiefly limestone. Wetherby (Westley, Wild.)

Of the Hypnums *Brachythecium plumosum*, the rusty Feather Moss is common on sub-Alpine shady rocks, stones in rivulets, walls, &c. Stems creeping, sub-pinnate, leaves ovate; concave, acuminate, serrulate near apex, nerved above half way; capsule small roundish-ovate cernuous; seta roughish; lid conical acute. Monoicous; found on Heaton Park wall (Bastow). Frequent on walls, rocks, trees, &c., is *Rhynchostegium confertum*, the clustered Feather Moss; also on Heaton Park wall (Wild), and walls chiefly limestone is *Rhynchostegium murale*, the Wall Feather Moss.

In similar situations to the last two is *Hypnum resupinatum*, the upward-turned Feather Moss. Its leaves which point upwards are secund, ovate-lanceolate, tapering to a point, entire nerveless; capsule oblong, erect; lid with a long beak. Millers Dale (Whitehead, Stanley.)

Two very common Mosses on shady banks are *H. Schreberi* and *H. purum*; the neat meadow Feather Moss, while *Hylocomium brevirostrum*, the short-beaked Feather Moss is not recorded for Derbyshire in the London Catalogue. Found in Millers Dale (Whitehead, Nield, Stanley.)

WILLIAM STANLEY.

EXTRACT FROM

PROF. MARTIN DUNCAN'S ADDRESS

TO THE MEMBERS OF THE ROYAL MICROSCOPICAL SOCIETY, FEBRUARY 8TH, 1882.

The Abbe Theory of Microscopical Vision.

AS a notable feature may be mentioned the greatly increased interest which has been awakened in the important contribution to the theory of the Microscope, originated by our illustrious Fellow, Professor Abbe. Although those views are now several years old, and were brought before the Society so long ago as 1877 by our then Treasurer, Mr. J. W. Stephenson, the recognition of the extraordinary nature of the experiments, was until lately confined to a very small circle. Both in this country and in Germany and America, however, the past year has seen a great extension in the number of those who have followed these experiments, and who have appreciated the important bearing which they have on microscopical vision.

I have used the term "extraordinary" because I think that every one who has seen these experiments will readily agree that it is extraordinary, in every sense of the word, to find, that merely by excluding a greater or less number of the "diffraction" images found at the back of the objective, a great variety of entirely different appearances are presented by one and the same object—lines at a known distance apart doubled and quadrupled,—or that objects in reality quite unlike can be made to seem identical—multi-sided figures giving images of squares. In short, the *same* objects may appear to be *different* in structure and *different* objects may seem to be *identical*, entirely according as their diffraction images are made dissimilar or similar by artificial appliances between the objective and eye-piece. The appearance of particular structure can even be "predicted" by the mathematician, before it has been actually seen by the microscopist.

The result of these experiments is to show that a distinction must be drawn, between the vision of minute objects and what may be termed, for this purpose, "coarse" objects, *i.e.*, those which are considerable multiples of the wave-lengths.

The latter are imaged by the Microscope, substantially in the same way as by the camera or the telescope, and their images correspond point for point with the object. We are therefore able to draw the same inferences as the actual nature of such objects, as in the case of ordinary vision.

Minute objects, or parts of objects, only a few multiples of the wave-lengths, are, however, imaged in an entirely different way, viz. by the diffracted rays produced by the action of the minute structure. If *all* the diffracted rays from the object are reunited and reach the eye, an image of the real structure is obtained. If *some* only of the rays are transmitted, the image is no longer necessarily a true representation of the object, and the smaller the admitted portion the more incomplete and dissimilar the image. Now as the objects become more and more minute, the diffracted rays are more widely spread, and fewer of them can be admitted by an objective even of largest aperture. The visible indications of structure in such images are not therefore necessarily comformable to the actual nature of the object under examination, and the only inference that we are entitled to draw from the image as presented to our eye, is the presence, in the object, of some of the many different structural peculiarities which are capable of producing the diffraction phenomena observed in the particular case.

Our veteran microscopist, Dr. Carpenter, C.B., has embodied, in the edition of his widely known work published during 1881, a statement of the leading points of the diffraction theory, which is valuable as containing the results of his own matured views on the subject. He says (p. 187), "This doctrine, originally based on "elaborate theoretical investigations in connection with the undu-"latory theory of light, has been so fully borne out by experimental "inquiries instituted to test it, and is in such complete harmony "with the most certain experiences of microscopists, that its truth "scarcely admits of a doubt."

There are one or two points that require to be kept prominently in mind in regard to the diffraction phenomena in question; 1st, that they are not to be confounded with the so-called "diffraction band" observed round the outlines of objects illuminated by oblique light, nor with the "diffraction" rings displayed by brilliantly illuminated globules; 2nd, that they are not confined to transparent objects illuminated by transmitted light, but are also produced by *opaque* objects; and 3rd, that they are not limited to lined or regular objects, but also extend to *irregular* structures or isolated elements of any shape; in fact universally, to structures of all kinds, whenever the uniform propagation of the luminous waves is disturbed by the interposition either of opaque or semi-opaque elements, or of transparent elements of unequal refraction, which give rise to unequal retardations of the waves. They therefore apply not merely to the "resolving power" of objectives, but to their general *delineating power*—the power of the Microscope to show things "*as they are.*"

The 3rd point is, I need hardly say, most important, and one which it will be very interesting to have more fully elucidated, having regard to Professor Abbe's statement that objects (such as the flagella of Bacteria) which are only a fraction of a wave-length in diameter, will necessarily appear to us, not in their proper proportions, but with greatly *increased* diameters, and that very minute striations must appear as if the dark and bright interspaces were nearly of *equal* breadth, although in reality not so.

There are obviously many histological problems, such as the question of the structure of muscle, which a proper knowledge of this part of the subject may greatly help to elucidate.

The facts which we now have before us in regard to microscopical vision, are sufficient to justify the injunction of Professor Abbe that "the very first step of every understanding of the Microscope is to abandon the gratuitous assumption of our ancestors that microscopical vision is an imitation of macroscopical, and to become familiar with the idea that it is a thing *sui generis*, in regard to which nothing can be legitimately inferred from the optical phenomena connected with bodies of large size." That there must be a great deal more yet to be elaborated in regard to the origin and nature of the phenomena we have been considering, is obvious, and I hope that the attention of our own physicists and microscopists will be directed to a subject of such extensive practical bearing, not merely to the theoretical microscopist, but to the large class of practical histologists who are entirely dependent upon the Microscope for the accuracy of their observations.

The Aperture of Objectives.

The "aperture question," as we all know, gave rise, several years ago, to a somewhat acrimonious controversy, not in the 'Proceedings' of the Society, but in the unofficial section of its then Journal, and doubtless there were some Fellows who, at the beginning of last year, regarded with no little apprehension the prospect of a revival of that controversy. But, notwithstanding the warmth with which it was debated in its new form, no one will, I am sure, deny the very great value that the renewal of the discussion—between Mr. Crisp and Mr. Shadbolt—has been in bringing to the light what had previously been confined to a few. If any one does not now comprehend how an immersion objective can have an aperture greater than that of a dry objective of 180°, at least it cannot be any longer charged against this Society, that means have not been provided to enable him to do so.

The essential difference between the old and the new view of aperture is simply, that the former considered only the rays which *enter* the objective, while the latter deals with those which *emerge* from it.

The disadvantage of the former method, which estimated the incident pencils entirely by their angles, has been its inevitable tendency to give a fictitious importance to the angle of the entering pencil, which was supposed to have a special virtue of itself, in the delineation of objects. Naturally, therefore, the same angles, whether in air or any immersion fluid, were considered to produce an equal effect, and the advantage of immersion objectives was rested on minor points.

An estimation of the emergent beam, however, must obviously give the same result as one of the incident beam (assuming them both to be correctly made), it being of course impossible for anything to emerge that has not first been admitted. But to quote Mr. Crisp:—"The great and obvious advantage in dealing with the emergent pencil is that it is always in air, and so the perplexities are eliminated which have enveloped the consideration of the admitted pencil, which may be in air, water, oil, or other substances of various refractive indices."*

The subject of aperture is not, in reality, a difficult one, and any intricacy in which it may seem to be involved will be found to arise from the necessity of clearing away some of the old entanglements, such as the curious mistake involved in the "hemisphere puzzle" and similar matters. Looked at *de novo*, there are two simple stages in the aperture question.

(1) To appreciate that, in using the term "aperture" we use it not in any artificial sense, but as meaning opening and nothing else,—defining, simply, the capacity of an objective for receiving rays from the object and transmitting them to the image.

(2) That the aperture (as so defined) of an objective is determined by the ratio between the diameter of the emergent beam and the focal length of the objective. According as this ratio is greater or less, so the objective will receive and transmit a larger or smaller portion of the total quantity of rays presented to it.

The emergent beam of an air objective of 180° angle cannot exceed in diameter twice the focal length; that of a similar water-immersion objective may be one-third larger, and of an oil-immersion half as large again, and the relative capacities of such objectives (with equal angles) to receive and transmit rays will always be as 1, 1⅓ and 1½.

It cannot be too carefully borne in mind that it is not a question

* As pointed out by Mr. J. Mayall, jun., at the commencement of the discussion, if 180° in air is equivalent to 82° in glass, the 140° in glass of the immersion lens must represent something more. This fact is, however, so constantly misinterpreted, owing to the supposition that when the immersion fluid is introduced the effect is only that the 82° is no longer compressed by the action of the plane surface of the lens, but is allowed to expand to 140°. This is one only of the apparent difficulties that obscure the proper estimation of the incident pencil, and which are avoided by dealing with the emergent beam.

of this or that theory, but the ordinary laws of geometrical optics which determine that, all other things being equal, one objective will receive and transmit a greater quantity of light than another, and therefore has the larger or smaller aperture, according as the diameter of the beam emerging from it is greater or smaller.

(To be continued.)

LETTERS TO THE EDITOR.

APERTURES AND AMPLIFICATION.

Editor's remarks.—We present our readers with a *verbatim* report of the proceedings of the last meeting of the Manchester Microscopical Society, and understanding a paper was to be read settling for ever the aperture question, we therefore sent a reporter to take down such a valuable contribution. It is not our intention to debate the matter in its present form. Doubtless Prof. Abbe and his colleagues will feel proud of possessing such support as is afforded by the reader of the paper in question—we feel bound however to confess, that so far, we have not been able to appreciate the importance of what has been advanced, nor do we see what propositions have been established. The reader was, no doubt, eager, like Goliath, for the fray, and if he wished his views to be widely circulated, we have aided him in this respect.

Upon page 274 may be found Professor Martin Duncan's address to the members of the Royal Microscopical Society; it is so clearly expressed that we commend it to the notice of members of all societies, both young and old.

To the Editor of the Northern Microscopist.

Dear Sir,

Referring to the Aperture Shutter, at the last meeting of the Manchester Microscopical Society, Mr. Miles described it as a scientific toy. Now, if we are so to describe every piece of apparatus which does not answer all our individual requirements, we shall very soon dispense with the whole of our Microscopic accessories. Take for instance the "spot lens," that simple and useful little instrument for producing such beautiful effects of dark-ground illumination of Pond-life, Polycistina, Mosses, &c., but, which for the majority of objects is entirely useless, and is seldom or never used in tracing out the life-history of vegetable or animal organisms. Again, take the Camera-lucida, for which we pay prices ranging from 6s. 6d. to £2 2s., but, which every microscopist who can smoke an ordinary cover-glass and bend a bit of tin, can just as easily dispense with.

All who have bought objectives of high angular aperture have felt the want of penetration in observing opaque and other objects, such as Seeds, Pollen, Foraminifera, Polycistina, &c.; and to those whose pockets are limited, any instrument ought certainly to be welcomed which obviates the necessity of purchasing duplicate objectives of lower angular aperture.

That the Davis Aperture Shutter fulfils this condition was well illustrated a few days ago upon a slide of Polycistina, placed under a half-inch objective of 80°, and dark-ground illumination with the condenser. The result was a glare,—no definition, no penetration; but when the aperture shutter was applied, an exceedingly good dark-ground was obtained, with penetration sufficient to clearly define the whole of the interior markings of some of the larger cone-like forms.

That the Shutter will prove a very useful addition to our list of accessories, admits I think of no doubt, and I have heard it favourably spoken of by more than one working microscopist.

Yours respectfully,

WILLIAM STANLEY.

The Aperture Shutter.

Sir,

There has been a good deal of discussion of late about the merits of the new "Aperture Shutter": perhaps you will allow me to give my testimony to its value both in photo-micrography and also in ordinary microscopic work.

On exhibiting foraminifera, sand deposits, and big diatoms, I have frequently found that the power which gave most detail lacked sufficient penetration to bring all the objects on the slide into a common focus; a very slight increase of penetration would answer, and a lower power would not always give the desired effect. Since I have used the Shutter this difficulty has vanished; for, by a suitable contraction of the diaphragm, the desired structural detail is preserved, while all the objects are shown in good focus. With proper illumination the loss of light is inappreciable. Some may say, "Why not use special low-angle lenses, which will give all requisite penetration?" Simply because penetration is far from being the only desirable quality in an objective. Lenses that possess great penetration usually possess little else, and the loss of light entailed by their use is far greater than that experienced when using a wide-angle lens with the Aperture Shutter. I have been a daily worker with the microscope for several years, and being advised to begin with low-angles, have been repenting ever since my having followed that advice. I have used the microscope as a scientific tool, applied to hard work, and have found that all good work must be done with wide-angle lenses: the only drawback to their use is now removed by the introduction of the Aperture Shutter.

Now as to photography, with which I am specially engaged. It has been said that a photograph, of a diatom, say, shows more than the eye can see in the microscope: that the Aperture Shutter does not improve penetration to the eye, although, in some mysterious way, it may do so in photo-micrography. I have taken many hundreds of photo-micrographs, and let me tell those who are unacquainted with its methods this:—*you can get in your photograph no more than your objective will show you on the focussing screen*, but if not expert, you very often get *less*. If your photograph does not give you a true picture of the object, as seen down the microscope tube, then your manipulation or apparatus is at fault.

To give an example: lately I have been doing delicate work—photographing $\frac{1}{1000}$ of a grain of arsenic, using moderately high powers. Now I found, when examining the deposits, that I often could not get all the crystals into good focus at once. I knew that a good eye-focus meant a good photographic focus, and that it would be but a fool's experiment to try to get a picture which would be in photographically good focus, when I had failed to get a good visual one. In minute photography the most exact focus is everything. So I tried the Aperture Shutter, and found that with it I could easily get all the crystals in good focus; the reduction of aperture was too small to spoil definition or illumination. As soon as I had got all the crystals in the field in sharp focus on the screen, I proceeded to take several negatives, using different lengths of camera to produce enlargements varying from 300 to 500 diameters, and all my photographs came out sharp and distinct, as I had seen them in the microscope and on the focussing screen. I have used the Shutter with a $\frac{1}{16}$ inch objective, both when examining and photographing "big" diatoms, and have found it simply invaluable.

I have tested the Shutter severely, using it with objectives varying from 5 inches to $\frac{1}{16}$ inch focus, and have concluded that if any microscopist condemn it as a toy, then his microscope is probably one too—a toy he doesn't know how to play with.

I am, sir, yours, etc.,

J. H. JENNINGS.

SIR,

With reference to Mr. Miles' paper, of which I suppose a notice will appear in your next issue, it would seem that the subject, by eliciting so little discussion, was uninteresting to the members. This is not so; but when "apertures" are spoken of, one's whole mind must be given up, and such subjects are usually styled *dry*, especially by the younger members. There were no doubt many present who were capable of entering into the discussion, but certainly some of the statements and explanations of Mr. Miles completely "took the wind out of their sails," and so they preferred to sit still and say nothing, the more especially as the essayist had given the paper a very decided personal turn. It is a pity that scientific societies should not insist upon eliminating the personal element from their papers.

I hope, sir, you will allow me to suggest to the reader of the paper in question the propriety of revising his information on the spectrum. How astonished he would be to see a photograph taken through red glass! But, according to him, photography is possible in the dark! I fully expected the paper would be a digest of all those beautiful communications which have appeared during the past two years in the Journal of the Microscopical Society, but, to my disappointment, it contained only such statements as these, without any attempt at proof:—

"Consequently the visual angle under which we see an object is always in proportion to its amplification."

"My contention to-night is" * * "that in the computation or formulating of objectives a just proportion of power and aperture should always be maintained."

"Now the highest attainable aperture is soon reached."

"I could not for the life of me recollect what merits in particular were ascribed to powers of wide aperture."

"This of course will give increased penetration."

"It scarcely needs demonstrating that an inferior image *must be* the result."

Now, sir, I strongly object to such assumptions as these without proof, and I must argue that Mr. Miles' paper has been a most disappointing one, for it is when looked into carefully a sharp attack without argument, or in the words of the chairman, "it is quite certain some of the remarks are a little hard upon Mr. Davis."

I hope, sir, you will not let the matter rest.

I am, etc.,

PHOTO.

SIR,

Being present at the last meeting of the Manchester Microscopical Society when Mr. Miles attempted to explain what "aperture" was, I was surprised to hear him declare that 180° or an aperture of 1.0 was impossible of attainment. Can it be true that the papers read before the R. M. S. can have produced such little result? but what shall be said of one who endeavours to enlighten his brother members upon the aperture subject, and when he is asked a single question on water and oil immersions has to declare, "I'm not well posted up in it—it is as well to admit a thing at once." Comment is unnecessary. I enclose my name, but not for publication, if you please.

And am, etc.,

MICRO.

Mr. Shipperbottom, of Bolton, writes:—"I have promised a paper on Photo-micrography and Micro-photography for the Bolton Society this session, and I am pushing forward the construction of a camera replete with several mechanical and optical fittings which experience has taught me to be useful in producing Micro-stereograms as well as Mono-photographs. When completed I hope to give a practical demonstration before our Society.

Your Shutter will be a most useful addition for the purpose of aiding in the production of that amount of penetration which is essential for the production of Micro-stereograms. I do not believe a presentable Stereo-photograph of the larger forms of Polycistina or Foraminifera could be produced without your shutter (or its equivalent, a smaller stop)."

Mr. John Browning writes:—"I have read the discussion at the Manchester Microscopical Society on the aperture of objectives. I regret that my engagements will not permit me to write at any length on the theory of the subject, but I think a few lines on my practical experience may be interesting to some of your readers. It has been my custom for many years to test all my objectives before leaving the factory. This I have done with the usual well known tests, and I have always, after using the ordinary A eyepiece, tried successfully B, C and D upon them. When the objectives have been so good as to satisfy me, I have found but little loss of definition by using these higher power eyepieces. And here I would like to point out that the power of the eyepieces used in microscopes is very low as compared with the eyepieces used in Astronomical Telescopes. Of course, in this case, the image formed by the object glass of the telescope is magnified by the eyepiece in a manner exactly similar to the action of an eyepiece on the image produced by the objective of the microscope."

Dear Sir,

May I crave your permission to make one or two remarks upon a paper recently read on the Aperture question before the Manchester Microscopical Society. The reader of that paper commenced by setting himself a task which he said was exceedingly easy, viz., to explain what is meant by "aperture." Its easiness I admit, but cannot agree, that a circle consists of 360 degrees, and by drawing lines through it we can cut off any number of these degrees, constitutes a performance of this simple task. Surely for the "younger members" who might need such milk as this, something more would be required also. The reader did not apply these elements of geometry to his subject at all, and of the principles of numerical aperture left us profoundly ignorant. Perhaps this is not to be wondered at when considered in connection with an inference which he drew from a fact mentioned in the N. M. of last month. The fact was that a better image was produced with an inch of 35° and the C eyepiece than with a half-inch of 40° and the A ocular; the inference was that this proved the superiority of low angled glasses, as a better result was obtained from 35° than 40°. Is not this mere sophistry, and intended for effect upon a mixed audience, or was the reader really unaware that 35° in a one inch lens corresponds to considerably more than 40° in a half-inch? or does he argue upon the number of degrees only, and leave the lens entirely out of consideration? Moreover, has he not made a slight mistake upon the above point? and were not the photos. in last month's N. M. given as test results shewing what *might* rather than what *should* always be done? On one point I think that all those who heard the paper will agree with its reader, namely, that "ideas upon aperture are sometimes rather vague, and this is occasionally betrayed where least expected."

I am, etc.,

ONE WHO WAS PRESENT.

NOTICES OF MEETINGS.

BOLTON MICROSCOPICAL SOCIETY.—The members of this Society met on Friday the 1st of September, after the summer recess. The meeting was fairly well attended, and a very interesting evening was spent, chiefly in examining living organisms brought by various members. Mr. A. S. Pennington, in the absence of the President, occupied the chair. During the recess two out-door meetings have been held,—Chequerbent being the hunting ground in the first instance, and Hulton Park, at the invitation of of W. W. B. Hulton, Esq., the second. Both rambles were very pleasant, and the find in each case good. Great service was rendered to the Society by Mr. Tonge, agent to Mr. Hulton, who spared no pains in making each of the meetings a success.

MANCHESTER MICROSCOPICAL SOCIETY.

THE monthly meeting of the members of the Manchester Microscopical Society was held on Thursday Evening, Sept. 7th, 1882, at the Mechanics' Institution, Manchester. Mr. THOMAS BRITTAIN, F.R.M.S., the President, in the Chair.

The Secretary, Mr. Charles L. Cooke, read the minutes of the previous meeting.

The following gentlemen were elected members:—Mr. H. B. Bidden, Sale, Cheshire; Mr. W. F. Follows, Polygon, Eccles; Rev. G. W. Reynolds, M.A., St. Mark's Rectory, Cheetham Hill; and Mr. R. C. Pilling, Robin's Nest, Blackburn.

The CHAIRMAN: You will, many of you, be aware that the next will be our experimental meeting. We have amongst us a number of gentlemen who have been making rapid progress in the preparation of objects, and have been doing the work exceedingly well. We think it very desirable that members should have an opportunity of watching the process they adopt, and there is no doubt that the evening will be a very profitable one, especially to the younger members of the Society who have had no experience in object-mounting. You will have the different modes of mounting shown before you on the tables. I believe it will be sufficiently profitable, and that the number of workers will be quite enough to make the evening exceedingly profitable. The members on that occasion may bring friends with them in any reasonable quantity. We want to create an interest in our proceedings outside the Society, as well as inside. We know that there are some outside who sympathise with us, and who will be very glad to come on that occasion, especially the ladies. I know some ladies who do work of this kind exceedingly well. One or two of the members are very proud of their wives, and I do not wonder at it, for they show some excellent work done, and particularly in that difficult duty, which I always find awkward, of ringing. I cannot ring very well—my hand shakes a little—but some of the ladies can do it very well. I am sorry to see that Mr. Davis is not here to-night. I had hoped that the question of apertures would have been completely settled to-night. I don't know what will happen, I am quite in your hands; whatever you think should be done—whether the question should be adjourned or not, or whether you had better settle it at once—I am quite at your service, and I shall be very glad of any opinion from those who have an opinion upon it to give. Mr. Miles, you will notice, is down for a paper on this subject. I suppose it will be your desire that he deliver that paper, and after that you can take your own course.

The SECRETARY: I have been asked by Mr. Stanley to mention that there will be a meeting of the Ramble Club as soon as the business of this meeting is over.

The CHAIRMAN: Has any member anything particular to refer to? We are always glad to receive information from our members, and if in their excursions they have found anything especially interesting to the Society, we are always glad to hear what they have to say.

Mr. FLEMING displayed a rough sketch of a Zoophyte, or *Laomedea geniculata*, which he had picked up at Southport.

Mr. STANLEY said he had brought down a few of the *Hypnaceæ* which is the largest family of the mosses. There are 120 species, and they are remarkable for their creeping habit. When the moss is dry, it is extremely crisp, aud very pleasant indeed to sleep upon. It makes a very comfortable pillow. It is used, I believe, by many of the Laplanders for sleeping upon, and it is also used by the women for packing their children in when they carry them on their backs, where they rest secure and comfortable while they travel considerable distances. I have not been able to mount it for the microscope.

Mr. ROBINSON: I have brought down with me this evening a larva which I am not able to name. Perhaps some gentleman can help me.

Mr. J. L. W. MILES: Mr. President and gentlemen—It was your pleasure that this subject [the optical performances of objectives] which I referred to at the July meeting should again be brought up this evening. Such being the case, after consulting with Mr. Cooke, he confirmed me in what was my opinion, namely, that it would be my duty to introduce the subject personally and a second time this evening. As you are aware, that which I called a paper at the last meeting was little more than a running comment upon Professor Abbe's paper, but as the subject was this evening to come up for what you may call a detailed discussion, I thought it better that I should commit my thoughts to paper; firstly, because it would, perhaps, prevent me repeating myself; and, secondly, because it would prevent me, perhaps, overlooking some little points to which I wish to call your attention.

I think I have the sympathy of those gentlemen who are of my way of thinking, and I hope I shall have the indulgence of those who differ with me. At all events, if I stumble in my endeavours to-night to do the subject justice, I am sure you will bear with me. I will just say to commence with, that this aperture question is, in my opinion, a very simple one, but, unfortunately, there is a variety of relative matters bearing upon it which are introduced and surround it, and make it appear to be more complicated than it should be. As you are aware, I was going to refer to one other subject, because I wish to-night to attempt what I have never seen done, because I thought it would perhaps be information for some of our younger members. That is, I wish to explain what is meant by "aperture." It is a very simple thing, in my opinion; I don't think I can make any mistake over it. There are gentlemen who are more fully able to explain the question than I am, but I will attempt to demonstrate to you what aperture is. I do so, because this is a simple question, something like another question that crops up annually, and that is kitchen boiler explosions. There is not a more simple thing, perhaps, that you could study than that, and yet there is not one plumber out of twenty, nor one educated man out of a hundred who talk about it, that knows the cause of them. Perhaps I had better commence straight off by trying to explain what is meant by aperture. You all know that in geometry, for the purpose of measuring angles and segments of circles, a circle is divided into 360 degrees. I put a circle here. If we draw a straight line right through the circle, we cut it in two, and we have 180 degrees left. I want to point out one thing to you to start with. Of course, many people, speaking of an angular aperture, are not aware when a possible aperture ceases. An angular aperture, or a possible aperture, ceases somewhere a little over 170 degrees. I am sorry Mr. Davis is not here, because he speaks of an aperture of 178 degrees, and I wish to ask him a question, whether he had ever seen or verified a glass of 178 degrees. As I was saying, this semi-circle cut in two represents half of 360 degrees, which is 180 degrees. The right angle is an angle of 90 degrees, and if we make another bisection we have an angle of 45 degrees. And so we go on until we arrive down here, somewhere about 170 degrees. Perhaps that will do to start with. I think this is perfectly clear. I shall have to refer to it again to show you what I mean by this question, but I think that, as far as it goes, it will answer the purpose for the present. I hope every one can see it. When we speak of the aperture of a lens, I take it to refer to the visual angle at which, by its aid, we see an object. Now, as our President pointed out to you in May last, amplification, or the apparent magnitude of an object, depends upon the distance from which it is viewed; consequently the visual angle under which we see an object is always in just proportion to its amplification. My contention to-night is, for the purpose of argument, That in the computation or formulating of objectives, a just proportion of power and aperture should always be maintained. Some confusion is likely to arise at this point; I therefore desire that this proposition of mine should not be misunderstood. It really involves what Professor Abbé calls "progressive increase of aperture in the higher powers." Now, as the highest attainable aperture is soon reached, it remains only a question as to what rate of progression should take place conjointly with increased amplification. If we seek for the highest attainable aperture in a 1-10th inch objective, (and I see lenses of 1-8th inch wide aperture 170° advertised), objectives giving a greater amplification will be, correspondingly, glasses of a low angle. Ideas upon aperture are sometimes rather vague, and this is occasionally betrayed where least expected. If we admit that the highest aperture can be utilized in a 1-16th objective, it becomes amusing to hear anyone speaking of a high angle 1-35th inch or 1-50th inch I said at the commencement, that it was my contention that there should always be maintained something like a just apportionment of aperture and amplification. If you wish to see an object *as a whole*, given a suitable power, that aperture will suffice which will give you the best image (mind you) *as a whole*. This proposition embraces the whole question. If you wish to see only a portion of the same object, that portion, for the time being, constitutes the *whole of what you look at*. Here, again, you will choose a power and aperture sufficient to produce the best image of the part *as a whole*. You will scarcely believe me, but at this point I nearly broke down; I could not, for the life of me, recollect what merits in particular were ascribed to powers of wide aperture. Of course I knew their use had been strongly advocated for some considerable time, or I should have come to the conclusion they were recommended merely to make a use for the new aperture shutter. I have always been under the impression that a working microscopist required a range of powers. Possessing these powers, I never could see the advantage of excess of aperture in any given objective, when by the use of a higher-powered objective a better result could be obtained. Latterly, however, it has been assumed (so I take it) that, two or three lenses only are required for practical work, providing, of course, they are lenses of wide aperture. This, I venture to assert, is a most pernicious doctrine. This contention rests upon a variety of assumptions incompatible with each other. We are told that by the use of deep eye-pieces and the aperture shutter any required amplification or amount of penetration is at our disposal. To this I would say, "Yea, verily! of a sort." I must here propound some propositions, and I shall be glad to let copies be taken for consideration. Given a certain power and a certain aperture, say an inch of 35°. If this aperture is necessary to constitute a good lens, why is it not impaired when cut down to an aperture of 16°? If the image given by the aperture of 16° is not inferior, why have an aperture of 35°? Or, again, with the same objective, increase the amplifying power, by a deep eye-piece, to 160 diameters: is, or is not, the result obtained inferior to that given by 90 diameters? If not, we must conclude that an aperture of 35° is sufficient in relation to power for an amplification of 160 diameters. If the result is inferior, wherein lies the merit of deep eye-piecing?

Whatever authority you turn to, you are always warned against accepting results obtained by this means. Increased power thus got is not, be it remembered, increased magnification of the object itself; it is merely an enlargement of the size of the image formed in the first instance by the object glass. Abbé says (and I may here remark, if he is thrown overboard by his old friends, he will find plenty of new), and the same opinion is held by Carpenter, Beale, Marsh, T. Davies, and others,—"That forcing a high amplification, by this means, from a low-power objective is always connected with considerable loss of sharpness of the image, owing to the magnification of the residuary aberrations which are inherent even in the most finished constructions." It is also certain that Dallinger, as I shall presently show, and who may be taken as a leading authority in connection with everything relative to the use of high powers—does not make use of deep eye-pieces except as a last resort. Two serious objections to the use of object glasses of wide aperture are, loss of working distance between the object and the objective, and want of penetration or focal depth by which involved structural relation can be easily made out. The importance of these two requirements in low and medium powers are indispensable, and in this assertion I shall, I think, be borne out by every member who works with his microscope. No fancied accomplishment in a lens will ever compensate for these useful attributes. Dr. Carpenter, speaking of penetration or focal depth, says, "The possession of a high measure of it is so essential to the satisfactory performance of those objectives which are to be employed for the general purposes of scientific investigation, that we cannot consider its deficiency to be compensated by the possession of any degree of resolving power whose use is comparatively limited." It is to satisfy this demand for penetration, and to disarm their opponents, and reconcile them to the use of wide apertures, that the use of the aperture shutter is recommended. We must here again have recourse to our diagram, when we shall see upon what principle this instrument works. Supposing we have an aperture of say 130°, we shall find that by cutting off the marginal rays that we leave an inner cone of say 65°. This of course will give increased penetration, but it is essential to recollect that "the defining power of an objective depends upon the completeness of its corrections;" that is, upon the proper distribution of all the rays which pass through the objective. By the use of a stop we sacrifice the completeness of the corrections by cutting off a large marginal zone of rays, and it scarcely needs demonstrating that an inferior image *must be* the result. In a properly constructed objective the rays are *scientifically distributed and utilized*, and as a result, the focal point being further removed, we get a lower aperture without that serious sacrifice of marginal rays and loss of light necessary to good definition. We are here, however, met by an artifice which may be said to be "an expedient which minimizes the apparent difference in the performance of two lenses, one supposed to be ground to a low aperture, and the other reduced by a stop. This artifice, ere long, will be known as the photographic trick."

Before proceeding further, however, I would remind you that wide angled objectives are close workers, and the use of a stop does not increase the working distance. This circumstance alone militates against the use of the shutter. The difficulty in the way of illuminating and working with opaque objects with such powers as the ½-inch or 4-10ths objectives of high angles, combined with the serious loss of light in the use of a stop are sufficient for their rejection. In this month's *Northern Microscopist*, page 238, occurs this passage:—"There are many lenses of this power (½-inch) in use possessing an aperture of 40°, used specially for the study of Foraminifera, Polycistina, and such like solid objects. Now, we argue that the half-inch of 40° is entirely unnecessary; a better image with more penetration, more light, and better definition may be secured by using the one-inch of 35°, and the C eyepiece, and thus giving considerably more working distance than could ever be obtained from a half-inch." This opinion I am disposed to endorse. I should say that an inch objective of 25° for Polycistina, and a two-inch of 12° for Foraminifera, with the B eyepiece in each case, would give a better result. I will, however, take the paragraph as it reads, and I claim it as an important admission. It is a very unfortunate one for the writer, for it practically admits all I contend for, namely:—That a better image, of the same amplification, with better definition, with more working distance and more penetration, can be obtained with an aperture of 35° than one of 40, even under the forced amplification of a deep ocular. Now for the photographic test. I am sorry to say that my acquaintance with photography is not sufficient to enable me to deal with this part of the subject as I should like. As, however, I cannot accept the photographic test, you will expect something like a reason. Without for a moment insinuating that they —the photographs—are not honestly and fairly produced, I should be better satisfied were I present when these photographs were taken. But I have another reason. I believe there are conditions set up and at work in the production of a photograph, which are not identical with the ocular use of the objective. Let me venture to explain. In addition to what is known as the chromatic spectrum, coloured luminous rays, the result of decomposed light passing through a prism, there are a number of rays which neither give out light nor heat. These rays are called actinic or chemical rays. These rays, be it remembered, are non-luminous, invisible; they are of immense importance, however, to the animal, vegetable, and mineral kingdom, and in promoting chemical changes. If, for instance, you put hydrogen and chlorine gases into the same bottle, and cause them to combine or mix chemically, they will explode with a loud report.

They will combine and explode if you expose them to these chemical rays I speak of; but they will not if you expose them to the lighting or heating rays alone. It is the power of the chemical rays which causes them to explode. Now, I believe, I am correct in saying it is the power of these non-luminous chemical rays which produces a photograph. Certainly it is not the visual or luminous rays. As an illustration of this, it is only necessary to call your attention to what is known as the dark room or developing chamber. Of course, light is the medium used to take a photograph, and I dare say you all know how sensitive the prepared plate is to light—that is, light from which actinic rays are not eliminated—so sensitive, indeed, that no sooner is the cap removed from the camera lens than the requisite impression may be said to be got. This so called dark room is not, however, dark, as light is admitted through a window of yellow glass, and as a matter of fact the window is often smaller than necessary. Now this yellow glass has the property of intercepting chemical rays, and visual rays alone pass through into the room; consequently the sensitive plate can be exposed, and other operations carried on as though in the dark. On the other hand, a photograph can be taken in the dark, providing these chemical rays are present. Take a line engraving, and place it directly in the sun's rays for a couple of hours; then take it into a dark room and place it face upwards at the bottom of a box; have ready a piece of paper wetted with a solution of some of the salts of silver (ammonia-chloride or iodide, or chloride); lay the above face to face with the engraving, close all up and keep dark for twenty-four hours, when you will find that sufficient chemical rays have been given off from the engraving to produce a copy on the prepared paper. What I want you to understand is, that there are conditions essential to a satisfactory ocular performance of an objective, which do not exist, or are not necessary, at all events to the same extent, to the production of a photographic picture. The cutting off, by means of a stop, of the marginal zone of rays in an objective, does not, in my opinion, affect its working capabilities for photographic use to the same extent as its ocular performance in the microscope. If you cut off the outer visual rays of an objective, there is a sad loss of light. This cannot be compensated for in the microscope, but in taking a photograph it simply necessitates a little longer exposure.

That, gentlemen, may be said to constitute my thoughts upon the matter; but, in addition to that, I thought I would take the liberty of addressing a letter to Mr. Dallinger, a gentleman who is well known to have worked with high powers, and I thought it could not have escaped his consideration what would be necessary in these powers for their working capabilities. I wrote him a short, courteous note, asking him would he oblige by expressing an opinion on the matter. I did not hold out any leading questions at all. I am sorry I did not keep a copy of my letter, but it consisted of about ten lines, saying this matter was coming up for consideration in consequence of Abbé's paper. After a week's interval, I received this letter. It is written, I think, from Scarborough, where he was at the time. It seems to have been an unfortunate time. I suppose all these gentlemen are away on their holidays, and I can imagine they don't like to be troubled. Mr. Dallinger favoured me with a rather lengthy explanation. It is as follows:—

"AUGUST 18TH, 1882.

"MY DEAR SIR,—I am away from home, and so placed, that writing of the "kind that your communication requiries is, alas, impossible. I must, there- "fore, briefly state (1) that for the last ten years I have, as a matter of actual "experimental necessity, adopted the views now clearly and fully put forth by "Abbé."

He goes on to qualify somewhat this statement, but it is well to remember that he endorses Abbé to the full. The letter continues:—

"(2) No one has ever appreciated or found more pleasure and profit in the "use of the large angles with which our lenses have been more and more "perfectly provided for the last ten or twelve years than I have. As they have "been produced I have obtained them each and all, that had any real value, "whether produced in this country, the continent, or America; and, in some "cases, I have incited certain English makers to produce certain special "formula during that time. But while I have used all lenses, from the ¼th "to the 1-50th, constantly during this time, what work I have done could "never have been accomplished, if I had *only* had lenses with *large angles* to "work with. Much that had been done could never have been done *without* "*them*; but the work, as a whole, could never have been done at all if only "such had been at my disposal. Hence I have, in all my special working "powers, *three* lenses of the same power, and, in some cases, four, and *each* of "them in following out the details of a life-history of an organism, say of the "1-3000th to the 1-6000th of an inch in length is absolutely needed, and its "place cannot be supplied by the other. Thus, I have two 1-50ths, one "having a very low angle"—[fancy a low angle 1-50th; what will he call a low angle—1-50?]—"and the other as great a numerical angle as an oil immer- "sion can provide when worked by the best makers. In the 1-35th, I have "but one lens, a medium angle, because it was intended only for general work "and, mainly, central illumination. I have, however, three 1-25ths, four "1-16ths, and so on: and I know exactly what each will do, and no more "attempt to get the work of one out of the other than the maker of them would "attempt to get their several results by grinding them to the same formulæ. "(3) I talked this matter over in detail, pointing out results six years ago with "some leading experts; and although, during two or three years, many have "thought that Abbé's mathematics and views were adverse to this view of "mine, I felt convinced by reading between the lines of his papers, and remem- "bering their special object, that it was not so. Still, Dr. Carpenter was good "enough to get a detailed view of my experience and opinion before publishing "the last edition of *The Microscope*, and he has in his preface and throughout "the volume, given in effect my views, which now the unmistakable declara- "tions of Abbé coincide with and confirm. (4.) The homogeneous lenses have "given me splendid results, some of which will shortly be published; but *no* "immersion lens of *any* kind COULD be used to work out to the end an organic "life-history—that is, if it involved life and movement, because the object "being in a limited area, and (possibly) in fluid, the fluid under the cover does, "by following the movements of the object, at length, without the spectator's "knowledge, mingle with the fluid *above* (employed for the lens) and thus "destroy the whole object of search and study. I would have given a diagram "of this as it is most important, but I hope you will understand, for I have no "further time. This fact, then, makes air angles of the highest importance, "and I hope the highest results have not yet been attained with them. In the "main, then, I agree with Abbé. I agreed with his former papers, with the "reservation only which is now no longer needful, because his last paper, to "which you refer, expresses and admits what my reservation implied. This "letter is written in haste, and without an opportunity for revision.

"Believe me, truly yours, "W. H. DALLINGER."

In addition to that I wrote to Professors Huxley and Tyndall. I have received a note from Tyndall. It appears my letter followed him all the way to Switzerland. It is dated the 28th August. Now, this letter is very short, but it certainly carries out one idea which I agree with, and that is that, after all, you could carry out good scientific microscopical work without bothering your heads about angles at all. (Cheers.) The letter is as follows:—

"ALP LUSGEN, BRIEG, SWITZERLAND.

"DEAR SIR,—I should willingly aid you in your inquiries, but my knowledge "would not warrant any expression of opinion on my part as to 'the aperture "question in connection with microscopical investigation.' In my own obser- "vations with microscopes, I have simply accepted the means which the skill "of others placed at my disposal. "Yours truly,

"August 28th, 1882." "JOHN TYNDALL.

Now, from some cause or another,—perhaps my letter has not reached the gentleman,—I have, unfortunately, received no reply from Huxley. I am very glad that I received that letter from Mr. Dallinger, because, after all, he is our great authority.

The CHAIRMAN invited discussion. He said: We have had the matter brought pretty fully before us. The opinion from Mr. Dallinger of itself is a very important one. I hope some gentleman will set the ball rolling.

Mr. FILDES: This is quite beyond me, but I should like to ask Mr. Miles if it occurred to him to ask Mr. Dallinger's colleague in Liverpool, his opinion on this question, because, I presume, that gentleman is an authority on the microscope as well as Mr. Dallinger. His name is Drysdale.

Dr. WEBBER: There is one thing I should like to point out. I am not accustomed to use the lower powers, and cannot say anything at all about them. If you, however, take a blood corpuscle and magnify it 500 diameters, that would be nearly four millimeters in apparent size. The very highest aperture glass made, with no matter what eye-piece, can only divide that small space into something near 45 parts. I mean, if the glass were made as high as it possibly can be theoretically, there is not one glass made which comes even near to it. The ordinary 1-12th, of rather low angular aperture, will divide the same space into nearly 30 parts as far as I can remember—from 29 to 30, I think—and I don't think there is such a very great difference between these two. You have 2-3rds or more in the dry cheap glass, than the low numerical aperture of the very best and dearest glass that is made. Another thing I wish to remark upon is that Mr. Davis speaks a good deal in his papers of Abbé's test objectives, and how they work under high eye-pieces. Professor Abbé, in his paper, refers especially to what he calls empty amplification, pointing out that you can only divide within certain limits.

Mr. NAPPER: I have here one of the numbers of the *Journal of the Microscopical Society*, and on the covers is a table of apertures. We are told that 180° of air aperture is equal to a numerical aperture of 1·0. On the same page we have objectives noticed of 180°, water immersion, which is equal to an aperture of 1.33 and 180° of homogeneous immersion, which is equal to an aperture of 1.52. This seems to show to us how an aperture greater than 180° in air can be got. 180° in air would be equal to a numerical aperture of 1·0, and yet there is an objective noticed with an aperture of 1.52.

Mr. MILES: The first question was, I think, Did I think of writing to the gentleman who is Mr. Dallinger's colleague? Well, I did not think of it at the time. I should have liked to have written if I had dared to take the liberty, and, as a matter of fact, I would have done, as this is an important question, but as I had written to three gentlemen, and as I had been very busy, I thought perhaps that would do. I thought possibly there would be those at this meeting who would be able to quote the opinions of various gentlemen, and that it would not, therefore, be necessary for me to get further opinions. I do not myself profess to be acquainted even with the names of gentlemen who are known in the microscopical world. There is another question which has been asked in relation to Swift's ¼ inch. I have one, and a most unworkable objective it is. I do not know what the aperture of that lens is, and I am quite unable to answer the question how it comes about that it works so close, because not knowing the aperture, of course we have nothing to guide us. It certainly works very close, and I believe the aperture is measured from the distance by which it works, and if that has anything to do with it, it must be a good deal higher than he puts it at. Mr. Napper has introduced a question that I am not well posted up in. It is as well to admit a thing at once. I cannot answer his question, but I think there is a gentleman present who can explain where the apparent difference exists, and if he will kindly undertake to do so, I shall take it as a favour. I have not been able to get hold of anything that explains this numerical aperture question. It differs somewhat, I know, from aperture illuminations in air. Might I call upon Dr. Webber to explain? I think that gentleman has given the subject some consideration; and he is certainly better qualified than I am to give Mr. Napper the information asked for.

Dr. WEBBER: You pay me a very great compliment which I don't deserve, for although I fancy I have a clear idea of what is intended by numerical aperture, I don't know that I have the ability to make it clear to others. It is one thing to understand a matter, but another to make it clear to others. As far as I have been able to catch it, it means that a quantity of light passing through a certain medium may be greater or less. That, so far as I can understand, is that a volume of light passing through air is scattered the same way as a very fine gas might be scattered, while if passed through oil or water in the same space a greater quantity of rays of light is passed. It is perfectly impossible to get 180 degrees of angular aperture, because you have no focal point. Light passing through air in a given quantity is called one at 180 degrees of air. This is simply a mathematical quantity, a convenient standard. It is called 1.0 because it is the limit of light passing through a lens having that supposed aperture. If that lens were used in water, the same quantity of light would be cut into a narrow angle by the reflective power of the water; so that, if you had 180 degrees in water, you would have a larger body of light passing through than you would have through 180 degrees in air. The whole difficulty of the opticians, I believe, at first was, not to get that, which is very easy, but to get a combination to take up those rays, and they have succeeded to some extent; that is to say, they can make ordinary immersion lenses in water contain very nearly 40 per cent. more than the dry lenses take up.

The CHAIRMAN: At our next meeting we shall not have time to carry on the discussion on this subject, supposing you were to make a motion to adjourn the discussion. The next meeting is a special meeting for special purposes. I am in your hands, if you think it is worth while to take up the question again at the next meeting but one. I think it is myself. Mr. Cooke thinks that, as the matter refers so much to Mr. Davis, he should have a chance of replying. That could be got if he will give notice of a paper to be read at the November meeting. It is quite certain that some of the remarks of Mr. Miles are a little hard upon Mr. Davis, and I am sure Mr. Miles would not wish to prevent him having a word to say on the subject; and if he will give notice—which I think he will—to read a short paper at the November meeting, the subject can after that be closed.

A member suggested that Mr. Davis should be asked to read a paper.

The CHAIRMAN: I think we may leave it in that way. I think I can promise that Mr. Davis will read a paper.

Mr. STANLEY: I rise to move a vote of thanks to Mr. Miles for the trouble he has taken to make this matter clear to the younger members of the Society. We all know that it is an extremely difficult thing for young microscopists to know what kind of glass they should select, and Mr. Miles to-night has certainly given us some idea as to what class of glass we should get. I think it all comes back to the original point, which is, that it entirely depends upon the class of work you are doing. For myself, I have got two, and the one most suited to my botany was one of very low power, and the price was low too. There is, however, one thing that this discussion has brought forward which I think is of real value to the Society, and that is the letter from Mr. Dallinger. I think that if we take that letter as the stand-point from which to judge any objective that we may require to get in connection with the work we are doing, we shall have something definite, and shall not make any mistake. As he clearly says in his letter, he of course uses different angular apertures for different classes of work, and one wont do for the work of the other. It is therefore quite clear, and I think we are indebted to Mr. Miles for the great trouble which no doubt he has had in order to make himself acquainted with the various points in connection with objectives.

Mr. MESTAYER: I have pleasure in seconding the motion.

The motion was then put and carried.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to Mr. George E. Davis, The Willows, Fallowfield, Manchester; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

The attention of our correspondents is respectfully drawn to the Editor's change of address.

J. D. W. Chicopee.—We have duly received your letter dated the 16th ult., and will place it in the hands of those you wish on our next visit to London, which will be shortly.

H. S.—If you have a good supply of mounted and unmounted objects on hand, why not advertise them in our exchange column?

J. H. C.—We wrote you that complete sets of Vol. I. are very scarce. We think, however, we see our way to making up another set.

J. B.—You will notice from the preceding answer how difficult it is to make up complete sets of Vol. I. There are two more correspondents to be supplied, and each, of course, must be served in turn.

A. B.—We are sorry your letter respecting the aperture question is too personal. We wish to keep as clear as we can of all personalities.

Alpha and others. See reply to A. B.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a nom de plume under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

Oculars.—Two good eyepieces by Browning, both two inch, in exchange for well-mounted slides, send list. H. A., care of Editor.

Sea Weeds offered, specimens of foreign genera; wanted, British. Lists on application.—R. Wood, Westward, Wigton.

Air Pump.—A small air pump in exchange for accessories—cost thirty shillings. Offers in slides also received. F. C. S., care of the Editor of this Journal.

Mosses and Lichens in exchange for mosses, flowering plants, or fossils. Lists exchanged.—E. H. Starling, 146, Alexandra Road, London, N.W.

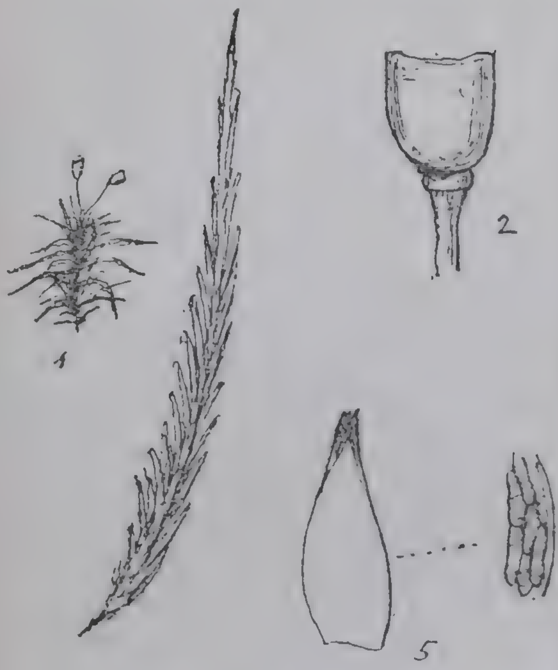
Exchange. For well mounted slides will exchange pig parasites (*Hæmatopinus suis*) and others. Send list.—J. E. Fawcett, Rawdon, near Leeds.

Diatoms (mounted and named) wanted in exchange for shells, fossils, &c.—P. Mason, 6, Park Lane, Piccadilly, London.

Diatom. Slide of *Gomphonema geminatum* in exchange for any interesting object.—A. W. Griffin, Saville Row, Bath.

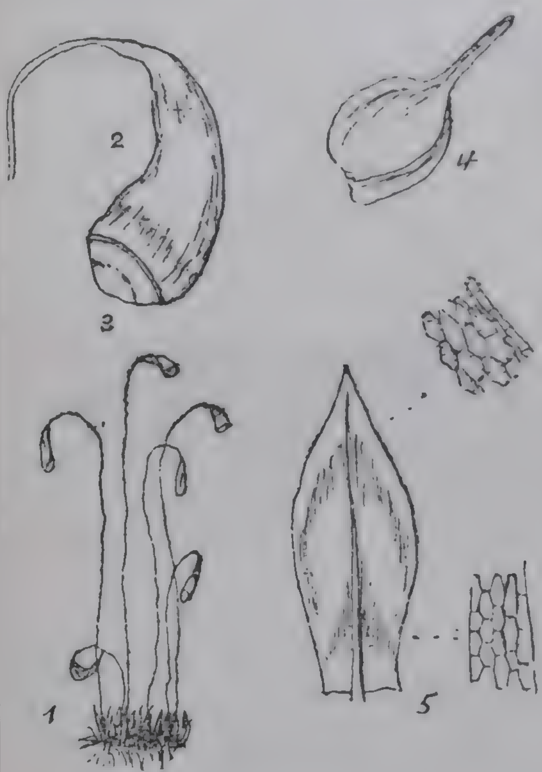
Miscellaneous Slides. Lists for exchange may be had on application to Junius, care of the Editor.

A few Accessories in exchange for well-mounted slides. Send list. Pyro, care of Editor.

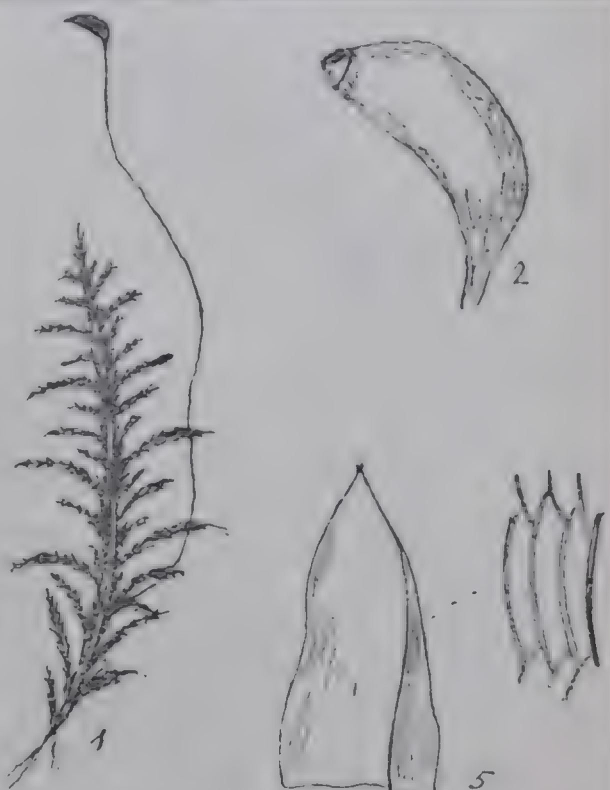


Sphagnum acutifolium.

Tortula muralis.



Funaria hygrometrica.



Hypnum cuspidatum.

1. Plant (nat. size)
2. Capsule.
3. Operculum or lid.
4. Calyptra.
5. Leaf and areolation.
6. Male inflorescence.
7. Antheridia and Paraphyses.

W. Stanley, *del. ad nat.* Cattell, *Photo Zinco.*

THE NORTHERN MICROSCOPIST,

AND

MICROSCOPICAL NEWS.

No. 23. *NOVEMBER.* 1882.

THE ELEMENTS OF MICROSCOPY.

By George E. Davis, F.R.M.S.

I.

THE HUMAN EYE.

A paper read before the Manchester Microscopical Society.

IN all studies, whether it be of pure Microscopy as a Science, or whether it be of one of those departments of Natural History in which the microscope is brought in as an aid to vision, we must, at the outset, recognise the importance of a study of the human eye.

Constructed as this organ is of a delicacy 'twere sheer folly to attempt to describe, it has, we know, many imperfections, produced, no doubt, by misuse, but which are apt to modify the conclusions we may draw from our observations, unless we are careful to study well into what lines such imperfections may lead us.

Nature has given us in this organ a means whereby all objects may be compared with each other, the more especially as to size, colour, and general characters, and it must astonish the student, should he ever think so deeply, to find that so little is known definitely as to *how* we are able to appreciate magnitudes, colours, and forms. It is easy to say that the eye lenses focus a picture of the object upon the retina, and the irritations are carried by the optic nerve to the brain, but do we practically realize what this means?

Then again, without more of our senses than one are brought to bear upon a matter under consideration, we can scarcely form a true opinion upon our subject.

Take something which greets our vision for the first time. We know not what it is; we can see it, it is true, but we have to bring in the aid of other senses ere we can be correct in our judgment;

and even then, our judgment being formed by comparison, and also by experimental contact of substances with our senses—so to speak—opinions which are formed must, to a certain extent, be modified with the amount of true experience to which our nerve centres have been previously subjected.

Take two experts; give to each one a sphere composed of lead and tin. Upon asking them what substance they were handling they might probably guess, perhaps not; they would poise it in their hands, look at it, smell it, try to cut it, perhaps, examine its metallic lustre, and it would be very odd indeed if they could agree as to the composition of the alloy, unless settled by an assay upon the balance.

Has it ever struck any one here that such processes as these go on in Microscopy, and that it is necessary to carefully study the organ of vision in order to gain a true insight into the object presented to us?

Fig. 22.

I will now throw upon the screen a diagram of the eye (fig. 22), after Helmholtz. It is, as you will see, a nearly spherical ball, capable of many movements in its socket. It possesses an outer translucent covering called the sclerotic coat, or simply sclerotica, which may be seen at H. It is thick, horny, and opaque, except in its anterior portion.

This sclerotic coat envelopes about $\frac{5}{6}$ of the eyeball, and in common parlance is called the white of the eye.

The anterior transparent portion is called the cornea, and has the shape of a very convex watch glass. It is through this membrane that the light passes to the interior of the eye. The cornea and the anterior portion of the sclerotica are covered with a mucous membrane.

Behind the cornea is a diaphragm of annular form called the iris; it is coloured and opaque, the circular aperture in its centre, C, being called the pupil.

The iris, D, serves the purpose of regulating the admission of light; it varies in colour in different individuals, and is the part referred to when we speak of the colour of a person's eye.

Behind the pupil is the crystalline lens, E, having a much greater convexity at its posterior surface than at the anterior.

The large posterior chamber is covered with the choroid coat, I.

except in front, and this is lined with a delicate membrane, called the retina, shown at K.

The choroid coat consists of a highly vascular membrane containing pigment cells, filled with an intense black mucus, called the pigmentum nigrum.

The cavity of the cornea is filled with a liquid called the aqueous humour, having a refractive index approaching that of 1.3366, while the larger cavity is filled with a transparent jelly, called the vitreous humour, possessing a refractive index of 1.3379, enclosed in a very thin transparent sac, called the hyaloid membrane.

I have now described the principal apparatus of the eye, and may take some of the parts in detail.

The crystalline lens is built up of layers, increasing in density inwards, the effect of which is to diminish spherical aberration. This lens is enclosed in a transparent capsule, held in position by an elastic membrane. It can be changed in shape by means of a delicate muscular arrangement to adapt its focus for near or distant objects.

You will all know that glass lenses of varying curves have different focal lengths, and it is by a process of altering the curves of the crystalline lens that we are able to see objects distinctly which are situated in several focal planes.

It has, perhaps, been noticed by all of you that there is a near point at which objects can be seen most distinctly; this point varies in individuals, but averages from 8 to 10 inches. As we move farther away from the object, although diminished in size, it may be seen more easily and with less effort.

It would seem, then, that all objects are rendered apparently larger as they continue to approach the eye, but a limit is soon found to this, as at a distance of six inches distinct and easy vision is not possible (except in very abnormal cases).

The reason of this is well-known—the anterior focal point of a convex lens when shortened lengthens the posterior conjugate focus, so that when an object is brought too near the eye the image of it is projected behind the retina, and the crystalline lens cannot accommodate itself to such extremes. But we know that objects can be seen distinctly at great distances apart, and it may be useful to demonstrate how this is brought about.

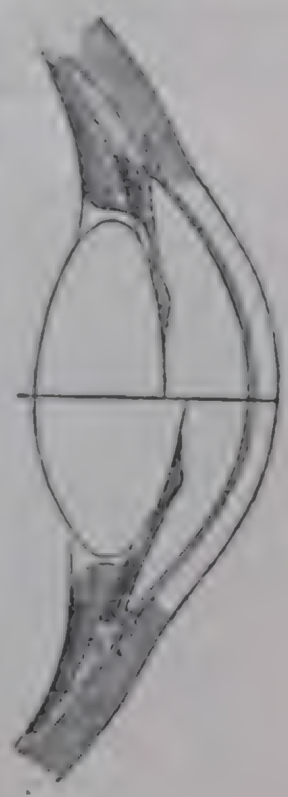


Fig. 23.

The figure (23) represents a cross section of the crystalline lens. The real mechanism of accommodation has been much disputed, but the results, as observed, are, that the curvatures of the crystalline lens are altered as the observer adapts his eye to near or remote vision; increase of curvature, of course, shortening the focal length of the crystalline lens, and being better adapted for near vision, while the shallower curve is necessary for the distant view of remote objects. Helmholtz has shown that the radius of curvature of the anterior surface of the crystalline lens may be varied by means of the muscular arrangement, from 6 to 10 millimetres.


Fig. 24.

We may now cast another glance at the iris. This apparatus is really a continuation of the choroid tunic which lies between the sclerotica and the retina: it ends in front, in what are called ciliary processes which you may see in the picture on the screen. The small muscular ring surrounding the pupil is called the sphincter muscle. (Fig. 24.)

Now, the principal use of the choroid tunic, or rather the pigmentum nigrum which it contains, is to absorb those rays of light which have passed through the transparent retina, preventing their reflection, which would interfere with the distinctness of the image.

Fig. 25.

I can now show you a diagram representing the posterior inside of the eye, after Henle. You will see the choroid tunic, the retina, and sclerotica as the three outside rings, while the centre is ramified by nerve filaments and blood-vessels. (Fig. 25.)

These nerve filaments and blood-vessels lie in the retina, which really forms a continuation and extension of the optic nerve; it touches the outer circumference of the iris at the front, and lies open as a cup-shaped disc in the interior of the eye, it receives the rays of light which have passed in turn through the cornea, aqueous humour, crystalline lens, and vitreous humour, and forms a picture at the focus of these.

The nerve fibres of the retina are excited probably by a product of the action of the light picture upon the visual purple, and the irritations are transmitted to the brain by the optic nerve, producing the sensation of vision.

The picture produced upon the retina has been compared with that produced by a photographic lens upon a screen or ground glass; but it will be seen that the instances are not strictly parallel. In the eye the rays falling upon the cornea do not again encounter air, the picture is formed *in* the highly refractive substance, while in the photographic image air intervenes between the screen and the lens, and between the lenses themselves.

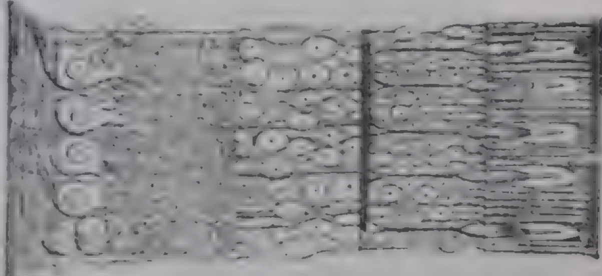
Then, again, the adaptation of the eye to various distances is obtained by a process so dissimilar to that of the lens in the camera, that it is well no comparison should be instituted.

The retina has been previously described as a delicate membrane lining the choroid tunic, inside the sclerotica.

Now, if we make a section of the retina we shall probably find its structure very similar to the diagram. (Fig. 26.) I say probably, as I have never met with sections which displayed the structure so well as Max Schultze has indicated. He has described the various layers which you see before you, as follows:—

Starting from the junction of the retina with the vitreous humour, we have—

The layer of nerve fibres .... *a.*	The outer granular layer............... *f.*
The layer of nerve cells.................. *b.*	A second fine membrane .... *g.*
The granular layer .... *c.*	The layer of rods and cones .... *h.*
The inner granular layer .... *d.*	Pigmentum nigrum of the choroid... *i.*
The intermediate layer .... *e.*	


a. b. c. d. e. f. g. h. i.
Fig. 26.

The retina is the terminal organ of vision, all the apparatus in front of it being merely for the purpose of securing that an accurate image should be focussed upon it. As to how the luminous impressions yield to us such a definite idea of things is a question still under consideration, many have tried to solve it, but I am not sure whether we are any nearer the mark than those philosophers who lived 2000 years ago.

There are several curious properties inherent in the retina. By means of the ophthalmoscope may be seen a point, a little out of the centre, where the optic nerve enters the eye. This spot is totally blind, it cannot perceive a trace of light, and if the image of an object falls upon this blind spot, that object is totally invisible. It is at this spot also where the blood-vessels enter the eye, and ramify through nearly the whole of the surface layers of the retina.

In the centre of the figure (25) you will see also a dark shaded portion practically free from blood-vessels. It is a round, yellowish elevated spot, about $\frac{1}{24}$th of an inch in diameter, and it is here that the sense of vision is most perfect. It is called the yellow spot of Sœmmering; it is not covered by the fibrous part of the retina, but a layer of closely set cells passes over it, and in its centre is a minute depression called the *fovea centralis*.

In the short space of time at my disposal it has only been possible to give you a rough outline of the structure of the human eye. You must not think that I have exhausted the subject; I have only selected such matter as bore upon good or defective vision, or upon the construction of the microscope. On the other hand, I think enough has been advanced to show you that this organ is liable to imperfections which may, and are extremely liable to modify all our observations made over the tube.

In order to produce a picture upon a screen, you will be aware that a lens is not absolutely necessary, if a diaphragm, perforated with a series of holes, be placed in front of the electric lamp, the screen will be decorated with as many images of the carbons as there were holes in the diaphragm; but another illustration will perhaps render this more evident. A small hole pierced in the

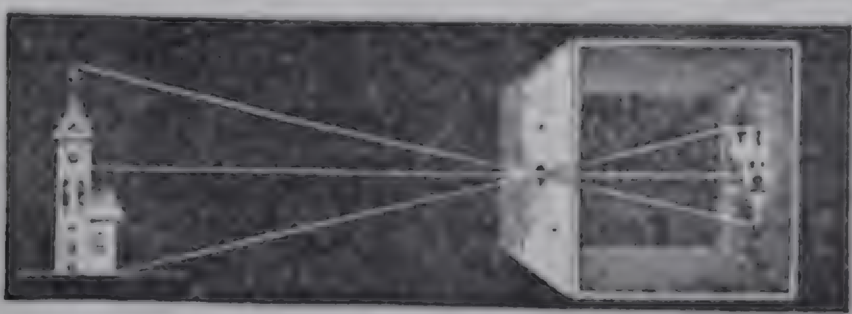


Fig. 27.

shutter of a darkened room (Fig. 27) allows of the passage of rays from a well illuminated landscape, so that a small but inverted image is cast upon the screen; the further the screen is placed away from the aperture the larger will the image be, though less distinct, and *vice versa*. The picture produced is not so good as that formed by a lens, it is dark and somewhat confused at the margin, and if the aperture is enlarged, there is still greater confusion, until the image is finally lost.

Now, if we take an ordinary lens of glass and attempt to produce a picture with it, you will find the centre alone is plainly visible—the lens is afflicted with what is termed spherical aberration, that is, the rays from its periphery are brought to a focus in a different plane to those occupying a central position.

Now, this fault may be illustrated by a diagram, which may now be thrown upon the screen. (Fig. 28.)

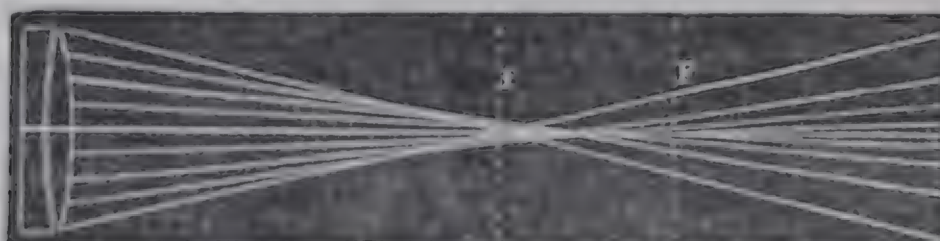


Fig. 28.

But although it is so easily shown in a diagram, I am not so sure that a small amount of spherical aberration is easily detected by the student. It appears as a haze or fog of light over the object. I have here a lens strongly afflicted with spherical aberration, and will show you at the close of the paper several objects with it.

In the human eye this defect is not observable to any great degree, as the peripheral or more strongly refracting rays are cut off by the iris. Then, again, the curvature of the cornea is ellipsoidal rather than circular, so that the rays farthest from the axis are least deviated, while the two curves of the crystalline lens correct, so to speak, the one the other; and, lastly, this lens is of such construction that its refractive power diminishes from the centre to the circumference.

Another defect in the eye is due to the different meridians having dissimilar degrees of curvature.

If these concentric circles are observed with one eye, they are seldom all distinct at the same time, and there is produced a kind of Maltese-cross effect, not perceivable, perhaps, in many instances with large circles, but are noticeable when drawn to such a size that the outer one is about two inches in diameter. (Fig. 29.)

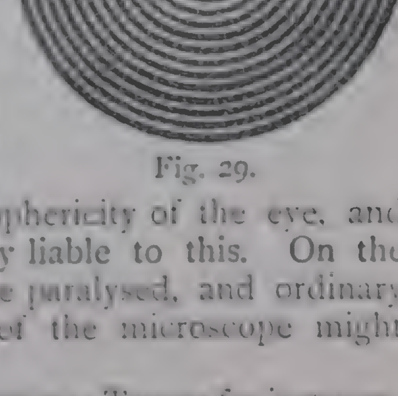


Fig. 29.

This defect is called astigmatism, and known to oculists as a common cause of headaches. Spasm of the focussing apparatus may derange the sphericity of the eye, and so affect vision. Strained vision is very liable to this. On the other hand, the same apparatus may be paralysed, and ordinary vision deficient, whilst the focussing of the microscope might possibly correct it.

Astigmatism has injuriously affected painters; Turner for instance, whose later pictures are discovered to be slightly distorted, in consequence of the power of accommodation or self-correction having been lost with age.

In microscopic drawing, as with the camera lucida, the perspective may be misrepresented, in consequence of astigmatism, and thus endless disputes may arise even amongst the most careful observers.

We have now to deal with errors of refrangibility, and it will probably have been assumed that the eye apparatus is entirely corrected for colour. This is not the case, however, except when an object is in exact focus, and the reason that the error due to refrangibility remains practically unnoticed is that the distance between the focal point of the red and violet rays is extremely small. The error due to refrangibility may be noticed by means of the concentric circles already shown you; by bright daylight adjust the eyes to some object twelve inches away, and without moving the eye insert at a distance of four inches the card inscribed with black circles, when a yellow and blue colouring will be plainly discerned.

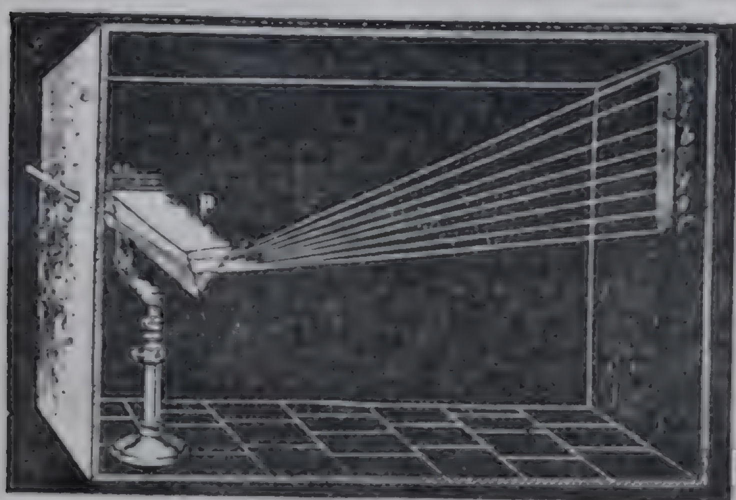


Fig. 30.

In order that you may thoroughly understand the error of refrangibility, the picture afforded by the passage of a solar ray through a prism of glass is thrown upon the screen, the rays are deflected unequally, the red least and the violet most. (Fig. 30.)

It may be advisable here to state that the degree of dispersion of the rays of white light depends upon the medium through which the ray passes, and this amount of dispersion is measured by the distance the most prominent dark lines in the spectrum are from each other. The diamond disperses much less than crown glass, while the deflection of the ray is greater; but this is a subject it is not possible to enter upon this evening.

I now show you a diagram illustrating the effect produced upon a ray of white light by a double convex lens, but you must not consider the subject can be practically studied as easily as the diagram would indicate. The chromatic and spherical aberrations are very complicated phenomena, and although they may be diagrammatically represented upon a screen, still the picture seen by a double convex non-achromatic lens of glass is not foreshadowed in any way in the diagram. *This was shown by a coloured transparency.*

Now, beside these errors, there are others to which the microscopist should devote special attention; they are caused by small opaque particles existing in the transparent media of the eye-ball. These cast their shadow on the retina, and produce images which appear to exist outside the eye. These extra-retinal images often appear as globules, bacterioid-shaped bodies, or strings of minute pearls, and may be studied by directing the eye to a sheet of strongly illuminated opal glass, through a small aperture made with a fine needle in a piece of thin blackened cardboard. (Fig. 31.)

When the microscope is used in a vertical position, these globules often gravitate to the centre of the cornea, and even after prolonged use of the inclined tube an observer may often be perplexed by the layer of mucus, or a lachrymal discharge covering the surface of the cornea.

Just a few words as to colour perception. Colour is a special sensation excited in the retina by rays of a definite wave length, and the reason why certain objects are presented to our view with colour is that when white light falls upon a given surface, some is absorbed, the remainder being reflected. If the green rays are reflected, then the object appears green, and if the red rays are alone reflected, then the object will be red.

Fig. 31.

The generally accepted theory of colour perception is based on the assumption that three kinds of nerve fibres exist in the retina, the excitation of which produces sensations of red, green, and violet, and that modifications of these three sensations yield all intermediate tints.

This theory will explain some of the phenomena of colour blindness—if the nerve fibres which should give their special sensation are paralysed, or are wanting, the sensation only of the complementary tint will be transmitted with all the defects of the eye; it must not be forgotten that many phenomena consist more in errors of judgment than in absolute error of form or sensation.

Now in regard to errors of judgment, we must admit that all our estimations are made by comparison. In magnitude we are guided by the size of the retinal image as determined by the visual angle—for position we must have some starting point, and as for distance, every one knows how delusive an inexperienced estimate of this is. At sea, a landsman could not judge of the distance of a passing vessel to a few miles, nor could we form any accurate idea of the size of any object emitting practically parallel rays without we had something to compare it with.

We now come to a point which has been much disputed in the study of microscopy—binocular vision.

The two eyes move together as a system, so that we direct the two lines of regard to the same point in space and consequently see but a single image; but it is possible to see two—if one eye be displaced a little with the finger two images are seen, while if the other be displaced to a corresponding amount the one image is restored.

The value of binocular vision may be easily ascertained by experiment. When a picture is presented to the retina of each eye, the compound picture is much brighter than when one retina only is employed.

To each point of the retina of one eye there is a corresponding point in the retina of the other, and impressions produced on one of these points are in ordinary circumstances indistinguishable from a similar impression produced on the other.

When both retinæ are similarly impressed, the general effect is that the impressions are more intense than when one eye only is employed; and we also get a perception of relief, that is of form in its three dimensions.

Take two A eyepieces and look through them to the sky, so that two distinct circles are seen; now bring them together so that one circle overlaps the other, when this overlapping bi-convex portion will be found double the brightness of the remaining portions of the circles.

We are indebted to stereoscopic vision for the perception of relief or form in three dimensions, which occurs when the images falling upon the corresponding points of the two retinæ are not exactly similar. In looking at an object with both eyes the rays do not run parallel from one side of the object to the eye on that side, but the right eye centres itself to the left side of the object and *vice versa*. This may readily be seen by holding up a finger between our eyes and the wall, and looking at the latter. Two fingers may be seen projected on the wall, one of these is seen by the right eye and the other by the left; but our visual impressions do not inform us which picture is formed by which particular eye. Now, while steadfastly looking at the wall, close the right eye and the left finger will disappear, while on shutting the left eye, the right finger is rendered invisible.

When two similar pictures are presented to the eyes, the impression is more vigorous and looked at with greater ease than when one eye only is employed; vision in this case is called pseudoscopic.

Binocular vision should be employed wherever practicable; it will be found much less trying to the eyes than monocular efforts.

I have now mentioned the leading features of the human eye; you will all admit, I have no doubt, that it is extremely liable to imperfection, and as such is the case, strict attention to details is demanded from the microscopist.

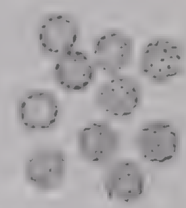


Fig. 32.

Now although the human eye appears such a wonderful instrument, there are many problems it is unable to solve without extraneous help. Many of you know perhaps the bunt of wheat, *Tilletia caries* (fig. 32). With the unaided eye you will be able to discern nothing more than a black dust, the various details having to be made out by other means. Then again, with objects so minute as the diatom, *Amphipleura pellucida* (fig. 33), the object itself is almost invisible to the unassisted eye, to say nothing of the beautiful carvings with which the valves are embellished, and which exact for their elucidation the most perfect lenses with which we are acquainted, and the most accurate manipulation of the illumination. You may indeed see the contour of many forms of diatoms without extra optical assistance than that afforded us by nature, but not much more than this, as if the eye is approached too closely the picture falls behind the retina and is lost.

I will now show you upon the screen a very much enlarged transparency of the diatom, *Pleurosigma angulatum*, which illustrates in a remarkable manner how errors of observation are likely to creep in. It is hard to believe at first that the white circles which you see are not hexagons, but are in fact true circles, which close investigation will prove.

I have already mentioned the fact that starting with the distance of most distinct vision, continued approach to the eye finally renders the object invisible, the rays being thrown *behind* the retina, the mechanism of accommodation being insufficient to produce a curve deep enough to bring the picture to a short conjugate focus.

This can, however, be done by interposing a lens or lenses between the object and the cornea, so that a virtual image of the object is seen. How this affects the rays of light proceeding from an object I must leave to be explained in Part II., which will deal with "Some of the properties of lenses."

Fig. 33.

HEPTAGENIA LONGICAUDA.

(Family-Ephemeridæ.)

By W. Blackburn, F.R.M.S.

IN the *Northern Microscopist* for September last, some aquatic forms of the genus Heptagenia are mentioned as having been found at Bramhall during a ramble of the members of the Manchester Microscopical Society in that neighbourhood. Being desirous of ascertaining the species to which they belonged, I reared some specimens collected on that occasion through the subimago into the imago state, and then found them to be *Heptagenia longicauda* (Eaton). Stephens has described this species under two different names, *Baetis longicauda* and *B. subfusca*. It appears to be peculiar to the British Isles, although the genus to which it belongs is one of the most widely distributed throughout Europe and America. The eight species found in Great Britain are *H. semicolorata, sulfurea, flavipennis, elegans, venosa, longicauda, insignis*, and *lateralis*.

The Rev. A. E. Eaton in his valuable monograph describes the nymph of this genus as "Nympha agile reptans, laminis branchialibus utrinque septem; laminæ simplices integræ, fasciculis e radicibus singulis filamentorum branchialium." Herein is an important omission, for bundles of branchial filaments which are attached to the roots of the first six pairs of plates, forming the external abdominal gills, are in fact absent from the seventh pair. Westwood, in his description of the aquatic form of Baetis of De Geer, which is the same genus, notices this peculiarity of the nymph. Some other characteristics of the nymph are a very broad head and thorax, comparatively short antennæ, maxillary palpi two-jointed, and the legs with the femora widely compressed. Altogether the insect has an appearance of stoutness and strength, when in the water, differing most materially from the slender and graceful form it assumes when it casts off its swaddling clothes and emerges as a subimago. In the latter condition it assumes the characteristic attitude of the genus when at rest, with all its feet on the ground, the wings erect, and the two caudal setæ divergent, the central filament of the tail having been left in the water. It has four wings, but they appear to be unnaturally small and wanting transparency, owing to their being folded up in the cases of the subimaginal skin. It now waits in quietude for this skin to dry, and then endeavours to extricate itself, and, escaping through an opening in the thorax, appears in its final form of an imago. In a few minutes the wings expand to their full dimensions, and appear of a more glassy nature, with the nervures more clearly defined, the posterior wings being of course much smaller than the anterior, but bearing some similitude to the latter in the character of neuration; the neuration of the anterior wing is somewhat complex, the longitudinal and transverse nervures being rather numerous, the latter especially so in the costal area, and the interneural veinlets of the terminal margin being continuous with either the transverse or longitudinal nervures. The legs are thin, the forelegs of the male having extended considerably in length; the tarsi have five joints, the second, third, and fourth gradually decreasing in length, the fourth joint being the shortest, and the fifth terminating in a single claw with an oval pulvillus or pad. The antennæ are somewhat shorter than before, but the caudal setæ have undergone a sudden elongation, so that in some species they are several times their former length. This is notably the case in Heptagenia longicauda, as its specific title indicates.

I observed the transformations of the tail in one specimen. It was a male, having the three-jointed abdominal claspers common to the sex in this genus. The length of its body was 11 millimetres. The mature nymph had the central seta of the tail 9 mm. in length, and the external setæ 8 mm., each of the latter consisting of 71 segments. In the subimago, these setæ expanded to 13 mm., with the same number of segments as before. In the imago, however, the setæ had undergone a sudden extension to about 27 mm.; but upon observing that one of them possessed only 60 and the other 64 segments, I looked for the lost segments in the last caudal moult, and there found an opacity in the terminal segments indicative of the presence of the missing extremities. Adding a proportionate amount for the inclosed segments, when expanded, to the previously ascertained length of the setæ, I found that each seta, when perfect, would be about 32 mm. long, or four times its length in the nymph; and that its rapid extension was doubtless due to the sudden relief from compression which the segments had undergone during growth in the two previous states, the segments being then probably in a state of intussusception, to use a medical term with an appropriate signification. This specimen had considerable difficulty in extricating itself from its subimago skin, owing to an accident which it met with in leaving the water. Observing the nymph to be rather restless, and to be making frequent essays to the surface of the water, I placed it in a small glass trough, about half full of water, to watch the process of moulting. I had not long to wait, for the insect set about it as soon as it had familiarised itself with its new environment; but, in escaping from the trough, one wing-case was caught by the top of the wet glass, and dragged along it for a short distance, flattening its tip. This tip, belonging to one of the anterior wings, the imago was unable to extricate when engaged in its final moult; so that it was compelled to carry the subimaginal skin poised above its body at the tip of the damaged wing for some hours, presenting the most curious appearance of carrying its own exquisitely made garment, until I summoned the aid of chloroform and detached it. One specimen was unable to extricate itself from its nymphal skin, being drowned in the attempt. This I have preserved in my cabinet in the act of escaping.

This species is to be found from July to September emerging from cool streams to assume its final forms of short-lived aerial beauty.

EXTRACT FROM

PROF. MARTIN DUNCAN'S ADDRESS

To the Members of the Royal Microscopical Society, February 8th, 1882.

The Abbe Theory of Microscopical Vision.

(Continued from page 278.)

AS Fellows of this Society we may, I think, be proud of the able communications, relating to this subject, which were published last year in the April and June numbers of the Journal.

Numerical Aperture.

The abandonment of the angular notation for aperture necessarily follows, as soon as the correct view of aperture is appreciated; for when we know that the apertures of three objectives are, for instance, as 98, 126, and 138, no one would insist that they should be designated 157°, 142°, and 130°. A notation can have no title to be considered a scientific one, which denotes things as the same when they are really different (60° in air and oil) or different when they are the same (180° in air and 82° in oil).

Until, however, the "law of aplanatic convergence" had been demonstrated by Professor Abbe, no principle had been established by which the ratio between emergent beam and focal length, could be conveniently denoted.

It would not be possible for me to condense, without a sacrifice of intelligibility, the steps by which he subsequently showed, in a very beautiful manner, that the ratio in question can be expressed by the product of the refractive index of the medium in front of the objective, and the sine of half the angle of aperture, that is by $n \sin u$.

Taking for our *unit* the capacity of an objective for collecting the whole hemisphere of rays from an object in air (*i.e.* the case of a dry objective of 180° angle) we obtain the "numerical" notation, which commencing with the lowest numbers advances as far as 1.52 with oil-immersion objectives, and by the use of which not only are apertures compared in the same medium, but in different media also, and we see whether they are smaller or larger than the maximum of a dry objective.

It is gratifying to find that the reproach hitherto attaching to microscopists, for the use of misleading notation, is, thanks to the efforts of this Society, being rapidly removed, and that the initials N.A. are no longer so mystic a symbol as they have been. I understand that many of the opticians have decided to use the numerical notation in the future issues of their catalogues, which is a step in the right direction, which we shall hope to see generally followed.

Whilst on this subject I may point out how important it is that in observations with high-power objectives, their aperture as well as magnifying power should be stated. Whether a large or a small aperture has been used, may make a very material difference in the value to be attached to the results described.

The "Homogeneous Immersion" principle.

The utility of homogeneous-immersion objectives being established beyond doubt by practical experience, it is interesting to note that the origin of the principle is very fully recognized by Professor Abbe to be due to our esteemed Fellow Mr. J. W. Stephenson.

The two essential points in homogeneous immersion are, 1st, the increase in aperture obtained by the use of a fluid of high refractive index and, 2nd, the enhanced optical performance arising from the total suppression of spherical aberration in front of the objective. Professor Abbe states that although Amici first applied oil immersion, he failed to recognize the specific advantage of an immersion fluid being as near as possible in refractive and dispersive powers to the crown glass (*i.e.* "homogeneous"). He finished his lenses and then sought for oils and mixtures of oils of various refractive powers for obtaining the best correction. "It was Mr. Stephenson who, in his first communications with me, expressed the opinion that doing away with the anterior aberration would improve the defining power, and especially would afford very favourable conditions for further increase of aperture."

The importance of this system will be appreciated when we remember, in regard to the first point (the increase of aperture), that the theoretical resolving power of an objective is thereby raised from 96,400 lines to an inch, which is the maximum of a dry objective, to 146,528 the maximum of an oil-immersion objective, the illuminating power being also increased from 1 to 2.25: while as regards the second point, we are able by the homogeneous-immersion method to reduce the problem of correcting a very wide-angled objective to the much less difficult one of correcting an objective of *moderate air angle*. Our lamented President, the Rev. J. B. Reade, declared in 1870 that "the ghost of aberration will never be entirely exorcised even by cold water." But there appears to be good ground for believing that oil has practically accomplished that object.

During the past year several kinds of fluids for homogeneous immersion have been brought before the Society, such as chloral hydrate and glycerine, iodide of zinc and glycerine, and gum dammar and cedar-oil. Two other vegetable products have also reached us, "tacamaque" and the gum-resin "oliban," or "incense," both dissolved in cedar-oil. While the dammar is claimed to be unchangeable, and to be in refractive and dispersive powers very near that ideal of a good immersion medium, "fluid crown glass," there is evidently room for further research in this direction, particularly for a fluid which will not attack the various varnishes in ordinary use.

Lastly must be noted an important advance in practical manufacture by the construction, by Messrs. Powell and Lealand, of a homogeneous-immersion objective of the large aperture of 1.47 N.A. out of a possible 1.52. As long ago as 1850 one of my predecessors in this chair, expressed the belief that objectives had then "nearly, if not quite, attained the limit of perfection," and whilst it will be prudent even at this much later date to avoid any assertion of finality in the present, or scepticism as to the possibilities of the future, it must be admitted that so far as regards aperture and resolving power we have arrived at a point beyond which it will, to all appearances, be difficult to advance, at any rate not without serious restrictions in the use of the objectives. Whilst it might be possible to work front lenses for objectives out of diamond and so to increase the aperture to 2.5 N.A. and the resolving power to 241,000 lines to the inch, it must be remembered that it would be essential at the same time to provide an immersion fluid, slides, cover-glasses, and illuminators of the same refractive index as diamond also.

Penetrating Power of Objectives—Depth of Vision.

This again is a subject which has long been obscure; very various opinions being held as to the true nature of what has been generally termed the "penetrating power" of an objective. By some it has been declared to be a defect in the construction of the objective—residual uncorrected spherical aberration, in fact; and by others as necessarily inconsistent with perfect definition, even with the best methods of construction; the only approximately correct notion regarding it, being that it decreased as the angle of aperture increased.

Professor Abbe, however, in a very valuable paper, placed the question on the scientific basis so long needed, showing that the total *depth of vision* in the Microscope, *i.e.* the solid space which at *one* focus of the Microscope is visible with sufficient distinctness, depends not merely on the *depth of focus* of the objective, but is the sum of that and the *depth of accommodation* by the eye.

The depth of focus (other conditions remaining the same) varies in inverse ratio to the magnifying power and also to the numerical aperture of the objective. Thus with a $\frac{1}{4}$-inch and $\frac{1}{2}$-inch of the same aperture the depth of focus of the former would be twice that of the latter, or if the powers are the same but the apertures are .50 N.A. and 1.50 N.A., it would be as 2 to .66.

The depth of accommodation depends upon a point which was entirely new to microscopists until developed by Professor Abbe, viz. the peculiar property of microscopical amplification, by virtue of which the linear amplification of the depth of an object is largely exaggerated, being equal to the square of the linear amplification laterally. Thus an object magnified, according to ordinary parlance, 100 linear diameters (*i.e.* in breadth) is magnified 10,000 linear diameters in depth. Now the depth of accommodation varies in inverse ratio to this depth-amplification, that is inversely to the square of the magnifying power, so that whilst large with the low powers, it decreases very rapidly and disproportionately as the power is increased.

The joint effect, therefore, of the diminution in the depth of focus and depth of accommodation is that the total depth of microscopical vision diminishes, not in the same ratio as the increase in the magnifying power, but at first in a much greater ratio. With the low powers we have considerable depth of vision, as it is then chiefly influenced by the large accommodation-depth. As we proceed to the medium powers (100–300) the accommodation-depth very rapidly diminishes, and becomes equal to that of the small depth of focus, so that the total depth of vision is necessarily small also. As the power is further increased, the accommodation-depth ceases to have any influence, and the depth of vision becomes principally depth of focus only. If, for instance, an amplification of 30 times is increased to 300, the depth is reduced not to $\frac{1}{10}$ but to only $\frac{1}{50}$ of its original amount: or taking the depth of vision with a power of 10 times to be 2 mm., with powers of 30, 100, 300, 1000, and 3000, it is only .254, .0273, .0047, .00094, and .00026 mm.

The formula

$$\text{Depth of vision} = n\left(\frac{L^2}{N^2}\lambda \times \frac{L\omega}{Na}\right)$$

shows at once how much the depth of vision may vary by a change in the conditions—represented by the various factors in the formula —which make up the total effect, important among which, as will be seen from the form of the equation, is the refractive index n of the medium in which the object is mounted.

(To be continued.)

NOTES ON MOSSES.

NOVEMBER.

OF the various families of British Mosses by far the largest, as well as the most highly-developed, is the family Hypnaceæ, or Feather Mosses: named from ὕπνος, sleep, on account of some fancied soporiferous property, no doubt arising from its crisp and elastic nature when dry, making it a very pleasant bed, and a useful filling for pillows, &c.

The squirrel and dormouse, and whole tribes of birds use Hypnums as a material for their nests; and if we shake a tuft of moss over a sheet of paper we shall find that it harbours a population we little dream of—elegant little mollusca feeding among the branches, with tiny beetles and poduræ and curious acari hiding at the roots.

According to the London Catalogue the family incudes 21 genera, numbering 126 species, if we add the genus Thuidium, unaccountably placed amongst the Leskeaceæ; while the genus eu-Hypnum, or true Hypnums, is again divided into 11 sub-genera. The character and branching of the stems; the arrangement, character, and areolation of the leaves; also the form, &c., of the capsule and its lid, constitute the main features upon which these divisions are based; but in many cases these distinctions are not well marked, and require very careful examination under the microscope to correctly classify them. Taken as a whole, the stems of this family of pleurocarpous Mosses are mostly creeping and cæspitose, pinnately or irregularly branched; branches erect, spreading, or horizontal; leaves ovate, or ovate-lanceolate, more or less acuminate, concave, entire, or serrated; nerved or nerveless; nerve very variable in length according to the species; areolæ mostly narrow and elongated; capsules cernuous; rarely pendulous, but sometimes nearly erect, ovate or oblong, and tapering at the base; lid conical, or more or less obliquely rostrate; calyptra cucullate, pale, and rather small; peristome double, and possessed of intermediate cilia; the outer peristome of 16 equidistant teeth, the inner a membrane divided half-way down into 16 carinate processes alternating with the outer teeth; spores small reddish-brown or yellow; inflorescence, dioicous, monoicous, or synoicous.

More species are recorded as ripening in this month than in any other single month: about one-third of the species fruiting in October and November, and one-third in April and May. Many species do not fruit at all in Britain.

In the genus *Thuidium* there are five species distinguished by their erect pinnate or bipinnate stems with numerous branched villi, and densely papillose character of the leaves. Frequent round Manchester in woods and on banks in a barren state, and fruiting in Millers Dale is *Thuidium tamariscinum*, the Tamarisk Feather Moss, so named from its resemblance to the Spanish shrub *Tamarisk Gallica.* It is dioicous; stems arched and interruptedly tripinnate, with short leafy processes (villi) on the stem amongst the leaves; stem leaves cordate, acuminate, plicate; branch leaves ovate, obtuse; serrulate near and almost nerved to apex; all papillose at back; capsule oblong-cylindrical, curved, cernuous; lid with a long beak.

The genus Brachythecium comprises fourteen species recognised by their irregularly branched stems and silky, patent or sub-secund leaves, more or less decurrent, thinly nerved and striate; cells narrowly hexagon rhomboid; capsules ovate, sub-globose, or oblong.

Very rare is *B. salebrosum*, the smooth-stalked, streaky, Feather Moss; stems sub-pinnate; leaves ovate, acuminate, sub-serrulate; striated, nerved above half-way; capsule shortly ovate, cernuous; lid conical, monoicous. A variety, *Mildeanum*, with lanceolate leaves, is found on the sands at Southport.

The larger streaky Feather Moss, *B. glareosum*, has been found in Cotterill Clough, and is distinguished from *B. salebrosum* by the dioicous inflorescence and the more tapering leaves with very long slender twisted points; capsule ovate-oblong, cernuous, arcuate; lid conical, with a distinct beak. *B. albicans*, the whitish Feather Moss, is found amongst grass in sandy places, but is not common in fruit. It is known from allied species by its slender, delicate habit, and by the pale green membranous leaves, which are closely imbricated, ovate-lanceolate; striaedt, entire and nerved above half-way; capsule ovate, cernuous; lid conical. Common on walls, sandy hedge-banks, and at the roots of trees is *B. velutinum*, the velvet Feather Moss. Growing in compact, dull-green patches, its stems are creeping, with short, erect, crowded branches; leaves sub-secund, ovate-lanceolate, acuminate, serrulate at the apex; nerved above halfway; capsule ovate, cernuous; lid conical, apiculate.

Of the two broad groups into which the genus Brachythecium is divided, *velutinum* belongs to the second or rough-stalked fruit-stalked, while the four preceding species are members of the first group, having smooth setas.

Found only on the summit of Ben Lawers, and never in fruit, is *B. cirrhosum*, the tendril-pointed Feather Moss, from the long, narrow points of the leaves, resembling *Eurhynchium piliferum*, of which it is thought it may possibly be a variety, though different in its manner of growth. It occurs in similar situations on the Alps of Switzerland and Germany.

Having rough fruitstalks, but differing from the last genus in their narrow and wavy-like (vermicular) cell-structure are *Scleropodium cæspitosum*, the green-patch Feather Moss, found on damp walls and roots of trees in Lancashire, Cheshire, Yorkshire, and Derbyshire; and *Scleropodium illecebrum*, the alluring Feather Moss, frequenting banks and rocks near the sea, mainly in the Southern Counties.

Also, divided into two groups, with smooth or rough setas, is the genus Eurhynchium, the principal distinguishing feature being the lid with its long beak. The stems are more or less pinnately branched, and the areolation narrowly-rhomboid or sub-vermicular and dilated at the angles; capsules either cernuous or horizontal.

Of the species, so very rare as to be doubtful, although figured in Bryologia Britannica, is *E. strigosum*, the rustling Feather Moss, the only recorded find being in Cornwall.

Common on trunks of trees and rocks is *E. myosuroides*, the acute-leaved Feather Moss. Stems slender, with fasciculate branches; leaves lanceolate-acuminate, spreading from an ovate base; serrulate and nerved more than half-way; capsule elliptic-oblong, inclined on a smooth-twisted or curved seta; dioicous. Found on moist rocks in a barren state in several localities in the neighbourhood of Manchester, and in fruit near Bolton and near Todmorden, is *Heterocladium heteropterum*, the wry-leaved Feather Moss. Stems procumbent, often rooting at the apex; leaves ovate-acuminate, small, more or less secund, denticulate (with small teeth), somewhat papillose at back, nerved half-way, or shortly nerved and forked; capsules oblong, almost erect on a smooth seta; dioicous.

Two common Mosses in the neighbourhood of Manchester are *E. prælongum*, the prolonged Feather Moss, found on shady banks, and *E. Swartzii*, Swartz's Feather Moss, found on moist banks and rocks.

E. prælongum has sub-pinnate stems, two or three inches long, with slender attenuated branches; leaves of the principal stem squarrose, recurved, broadly cordate, and suddenly tapering to a long point;

nerve carried nearly to base of point; branch leaves lanceolate, acuminate; all serrate; capsules small, oval-oblong, with purplish spots at the base, where it is suddenly bent at an angle from the apex of the rough fruitstalk as in *E. purum;* lid with a long slender beak; dioicous.

A variety, *Stokesii*, is not uncommon in the Welsh woods.

E. Swartzii differs from *E. prælongum* in its manner of growth, having creeping stems, with short erect branches; leaves uniform, ovate, serrate, nerved more than half-way; fruitstalk rough; capsule ovate, cernuous; lid rostrate; dioicous. In Stirrup Wood and at Marple is found *E. pumillum*, the dwarf Feather Moss. This moss is mentioned by Wilson as growing in Winwick stone quarry, near Warrington, along with *prælongum* and *Swartzii*.

On shady banks and in woods, but rare in fruit, although found fruiting in Cotterill Clough, is *E. piliferum*, the hair-pointed Feather Moss, with imbricate, elliptical, serrulate leaves, suddenly contracted into a long serrulate, almost piliferous point, concave, and nerved half-way; fruitstalk rough; capsule cernuous, oblong; lid rostrate; as long as the capsule; dioicous.

Growing in dense bright or dark-green patches on limestone rocks in Millers Dale may be seen the thick-nerved Feather Moss, *E. crassinervum*, and a beautiful moss, very little known on the continent, is *Hyocomium flagellare*, the thong-branched Feather Moss. It is found on shady rocks by the stream in Staley-brushes, and also in Bamford Wood. Stems one inch or more, arched, pinnate; stem-leaves squarrose, broadly cordate, acuminate; branch leaves spreading, sub-secund, roundish-ovate; all sharply serrate, and mostly two-nerved at base; fruitstalk rough; capsule ovate, oblong, cernuous; lid conical, acute, dioicous. When growing in water it is always barren, and the stems and branches are much elongated.

Two common Mosses are *Rhynchostegium tenellum*, the tender awl-leaved Feather Moss, principally found on limestone rocks and walls; and

R. ruscifolium, the long-beaked Water Moss; frequent on rocks and stones in rivulets; while not uncommon about Ashley and Bowdon is *Thamnium alopecurum*, the Fox-tailed Frond Moss. It is a fine moss, with stems two or three inches in height, growing from a creeping rhizoma, naked in the lower part, with numerous branches above, disposed in a pinnate manner. Stem leaves scale-like below; upper leaves ovate-lanceolate, concave, serrate, and strongly nerved to apex; capsule shortly ovate; cernuous or erect; lid with a long oblique beak; dioicous.

With the exception of six species, whose leaves are patent squarrose, and which comprise the sub-genus Campylium, the eu-Hypnums, or true Hypnums, are distinguished by their falcato-

THE DUST FROM BOILER FLUES UNDER THE MICROSCOPE.

OUR attention has recently been called to the minute particles of dust found in the flues leading from boiler and other furnaces, and there are so many points of interest connected with this apparently insignificant matter that a few words on the subject may not be out of place.

So long ago as 1868 Mr. J. B. Dancer published his observations in this direction in the form of a pamphlet, and not long since he kindly sent us a slide of these particles from which the phenomena he mentions might easily be observed.

When coal undergoes combustion there is always a certain amount of ash which does not pass away in the gaseous form. A good deal of this is carried by the draught through the flue into the chimney, but a certain proportion of it, including most of the heavier particles, falls and is left behind on the bottom and sides of the flues.

If this be examined under a power of 40 or 50 diameters it will be seen to consist largely of ferruginous matter with crystalline substances and a vast number of minute spheres. These latter are best separated for inspection by washing the dust with water in such a manner as to let the lighter particles float away. If the remainder, consisting of the desired spheres and other heavier particles, be dried and sprinkled upon an inclined glass plate, a gentle tap will set the balls rolling and they can thus be easily collected. Some are transparent, some opaque white, and others variegated like polished agates. The majority, however, appear like a rusty cannon ball or are of a brilliant black colour. Almost all have an aperture in them similar to that of a bomb-shell, and appear to be hollow, as though a gas had been imprisoned, and undergoing expansion from the heat, had forced an opening in the side of the cell and escaped.

Mr. Dancer gives his opinion as to the probable constitution of some of these balls. He thinks that the transparent ones consist of silicates of soda and potash, which may also be present, combined with lime and alumina, in the opaque white. Most of the others contain iron in different combinations, as ferrous oxide, black magnetic oxide, and sulphide. Some of the black balls, he conjectures, are of metallic iron coated externally with a silicate. There seems a greater amount of iron present than can be accounted for by the quantity always present in coal-ash, and perhaps this represents the tear and wear of the ironwork about the furnace. The presence of the metal may be demonstrated in a somewhat amusing manner by bringing a magnet under the slide. The globular form of these bodies is probably due to their having been thrown off in scintillations, as, in the molten state, they would assume the spherical shape when carried along by the draught. Hydrochloric and nitric acids exert very little influence on the ferruginous globes.

NOTICES OF MEETINGS.

ASHTON-UNDER-LYNE BIOLOGICAL SOCIETY.—The Annual *Soirée* of the Ashton-under-Lyne Biological Society was held on Saturday, Oct. 7th, in the Mechanics' Institution. Mr. J. R. Byron presided. The report, which was read by Mr. J. S. Rouse, the Hon. Secretary, stated that during the year, in addition to a series of winter lectures and summer rambles, the members had been engaged in collecting the material for a list of fauna and flora of the Ashton district, and several instalments of this had appeared in the *Ashton Reporter*. In the coming Session the Committee hoped to draw special attention to the scientific collections in the Ashton Free Library. The adoption of the Report was moved by Mr. J. E. Sunderland, who congratulated the members on the work of the year, but doubted the expediency of reproducing in the new flora the stations named by Richard Buxton, as the great changes since his day must have eradicated the plants from many of the habitations recorded in the "Botanical Guide." Mr. C. E. Redfern, in seconding the resolution, gave some details of the work in progress, and said that it was not intended in the final issue to adopt the materials of Buxton except where they had been verified by observers in the present day. Mr. W. E. A. Axon, in supporting the resolution, hoped that the lists, at least in a preliminary form would be ready for the Southport meeting of the British Association, at which the Lancashire Scientific Societies, and especially those having a large proportion of artisan members, ought to be well represented. The Report having been adopted, the Chairman said that they had now come to the most important business of the evening. This was the presentation of an address and purse to Mr. Thomas Whitelegge, a workman naturalist, of whose life and remarkable powers of observation an account was given in the *Guardian* on Friday last. Mr. Byrom, in making the presentation, assured Mr. Whitelegge of the admiration and continued goodwill of his fellow members and of their earnest wishes for his prosperity in the colony of New South Wales, to which he is going. A letter was read from Sir J. D. Hooker testifying in the warmest manner his appreciation of Mr. Whitelegge's botanical researches. Mr. Whitelegge having made a suitable response, the formal proceedings closed with a vote of thanks to the Chairman, which was proposed by Mr. J. D. Reyner. Mr. D. F. Howorth, in seconding this, said that Mr. Whitelegge's advice had been of great service to the Committee of the Ashton Free Library with the selection of books for that Institution. The remainder of the evening was devoted to the examination of numerous objects of natural history exhibited by the members and their friends.

LIVERPOOL MICROSCOPICAL SOCIETY.—The seventh meeting of the 14th session of this Society was held at the Royal Institution, Colquitt-street, on Friday, Oct. 6th, when, on the nomination of the President, Mr. W

H. Weightman, seconded by Mr. C. Botterill, Mr. F. T. Paul, F.R.C.S., was elected president for the year 1883. Messrs. Reginald P. Thacker and Edward Friend were elected honorary members. The paper of the evening was read by Mr. F. T. Paul, F.R.C.S., the president-elect, entitled "On Hair and Allied Structures." He said that as the subject was a very wide one he would limit his remarks to a consideration of the morphological relations of the various tegumentary appendages which must be regarded as allied to hair. The structures which were included in this general association were of the most opposite character, but were uniform in the possession of certain common qualities of a protective or attractive nature. After a few general remarks upon the adaptation of the external covering to the requirement of the individual, showing the combination of as much attractive beauty as was consistent with the welfare of the species, the development of the skin in vertebrate animals was described. Special attention was called to the history of the two layers of which it is composed, showing their separate origin and different character throughout life—that the epithelial layer may be modified to form horny or calcified tissues, and the connective tissue layer to form bone, ivory, cartilage, muscle, nerve, &c., so that where complicated structures like teeth, spines, feathers, and so forth were produced, they always knew what share each layer had taken in their formation, because they knew to begin with what modification each layer was capable of undergoing. The appendages were divided into two classes—those developed from comparatively large areas of skin tissue, such as nails, claws, hoofs, horns, scutes, and beaks, and those developed from a small bud or germ from the epithelial layer, such as hair, feathers, scales, spines, teeth, and glands. The developmental relations of the first class were then considered, and special reference was made to the fossil remains of birds that have recently been discovered and described by Professor Marsh, of America, in which there is a full set of reptilian teeth in the beak or jaw, which, together with the abortive germs in some existing species, and the serrated beaks of fossil and recent birds, show a gradual change from the reptilian jaw to the present beak. Taking the second class, fish scales were omitted as too large a subject to be compressed into one paper; but the development of the hair, the various phases of its life history, its decay and reproduction, were fully considered; and the microscopical characters of the most striking varieties of hair were illustrated. Attention was called to the character of the papillæ, and the effect of its modifications in size, shape, and position in producing special kinds of hair—size, shape, curling, &c.; but more particular allusion was made to the extremely complex nature of the papillæ which inspires the extraordinary combination of cells resulting in the production of a perfect spine or feather. A short account was given of the glands of the skin, especially in such animals as the naked amphibians, in which they act as weapons of defence by pouring out an acrid secretion which is obnoxious to the palate of some of those animals that are naturally disposed to prey upon them. The paper concluded with some suggestions for preparing these tissues for the microscope, and the author specially recommended a new staining fluid which possessed a remarkable power of colour differentiation. The paper was largely illustrated by skillfully-prepared drawings, and at its close, on the motion of Dr. Carter, a hearty vote of thanks was accorded to Mr. Paul. The evening concluded with the usual conversazione and microscopical exhibition.

MANCHESTER MICROSCOPICAL SOCIETY.—The October meeting of this Society was more than ordinarily interesting. The chief feature was an exhibition of amateur work, as well as demonstrations of the various operations in the preparation and mounting of objects, by the several gentlemen who have taken such a keen interest in the mounting class from its commencement. The meeting was open to members and friends, each member being supplied with several complimentary tickets for the occasion. A glance at the tables showed that real progress had been made by those members who had applied themselves to the difficulties of preparation of objects, and it is satisfactory to note that a senior division has been arranged for teaching the various modes of dissection, the preparation of animal and vegetable tissues, staining, and the use of the microtome.

Mr. Stanley exhibited a good collection of mosses and hepatics, and also a selection of sections of animal tissues; Mr. Lean algæ and lycopodiaceæ insect and vegetable dissections; Mr. Fleming volvox globator, mounted in osmic acid; Mr. Mestayer micro-fungi; Mr. Chaffers foraminifera, recent and fossil; Mr. Brauer marine algæ from the Isle of Man, and zoophytes from the Channel Islands and St. Anne's-on-the-Sea. Other exhibits by the members generally were there in plenty. A special feature of the meeting was the illustration of the various processes in connection with the preparation and mounting of objects. This was practically shown at the various tables by Messrs. Lofthouse, Miles, Furnivel, Stanley, Hay, Graham, Chaffers, and Hall. These gentlemen successively showed the mounting of an object, from the centering of the slide and making the cell to the embedding of the object in its medium and finishing it off with its plain or ornamental ring of coloured varnish. Mr. Hay, of the Salford Royal Hospital, was eagerly watched in cutting sections, both by the ordinary method and by the use of the combined freezing microtome, lately introduced by Mr. H. P. Aylward.

MANCHESTER CRYPTOGAMIC SOCIETY.—Monday, Sept. 18th, Captain Cunliffe in the chair. Several of the members had made recent excursions to the Breadalbane mountains, and exhibited some of the rarities brought home.

Mr. Ashton showed specimens of *Timmia*, *Orthotrichum Ludwigii*, and *Hypnum Oakesii*.

Captain Cunliffe specimens of *Orthothecium rufescens* in fruit; *Dicranella squarrosa* and *Stylostegium cæspiticium*. All the parties had found the beautiful *Hypnum crista-castrensis* fruiting more abundantly than had hitherto been seen, and Mr. Ashton brought a number of specimens for distribution amongst the members.

Mr. W. Horsfall contributed freshly gathered specimens of *Cryphæa heteromalla* from Tenby.

Mr. H. Boswell, of Oxford, sent specimens of a *Sphagnum* new to Britain, which hitherto had only been found in America, and known there as *Sphagnum Torreyanum* (Sull). He had discovered it this summer at Whitchurch, Salop. Mr. Boswell also sent specimens of *Sphagnum intermedium* var *pulchrum* (one of the prettiest of the bog mosses) from the same locality, and Tortula princeps from Blair Athol.

Mr. T. Rogers exhibited several frondose hepatics from Southport, the *Pallavicinia Hiberniae*, being remarkable for its strongly pungent odour when dry.

"APERTURES AND AMPLIFICATION."

To the Editor of the Northern Microscopist.

Sir,

I have read Mr. J. H. Jenning's remarks in your last publication, and accept them as the conscientious *opinions* of a gentleman with whom however I must beg to differ.

Mr. W. Stanley, another correspondent, in his eagerness to bear testimony to the serviceableness of the Davis Aperture Shutter, gives a forcible illustration of the value and usefulness of low apertures, and, per contra, of the want of merit and utility in objectives of wide aperture; by describing the effect produced with a slide of Polycistina placed under a half inch objective of 80°.

"*The result was a glare;—no definition, no penetration.*" Mr. Stanley's inexperience leads him astray somewhat, and he innocently mixes up cause and effect. More of this however anon, and in another place.

I have also carefully noted the remarks of "Photo," "Micro," and "One who was present," but must respectfully decline to notice "Anonymous" correspondents, and should prefer those of my opponents who are members of the Manchester Microscopical Society to show themselves openly and manfully, an opportunity presenting itself at the Society's next meeting, when two or more papers will be read on the Aperture question.—Yours respectfully, J. L. W. MILES.

On receiving the above letter for insertion, we returned it to the writer for revision as we thought that upon mature consideration he would not desire to weaken his case, by charging with inexperience, one who is already known to our readers by his articles on Mosses. The letter came back to us unrevised, with a few personal remarks, which we do not reproduce, and a second request for publication. In acceding to this request we wish to inform our readers that Mr. Stanley's experience may be judged from the fact that the whole of the drawings illustrating his articles were drawn by him from the microscope, we reproducing them in *facsimile* by photo-zincography. Mr. Jennings, we hope, will only smile at his *facts* being written *opinions*.—[ED.]

NOTES AND QUERIES.

CHANGE OF ADDRESS.—The Editor desires to call the attention of his correspondents to his change of address. It is now The Willows, Fallowfield, Manchester, where all communications should be addressed.

MICROSCOPIC STUDY OF DYED SILKS.—The Chemical Review recently contained an interesting notice on the appearance of dyed silks under the Microscope. There is a striking difference between the fibre viewed lengthwise and in cross-section. In the former case the dye appears uniform, but in the latter it is seen that the colouring matter lies in circles round the centre of the section, its intensity usually increasing from the centre to the circumference. If specimens of silk be taken at intervals from immersion in dye-liquor, the breadth of these coloured rings will be seen to increase till they reach the centre. When silk, already dyed a light shade, is dyed to saturation with a second colour, the section will exhibit an inner circle of the pure second colour and an outer ring in which the two colours are blended. If, however, the silk is dyed to saturation the first time, and but lightly the second, the inner circle will be of the original colour, while the outer ring exhibits the result of the two.

Heat has sometimes a great effect in promoting the penetrating power of the dye. Thus, Prussian blue gives a broader ring in two hours aided by heat than in twenty-five hours in the cold. In five hours when heated, the tint is uniform throughout. If, however, a silk be ironed and blued imperfectly, and afterwards dyed to saturation with galls hot, there will be exhibited a dark bluish grey inner circle with an outer blackish blue ring, which latter may also be seen in dyeing blacks having a ground of Prussian blue. The black in this case, again, does not reach the centre.

Imbedding in Paper pulp.—In the August number of the Journal of the Royal Microscopical Society is given a simple plan of imbedding tissues for Microtome cutting by B. W. Richardson. Strips of white unglazed paper are dipped in water and rolled tightly round the structure to be embedded until a plug is formed requiring some little pressure to send it home in the microtome well. The strips of paper should be of a width slightly exceeding the length of the structure to be cut. This method is more suitable for vegetable than for animal tissues, but Dr. Richardson has found it successful with the latter also. Stems of plants should be previously soaked in methylated spirit for a few weeks and animal tissues in whatever fluid is most suitable for their preservation, and, if necessary, for their hardening, as the structure must be of sufficient firmness to stand being pushed home in the microtome well. J. R. M. S., Aug., 1882.

Manipulation.—I have lately found that the best way of raising a micro. cover glass and putting it on the slip, is by means of suction from the mouth through a piece of glass piping, with a small piece of rubber tubing at one end. By inhaling through the glass pipe, the cover glass will cling to the rubber end, and can thus be transported anywhere, and deposited by ceasing the suction. The cover is thus prevented from being soiled or broken.

I have applied a modification of this method for lifting small and light objects without injuring their structure, *i.e.* :—A glass tube drawn out to a very fine point, with the smallest conceivable hole through it; a slightly curved tube is the best form.

I am not aware that the method has ever yet been made use of. Perhaps microscopists will try it.—J. Tertius Wood.

Studies in Microscopical Science.—Since our last notice, nine more numbers of this weekly periodical have been issued, containing the following chromo-lithographs :—Human Kidney—horizontal section of papillary portion; transverse section of aërial stem of the Field Horse-tail *(Equisetum arvense)*; vertical section of Human Kidney; transverse section of root of Dandelion *(Taraxacum officinale)* showing a portion of the Xylem, and also bast and cambium × 700; section of the bronchus of a sheep in lung tissue; section of stem of *Lycopodium Wildenovii;* vertical section of Human Lung; section of stem of *Pilularia globulifera*; the last number (23) being illustrated by a representation of a vertical section of the lung of a cat, injected with carmine.

The illustrations are kept to the high-class standard, with which they were commenced, and the preparations accompanying the letterpress show very completely the details intended to be exhibited. In several instances perhaps slightly thicker sections might have been given with advantage, but it must be admitted that *all* the *minutiæ* cannot be expected in one single mounted slide.

The methods of preparation of the lung on pp. 159 and 160 will be read with interest by the student of histology, and also those relating to the kidney on pp. 135, 136.

Microscopical Mounting Classes.—The opening meeting of the session of the Manchester Society was held on Wednesday evening, the 11th inst., Mr. J. L. W. Miles in the chair. It was extremely well attended, rendering necessary the formation of a junior and a senior division, and showed that the value of practical exposition is becoming more and more appreciated by the general members of the Society.

As illustrating the scope of this section, the junior members, as in previous sessions, will proceed with cell making for dry and fluid mounts; mounting in balsam and glycerine jelly, ringing and finishing off; while the senior members are promised among others, demonstrations by the following gentlemen :—

Preparation and section cutting of vegetable tissues, Mr. R. L. Mestayer; Animal tissues and mounting of insects in pure balsam, without pressure, Mr. H. C. Chadwick, F.R.M.S.; Extraction of palates and insect dissections, Mr. W. Chaffers; Dissection of the oyster, Mr. E. P. Quin; Fluid mounts, Mr. J. L. W. Miles; The use of the Microtome, Mr. A. Hay; Double staining, Mr. A. J. Doherty, and Microcrystallization, Mr. E. Ward, F.R.M.S.

Mr. W. Stanley, in the junior division, proceeded to illustrate by means of brown cement and brass rings, the first processes of cell making for dry and fluid mounts. In the senior division the demonstrator was Mr. J. L. W. Miles, who cut sections of the potatoe for mounting as a dry and opaque object, emptying a portion of the cells of their starch contents, and thus exhibiting clearly the cell structure; the remaining cells showing the starch *in situ*.

Of the many methods of mounting sections of the potatoe, this is perhaps the most satisfactory, whether we regard it as an object of interest and beauty, or as a slide for botanical instruction. Mr. Miles also mounted starch in balsam for the Polariscope.

Colouring Infusoria.—M. A. Certes, in a recent number of Comptes Rendus, has an interesting article upon a method of colouring infusoria during life. With the exception of the Opalines and the Haptophrya, all the ciliated infusoria can ingest or take in particles of carmine or indigo from the water in which they live. In a weak solution of quinoliéne blue or cyanin the organisms will take a faint blue colour so long as thirty-six hours before death, but with this exception the cells do not become tinged till life is extinct. The colour is deepest in the fatty granulations of the protoplasm, and is scarcely seen in the nuclei, while the vibratile cilia, the cuticle, and the pulsating vacuoles are intermediate. This renders it easy to watch the phenomena of the division of the nucleus in the living animal undergoing division, and affords another proof of the difference in composition between cellular and nuclear protoplasm. The aqueous solution of cyanin which should be used for these experiments, is an excellent reagent for fatty matter. An alcoholic solution, like osmic acid, fixes the form of many species.—*American Monthly Micro. Journal.*

STAINING FAT-CELLS IN THE FASCIA OF A CALF'S NECK.—Dr. W. R. Weisiger, Manchester, Va., U.S.A.—After soaking for from half-an-hour to three hours in a half per cent. solution of osmic acid, the portion of the fascia is placed for fifteen minutes in a solution consisting of carmine ½ dr., borax 2 dr., water 4 oz. It is then washed quickly and mounted in glycerine, to every ounce of which two drops of formic acid have been added.—*American Monthly Micro. Journal.*

DISEASE GERMS.—The common belief that the air is always full of the spores of fungoid growths is an erroneous one, as the quantity present depends largely upon the weather, and at times very few are to be found. There is a not less general opinion that all these bodies are injurious to health, but this notion, which doubtless originates from the belief held by most medical authorities that certain of these spores are the germs of specific diseases, is disproved by facts, as there are many kinds which though very abundant at times exercise no injurious influence on the system.—A. R. D.

COVER-GLASS.—We learn from the *Zeitschrift für Instrumentenkunde* that Germany is competing with England in the manufacture of thin cover-glass, of which Messrs Chance of this country have hitherto enjoyed a monopoly. Dr. Otto Schott has discovered a method of making at a less cost glass equal in quality to that now used. Messrs. Halme and Schott, Annen bei Witten, Westphalia, are the manufacturers.

STAINING NUCLEI OF SPIROGYRA.—The Editor of the American Monthly Micro. Journal gives the following method. After being killed with alcohol the plant is allowed to remain for several hours in a perfectly neutral solution of carmine. When well stained, the excess of carmine is removed by washing with water or glycerine, and the specimen mounted in the usual manner.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to Mr. George E. Davis, The Willows, Fallowfield, Manchester; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

H. S., London.—We hope to be able to announce a change in the December number, but our arrangements are not yet made.

H. S., Ipswich.—The objectives you name are of foreign make. This would be patent to you if you took the front cloak away.

D. B.—No. Our mind is made up, and no amount of encouragement will induce us to debate the subject with one who is evidently unacquainted with the first principles of optics.

W. M.—You are mistaken, we have no interest in the aperture shutter, and if you "can get as much penetration without it," why do so by all means.

D. D.—The fungus is *Aregma bulbosum;* it may be mounted in balsam and benzol. It would be impossible for us to start such a department as that you mention, at least at present.

F. H.—We are surprised that you should object to the use of the aperture shutter "on account of the aberrations it introduces," and then state obtaining penetration by "shortening the tube." Do you not know that objectives as a rule are corrected for the full length of tube, and that you are disturbing the corrections at any other length.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free.* They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

OCULARS.—Two good oculars two-inch (a pair) in exchange for well mounted slides.—H. A., care of the Editor.

SCOTCH "Disruption Worthies," by Wylie, complete in 15 two shilling clean and perfect parts. Wanted micro. slides, accessories, or offers. Morrison, 148, Clarence-street, Bolton.

ACCESSORIES.—A few accessories in exchange for well mounted slides.—PYRO, care of Editor.

LICHENS.—Wanted mounted specimens, or sections, in exchange for other lichens, or stained vegetable sections.—A. J. Doherty, 21, Barton-street, Moss Side, Manchester.

SECTION CUTTER in exchange, has graduated top ring and two screws for holding objects in position.—MICROTOME, care of the Editor.

INJECTIONS.—Wanted well mounted micro. slides for unmounted opaque injections.—M. D., 2, Westbury Gardens, Clapham Park, London, S.W.

RAW MATERIAL.—Accumulation of micro.-material, especially fungi for mounted objects, clean diatioms, dryed plants or insects.—G. H. Bryan, Thornlea, Cambridge.

DIATOMS WANTED.—Mounted or unmounted microscopic objects for good gatherings of *Campylodiscus costatus*, *Meridian circulare*, *Achnanthes longipes*, &c. Liberal exchange given. W. White, 7, Warden-place, York-street, Nottingham.

AIR PUMP.—A small air pump, cost thirty shillings, in exchange for well mounted slides.—F.C.S., care of the Editor of this Journal.

THE NORTHERN MICROSCOPIST,

AND

MICROSCOPICAL NEWS.

No. 24. *DECEMBER.* 1882.

THE THEORY OF APERTURE IN THE MICROSCOPE: A POPULAR EXPOSITION.*

By W. Blackburn, F.R.M.S.

"APERTURE" has been truly described as the capacity of the object-glass for receiving light from the object and transmitting it to the magnified image. If we admit this to be a correct definition of the function of aperture, and to me it appears to be a self-evident proposition, then there only remains for us to investigate the conditions under which light is so received and transmitted.

Until within the last few years, it was the custom to estimate the aperture of an objective by the angular extension of a cone of light impinging upon the front surface, and having its apex or radiant-point in the object, or as much of this cone as was transmitted by the lens. (See fig. 34.) The angle of transmitted light was measured by placing the body of the microscope in a horizontal position in front of a lamp ten or fifteen feet distant, and, upon a rotating circular platform with a graduated edge, moving the microscope to each side until the edge of the flame appeared to divide the field in the eye-piece; and the angle of rotation, read upon the graduated arc, indicated the angular aperture of the ob-

Fig. 34.

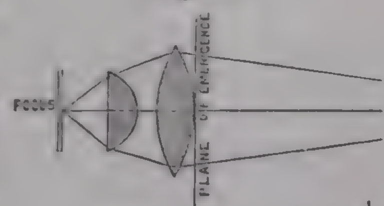
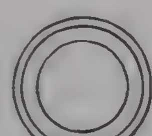
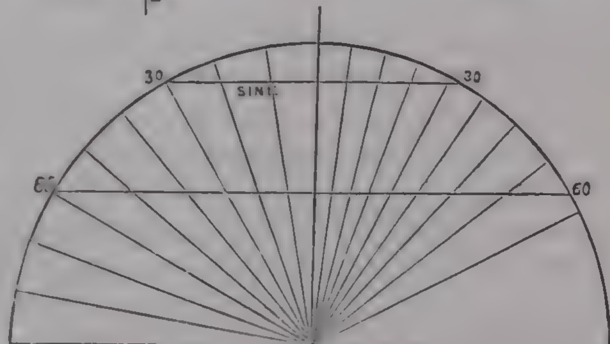


Fig. 39.





FALSE THEORY. TRUE THEORY.

Fig. 36.

* A paper read before the Manchester Microscopical Society on Nov. 2nd.

jective. This process is now much better performed by Abbe's Apertometer, which is a semi-circular disc of glass of high refractive index, having graduated scales on its surface; and as it also acts as a wide-angled condenser, it permits of the highest balsam-angles being measured by it.

"Angular aperture" was thus regarded as the correct measure of the capacity of the objective for receiving and transmitting light. This theory rests upon the assumption that light is emitted from the minute radiant elements of the object with equal intensity in all directions, and that, in a vertical plane section of a hemisphere of such light, an angle of 120° would contain twice as much as one of 60°. This assumption is incorrect, as, in accordance with the established laws of optics, the light must be of the greatest intensity in the line of perpendicular emission, and must diminish towards the sides of the hemisphere in the ratio of the cosine of the obliquity from the perpendicular, as shown in Fig. 35. The angle of 60°, or 30° on each side of the perpendicular line, will, therefore, contain more than half the quantity of light in the angle of 120°, their relative proportions being as 50 to 87, which is the ratio that the sines of their semi-angles (30° and 60°) bear to each other. This will be evident on referring to Fig. 36, where the angular equivalents of light on the two theories are represented, as well as the sines of the angles of 30° and 60°, and the relative quantities of light received by these sines in each case. The same principle holds with regard to all other angles in air, viz., that they must be compared with each other by means of the sines of their semi-angles.

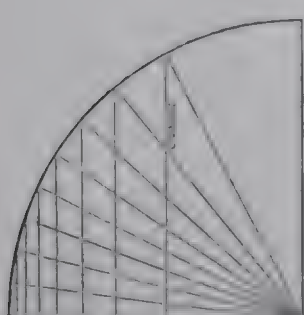


Fig. 35.

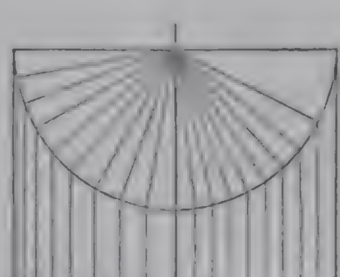


Fig. 37.

Now as the areas of circles are to each other as the squares of their radii, so the *total quantities* of light received by objectives of different angular capacity must be in the relative proportion of the squares of the sines of their semi-angles. The *illuminating powers* of lenses must, therefore, be compared with each other by means of the squares of the sines of their semi-angles of aperture. So that if we express this power in an air-angle of 60° by the number 250, in an angle of 120° it will be 757, and in one of 180° it will become 1000.

If light were emitted from every minute surface-element with equal intensity in all directions, we should see the illuminated disc of the full moon, and that of a planet through a telescope, to have greatly increased brilliancy from the centre to the circumference, because in any equal small apparent areas of their surfaces the number of real surface-elements emitting light must increase rapidly as the areas recede from the centre, and enormously as they approach the circumference. This is not the case; and the reason why this increase of brightness from the centre does not take place is to be found in the decrease of intensity of the emitted rays in the ratio of the cosine of their obliquity from the line of perpendicular emission. This principle is illustrated in Fig. 37, where the two theories are compared with reference to pencils containing equal quantities of light emitted from a luminous hemisphere, such as that of the moon, in a parallel direction towards the eye. It will be observed that the *false* theory of angular equivalents of light gives rise to pencils decreasing in diameter towards the sides of the hemisphere, and therefore of greater intensity in that direction; whilst the *true* theory of angular equivalents results in equal pencils of therefore equal intensity.

Angular aperture is thus shown not to be a scientific method of formulating *real* aperture, and we are left to seek it in a more correct notation, bearing the expression of the relations of the *sines* of angles to each other. This expression we find in the system of "numerical aperture" tabulated by the Royal Microscopical Society, and now published on a fly-leaf of their Journal, together with other interesting matter connected with it. In this system, *radius*, or the sine of the semi-angle of 180°, is taken as unity or 1.0; so that all apertures in air must be less than 1.0 in proportion as the sines of their semi-angles are less than radius. For instance, the angle of 140° in air has a semi-angle of 70°, the sine of which is .9397, or .94 nearly, which is the *numerical aperture* of 140° in air. A useful table of natural sines, which will enable anyone to convert *angular* into *numerical* aperture almost at a glance, will be found in Mr. G. E. Davis's "Practical Microscopy," chapter IX., and in chapter V. there is a copy of the *numerical* aperture table of the Royal Microscopical Society.

Those who wish to know something of the controversy which has taken place between the old school of "angular aperturists" and the new school of "numerical aperturists," especially if they have any lingering scepticism as to the superiority of the new system of notation, should read the very able article in the Journal of the R. M. S., for 1881, p. 303, written by Mr. Frank Crisp, B.A., LL.B., Hon. Sec. R.M.S., from notes by Prof. Abbe and others in possession of the Society, and forming a most convincing argument in support of the new theory and in refutation of the old one.

So far we have considered the case of angles in air only, *i.e.*, when, in estimating apertures, a stratum of air exists between the object and the front lens of the objective, which is, therefore, called a *dry* objective. We have now to consider the case of *immersion* objectives, where the light from the object must traverse a film of water or oil interposed between the front surface of the lens and the cover-glass, to the under surface of which the object must be adherent, if dry, or otherwise mounted in a medium of equal refractive index to that of the immersion fluid; and in doing so we shall perceive how an immersion lens can have a greater aperture than 180° in air, or a greater *numerical* aperture than 1.0, which is the same thing.

As a preliminary, I must remind you of certain principles involved in the behaviour of rays of light passing from air into media of greater density, such as water and oil. In the diagram, Fig. 38, let A O be a ray of light falling obliquely upon surface of water at O, and refracted in the direction of C, or nearer to the *axis of incidence* B D than the original direction of the ray: then the sine A B of the *angle of incidence* I will be to the sine C D of the *angle of refraction* R as 1.33 to 1.0, and this proportion will be maintained for every obliquity of the incident ray. The number 1.33 is, therefore, the co-efficient of refraction in water, or the *index of refraction* for that medium. In like manner the index of refraction for crown glass is 1.52, for cedar-wood oil 1.51, for Canada balsam 1.53, and for bisulphide of carbon 1.68. Now as every ray of light falling upon the point O, within the angle of incidence I, must, in passing into water, be refracted within the angle of refraction R, it follows that the smaller sine C D in water must receive all the light transmitted through the greater sine A B in air; and that equal plane angles in air and water must, under similar conditions, receive amounts of light in the respective proportions of 1.0 and 1.33. Now let the line C D represent one-half of the diameter of the front surface of a water-immersion objective having its focal point in O, where an object is placed in contact with the immersion medium and illuminated by the semi-angle of light B O A: then, as the amount of light falling upon C D in water is equal to the amount falling upon A B in air, it

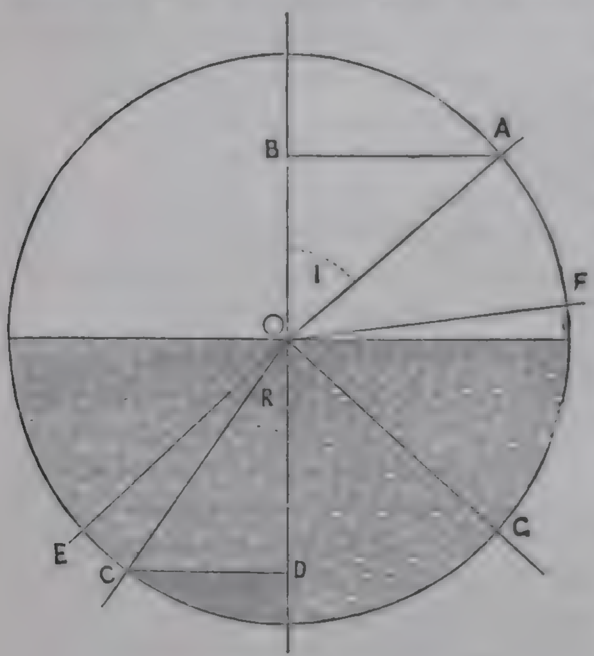


Fig. 38.

necessarily follows that the interposition of the immersion fluid between the front lens and the object has increased the quantity of light entering any given semi-diameter of the front surface of the lens in the proportion of the refractive index of water, 1.33; because, if water had not been interposed, the light from the object would have spread over the larger angle E O D, equal to B O A in air; and as the areas of circles are to each other as the squares of their radii, so the amount of light received by the whole surface of the front lens of a water-immersion objective must bear to that received by the surface of a dry objective of similar angular capacity the ratio of the square of 1.33, or 1.77 to 1.0. Similarly in the case of oil as the immersion medium, with an index of refraction = 1.52, the semi-diameter of the front surface of the lens will receive 1.52 times the quantity of light that a similar portion of a lens of the same capacity will receive in air; and the illuminating power of the two lenses will be in the ratio of the square of 1.52, or 2.31 to 1.0. A correct system of notation for apertures will, therefore, require that, when the light passes through different immersion media, the numerical expressions for aperture shall be multiples of the sines of the semi-angles with the refractive indices of those media. This principle is carried out in the system of *numerical aperture*, where *radius*, or the sine of half the angle of 180°, being taken as = 1.0 in air, it becomes = 1.33 in water, and 1.52 in oil.

We have seen that in the diagram, Fig. 38, the ray of light A O, falling upon the water at O, is refracted to C. In like manner a ray of light C O, passing from water into air, will be refracted in the direction O A, the angle of incidence in this case being R, and the angle of refraction I. Now, if we enlarge the angle of incidence until it is nearly 48½°, we shall find that a ray of light E O will be refracted in such an oblique direction O F, that any increase in the angle of incidence will result in no light passing out of the water, but in the whole of it being totally reflected at O in the direction of O G; and the angle E O D is, therefore, called the *critical angle*, which for water is 48½°, and for crown glass or oil 41°. If the system of notation in *numerical aperture* is correct, therefore, we ought to find that 1.0, = 180° in air, is also equal to twice the critical angles in water and in oil; and we accordingly find that *radius* divided by the refractive index in each case is equal to the sine of the critical angle, and that 180° in air is consequently the same thing as 97° in water and 82° in oil. It will be obvious that any excess over these apertures in water and oil must represent greater apertures than 180° in air.

It may be asked whether we can see these apertures in excess of 180° in air through the microscope; and, if they really exist, what is their practical utility, since dry objectives are made that will take up very wide angles of light, and we have the means of condensing it upon the object by suitable lenses placed beneath the stage. If we take a very wide-angled homogeneous immersion objective (say 1.43 N A) *i.e.*, one constructed upon a formula which requires the immersion medium to be of the same refractive index as the crown glass of which the front lens is composed, and measure its aperture *in air* by means of Abbe's apertometer, we shall find it to be represented by 1.0, or the greatest air-angle of 180°. If we now place a drop of water in front of the objective, we shall find that the aperture has suddenly expanded to 1.33, the numerical equivalent of 180° in water, and one-third greater than the aperture in air. If again, we remove the drop of water and substitute a drop of oil, we shall find that the aperture has again extended itself, that the full capacity of the objective is now seen to be in excess of 1.33, and therefore greater than 180° in water.

The truth revealed by the apertometer is confirmed in another way. The researches of Professor Abbe, on what is known as the "law of aplanatic convergence," have shown that the aperture of an objective requires a certain ratio to be observed between its focal length and the utilised diameter of its back lens measured at the plane of emergence. (See Fig. 34.) This ratio, in a dry objective of 180° air-angle, supposing that angle to be possible, will be as 1 to 2; or, in other words, the focal length will be equal to the semi-diameter, which latter may, therefore, be expressed in terms of the focal length by 1.0. In a water-immersion objective of 180° water-angle, this ratio must be increased by one-third, and the expression for the semi-diameter will be 1.33. Similarly an oil-immersion objective of the same angle will require this ratio to be expressed by 1.52. In Fig. 39 is shown the relative proportion of the diameters of the back lenses of three objectives of the same focal length and angle, in air, water and oil respectively. As these numbers represent also the refractive indices of the immersion media in each case, as well as the numerical apertures of the objectives employed, it is very evident that *aperture*, in the sense of *opening* merely, must be compounded of the *sine of the semi-angle* of aperture with the *refractive index* of the immersion medium, and that angles greater than 180° in air or water are not mere theoretical expressions.

The practical advantage of the new notation over the old may be illustrated by a very simple comparison. In comparing two dry objectives of 140° and 160° angular aperture respectively, one would naturally suppose that the real aperture of the one exceeded that of the other by one-seventh. The *numerical* notation informs us that this is not the case, but that their real apertures are as 94 to 98, and that the excess of the greater aperture is not one-seventh but only one-twenty-fourth. Other inconsistencies of the *angular* aperture notation will be readily suggested by an examination of the *numerical* aperture table already referred to.

Of the practical utility of wide-angled objectives every microscopist knows something. However much we may differ as to the utility of wide angles for low or medium powers, we all know that the resolving capacity for such minute structure as the striæ of diatoms in any given power is in direct relationship to the aperture. A half-inch dry objective of 60° will show the dotted structure of *Pleurosigma formosum* or *P. hippocampus*, which the same power of 40° will fail to resolve under any conditions of illumination of the object. This property is found in all lenses to increase with the aperture, until the highest numerical aperture is attained. The capacity for resolution, inherent in wide angles, was formerly supposed to rest upon the increase in the quantity of light transmitted by them, and in the obliquity of the marginal rays enabling us in some mysterious manner to see round the object. The researches of Professor Abbe have, however, proved that the microscopical vision of very minute structure depends upon other considerations than the ordinary laws of geometrical optics, and can be explained only by a reference to physical phenomena.

There is, perhaps, no theory more firmly established on a physical basis than the undulatory theory of light. If a wave of light cannot actually be seen, it can be *and has been measured.* According to Angström, the length of a wave of monochromatic light varies from $.7604\mu$, corresponding with the dark line A in the extreme red of the solar spectrum, to $.3933\mu$ at the line H_2 in the extreme violet (1μ or micromillimetre $= \frac{1}{1000}$ of a millimetre, or rather more than $\frac{1}{25000}$ of an inch); the line E near the centre of the luminous spectrum in the green having a wave-length of $.5269\mu$, or about $\frac{1}{48000}$ of an inch, which is about the distance of the striæ on *P. angulatum*. So long as the visible details of an object are large enough to be many multiples of the wave-length of light, the rays are propagated from them in rectilinear directions, as in ordinary vision, or as seen through the telescope; but when these details are only a few multiples of the wave-length, the rays are intercepted by the minute elements of the structure, diffracted from their rectilinear paths, and result in *spectra* or distorted images. The number of diffraction spectra proceeding from any minute structural element will depend upon its morphological character; and the amount of separation of the spectra from the rectilinear direction will depend upon the minuteness of the intercepting structural particles. The more complicated the structure the more numerous the spectra; the smaller the particles, the greater the separation. If an object containing minute structure be viewed through the microscope, and the image formed upon the retina be a combination of all the diffracted rays, the real structure of the object may be seen. If only the central rays pass to the eye, and the diffracted rays be excluded, no minute structure will be visible. The central light and at least one diffracted ray, or two diffracted rays only, are essential to the visibility of *any structural detail*; and the likeness of the image to the real character of the object will depend upon the number and position of the diffracted rays that are combined in the visual image. Diffraction spectra can be seen in the microscope, and have been exhibited, together with their resultant images, to the R. M. Society, the Quekett Microscopical Club, and elsewhere.

If a plate of glass with fine ruled lines, such as are represented in Fig 40 in the magnified image, be placed upon the stage of the microscope, and a beam of white light from the mirror made to pass through a small opening in a diaphragm between the mirror and the stage; upon removing the eye-piece and looking down the tube, spectral images of the source of light will be seen on each side of the central beam, as in Fig. 41; the closer images of the upper line being formed by the wider lines of the plate, and the more distant images by the closer lines. If a diaphragm be now placed at the back of the objective, covering all the spectra, and allowing only the central rays to pass, upon replacing the eye-piece the lines on the plate will have disappeared. If we now place another diaphragm at the back of the objective, so as to exclude all but the central rays and the outermost spectra, upon replacing the eye-piece we shall see more lines than are in the object, the appearance being as in Fig. 42. The false lines are the result of the phenomenon of interference or intermixture of the luminous waves. On this principle a great variety of effects may be produced from object-plates ruled to different patterns and an adequate manipulation of the spectra produced by them. Upon the admission or exclusion, more or less, of the diffraction rays, as they are bent off in angular groups, depends the capability of the microscope to show things as they are in nature, and therefore affects, not only the resolving power, but the delineating power of the instrument.

Fig. 40.

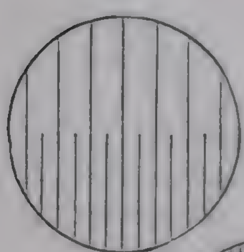
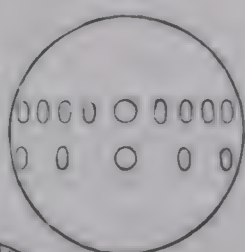


Fig. 41.



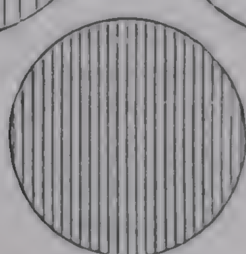


Fig 42.

Professor Abbe says that very minute structural details, as a rule, "cannot be interpreted as morphological but only as physical characters, not as images of material forms, but as signs of material differences of composition of the particles composing the object; so that nothing more can safely be inferred from the image as presented to the eye than the presence in the object of such structural peculiarities as will produce the particular diffraction phenomena on which the image depends."

In examining such minute structure as the striæ of a diatom, it has been shown* that, if we take the distance of the striæ as $.6\mu$ (about $\frac{1}{12000}$ of an inch) and the wave-length of light as $.55\mu$, in the centre of the luminous spectrum, the first diffracted ray will be directed outwards at an angle of 66°.5 from the axis, when central light is used, and this spectral ray will be collected on each side of the axis by a dry objective of 133° angular aperture, as in Fig. 43. In balsam the same rays will be deflected at an angle of $37\frac{1}{2}$°, and will therefore be received by an objective of 75° balsam-angle. If the distance of the striæ be twice the former quantity, or 1.2μ, then the dry objective of 133° air-angle will admit two diffraction rays on each side the axis, while an immersion lens of 133° balsam-angle will admit three such rays on each side.

This is another proof that an angular aperture in air is not an optical equivalent of the same angle in balsam or oil, but that the latter is something more, and its capacity for showing things *as they are*, when the structural particles under investigation bear comparison in minuteness with the wave-lengths of light, must be greater also.

As the structural elements become larger, the diffraction rays become contracted within smaller angles, until medium and low angles are capable of transmitting them, and the object at length becomes imaged upon common dioptrical principles.

If, instead of using central illumination, as in the last case, we now pass an *oblique* pencil of light through the smaller diatom, the direct ray and one spectral ray will be just received by an objective of half the angle of the former, or 66°5 in air, as in Fig. 44; and this aperture will be the theoretical minimum capable of separating lines = $.6\ \mu$. If we want to see images more characteristic of the real structural elements than mere lines, we must use wider apertures.

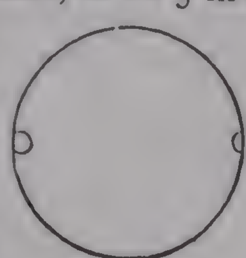


Fig. 44.

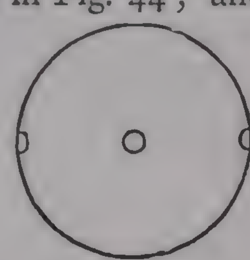


Fig. 43.

We may also diminish the wave-length of the light by employing rays corresponding with a part of the solar spectrum nearer the blue, and thereby gain the advantage of a slight decrease in the angle of diffraction. If the line E of the solar spectrum be taken,

* See Journal R. M. S., 1881, p. 357.

as in the numerical aperture table of the R. M. S., and the wave-length computed at .5269 μ, then the theoretical resolving power of an air-angle of 60° will be represented by 48,200 lines to an inch; and this power will increase in the direct ratio of the numerical aperture until the widest balsam-angle has been attained.

The penetrating power or stereoscopic capacity will, however, decrease with each increase of the numerical aperture. Professor Abbe has shown that, with any given aperture and amplification of the image, the power of penetration depends upon two factors, viz.: the *depth* of *focus* of the objective, *i.e.*, its capacity for showing portions of the object within and beyond the principal focal plane, and the *depth of accommodation* of the eye, or the range of its power to bring rays of different degrees of parallelism to a focus on the retina. The depth of focus is in the inverse ratio of the amplification, but the depth of accommodation is in the inverse ratio of its square; the former also varies inversely with the numerical aperture. So that, whereas in low powers the depth of accommodation is the chief factor, in the medium powers these two factors become equal, and in the higher powers the depth of accommodation becomes unimportant, and the depth of focus the principal or only factor in the entire depth of vision. According to Professor Abbe's table, if, with a numerical aperture of .50 and an amplification of 10 diameters, the total depth of vision be = 2.153 mm., with 100 diameters it will be reduced to .0273, or $\frac{1}{79}$th, and with 1000 diam. to .00094 mm., or $\frac{1}{2290}$th. The numerical equivalents for penetrating power in the table of the R. M. S. represent only one of these factors, that of focal depth, the other being unimportant, except with low amplifications.

It is beyond the scope of this paper to treat of the *practical* advantages and disadvantages of the use of wide apertures as affected by manipulation, working distance and other considerations, or of the relationship between the aperture and the power employed. But as an attempt to convey the views of the leading microscopists of the day on the definition and value of *aperture* as an abstract quantity in the optics of the microscope, I trust it will not be without a useful purpose.

EXTRACT FROM

PROF. MARTIN DUNCAN'S ADDRESS

To the Members of the Royal Microscopical Society, February 8th, 1882.

(Continued from page 310.)

Micro-Stereoscopic Vision.

THE determination of the depth of vision (in monocular observation) naturally throws great light also on the conditions for effective micro-stereoscopic vision. It is obviously only when an object can be completely *seen* in all three dimensions at one adjustment of the focus, that a true stereoscopic image of it can be obtained. So long as only a single layer of inappreciable depth is visible simultaneously with any distinctness, no stereoscopic apparatus, however perfect, can bring into view the form of the whole of the object.

Now with low powers we have large visual depth, so that objects of considerable thickness can be seen as solids. By reason, however, of the rapid decrease of the depth of vision to which I have referred, the thickness of the objects which can be seen in relief, rapidly and disproportionately decreases as the power is increased, so that only very thin objects are suitable with even the *medium* powers, the absolute depth, in the case of an object magnified 300 times, not amounting to a hundredth of a millimetre. With still higher powers the images of solid objects (though the decrease in depth is no longer so irregular) necessarily approach more and more to simple plane sections, the absolute depth with a power of 1000 times amounting only to a micro-millimetre. For medium and high powers, therefore, the only objects suitable for the stereoscopic binocular, are those which present, within a *small* depth, a sufficiently characteristic structure, that is, which have sufficient salient points for stereoscopic effect. We can, however, increase the depth of vision by using narrow illuminating pencils, and by mounting the objects in some highly refractive substance. The above considerations also show the importance of using the *lowest* power sufficient to recognize the object.

Whilst the reduction in depth limits effective stereoscopic observation, Professor Abbe properly points out that there is a compensating advantage in ordinary microscopic observation, in that as the depth-perspective becomes more flattened the images of different planes stand out from each other with still greater distinctness, so that "with an increase of amplification the Microscope acquires more and more the property of an *optical microtome*, which presents to the observer's eye, sections of the object of a fineness and sharpness that no instrument could produce by mechanical means."

Another novel point was the demonstration of the very material distinction between ordinary stereoscopic vision and that with the Microscope. The perspective shortening of the lines and surfaces by oblique projection, which is an important element of solid vision with the naked eye, is wholly wanting in microscopical vision, in which we have only the other element, a relative displacement of successive layers in the image. That these displacements are seen in the Microscope, depends entirely on the peculiar exaggeration in the amplification of the depth of an object which is not found in ordinary vision.

The paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope" is also a most useful contribution to the theory of micro-stereoscopic vision, establishing as it does the true criteria for both classes of effects, and at the same time clearing up a misconception that had arisen as to the supposed necessity for the rays from the two halves of the objective *crossing* in order to get proper orthoscopic effect. If the delineating pencils have been reflected an *even* number of times in the same plane, the rays must cross, but otherwise not.

Mounting-Media of High Refractive Indices.

To utilize the full benefit of immersion objectives, it is of course essential that the object should be mounted in a medium, the refractive index of which is not less than that of the immersion fluid; and down to a comparatively recent period Canada balsam was most commonly used for this purpose, particularly for diatoms.

Mr. Stephenson, however, pointed out that although by the use of the balsam we have attained our object so far as the aperture is concerned, yet we have done so at the expense of the visibility of the resultant image, which has become fainter by the nearer approximation to equality of the refractive indices of the diatomaceous silex and the balsam; the visibility of minute structures being proportional to the difference between the refractive indices of the object and the medium in which it is mounted. Instead of balsam, therefore, media of high refractive index should be employed; thus, as the refractive indices of diatomaceous silex and Canada balsam are respectively 1.43 and 1.54, the difference .11 is the measure of the visibility of a diatom in balsam. Using a solution of phosphorus in bisulphide of carbon, the refractive index of which is 2.10, the difference is .67, and the visibility of the diatoms is now more than six times as great as it was in the balsam.

Continuing his researches on this subject, and endeavouring to find the best media with high refractive indices, he has quite lately brought before the Society the utility of an *aqueous* fluid capable of being given the high refractive index of 1.68, viz. a solution of biniodide of mercury and iodide of potassium in distilled water. This more manageable and highly antiseptic medium appears likely to turn out to be of great use in the observation of many objects, as its strength can be diluted till the index of water is obtained. This is of advantage with such objects as muscular fibre, which are themselves of high refractive power, so that fluids of *low* refractive power must be made use of to obtain the required difference for more perfect visibility. The same communication also contains what was much wanted, detailed practical directions for mounting.

Any one who has seen the diatoms and scales mounted in phosphorus by Mr. Stephenson's method, and exhibited at our meetings during the past and present sessions, cannot fail to have been struck by the great increase in their visibility as compared with those mounted in balsam, or to have recognized the fact, that the theoretical consideration by which their visibility was pronounced to be much increased, was not unfounded.

In addition to the increase in visibility, there is also the fact that by means of such mounting fluids, the capacity of stereoscopic binoculars with the higher powers is considerably enhanced. True stereoscopic effect, as we have seen, requires a depth of vision not less than the thickness of the object under observation—a depth which, as already shown, increases in direct proportion with the increase in the refractive index (n) of the mounting fluid. If one object is in air when $n = 1.0$, whilst another is in a solution of phosphorus, where $n = 2.1$, the depth of vision will be more than doubled. Objects, therefore, that by reason of their thickness could only afford an unsatisfactory stereoscopic effect in air may be seen in full relief when mounted in phosphorus.

Here, again, the deductions of theory were remarkably verified by the recent exhibition of *Surirella gemma*, under the binocular, with a $\frac{1}{25}$-inch objective.

Relative Value of Objectives with Large and Small Apertures. ("All-round Vision.")

I now come to a much-vexed question, that of the relative value, practically, of objectives of large and small apertures, in regard to which a great variety of opinions have been promulgated.

The oldest of these views was that which made the preference between the two kinds of objectives, depend upon whether they were to be used for the "ordinary purposes of the biologist," or for the examination of diatoms or other lined objects. The objection to this view is, that it assumes the only function of a large aperture to be its resolving power, a much too restricted notion, and one which deprives the working biologist of a most essential aid to his observations upon structure.

A more modern view errs in the opposite direction, and insists upon the universal superiority of large apertures, so that work done with small apertures will "have to be done over again."

There is again a third view, still more recently put forward, which goes much further than the preceding, and according to which it is impossible that wide apertures can give correct images. First on account of the unnatural "all-round vision" which it is contended is obtained with them, and secondly by reason of their supposed inherent defect in defining power, in consequence of the dissimilar images presented by the different parts of the enlarged area of the objective, with a confused image as the general resultant.

The want of exactness in the first two suggestions will sufficiently appear, when we have formulated the grounds upon which large apertures are shown to be indispensable for all observations upon minute structure for which high powers are necessary; but it will be desirable first to point out the erroneous interpretations upon which the third view (as to all-round vision and dissimilar images) has been founded, and for this purpose it will be necessary to refer to the paper by Dr. Royston Pigott, F.R.S., in which the subject is dealt with.*

After reminding his readers that he had shown that spider-lines, miniatured down to the fourteenth part of the hundred-thousandth of an inch, were distinctly visible to ordinary good eye-sight under proper microscopical manipulation (an experiment which, I may remark in passing, has not a satisfactory foundation), Dr. Pigott says:—"Under these circumstances it was interesting to know whether real objects could be detected by the Microscope in the surprising degree of attenuation represented by the millionth." Minute particles of mercury were obtained by smashing some with a watch-spring, and they were mounted in petroleum under a thin cover. A vertical illuminator was used to converge rays downwards, through the objective, upon the preparation. In a darkened room minute disks became visible, and upon some of them clusters of minute black points were seen with a power of 1000 diameters. Comparing them with a micrometer spider-line $\frac{1}{10000}$ inch diameter, some of the points were found to be decidedly smaller. Under 1000 diameters the particle was magnified one hundred times in the micrometric focus, and then appeared less than the $\frac{1}{100}$ of $\frac{1}{10000}$ inch, or less than the millionth of an inch, and the writer draws the conclusion that "real objects of unsuspected

* Proc. Roy. Soc., xxxi (1881) pp. 260-78.

minuteness may be microscopically displayed as well as minute miniature images." To this part of Dr. Pigott's observations it may be pointed out that it has never been supposed, so far as I am aware, that there is any limit of *visibility* in the Microscope other than that imposed by the sensibility of the observer's retina, the correction of the objective, and the illumination. The question of a limit of visibility is quite distinct from that of a limit of separation, just as in telescopic vision a single star is always visible, however small its visual angle, provided it is sufficiently *bright*, but a double-star requires a certain minimum aperture of the objective, dependent on the angular distance of both stars.

Discussing the variability of the blackness and thickness of the marginal annulus of refracting molecules, as exemplified in a glass spherule ·1 inch diameter, and in the featherlets of the death's-head moth and plumelets of *Hipparchus Janira* with objectives of 20° Ang. Ap. power 200, and 140° Ang. Ap. power 800, he writes:—"If then the minute fibrillæ of the plume can be clearly distinguished as closely packed black lines at a visual angle of 20 seconds with a low aperture of 20°, this result is fatally opposed to the popular idea that very close lines, or very minute lines or bodies, can only be distinguished with large angular aperture. These lines were most sharply seen though less than $\frac{1}{80000}$ inch thick." After denoting the disappearance of distinctive shadows and consequent obliteration of structural molecules with excessive angular aperture, illustrating his meaning by the structure of Podura scales, with different stops and under very varying conditions, Dr. Pigott states that he has come to the conclusion that residuary abberration was not the only cause of the obstinate obscuration of minute crowded molecules in translucent organic forms, but that

> "Excessive angular aperture, he found, attenuated margin. . . . There is, it may be said, something unnatural in the mode of vision intrinsic to very high angled glasses. It is undoubtedly true that such a glass presents an *all-round vision*. It really conveys visual rays from a given brilliant particle, at every inclination in azimuth and altitude, and this too at one and the same instant. To illustrate this position a minute die may be imagined the $\frac{1}{100000}$ inch broad. The highest angled objective really enables the observer to collect rays emanating from *four sides* and the top at the same instant. The human eye could at most view *three sides* at once. Doubtless the effect of this angular vision all round the corners, causes particles to look spherical, when sufficiently minute, even if cubical."

Now it is not necessary to say plainly that this view is founded upon a fundamental error, "belonging," to use Professor Abbe's words, "to the venerable relics of the past *naïve* period of microscopical science, which was characterized by an unshaken conviction in the validity of the hypothesis that microscopical vision is in all essential respects the same thing as ordinary vision." The "all round vision," by virtue of which we are supposed, when looking at a minute cube, to see at the same time the top and all the sides (with the result of rounding off the corners and angles !), does not really exist, as can be shown by the application of the simplest laws of *geometrical* image formation. The different obliquities of the rays in an objective of wide aperture cannot give rise to any all-round vision, for in the Microscope there is no difference of *perspective* attendant upon oblique vision as with the naked eye. The difference of *projection* of successive layers which exists is ineffective, except in the case of binocular vision. This absence of perspective may be readily established by examining an object alternately by an axial and an oblique ray; it will be found that there is no shortening of the lines in the latter case, and no capacity in the Microscope, therefore, "for all-round vision." Indeed if this theory were correct, microscopical vision, even of *plane* objects and with very moderate apertures, would be entirely destroyed.

Equally mistaken is the second branch of the view which I am considering, viz. that a wide aperture must, in the nature of things, impair definition on account of the increase, thereby produced, in the dissimilar images received through the several parts of the objective. In support of this view, illustrations drawn from stereoscopic vision are adduced, which admittedly does depend upon the dissimilar images formed by the right and left hand halves of the objective; but, as Professor Abbe has shown, the dissimilarity of images presented by an objective of wide aperture is a dissimilarity in the projection of *successive layers* only, and this is *not effective* unless we produce these images by different portions of the aperture *separately and conduct them to different eyes*, as in binocular Microscopes. The sole effect of the wider aperture when the images are not so separated, is a reduction in the depth of vision—to confine us to the vision of thinner objects, not to impair the definition of what is seen when the objects *are* within the range of penetration.

If we pass to practical experience, we shall find that the principles which theory establishes are amply confirmed. All who have worked with wide-angled objectives cannot fail to have recognized the great fact of modern practical optics, the perfection of definition obtained with such glasses—a fact which has been verified by such authorities as Mr. Dallinger, who, so long ago as 1878, stated of a new $\frac{1}{8}$-inch homogeneous-immersion objective of the wide aperture of 1·25 that "the sharpness and brilliancy of the definition which this lens yields is absolutely unsurpassed in my experience."

The question of the power of resolution supposed to be possessed by small apertures can also be brought to a very simple practical test by those who believe in that view exhibiting here to the appreciative assemblage which they would have around them, say 75,000 lines to an inch resolved with the low apertures referred to!

We have seen that on the one hand the depth of vision decreases as the aperture is increased, and that on the other as the objects become smaller and smaller the similarity of their images increases with the increase in the aperture—the one representing a disadvantage attendant upon large aperture and the other an advantage—and bearing this in mind we are in a position to arrive at a correct view of the relative value of objectives with large and small apertures, which I take to be this:—

Both kinds of objectives are necessary for investigations into the structure of *minute* objects, and an observer to be fully equipped, should provide himself with *two* objectives, one of moderate and one of wide aperture. The former would be used for the more general survey of the various parts of the object, and the latter for the subsequent examination of its minute structure. In searching, for instance, through a stratum of fluid for Bacteria a wide aperture would be unnecessary, but when a particular Bacterium is found, it is only that which will give us an accurate view of the flagellum.

But again, in the choice of the objectives, the *proper relation between magnifying power and aperture* must be maintained. For work with low powers, it is useless to have large apertures. The structure of the objects for which such powers would be used is not sufficiently minute to require large apertures for their proper delineation, and we therefore expose ourselves to the disadvantage of very restricted penetration and the trouble of delicate manipulation, without any corresponding benefit.

On the other hand, it is equally useless to work with high powers (that is upon minute objects) with small apertures. We should have only an empty amplification—mere increase in the distance apart of the outlines, without any additional structure being made visible in consequence of the defect in aperture.

Whenever the subjects of our examination are so minute as to *require* high amplifications in order to be seen, then we must also have large apertures in order to obtain perfect delineation of the objects.

Leaving now the theoretical questions, which after all have so important a bearing on our practical work, reference only need be made to the descriptions published in our Journal of new inventions in regard to mechanical and optical appliances (most of which have been exhibited at our meetings) to prove that great progress is being made in the designing, manufacture, and application of the Microscope. Improved stands and eye-pieces, new immersion lenses, stages, and swinging substages, more effective fine movements and elaborate accessory apparatus of all kinds, indicate not only the activity of mind and the abundance of the resources of the microscopical optician, but that these things are really required in a progressive science.

It is to be hoped that the possession of excellent instruments and convenient apparatus will incite many of the Fellows to undertake more careful researches into the minute details of organic nature, or amongst the very fascinating rocks which are being so beautifully cut and mounted by petrologists. It is true that the difficulty of getting upon a path of original research is very deterrent. The activity of Continental and American microscopists is indeed great, and it is always necessary, before committing oneself to any statement, to search and prove its originality. Much microscopical research is quite beyond the powers of the man who has other avocations, and to whom the instrument is a pleasing, and none the less important, toy. Consider the paraphernalia required to study the microscopy of the details of a minute animal. It has to be put into hardening and water-absorbing solutions, then to be cut with microtomes, perhaps frozen in the first instance, then to be put into other solutions to be cleared and to have its fat got rid of, and then it has to be coloured once, twice, or thrice, and possibly to have some colour discharged. Finally it has to be mounted in a medium. It is necessarily somewhat deterrent for a modest microscopist to read the excessively pronounced opinions of manipulators, about the nature of the structure they discover in such complicated and altered organic matter, and to find that very contradictory opinions are published by different investigators about the nature of identical structures which have been differently prepared. It appears to many an amateur, who happens to investigate structures by disturbing their natural condition as little as is possible, that he is, as it were, out of the field. He may find it necessary, even in examining the simplest section, to pay especial care to the illumination and centering, and to the application of particular powers. He is, of course, conscious of inferiority, when he knows that somebody merely puts a chemically treated specimen under an objective without the least care about optics, and finds out, or thinks he finds out, the truth. But there are numerous opportunities for original research still to be met with in the structure of many of the commonest invertebrates and plants. The study of rocks is in its infancy, and there are many very interesting physical questions yet to be determined, and which can only be settled microscopically. Recondite manipulation is not much required in any of these researches, but rather a good knowledge of how to use the Microscope as an instrument.

If in any case there are obstacles to original research, it is always interesting to follow the work of some distinguished investigator. It is very rarely that a subject is treated exhaustively, and the sedulous yet candid critic, may solve truths which his predecessor had not approached.

In concluding this address, I cannot avoid a special mention of the recent death of a man whose genius and careful microscopical work, established an era in histology, and influenced that study of embryology which must ever be the starting point of philosophical zoology and botany. Theodore Schwann elaborated the "cell theory" forty-three years ago, and in the main it holds good at the present day. He lived to see its value appreciated by every zoologist, and to be able to follow the researches with improved lenses, and to recognize the entities which have no cell-wall. Schwann investigated most successfully the nervous system, and his name will ever remain associated with it. He died at a ripe old age, having led an industrious, simple, and most useful life, and having lived to see himself the recipient, on the occasion of his jubilee, of distinguished honours on the part of the scientific world.

NOTES ON MOSSES.

DECEMBER.

WITH very few exceptions, the whole of the Mosses mentioned in November may be gathered in this month; and those who care to see *Dicranodontium longirostrum* in very fine condition will find it in the wood on the right hand side of the stream in *Staley brushes*, growing in great luxuriance, although rather rare. This Moss first noticed in England in 1864 by Mr. John Whitehead, of Dukinfield, as being distinct from Didymodon, is of an extremely fragile character, the least touch of the fingers bringing away quantities of entire leaves; hence named by some authorities, *denudatus*.

Growing with it, and in fine contrast from its dense velvety appearance, will be seen *Campylopus flexuosus*, the rush swan-necked Moss; stems ½—1½ in. high, erect forked *(dichotomous)*, with reddish-purple radicles to apex, bearing *gemmæ* intermixed. Leaves patent straight or secund, sub-falcate, lanceolate and toothed at apex; red when old; nerve one-third width of base; capsule oval, regular, or gibbous; lid conico-rostrate, sub-alpine moist rocks and peaty soil.

Of the minute family of Earth-Mosses, two very rare ones may be mentioned, *Ephemerum cohærens*, and *E. tenerum;* the only recorded locality for the last one being the weald of Sussex (Mitten). *Phascum rectum*, the straight-necked Earth-Moss is frequent in fields and on banks near the coast: also found near the sea is *Schistidium maritimum*, the sea-side Grimmia; growing in dull-green or brownish patches; leaves rigid, not hair-pointed, straight, lanceolate, acuminate, keeled; nerve strong, reddish-brown, excurrent, margin plane; capsule obovate with a rostellate lid; teeth large and perforate.

Common on rocks and walls, especially on the limestone is *S. apocarpum*, the sessile Grimmia, from the capsule being seated

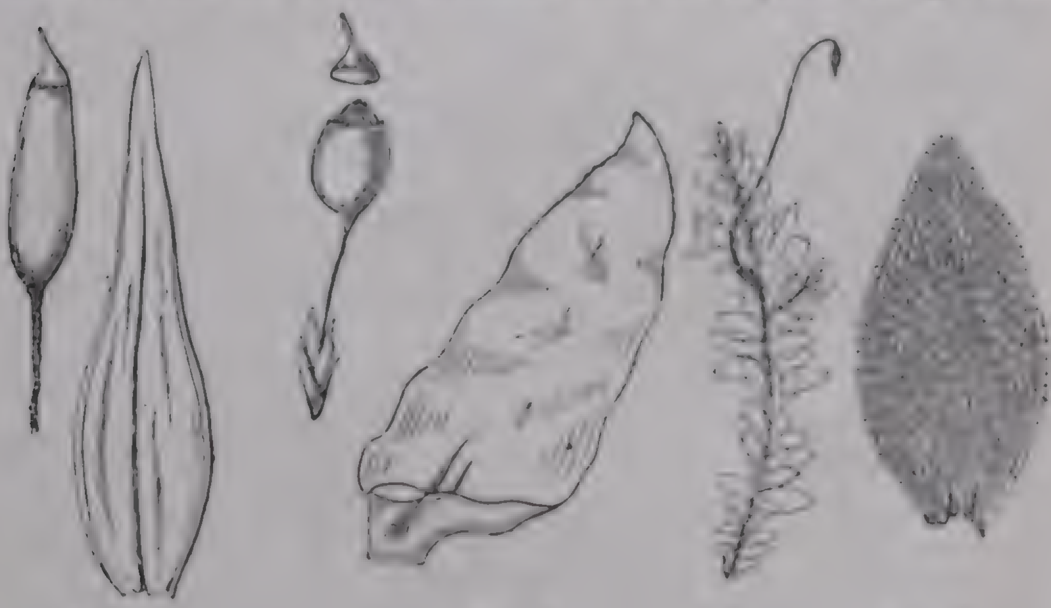


Fig. 45. Fig. 46. Fig. 47.

immediately on the apex of the stem, and surrounded by the upper leaves. Plant cæspitose; leaves spreading, lanceolate, acuminate from an ovate, erect base; upper ones with white points; margins much recurved; nerve ceasing below apex; capsule elliptical, and pellucid, with an oblique beaked lid; teeth dark red; calyptra divided at base.

A variety, *S. rivulare*, with turbinate capsules and dark green obtuse leaves, grows by streams.

Allied to the above are the *Rhacomitriums* or Fringe-Mosses; of which *R. ellipticum*, the oval-fruited Fringe Moss is found on moist alpine rocks in Scotland, Wales and Ireland. *R. aciculare*, the dark-mountain Fringe Moss, frequents wet mountainous rocks by streams, and has stems 1—3 inch cæspitose, decumbent and naked at base, branches very leafy; leaves spreading or secund; ovate-oblong, obtuse, sometimes toothed at apex, to which the nerve does not reach; capsules erect, oblong, smooth, with a small mouth, and on a long thin seta; lid with a long, straight, subulate beak: dioicous.

A very striking and common Moss on clay-banks and hedges is *Barbula unguiculata*, the Bird's-claw Screw Moss, from the peculiar appearance of its leaves. Its stems are ⅛—1 inch in height, cæspitose, dichotomous; leaves oblong-lanceolate, obtuse; margin recurved; nerve excurrent into a short mucro; capsules oblong, cylindrical, erect on a long reddish seta; lid with a subulate beak: dioicous.

There are two varieties, β. *cuspidata*, stems shorter; leaves narrower with a longer mucro, and γ. *apiculata*, with spreading recurved leaves and long mucro.

Didymodon luridus is a rare Moss on limestone walls.

Bryum intermedium, the many-seasoned Thread Moss is frequent on walls and rocks, and like *Funaria hygrometrica* is found fruiting almost all the year round. Stems about ½ inch, tufted, branched; leaves imbricate, ovate-lanceolate, acuminate, point sometimes toothed, margins recurved; capsule pyriform, narrow and sub-pendulous, tapering into a longish neck; lid conical-pointed; inner peristome with cilia.

A much larger Moss found on sandy shady banks, and described by Schimper as the most beautiful of all the European species, is *B. roseum*, the rosaceous Thread Moss, easily known by the shining rosette with which the stem is surmounted.

The stems are 1—3 inches high; lower leaves small, scattered, lanceolate; upper in a large rosaceous tuft, spatulate, apiculate, serrate above, margin recurved, nerved nearly to apex; capsule oblong-ovate, pendulous. Beautiful specimens in fruit have been sent from North American stations, where it is common, but in Britain the fructification is rare.

Found on moist banks, especially in Lancashire cloughs, and with lateral fructification is *Fissidens taxifolius*, the yew-leaved Fork Moss. Stems about ½ inch, fasciculate from base; leaves lanceolate, pointed, not bordered, finely crenulate, nerved almost to apex; capsule ovate, inclined on a seta curved at summit and inserted at base of stem; lid large, convex with a long oblique beak: monoicous.

Pleurocarpous Mosses: Of the Hypnoid group, *Orthothecium rufescens* is rare on moist shady alpine rocks: while common in Miller's Dale and generally throughout England on walls and rocks is *Homalothecium sericeum*, the silky Feather Moss. Stems 1 inch or more, creeping, branched; branches erect, curved; leaves imbricate, sub-secund, lanceolate, long-tapering, scarcely nerved to apex, striate, areolæ very narrow; capsules almost erect, cylindrical, tapering above on a rough seta; lid conical, obliquely beaked: dioicous. Fig. 45.

Belonging to the smooth-stalked division is *Eurynchium striatum*, the common striated Feather Moss; found in woods and on shady banks, and having stems loosely tufted, arched and sub-pinnate; branches drooping; leaves gradually tapering from a broad cordate base, squarrose, serrate, striate, nerved more than half way; capsules almost cylindrical, curved, cernuous; lid large, with a long slender curved beak: dioicous.

Somewhat rare on shady limestone rocks and roots of trees is the lesser-striated Feather Moss, *E. striatulum*, being smaller in all its parts than the previous species. *E. speciosum*, the showy Feather Moss has an ovate capsule on a rough seta, and lid with a long pointed beak; leaves ovate, serrulate, nerved almost to acute apex, bright green; on stones near springs, and sometimes in water.

The family *Neckeraceæ* is noticeable from having been named after *Necker*, a celebrated botanist who denied the existence of sexes in Mosses.

It has the fructification truly lateral; dimidiate calyptra and double peristome; the inner one of 16 cilia.

The capsules are oval-oblong immersed or pedicillate; lid obliquely rostrate; outer teeth 16 linear, subulate, long connivent into a cone; stems pinnate; leaves complanate.

The only species not fruiting this month is *N. pennata*, the Feathered Neckera. Found in Ireland and the East Highlands of Scotland, it fruits in spring, and is collected on the trunks of trees.

N. complanata, the flat-leaved Neckera, inhabits trunks of trees, walls, &c., and has been found in fine fruit in Miller's Dale. It has leaves complanate, ovate-oblong, and suddenly apiculate from a broadish apex, faintly and shortly two-nerved; capsules roundish elliptical, tapering below, erect; lid large, obliquely rostrate: dioicous.

N. crispa, the crisped Neckera, from the undulate character of its leaves has stems 4—6 inches, pinnate from a creeping rhizome, and leaves serrulate at apex; mountainous rocks and trees: dioicous: Fig 46.

In similar situations is *N. Pumila*, the dwarf Neckera, with a variety *β Philipeana*.

Consisting of large and beautiful mosses, as may be inferred from its including a "*gigantea*" and "*splendidissima*" among its foreign relations is the genus *Hookeria*, named in honour of Sir W. J. Hooker; to whom British muscologists are much indebted for the zeal and ability with which he has investigated both mosses and hepatics. With the exception of *H. lætevirens*, which is very rare and found only at Mousehold Cave, in Cornwall, and at two stations in Ireland; the only species representing this genus is

H. lucens, the shining Hookeria, found on moist banks in woods, or among shaded rocks in the temperate districts of Great Britain and Ireland.

In the neighbourhood of Manchester it has been collected in fruit at Handforth, in Bamford Wood and in Cotterill Clough. Both the foliage and fructification are beautiful objects, and when once known will not be easily mistaken for any other species.

Stems 1—3 inches procumbent, with irregular complanate branches; leaves large, complanate, roundish ovate, obtuse, entire, nerveless; areolæ large, hexagonal, pellucid, the leaves glistening in the damp shady spots in which it grows; the seta are lateral; capsule roundish elliptical, almost pendulous; with double peristome, the outer of 16 teeth, the inner of 16 cilia, united below into a membrane; lid conical, suddenly tapering into a long straight beak; calyptra mitriform: monoicous. Fig. 47.

Now the long evenings are upon us, limiting our search for objects in the woods, lanes and fields; it may, perhaps, be of some use to say a few words upon mounting mosses for the Microscope. A few hints with regard to drying and arranging specimens for the herbarium will be found in the report of the Manchester Microscopical Society's proceedings on page 225. To those who wish merely to examine their gatherings for the purpose of classification, it will be sufficient to place the Moss upon an ordinary slip with a drop of water and one of the larger cover glasses; first detaching with needles two or three of the stems and also the branch leaves, to note their form and areolation; and it may be here observed that for mosses, objectives of low power, giving good penetration, will be found to give the most satisfactory results; while a piece of ground glass placed on the stage of the microscope, underneath the slip, will considerably improve the definition.

In preparing the specimens for mounting, it is most important that they should be clean, and to attain this end, washing in water, with the aid of camel-hair pencils, will have to be many times repeated; this will tax the patience considerably, as the minute specks of dirt, in some instances, defy all the efforts made to dislodge them from between the closely imbricated leaves. A perfectly clean mount will, however, well repay all the trouble spent upon it; the capsule with its peristome, forming one of our most beautiful botanical slides, when seen with the spot lens, or as an opaque object; while the variety of the cell structure equals, if it does not surpass, that of the more highly organized Phanerogams. The washing may be greatly facilitated by first shaking well the specimens in a bottle half filled with water, frequently changing the water until every particle of dirt is dislodged, and being careful to lay aside the calyptras and operculums or lids; but much of the difficulty in cleaning may be avoided by mounting the specimens when freshly gathered; and those who are wishful to add to their cabinet, as perfect a slide as possible, must pay some little attention to the fruiting seasons of the various species, so as to place on the slide plants showing in addition to the leaf structure, the capsule with its peristome, and, wherever possible, the operculum and the calyptra.

The best medium and the one generally used is glycerine jelly, as it preserves the natural colour of the moss, and is not of so highly refractive a nature as balsam; an important consideration in observing the cell structure of mosses, algæ, &c., and, in fact, all vegetable structure where staining is not applicable.

First of all centre your glass slip by means of the turn-table, with an ink ring about the size of the cover glass required; then having liquified your jelly, by placing the bottle in a cup of warm water, place a fair portion of the jelly on the slip, take your specimens fresh from the water and arrange them on it; put on the cover glass, using as easy a clip as possible, as the jelly is of an elastic nature and more liable to spring if too tight a clip has been used; now hold your slide over the lamp, but not too close to the flame, until it boils, when if it is carefully watched a very perceptible crack will be heard; at this moment the slide should be immediately withdrawn from the lamp and placed upon a cold surface, such as the window sill, when the jelly will rapidly contract and in the course of half an hour all air bubbles will have been excluded. Before placing outside, the lids and calyptras should be carefully put in position under the cover glass, with a very fine needle, as they are apt to find their way out during the boiling.

It often happens that when the specimens are very thick, the slide after cooling will still contain a few air-bubbles; in this case add a little more jelly to the slide, and repeat the process.

I have found, however, in obstinate cases the following suggestion of Mr. Miles to prove very successful.

Take your slide with the clip on and flood it with boiling water from the kettle until you have removed all the jelly and your specimens are mounted solely in warm water, now tilt your slide a little and apply with a pipette the warm jelly to the upper edge of the cover-glass, when, if assisted a little with blotting paper at the lower edge, the jelly will gradually take the place of the water and you will have a mount quite free from air bubbles. With care, nearly all Mosses and Hepatics will stand the boiling process, although it is said by some to change the natural colour of the plant, but I think this is due either to over-boiling or to imperfect jelly, as the bulk of my specimens have all been boiled and are now as fresh in colour as the day they were mounted. For mounting without boiling, and this is necessary in the case of inflorescences, the specimens should be soaked for some days in a mixture of glycerine and water in equal parts, to which has been added a little methylated spirit, and care must be used in putting on the cover-glass that no air is enclosed in the jelly.

To clean off the superfluous jelly the slide should be nicely washed under the tap with an old tooth brush, ringing with one or two coats of white zinc cement, immediately it is dry, to prevent any further contraction at the edges. The best white cement I have found to be the following, from a formula given me by Capt. P. G. Cunliffe, F.R.M.S. :—Grind 1 oz. of Oxide of Zinc in a mortar with sufficient gold-size to form a thick paste ; then dissolve 1 oz. of Gum Damar in half-a-pint of Benzole, filter, and add gradually to above.

The advantages of this cement are : ease of manipulation, its non-liability to run in, and the addition of the gold-size prevents that extreme brittleness when old, so frequently complained of in the ordinary white cement.

WILLIAM STANLEY.

THE STRUCTURE OF THE CHARACEÆ.

BY CHARLES BAILEY, F.L.S.

A Paper read before the Leeuwenhoek Microscopical Club, Manchester, 27th October, 1882.

I.—AFFINITIES.

THESE plants constitute a natural order, or something higher, which, in a popular sense, must be considered a comparatively little known group. They are met with in fresh or brackish water, and are variable in size and habit. They are not recommended to our notice by any of their uses in the arts, nor by their employment in pharmacy or as food for either man or beast. They possess no common English name by which the child may distinguish them from other denizens of our brooks and lakes. They do not enter into legendary or fairy story like the hyacinth or the toadstool. They have never served as the badge of rival tribes or warriors like the broom or the rose. No grateful perfume is distilled from their cells. No poet like Milton or Shakspere has sung their praises or wedded their name to some beautiful conceit or fancy. No lover has ventured to associate them with youth and beauty, grace and tenderness, and they never enter into "the language of flowers." Yet the man of science has shown them to possess a voice and language which speak melodiously enough when their life is properly interpreted, and their relationships better understood.

They are of extreme interest to the physiologist and systematist, but even yet there is no common agreement as to the homologies of their organs, or to their exact place in the natural system of classification. They have been made the associates of the most diverse alliances in the vegetable kingdom.

Linnæus, with philosophic insight, placed them at first amongst the Algæ, but afterwards with a weaker grasp of their natural affinities, raised them to a position amongst flowering plants. In this latter view he was followed by his immediate successors. Still later, the elder de Jussieu and Robert Brown considered them to be monocotyledons, associating them respectively with pondweeds and frogbits; while other systematists have classed them with the dicotyledons, referring them to positions near to Myriophyllum or to Ceratophyllum. In recent years Agardh has placed them with Confervaceæ, and Brongniart near the ferns and pillworts.

Such diverse conclusions respecting their affinities give considerable importance to the structure of these curious organisms, and to the interpretations which attach to their several organs.

II.—Literature.

Their study has developed a considerable literature in the transactions of learned societies. Classical papers are those by Pringsheim on "di Vorkeime und die nacktfussigen Zweige der Charen," in his *Jahrbuch f. w. Botanik*, Vol. III., plates 9 to 13 (1863); by Nordstedt in Vol. II. of the *Arsskrift* of the University of Lund, entitled "Nagra iakttagelser öfver Characeernas groning" (1866); by Sachs in his *Lehrbuch*, p. 258 (1868); and by de Bary in the *Botanische Zeitung*, Vol. XXXIII., plates 5 and 6 (1875), "zur Keimungsgeschichte der Charen"—this last paper being translated in the *Journal of Botany* for October 1875, No. 114, p. 298.

In our own country a careful monograph of the British species, with illustrations, has been recently issued by Messrs. Henry and James Groves, and these gentlemen—who are regarded as our best English authorities for this difficult group—are understood to be preparing sets of the critical British forms, which will contribute to our better knowledge of the group.

Copies of these works were placed upon the table for the inspection of the members, together with numerous dried specimens, British and continental; and basing himself upon the writings of the authorities quoted, Mr. Bailey proceeded to explain the principal points in the structure of the Characeæ.

III.—Axial Structure.

For a long time they were regarded as an undivided group, but a closer acquaintance has led to their being separated into several genera, of which the two princpal are Chara and Nitella.

The first of these genera is easily recognized by the constitution of its stem; there is a large central tube surrounded by a number of narrower tubes. The outer tubes do not enclose the inner tube in a perfectly straight direction, but most frequently exhibit a spiral torsion from one node to the next; they are besides often encrusted with lime, which makes the plants very brittle to handle.

The second of the two principal genera is named Nitella, and in this group the tubes are translucent, while the cortical series of smaller tubes is absent; this difference of structure makes the Nitellas more flexible and softer to handle than the Charas.

The so-called stems of these plants are therefore composed of a single row of large axial cells or tubes placed end to end, and with or without cortical layer of narrower tubes. The extremities of the tubes are joined to their neighbours by a thin transverse plate made up of roundish cells, which constitute the node; and, excepting some hair-like processes, all the lateral out-growths originate from these nodes, giving rise to leaves or lateral branches in the upper portion, and to rhizoids or roots in their subterranean portion. The tubes are short at the growing end of the plant, but they increase in length considerably as they become distant from the terminal growing point.

The subterranean portion is not unlike the aquatic portion, but it does not possess any cortical layer: a number of fine tubular radicles originate at the nodes serving to bind the plant to the mud. Sometimes the subterranean tubes inflate and produce small bulbs, bulbils, or tubercles, and even star-shaped bodies (Montagne, *Annales, des. sc. nat.* third ser. Vol. XVIII.), all of which are white in colour, and gorged with starchy matter which serves as a reserve of nutriment for the growing plant.

IV.—Structure of the Cells.

All the young cells or tubes possess a nucleus, which at the outset is found in the centre of the protoplasmic mass. The cells increase by division, but each act of sub-division is preceded by the dissolution of the primitive nucleus and the formation of two new nuclei; further changes follow in the protoplasm which now lines the inner walls with a thick deposit.

From this time commences a rotatory movement in the cell contents, always in the direction of the long diameter. This peculiar movement is not confined to the tubes of the stem, but is met with in every cell of the plant; it is, however, best observed in the large translucent tubes of the Nitellæ. It is very difficult to adequately realize, much less describe, the order in which these currents flow in all their detail, but, broadly speaking, the floating particles are disposed in closely contiguous longitudinal series, forming together two large more or less oblique bands, and separated from each other by two very narrow bands from which the green particles of chlorophyll are absent. These colourless lines are merely the neutral zone, by whose sides move the two opposing portions of the current, up one side and down the other side of the cell. They have been called "lines of interference," though not in the sense in which the term is used in physics.

The cause of this movement so far baffles the investigations of physiologists; it is a dark continent, which no discoverer has yet crossed. It is undoubtedly a vital movement, as Corti, its first discoverer, stated, and, to distinguish it from the movements of liquids in the vascular tissue of phanerogams, it has been called an "intracellular circulation." Similar vital movements take place in the cells of many plants, as in the moniliform staminal hairs of Tradescantia.

V.—Reproductive Organs.

Reproduction takes place by means of organs which are analogous to those found in other cryptogams, but which are by no means homologous with them, neither by their development, nor by their ultimate form.

One of these organs is clearly an antheridium, having its own special structure. The other organ, or oospore, is open to so many interpretations of its morphology, that each investigator, coming to his own conclusion as to the correlation of its parts, feels it incumbent to invent some new name which, though it may baffle the student, suggests no false analogies. We shall examine each of these two organs in turn.

The antheridia occur in the form of solitary globules of an orange or reddish colour when ripe, but in their early stage they are green. Their position on the plant varies: in the monœcious species of Chara they are usually found below the oospore; in the monœcious species of Nitella the respective positions of these two organs are reversed; in Lychnothamnus they occur side by side. In the diœcious species these relations of contiguity necessarily disappear, but in their morphological signification and position remain the same. They are mostly in advance of the oospores in the order of their growth.

VI.—Structure of the Antheridium.

The antheridium is a complicated structure. Its walls are made up of eight flattened cells or valves, termed shields, having lobed or wavy edges; the prolongations of the margin of one valve fitting into the indentations of the next, thus helping to give the spheroidal envelope some rigidity. The four uppermost shields are triangular; the four lowermost are four-sided, on account of the insertion of a cell acting as a stalk.

The outer surface of the shields is colourless or hyaline, so that the globule looks as if it were surrounded by a halo of transparent jelly; the inner surface is covered with grains of chlorophyll, which change to orange or red as the antheridium ripens.

From the centre of the inner wall of each shield there projects a cylindrical cell termed a manubrium, filled with orange-red granules, and reaching about half-way towards the interior of the antheridium. The base of each manubrium is indicated by the eight bosses seen on the outer surface of the globule; while at the opposite extremity is a rounded hyaline cell called the capitulum or head.

Each capitulum in its turn gives origin to six other smaller cells, or secondary capitula, from each of which proceed four long whip-like filaments coiled several times upon themselves. Excepting the space occupied by the eight manubria, and the cell which acts as a stalk, these filaments entirely fill up the cavity of the antheridium.

Thus each globule, when developed normally, contains one stalk, eight shields, eight manubria, 8 capitula, 48 secondary capitula, and 192 filaments, say 265 parts; nor is this all.

The 192 filaments in their turn are compound organs, each being composed of a linear series of from 100 to 200 discoid cells; thus there are from 19,200 to 38,400 discs, each one of which contains an antherozoid. The antherozoid is a fine hair-like body, thickened at its posterior extremity and rolled spirally, while from the opposite extremity proceed two long and very fine cilia.

When the antheridium is ripe, the eight valves separate from each other at their edges, while the 20,000 to 40,000 antherozoids escape from the discoid cells and paddle away in the water with a cork-screw-like motion. The rupture usually takes place in the morning, and the movements of the antherozoids continue for some hours afterwards.

(To be continued.)

NOTICES OF MEETINGS.

MANCHESTER CRYPTOGAMIC SOCIETY.—Capt. Cunliffe, F.R.M.S., in the chair. Mr. James Cash exhibited and distributed specimens of a moss which he had collected on Meal Talmechan during his recent excursion to Scotland in the company of the chairman, and this he had determined by microscopical examination to be the rare *Myurella apiculata*. Mr. Cash also exhibited several other interesting mosses which he had collected in Montgomeryshire, including *Scleropodium cæspitosum*, *Myuma pulvenata*, and *Tortula latifolia*—the two latter species being new records for that district.

Mr. W. H. Pearson exhibited specimens of two new hepatics described by Dr. Spence in his recent memoir on the *Cephaloziæ*, namely *Cephalozia Cucantha* (Spuce), collected by Mr. Sim, near Banchory, Scotland, and *Cephalozia æraria* (Pearson) from the mouth of old copper mines near Tyn-y-Groes. Mr. Pearson also exhibited the following species:—*Jungermannia Helleriana* (Nees), a species new to Britain, collected by Mr. G. Stabler at Mardale, Westmoreland. The rare *Marsupella Stableri*, found on Cader Idris by Mr. G. A. Holt, this being new to Wales. *Harpanthus scutatus* from Tyn-y-Groes, by Mr. C. J. Wild, a rare species, hitherto only found in Wales at Beddy-clert, and *Anthelia Jurabzleana* from Ben Laorgh, by Mr. Peter Ewing, being the second station in Britain for this rare hepatic.

MANCHESTER MICROSCOPICAL SOCIETY.—The mounting class met again last week in the Board room of the Mechanics' Institution, Mr. W. Chaffers in the chair. There was a large attendance, the room being full.

Before operations commenced, attention was called to the desirability of forming a collection of "failures" in mounting. Slides, illustrating why and how failures occurred, it was thought, would have some practical value, by shewing what to guard against and avoid.

An increase in the number of volunteer demonstrators enables the class to carry on two or more demonstrations at one time, and on this occasion Mr. W. Stanley, officiating at one table, completed the process of dry mounting commenced at the last meeting. These mounts are usually for opaque illumination and observation, and are, as a rule, the first mounts which tyros are supposed to give attention to. The operation consists in hermetically sealing up in a cell, with a thin glass cover, some object previously prepared; thus rendering it at all times available for immediately placing under the microscope. Some objects can only be satisfactorily viewed by this method. One of the objects mounted, the insectivorous plant, *Drosera rotundifolia*, with insects in situ, is usually examined in this manner, and under a binocular is a very pleasing and instructive object.

At another table sat Mr. T. W. Lofthouse, who essayed to shew the process of mounting the proboscis of blow-fly in balsam. This is an old and familiar object. Few microscopists but what are acquainted with the mount; fewer still, strange to say, know how, or can put the mount together. Simple indeed appeared the operation as performed by Mr. Lofthouse with entire success. Matters were simplified much by a number of ingenious clips, springs, and other apparatus invented by the demonstrator, and which could be easily made by the lookers on. Whether those who watched the proceedings will find the execution of work as simple and easy a matter as it looked when done by skilled hands remains to be seen.

The President, Mr. W. Chaffers, distributed a number of objects for mounting, including Indian ferns, leaves, zoophytes, sponges, cuticles, etc.

NOTES AND QUERIES.

CHANGE OF ADDRESS.—On account of letters still being sent to Heaton Chapel, the Editor finds it necessary to again inform his correspondents that his present address is The Willows, Fallowfield, Manchester.

FINELY GROUND GLASS.—For the preparation of drawings for the lantern by Mr. Dallinger's method, a very finely ground glass is necessary. This is often difficult to procure, but many of our readers will be glad to know that it may be obtained from Messrs. Leather, Sadler, and Holmes, 38, Dantzic Street, Manchester.

MOUNTING THE PROBOSCIS OF THE FLY.—In our next issue we hope to give a detailed description of "How to do it," by Mr. W. Chaffers, who very successfully demonstrated the process before the members of the Mounting Class of the Manchester Microscopical Society at its last meeting.

DRAWINGS OF LIVING ORGANISMS.—We have received No. 8 of Mr. Bolton's "Portfolio," which is published at the price of One Shilling. The Vegetable Kingdom is illustrated by *Prasiola crispa*, *Rivularia angulosa*, *Vaucheria*, *Cosmarium botrytis*, various fresh water diatoms, and the frog-bit *Hydrocharis Morsus-Ranæ*. The Animal Kingdom by *Loxophyllum meleagris*, *Condylostoma patens*, Vorticellidæ, *Zoothamnium arbuscula*, *Stentor niger*, *Œcistes crystallinus*, *Floscularia campanulata*, *F. trifolium*, *Limnias annulatus*, *Piscicolo geometrica*, *Planaria lactea*, and the fry of the Mussel (*Mytilus edulis*). We are glad to note that the several drawings and descriptions are much more uniform than formerly, and this is important to those who wish to bind them into volumes.

MR. COLE'S STUDIES.—Number 24 of this series gives us a very minute description of the Pillwort—*Pilularia globulifera*. The minute structure of the stem, the general arrangements of parts, the microscopical appearances of transverse sections, and of longitudinal sections are all ably described in this number, and continued in No. 26, which latter also contains some admirable chromo-lithographs of the Dolerite from Dalmahoy Hill. No. 25 is devoted to the human thyroid gland, containing a general description with methods of preparation, and the bibliography of the organ. No. 27 contains drawing and description of thymus gland of calf; while No. 28 is devoted to Lichens, and is well-worthy of perusal.

Mr. Cole announces that No. 29 will contain a T. S. of the Human Pancreas, stained carmine, with an illustration magnified 333 diameters, with accompanying letterpress. No. 30 will contain a large plate of chalk drawings in black, illustrative of the different forms of Lichens, and their structure. The letterpress will contain a digest of the development of Schwendener's theory. The accompanying preparation will be a T. S. of the Thallus of the rare species *Sticta aurata*.

NOTICES TO CORRESPONDENTS.

All communications should be addressed to Mr. George E. Davis, The Willows, Fallowfield, Manchester; and matter intended for publication must reach us not later than the 14th of the month.

All communications must be accompanied by the name and address of the writers, not necessarily for publication, but as a guarantee of good faith. Cheques and money orders to be made payable to George E. Davis, the latter at the Manchester Chief Office.

J. W. G.—Thanks for the abstract of your paper. We will find room for it next month.

H. A.—You will hardly meet with any first rate stand at the price you name.

C. C.—We have not his address, nor do we know where it could be obtained, except through an advertisement in some paper he is likely to see.

T. A. R.—The plant is a Ranunculus, and not the Frog-bit. Your plant is very common in the South of England.

H. B. B.—The "slime" on the sides of canal banks is often rich in microscopic organisms.

R. A. D.—We hope to have a series of articles upon the subject next year.

E. G.—We can supply you with some Nitella if you will send your address, which you have omitted.

T. T. A.—Next year we intend calling our Journal "The Microscopical News," but we cannot alter the size as you suggest. It is now very handy for the bookshelf, and we find that the majority of our readers are against any alteration in size.

H. A. (London)—We are afraid that chapters on detecting the adulteration in foods, &c., would consume more time than we can at present afford.

J. P.—Send your objective into the Verification Department, and we will find out why it will not resolve *N. rhomboides*.

C. O.—Thanks for the specimens; we have sent them to an expert, and will write you on receipt of his report.

L. S.—Unscrew the eye lens of the ocular until the micrometer lines are in sharp focus.

EXCHANGE COLUMN FOR SLIDES AND RAW MATERIAL.

Communications not exceeding 24 words are inserted in this column *free*. They must reach us before the 14th of each month. Exchangers may adopt a *nom-de-plume* under care of the Editor, but in this case all replies must be accompanied with a penny stamp for each letter to cover postage.

FOR SALE.—Ross, 1 A largest binocular microscope stand, Jackson model; 2 A, 1 C eye-pieces, with upright cabinet. Price £24, cost £45. Also, Ross' Patent Objectives, ¼ inch of 80°. Price £4; 1-10th, price £6; 1-15th, price £9. The two latter can be used dry or immersion: all like new. Address, Senex, Mr. Chapman, Chemist, Deansgate, Manchester.

PRIZE MEDAL.—Anatomical and Pathological Sections in exchange for stained vegetable sections, leaves, &c. Also, Diatoms or offers.—Henry Vial, Crediton.

WELL-MOUNTED SLIDES in exchange for uncut tissues—injected and otherwise.—H. Vial, Crediton.

QUANTITY MICROSCOPIC SLIDES and material for exchange.—Apply, F. S. Lyddon, 2, Oakland Villas, Redland, Bristol.