Mr Francis with Mr R H Solly's Compts

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IMPROVEMENTS

IN

THE VIAL MICROSCOPE.

FROM

THE TRANSACTIONS OF THE SOCIETY OF ARTS, MANUFACTURES, COMMERCE, &c.

VOL. L.

C. VARLEY

LONDON:

PRINTED BY

J. MOYES, CASTLE STREET, LEICESTER SQUARE.

1834.

Mr. Cornelius Varley on his Vial Microscope.

In my last communication, Vol. XLIX. page 189, I stated a fact which I could not have discovered by any other than the vial microscope, it being expressly adapted for the continued observation of the same object, as well as for the successive observation of many objects, which may be put up in a series of vials for that purpose, and be kept alive for months in constant readiness for view.

The question proposed was, Whether gravity had any effect on the circulation of sap in chara? The vial containing it, in a growing state, was held in the hand, with nothing but the dark chamber and lens attached, and turned round before the window; the dark chamber preserving the object from the bad effect of so wide a light, and the width of the light enabling the vial to be freely turned round without losing the light from unsteadiness of the motion.

I first examined the regular circulating fluid, turning the plant upside-down often, and leaving it so for some time, then looking, then laying it first on one side and then on the other, and found no change, that fluid pursuing its course alike in every position. I next examined the central fluid in the main stem: it contained plenty of visible particles, and larger masses forming perfectly spherical balls. These move with variable speed, those in the centre only revolving. I fixed my eye on some of the largest balls whilst they were ascending, and continued sliding the vial in its jacket to keep them in view. I then turned the plant horizontally, keeping this current uppermost, and soon saw the balls sink out of it

Mr. Cornelius Varley's Vial & Animalcule Microscope.

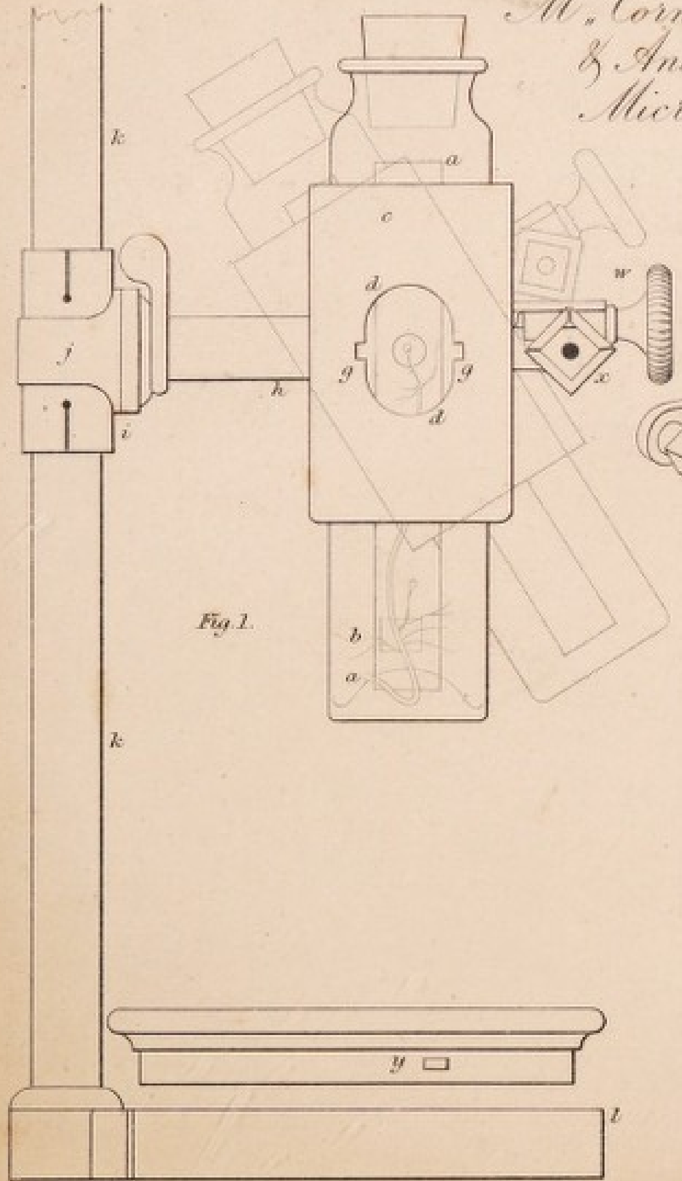


Fig. 1.

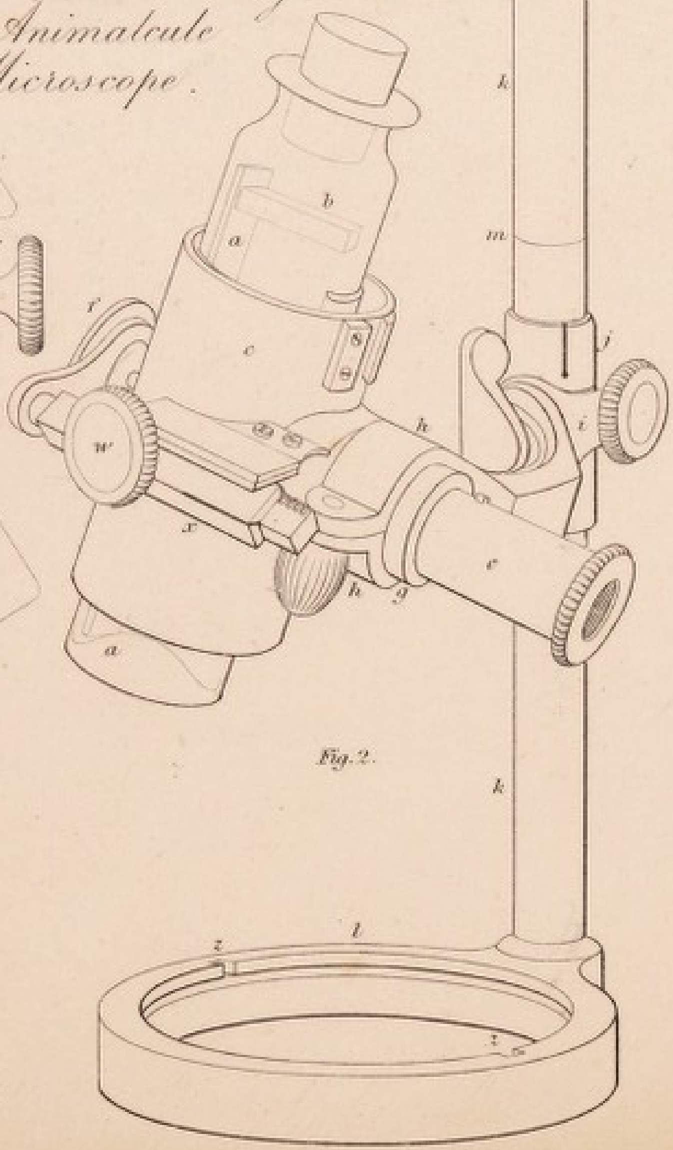


Fig. 2.

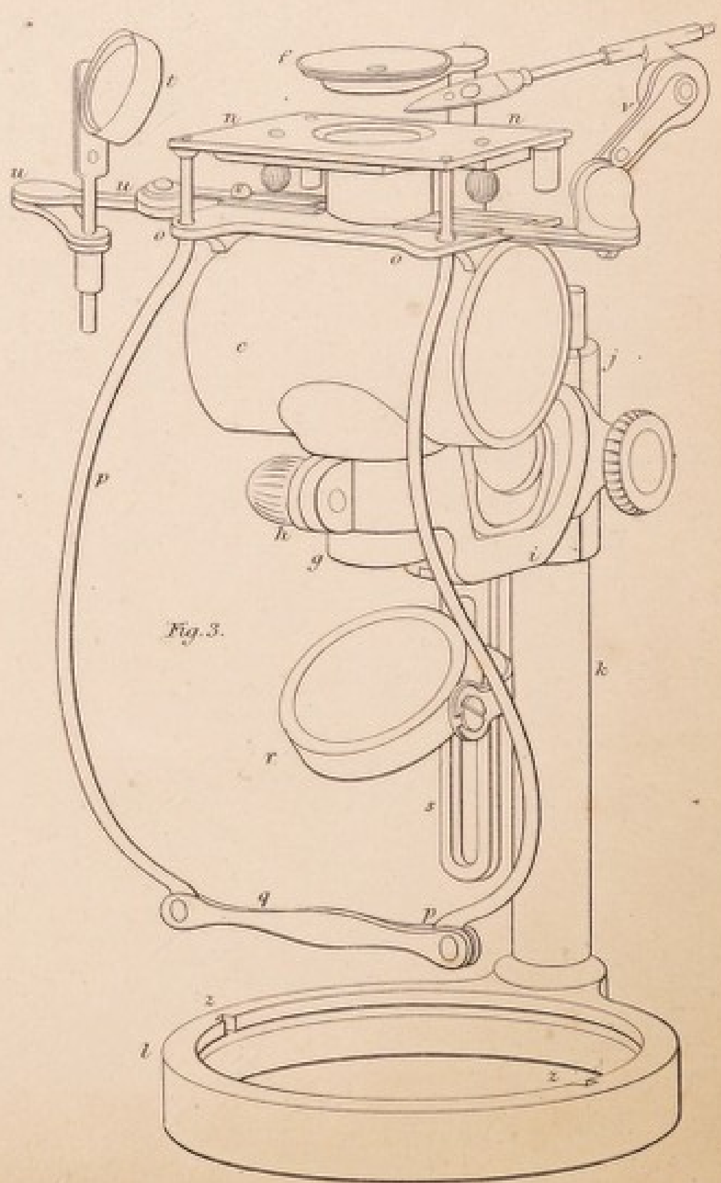


Fig. 3.

Drawn by C. Varley. Engraved by E. Turrell.

into the under returning current, and come back with it. I then placed that side uppermost, and saw them sink again into their former current, and again go on with it. By this means I could confine them to any part of the stem as long as I pleased, and keep them from going to either end.

This established the general fact, that the central fluid was passive, being only dragged along by its contact with the principal fluid.

This success led to other observations which required more steadiness than could be effected by holding the vial in the hand, and the power or capability of keeping the object in any position as long as we please, or moving it at pleasure any given quantity. Again, this vial microscope may be so efficiently and conveniently used by lamp-light, as to require on that account that it should possess every power of motion with great steadiness, to prevent it at any time from being diverted or directed from the light.

I have, therefore, with the assistance of Mr. Solly and Mr. Powell, entirely reconstructed it, so as to obtain every convenience that experience has shewn to be most desirable; and by this reconstruction, together with some small additions, it has become a general microscope, suitable for viewing every kind of object. But as its advantages will probably be best appreciated by an examination of the instrument itself, Mr. Powell, of No. 24 Clarendon Street, Somers Town, having made a microscope on this construction for Mr. Solly, has authorised me to state that he will have much pleasure in submitting it to the inspection of the Society.

Plate V. contains three views, drawn half the real size. Figs. 1 and 2 are mounted for viewing objects contained in vials. Fig. 3 shews it with the additions that make it a general microscope.

The aquatic plants to be viewed, or any that will live in water, are either introduced into the vial lying on the slip of glass *a a*, and brought close to the side, or placed first against the side and covered by the slip of glass. A piece of cork *b*, cut to a proper length and thickness, is then introduced and placed by tweezers, either at top, as in fig. 2, or at bottom, as in fig. 1, so as to secure the slip *a* sufficiently tight. The vial is then to be gently filled with water, and it is ready for use. It should only be corked whilst in use; the vial being brim-full, and the cork slowly twisted in, will exclude air-bubbles, which is frequently requisite.

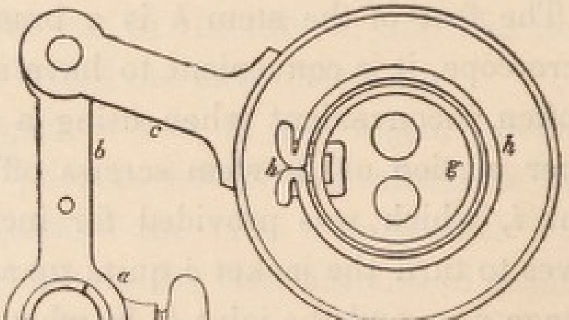
The vial, with the object so confined to its side, will bear turning round in all directions, without causing disturbance. It is to be put in the tube *c*, and slid about to bring any portion before the magnifier.

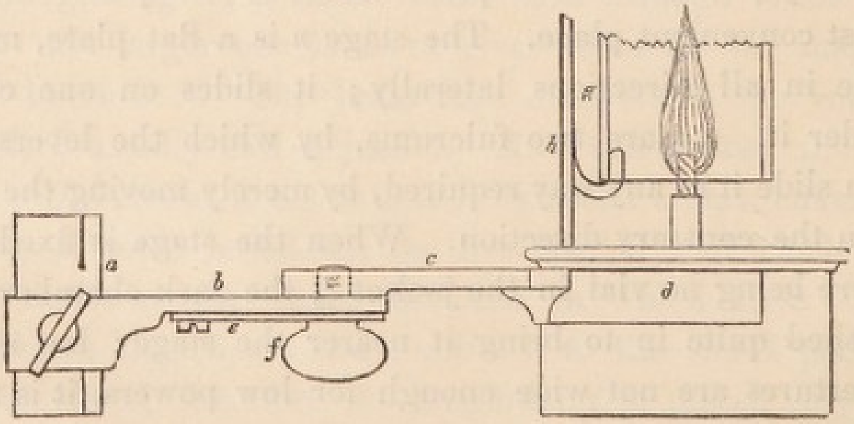
Although the object is now in our reach, it cannot be seen to any good purpose till all the extraneous light is shaded away; therefore the tube *c* lined with black cloth serves not only to hold the vial, but also to shade it. A hole is made at the back, as shewn through the front opening in fig. 1, to admit direct light through to the object: the larger one in front gives room for the magnifier to view it. The brass tube *c* in which the vial is held, I usually call a jacket. Now this jacket, though a needful shade, is not sufficient by itself: a dark chamber *e*, fig. 2, must be added, the two apertures of which are to determine the exact direction in which light shall arrive at the object, and confine it to the small portion under view; therefore the magnifier *f* is placed very accurately in the produced axis of this dark chamber, which axis also crosses that of the vial correctly at right angles, —the cylindrical form of the vial requiring this care.

Of course, whilst in use, the axis of the dark chamber must be directed to the light, and not move aside from it; yet the vial is to be capable of being turned quite round, either to right or left, as shewn in fig. 1 by dotted lines. Therefore the socket *g*, in which the dark chamber *e* is fitted, is itself made an axis, by being held in the clip *h* so as to allow of that motion without disturbing the light. In addition to this, the vial and chamber are made to turn round, fore and aft, so as to incline it to any particular light, and also to give it the slope most convenient for the observer; therefore the clip-arm *h i* ends in another joint *i*, at right angles to that at *h*. This joint *i* unites it to the socket *j*, which, sliding on the stem *k*, gives any required elevation.

The foot of the stem *k* is a brass ring *l*. As a vial microscope, it is convenient to have a long stem, but that is often inconvenient when using a stage; therefore the upper portion of the stem screws off at *m*, fig. 2, and the joint *i*, which was provided for inclining the vial, now serves to turn the jacket *c* quite up as in fig. 3, to receive a stage *n n*; and the joint *h*, by which the vial can revolve sideways, serves now to place the rack and pinion in the most convenient place. The stage *n* is a flat plate, movable in all directions laterally; it slides on one close under it. *o o* are two fulcrums, by which the levers *p p* can slide it in any way required, by merely moving the bar *q* in the contrary direction. When the stage is fixed on, there being no vial in the jacket *c*, the dark chamber *e* is pushed quite in to bring it nearer the stage; but as its apertures are not wide enough for low powers, it is then taken quite out as in fig. 3. The mirror *r* is made to slide up or down in the loop *s*. *t* is a condensing lens; it receives light from a much larger one, and is for illuminating opaque objects; it is mounted in a double-jointed arm *u u*. *v* is the tweezer-arm. In figs. 1 and 2, *w* is the pinion, *x* the square pipe, in which a square rack slides. In fig. 1, the hole is seen in the end of the rack; it receives the pin of the ring that holds the magnifiers. This fitting allows of the usual lateral motion over the stage.

For the sake of lightness and portability, the foot *l* is made a ring; but a weight is fitted to it, to add stability when required: this is shewn above the foot in fig. 1. Studs, one of which is shewn at *y*, project from opposite sides; they drop into the notches *z z*, figs. 2 and 3, below which a channel is turned all round, so that on twisting the weight either way, it becomes fixed.





When using the vial microscope before a lamp, they are liable to be moved away from each other, and thus interrupt the observation. To prevent this, and afford the convenience of moving it any where in complete order, I fit another socket *a* (see the wood-cut), with a binding-screw, on the stem *k*, from which the jointed arms *b c* project, so as to hold a small lamp in the spring-clip *d*: the joint has a spring *e*, and binding-screw *f*, to fix the lamp when adjusted. The lamp has a chimney *g*, held in the wire *h*, and two flames placed so as just to touch, by which their light is mutually brightened, and they are placed one behind the other with respect to the microscope, so as to increase the body of light; of course, any other convenient lamp may be attached to or held by these arms. But whatever lamp is used, it must be one that is easily detached; for although it serves quite well when the stage is inclined, it must be removed far enough to clear the head of the observer when the stage is placed horizontal: I assume 18 inches as a safe and convenient distance for the light, but here it will be too weak or small for the microscope, therefore lenses must be interposed to increase its effect. I will now describe the lenses most suitable for this assumed distance. Near to the lamp I place a lens, or rather a doublet, made of two planes placed close together, their flat sides towards the light: the radius of that next the light is $1\frac{6}{10}$ inch, its diameter $2\frac{6}{10}$; the other is $2\frac{1}{4}$ radius and 3 inches diameter; this doublet, when placed about 2 inches from the flame, will collect all the light that radiates in a cone of 60°, and direct it, converging towards the mirror, under an angle of about 10° or 12°: I therefore call it a collecting lens. This with transparent objects gives ample light for all ordinary powers; but in order to increase it still farther for the very highest powers, or when the objects are not very pellucid, another lens, mounted on a short thin tube, is fitted into the neck *g*, at its upper end within the jacket, so as to slide a little up and down: this small lens will condense the rather diffused light received from the mirror into a much smaller and more brilliant spot. For opaque views, the light from the collector is directed to the lens *t*, fig. 3, and by it condensed on the object. As these condensing lenses receive converging light, their focus must be nearly double the distance that they are placed from the object. $2\frac{1}{2}$ focus will do for that under the stage, and 3 inches for the lens *t*.

I have now given a general description of the microscope and its movements. Plate VI. contains all the farther details.

In Plate VI., figs. 1 and 2, *j* is the sliding socket made to fit on the stem *k*, Plate V: on one side is a round flat disc with a central stud; on this and against the flat face is fitted the disc *i* of the arm *h i*; this is followed by a strong spring 1 1, the other end of which is held by a screw 2; the collet 3, fig. 2, follows the spring, it being squared on to the stud; and the screw 4 binds all tight enough to move pleasantly, or so tight as not to move. It is desirable to keep the cranked arm *h i* as short as may be, therefore the screw-head 4 is made as thin as it will bear, and one side is left longer; and after the screw is cut, it is bent forwards and spread out by the hammer: or instead of this, the head may be left round, and have several holes in its edge to receive a pin lever. The end *h* of the arm is a clip with binding-screw *h*; it receives the neck *g*, and thus forms a joint by which the vial may revolve sideways: this neck *g*, and the socket *x*, is one piece; the vial-jacket *c c*, lined with black cloth, is attached to it by small screws. Fig. 3 is an end view of the neck and socket *x g*.

The adjustment of the lens is by a rack and pinion. In figs. 1 and 3 the pinion is removed; 5 is the opening through which it engages the rack; 7 7 is a square bar sliding in the socket *x*: the rack is cut in its upper angle as fine as forty teeth in an inch. The upper sides at each end of the socket *x* are made to spring on it, urging it close into the lower solid angle, and the pinion is mounted on a stiff spring, which presses it in the same way against the rack. Figs. 4, 5, and 6, are separate views of a plate, by which the pinion is attached to the socket *x*. Above fig. 5, *w* is the pinion alone; it fits well into the pipe 6, figs. 4 and 6, and this little pipe is cut so as to spring close on the pinion, and hold it quite free from shake; the spring-end of this pipe or pinion-socket is fixed at 34 to the cap, and this is to be attached to the socket by screws at 35. Thus, the ends of the socket *x*, and the spring that holds the pinion, pressing the same way against the rack, leave no shake any where; yet the pinion yields to every inequality, so as to give a very smooth motion.

Fine as this rack is, it is quite sufficient for the quickest motion, and by drilling several holes in the circumference of the pinion-head, a pin lever may be fitted in to them like a capstan-bar, and be used in the lowest hole as most convenient: this will reduce the motion to the slowest that can be needed. In the front or upper end of the bar 7 is a round hole, made to receive the taper pin 8 of the eye-ring, fig. 7. Fig. 8 is a top view of this ring; the aperture to receive the various lenses is exactly six-tenths of an inch, a size adopted by several makers. Two of these rings are provided, one with a pin 8, just as much longer than the other as the stage *n* is higher than the surface of a vial when in the jacket. Thus the whole length of the rack adjustment becomes useable, either with the stage or with a vial. This is done to keep the rack as short as possible, in order to avoid cranking the arm *h i* more than is absolutely necessary to let the lower end of the rack pass it.

In fig. 1, Plate V., is shewn the opening *d d* in the jacket; it is made no wider than to let the eye-ring touch the vial, and its length is just two-tenths longer than the eye-ring, to allow one-tenth of an inch motion up or down, it being two-tenths longer than the ring. This opening has a notch on each side at *g g*, through which pass the hooks 10, 10, figs. 1 and 9, Plate VI. These hooks are attached to the saddle-plate *o*, so as to lock it fast when slid into its place. As this plate is the foundation of the stage, it requires to fit well. The notches in the hooks 10 fit close to the sides of the hole *d d*; and at each end of the plate are curves 11, 11, fitting well on the jacket *c*.

Fig. 10 is an under view of this plate, shewing where the hooks 10, 10, are attached, and the saddle-pieces 11, 11; *o o* are two notches made to receive the lever-wires *p p*, Plate V. These wires are kept in by spring hooks 12, 12, which are shewn in the top view, fig. 11. This contrivance, by which the levers *p p* may be readily attached to, or detached from, the stage, is for the convenience of packing them in much less compass; and, for the same reason, one of the screws of the bar *q* takes out to separate the levers. It is, therefore, an improvement on my first lever-stage, published in the 48th volume. A neck 13 rises from the middle of the plate to receive rather tightly on it the short pipe 14, fig. 9. On this pipe is fixed the plate 15, to form a tablet on which the movable stage *n* can slide. Fig. 12 is a top view of this tablet; fig. 13 is the stage-plate *n* kept on the tablet, so as to move with an easy friction by means of a thin spring, fig. 14, which is placed under the tablet, and has two holes 16, 16, through which pass screws 17, fig. 9. They next pass through the enlarged holes 18, 18, of the tablet, and then screw into the holes 19, 19, of the stage-plate *n*, to hold all together. Thus the spring 16 and stage *n*, with the tablet between them, being gently drawn together by the screws 17, as in fig. 9, can slide any way, being only limited by the size of the holes 18, through which the screws pass. These are made as wide as the required motion. On farther binding by one or both the screws 17, the stage may be fixed so as not to move. Two holes are made in the front of the stage *n*, as shewn in fig. 13, exactly over the fulcrum-notches *o o*, to receive the upper ends of the lever-wires. These holes, and the joints of the lever-bar *q*, by which the lever-wires are connected together at bottom, are made exactly the same distance apart. Two holes are also shewn at the back corners to receive the usual springs; but as it is most convenient for the two springs to be separate from each other, these holes should have been made square to prevent the springs moving laterally. The back of the stage is hollowed, as shewn in fig. 13, to allow it to slide that way without touching the rack, or the pin of the eye-ring.

The apertures of the dark chamber *e* are only suited for a vial; and when the stage is used this chamber is pushed up as high as it will go, but then its upper aperture will not come flush with the stage; therefore a third aperture is used: it is a separate disc, like fig. 15, to be laid in the seat 14, on the tablet, fig. 12. Several are provided with different-sized apertures, and made thin and black: they perform best when the aperture is no wider than the field of view of the lens in use. The stage *n* also has a seat to receive a disc for opaque objects.

Fig. 16 is a section of the arm *h i* to shew a dovetailed groove made under it, to receive the mirror-bar *s*, figs. 1 and 17: the stud on which the mirror-arm turns is made to slide up and down in the bar *s*; the same spring within the arm serving to make both the turning and sliding motion smooth and easy, a thin collet being interposed between the arm and bar. Fig. 18 is a section of the dark chamber *e*; it slides into the neck *g*, figs. 1 and 3. In fig. 3 are shewn two notches 20, 20; and on the chamber *e* there are two studs 21, 21, to pass through the notches 20; then, turning a quarter round secures the tube in its place. In order to hold any sized vial equally safe in the jacket *c c*, and yet allow it to be freely moved about, a helical spring is placed within the chamber *e* to push out the tube 22, and thereby press its saddle-top 23 against the vial. This saddle is as long as the jacket, and lined with black cloth: it is fitted so as to be easily removed from the tube 22. One end is seen against the vial in fig. 2, Plate V. When the stage is in use the tube *e* is pushed quite in, and held there by the other two studs 24, 24. Fig. 19 is the tweezer-arm, made to fit either of the dovetails on the saddle-plate, figs. 9 and 11: the arm of the condensing lens fits in the same dovetails. Fig. 20 is a side view of the lower double joint of the tweezer-arm. Figs. 21 and 22 are two views of a small universal joint for holding the pin on which opaque objects are mounted: it takes the place of the tweezer-wire. Fig. 23 shews two views of its forked spring. When objects are very transparent, or their fluids very limpid, they require greater care in shading every surrounding part; for this purpose a dovetail is placed at the back of the jacket *c* to receive the end 25 of a bar, fig. 24; the other end is bent down so as to enter the vial, and lie close to its slip of glass *a a* that confines the object: that end is spread out thin, and has a small hole concentric with the dark chamber. I find this renders matter visible in fluids that before appeared limpid; the vial may be moved any way without disturbing this aperture, therefore any part of the object can be brought before it. Fig. 25 is a pair of stiff tweezers, suited for holding the bit of cork and placing it behind the slip of glass in the vial. Cranking the end allows the parts above to be nearly close, and gives more room to move about in the vial neck, and the cranks hold the cork in the right position; yet a plain tweezer, with only two such pins as the one at 26, serves pretty well.

My capillary tablets or cages, as described in Vol. XLVIII., Plate IV., figs. 23, 24, and 25, have caps that screw on. They were constructed for animalculæ, and answer perfectly well; but for botanical specimens it is frequently desirable to screw the cap on without its glass or mica turning round; and it is as desirable to be able to move the mica or glass when the objects are crowded, in order to move them, or to bring a clearer part of the mica over the part we wish to examine.

I have, therefore, so constructed the cages as to answer both these purposes. Fig. 26 is a section; and fig. 27 the parts of the cap separated, of their full size; 27, the circular glass tablet burnished, or cemented in, as usual; 28, the outer ring of the cap, it screws on as before, but here the mica is not cemented on to it, but on a ring 29 fitting loosely in it. This is followed by the thin springing ring 30, which snaps into the recess 31, 31, turned within the outer ring, and retains the mica-ring in its place, only free to move round. 32, 32, are two of six holes drilled around the tablet; and two corresponding holes are drilled in the mica-ring, in which pins may be put if the disc is never to turn round; but I prefer fixing no pins in: I only drop two pins, like 33, in, whilst screwing down the cap; and if at any period I have occasion to move the mica, I take the pins out, and, with the point in one of the holes, turn the disc back or forwards to assist in laying out the object; and when the object is right the pins may be entirely removed. Figs. 28 and 29 are section and top views of a cage, with a plain cap merely twisting on. This, in the larger cages, serves for common purposes, but is liable to kill the objects.

I never allow less space in width and depth around the tablets than is shewn in fig. 26. Tablets of glass, from two to four-tenths of an inch diameter, are the most convenient sizes; beyond that they are not so safely portable. Discs of glass are polished for these cages as thin as one-hundredth of an inch: they are much superior to mica when the focus can reach through them.

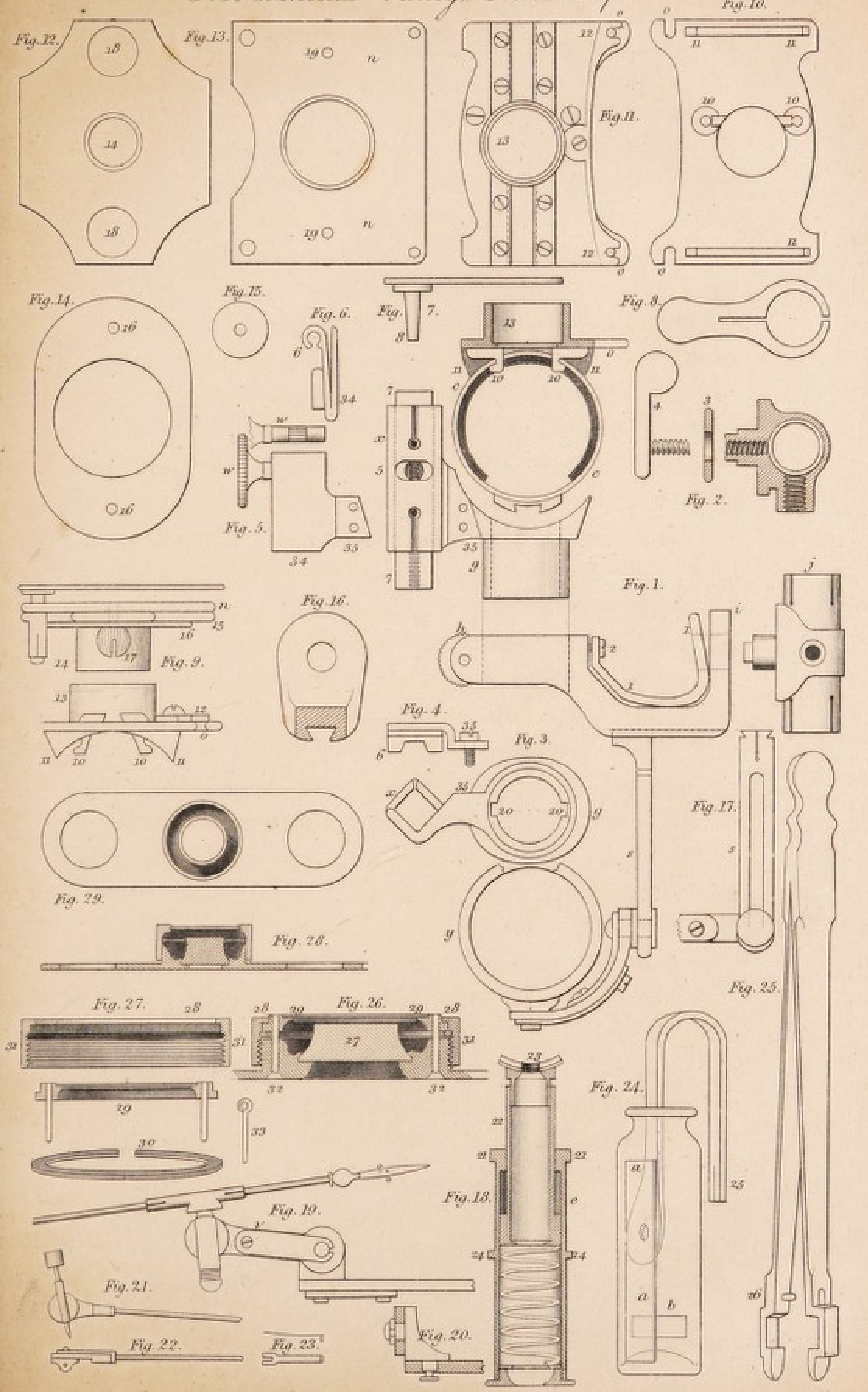
In Plate VII. are shewn different parts of *Nitella hyalina*, examined with this microscope.

I now subjoin the result of some additional observations on *Chara vulgaris* made with my vial microscope.

I shall, in the first place, refer to the general description of *Chara vulgaris* given in the forty-eighth volume, in order to make a small addition to it. I have there described the seed as being inclosed in a brittle shell, around which the five spiral tubes are wrapped. The variable thickness of this shell, and the seed* being some-

* In this communication I use the word fruit to signify the nucule with the surrounding tubes; and seed, to signify the nucule without the

Mr. Cornelius Varley's Microscope.



Drawn by C. Varley.

Engraved by E. Turrell.

times seen without it, or nearly so, led to some doubt of its nature. I therefore took a number of ripe seeds which had fallen from the plant; these, instead of shewing the natural chesnut colour of the bare seed, were all of a pale grey colour. I placed them in a watch-glass, and wetted them with extremely weak muriatic acid, which immediately caused effervescence, and slowly dissolved the shells, leaving the seeds clear; thus shewing, that probably it is not a necessary part of the plant, but only an incrustation of carbonate of lime; yet it is almost a rarity to find the seeds without it. This shell, or crust, is sometimes found very opaque, and sometimes so transparent as scarcely to be noticed; but these, on drying, will shew the grey colour of the crust.

Secondly, in Vol. XLIX., I described a single mass in the stalk of the globule, which slides with the circulating fluid up one side and down the other, and said that, what in other cells were separate masses are here all united to form this one mass. I now expect to shew that it is a very peculiar vesicle, distinct from the fluid in which it is placed, and one whose particular office yet remains for future search.

Those who are not well acquainted with the plant will

surrounding tubes; but it probably is really a seed-vessel containing only one seed. Those botanists who consider the *chara* tribe as flowerless or asexual plants (which is not my opinion), will consider the nucules as neither seeds nor seed-vessels, but sporules. The way in which the reproductive organs of *chara*, and other plants growing under water, become fertilised, is a subject well worthy of attentive observation. I should think there can be very little doubt but that the nucule was fertilised by the action of the globule; but I cannot at present venture to give any opinion how it acts. In the sixteenth volume of the Transactions of the Linnean Society, there is a very valuable communication by Mr. Robert Brown, on the action of the pollen in fertilising the ovula in orchideæ and asclepiadeæ.

better understand what follows, if they previously refer to the above-mentioned descriptions of *chara.*

Having now to state several new facts which may serve to extend our knowledge of the life of plants, it will be requisite first to describe very particularly the parts concerned, and then to shew what occurs in them.

In the *Chara vulgaris,* nine short branches grow round each knot; these are covered with about nine smaller tubes each, and have several joints, at each of which the male and female parts of fructification grow.

Fig. 1, Plate VII., shews one of these joints *a a,* with very small portions of the branch above and below it; *b* the globule or male blossom; *c c* the fruit, or female blossom It consists of five tubes, wrapped spirally round the seed.

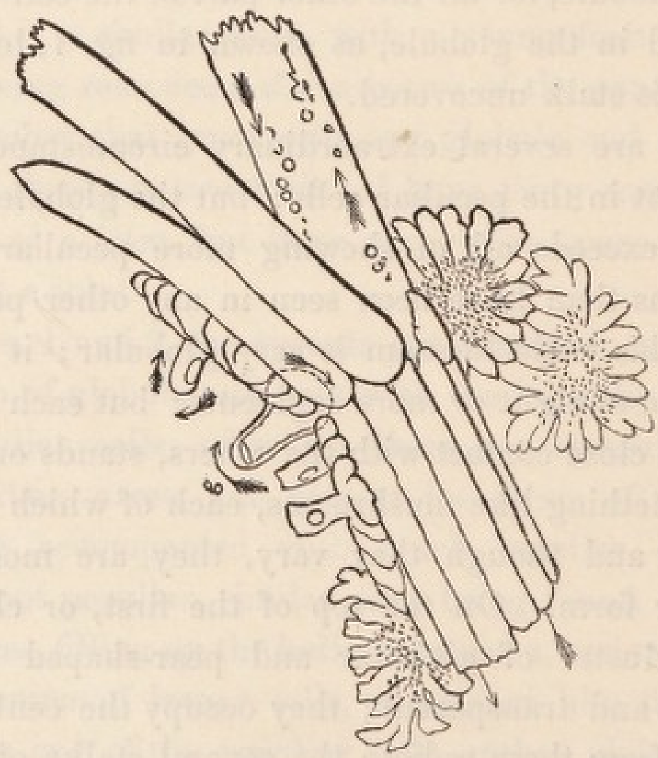
Fig. 2 is a larger view, to shew how the globule and fruit grow from the joint, close to each other.

Fig. 3 is a similar joint, with a young fruit only, the globule being removed; *d d* are two of the sprouts; four is the number that grow with one globule and one fruit, and six if there are two fruit. I have many samples with two fruit at a joint, but have never seen more than one globule at a joint.

In figs. 1 and 2 the sprouts are removed, to shew the connexion of globule and fruit with the joint, by means of very peculiar cells, of which there are several at each joint of these arms, and also at the joints of the stem; these are accompanied with much smaller cells, apparently not peculiar, similar ones being found at various other places, filling up the hollows between, and strengthening the union of larger cells, somewhat like fig. 4. In fig. 2, *e* is one of the peculiar cells, rather globular; one part is in direct contact with the central tube of the branch. Some of the surrounding tubes *f f* fit against it, and on each side the two peculiar cells *l* and *m* are in contact with it; the remaining part is covered by the globule, the fruit, and the sprouts. To this cell is attached the flask-shaped cell *g*; this is the stalk on which the globule grows. On the top of the central cell *e* is placed a flattish round cell *h*, and again on its top is a third very flat or very short five-sided cell; and, fourthly, above it stands the cell *i*, which is the stalk of the seed *j*. The cell *e* forms the base of the globule; and the cell *h* is the base of the fruit, for the five tubes that surround the seed spring from the cell *h*, close around the very small and flat cell, and close around the seed stalk *i*, giving to each a five-sided form. Around the bulbous part of the stalk *g* of the globule is a dotted line *n*; it is merely the boundary between the very minute cells that fill up the hollows and the globule, for all the other part of the cell or stalk *g* is inserted in the globule, as shewn in fig. 1, leaving no part of this stalk uncovered.

There are several extraordinary circumstances to be pointed out in the peculiar cells; but the globule, or male blossom, exceeds all in shewing more peculiar features and actions than have been seen in any other part of the plant. This male blossom is very globular; it is like a shell made of eight or more segments; but each segment, though in close contact with the others, stands on its own stalk, something like mushrooms, each of which is deeply notched; and though they vary, they are mostly of a triangular form. On the top of the first, or chief stalk *g*, is a cluster of globular and pear-shaped cells, all colourless and transparent; they occupy the centre of the globule; from these radiate the several stalks of the segments, four of which are shewn in fig. 1, and two separate ones in figs. 5 and 6. The stalks of the segments, as well as the chief stalk *g,* have a lining studded with vesicles, arranged so as to shew the ascending and descending current, precisely like the rest of the plant, with only this difference, that whilst in all other parts of the plants the vesicles are green, these vesicles are red. The space under the segments, between the stalks, is completely filled with long ringed vessels, like fig. 7; these proceed from the central cluster, and bend about without adhering to any other part. Thus, like a flower, all the internal parts grow separate from each other, only the segments adhere to each other so as to form a globular shell.

When this blossom comes to maturity, the under side of the segments appears to enlarge, so as to become either flat or reversed; this pulls the segments apart, and lays them out thus—



around the chief stalk *g,* like inverted mushrooms; some take their stalks with them; from some the stalks separate, and remain among the long vessels, and are occasionally found quite separate, like figs. 5 and 6, yet quite alive: the long vessels are mostly entangled together, but will separate into smaller clusters, like fig. 7. I have also seen the stalk *g* completely separated from the plant, like fig. 8. All these parts thus separated will keep alive for a day or two, and the stalk *g* for many days, if not removed from the plant. The segments, though so deeply notched, appear to be but one cell, and are themselves quite colourless, but have within them a great quantity of minute red transparent particles, which adhere together, and to the inner or lower side; so that, whilst the blossom is whole, these transparent cells look somewhat like the white, and the coloured layers at their bottom, hiding the cavity, make it look somewhat like the yolk of an egg.

Having described the parts, I will now describe what occurs at each place, as far as I have ascertained. In fig. 2 the peculiar cells *l m*, and others around the joint, are not so round as here shewn; but some are bent, and squeezed into very different shapes by the larger tubes of the branch. In the ordinary tubes or cells, there are green vesicles regularly arranged on the thin membrane which lines them; and the circulating fluid appears thickened by innumerable particles, a little denser, or not quite fluid, and with scarcely any colour. But in the peculiar cells *e h l m*, &c., there are generally very few stationary green vesicles except about the angles formed by the adhesion of other cells. The fluid within is very clear and limpid, with many very equally sized green vesicles floating in it. Those that are still, and those that are moving, appear to be the same; and some are seen to stop, and some stationary ones are seen to break loose and go on: they are rather larger than the orderly arranged green vesicles of other cells; but being loose, and the cells so glossy, they are seen very bright and distinct. This is not all; for they circulate round the cells very quick and freely, undergoing some extraordinary influence; for they knock against one another, appear to stick at some places, or as if they squeezed by, and then rush on quicker: many, as they come near particular parts of the cells, spin most rapidly as they go on, different particles turning in contrary directions; and others only catch a slight impulse to spin, suddenly turning round and back, and go on without spinning; others, near the centre of rotation, go round close together, then start into a quick whirl, then vary or slacken, and again start into a furious whirl, shewing considerable fluctuations in their motion; and in the larger rounds they appear to receive some impulse whenever they touch that part of the surface of the cell which joins the arm, as though they were slightly electrified. The arrows shew the directions of the circulations in these cells; but the proportions of size, and the placing of the cells, differ in different specimens; and also the directions of the circulation differ. But, supposing the seed to stand upright, the circulation in the cell *h* in some cases appears to be horizontal; and it is always horizontal in the little 5-sided cell in the middle. As this can only be seen in profile, the particles appear to dance round a ring: it may be that the refractions of the near side produce the appearance of jumping-up of the off-side particles. Here the stalk of the globule *g* is on the cell *e*, and the fruit on the cell *h*; but in other samples the cell *h* was largest, and *e* the small one. There the stalk *g* touched both; and in all cases the globule and fruit are so close as to touch each other. Thus, in these cells there is a decided peculiarity differing from the circulation ordinarily observed. On the little, very short, or flat 5-sided cell stands the seed-stalk *i*. It is a cell; and close around them, fitting well to their particular shapes, are the five spiral tubes *k k* rising from the cell *h*. These tubes are one cell from bottom to top, and are very angular, being flattened where they fit against each other; and the circulation in them does not appear to differ from that ordinarily observed in the stem and branches; but the current is invariably up on the outer side, and down in the inner one, against the seed. In the top centre the five tubes meet in sharp angles, so that the stream of them all may be seen to descend vertically, as shewn by the arrow above: also the currents in the 5-celled coronet are up the outside, and down the centre angles. Here, like most of the other terminating cells, the motion is slowest—sometimes too slow for our patience to watch.

In fig. 1, at the upper end of one of the five spiral ubes, there is a dot to shew the place which, for many hours, had a revolving cluster, like that shewn on one side with two arrows. The next morning it was gone. In many instances the upper ends of these five tubes which surround the seed will grow deformed, and become longer, raising the coronet much higher above the seed; and this lengthened part, just under the coronet, will become colourless, and much more transparent, whilst the coronet remains green, and the tubes also remaining green up to a level with the top of the seed. The transparent or dead appearance of these upper ends is caused by the disappearance of the green vesicles from that part. As far as the green vesicles remain orderly arranged, so far the circulating fluid comes up quite lively, and the descent is the same; but above this a few of the studs are disarranged, and the remainder appears to have dissolved into a sort of gum that smears the otherwise very transparent tube. Here the circulating fluid loses its steadiness, appearing to straggle about as though it had lost its guide; and at the very top a quantity of the fluid is gathered together, where, instead of returning down, it remains spinning or turning round the axis of the tube, producing that remarkable deviation from the usual circulation which was first discovered by Mr. Solly in the small sprouts, and described in Vol XLIX. This being very transparent, every thing is visible; it is, therefore, a very beautiful repetition of that effect, and shews how important the green vesicles are, and the necessity of their being orderly arranged, to direct, or cause the direction in which the fluid shall circulate.

In the foot-stalk of the seed there is a remarkable feature, for it is a short cell, and has one peculiar mass similar to that observed in the stalk of the globule; and when the circulating fluid is enough in quantity to completely cover it, it becomes quite round, being a clear transparent globule in a rather turbid fluid. When the central fluid predominates, so that this globule is not covered by its own fluid, it appears to slide or creep round. This change of form shews it to be a flexible vesicle. There is no fixed direction for this circulation; though it does not vary in the same seed, in different seeds it differs, so that I have seen it in every direction.

These most peculiar masses appear to have a singular directive power, for they always proceed one end foremost. In cases where they fill the end of the cells, so that they must return nearly in the same track, only close to the opposite side, they first make half a revolution, and then slide back without any further turning. Some of these are so pellucid as not to shew what happens; but others have some minute adhesions or texture on their surface, which shews correctly how they proceed. Thus far for the fruit. The globule or male blossom is much more extraordinary.

I have said that the peculiar cells are mostly clear, having few adhering or stationary vesicles, and none arranged so as to shew the course of circulation, but that bright green vesicles are hurrying round in a clear fluid. Not so with the stalk of the globule; for although it is completely immersed in the blossom, it has a lining covered by vesicles, arranged so as to shew the ascending and descending currents, precisely like external cells, only with this difference, that these vesicles are bright red, whilst those are green. Next, the radiating stalks of the segments or scales have similar red vesicles. From this description of the globule it is evident that it cannot be regarded as a single cell or vessel, containing a particular fluid; but as the segments grow close to each other, they merely enclose the space containing several distinct parts crowded together, as the parts of a flower before it opens are enclosed in the bud.

Fig. 8 shews the main stalk *g*, and figs. 5 and 6 the stalks of the segments entirely separated from the plant, from the scales, and from each other, yet quite alive, with quick circulation going on. In all these stalks there is that very peculiar single vesicle sliding or creeping round. This single vesicle is not in the central fluid, but in the circulating fluid; yet it often projects into the central fluid, from being more bulky than the depth of its own fluid can cover. The constancy of its occurrence and keeping to its own fluid proves it to be a distinct vesicle, and not a detached portion. Above fig. 6 is the segment of a sphere; it belongs to fig. 8, and shews the exact form, just like a plane convex lens, which the mass or vesicle assumed every time it passed over the top. Fig. 6 is a stalk of a segment perfectly detached; and for a long time its peculiar vesicle went round with the fluid, but at last this vesicle became sluggish, sometimes rising a little above where it is shewn, and then descending, the fluid still going round lively: sometimes this mass presented a front view, in which case it was quite round, but it as often shews an edge view like the two figures shewn beside it, the flat side sometimes to the right and sometimes to the left. When in full vigour, I have seen this vesicle pass minute particles in its own fluid; but when sluggish, they pass it, though they are occasionally detained a little while behind it. This circumstance seems to shew that it possesses a cause of motion independent of the fluid in which it moves. Thus much for the stalks and their single circulating vesicles. Of the central cluster of clear cells, some are shewn in fig. 5, and one in fig. 7; in them I have seen circulation, but must refer to them again.

From these cells grow out numerous clusters of long vessels like fig. 7, possessing the most extraordinary features yet observed. When these are first protruded from the globule, if not quite mature enough, their appearance is like dense or strongly marked ringed vessels, the divisions of which, or their contents, soon begin to appear irregular, and then assume the form shewn in fig. 9. When they are mature or protruding, their appearance is like figs. 10 and 11: after a while these curls within the divisions become agitated; some shake or vibrate about, others revolve in their confined places, and many come out, thus shewing that they are spirals of two or three curls; these with an agitated motion swim about, the greater number being like those shewn at *o o o o* around fig. 11. Now the field of view appears filled with life; great numbers of these spirals are seen agitated and moving in all directions; they all have a directile force, one end going foremost and never the other; many stray a great way out of the field; these, by getting clear of each other, are the best to observe; they do not quite keep their form as a stiff spiral, but their foremost end seems to lash about; and to many are seen attached almost invisible but very long fibres, as at *r r* in two of the spirals *o o*. These fibres were in quick undulations, which ran in waves from the spiral to their farthest end. It appears that these fibres cause many of the spirals to entangle together, and thus bring them sooner to a state of rest; therefore the separate ones were best to observe. At the end of fig. 11 there were motions that seemed like rapid whirls in the water, in the oval directions shewn by arrows at *q q q*, and they seemed to change place like an oblique circle vibrating. These were most probably rapid undulations in some of the very fine fibres, proceeding from end to end; for at the side of fig. 11 were two long fibres *r r*, which slackened enough to let the undulations be seen running through their whole length, as shewn by the arrows. These were observed till they came to rest; they were so fine as only to be known to be any thing by their undulations. I took some pains to estimate their thickness, which could not be more than the $\frac{1}{150,000}$ of an inch. In some samples, the spirals appear all to come out of the tube; in others, they are distinctly seen, but will not come out; in others, some only remained in, like fig. 11, where the contracted spirals were much agitated, and some revolving or breaking loose occasionally, so as to revolve; and there was the appearance as of most rapid but varying and intermitting circulation, in portions as shewn by the arrows *pp*. [There are most probably similar vibrations or wavings in the fine fibres, which must be wrapped up in some at present unknown manner within the cells, or portions of the tube, with the spirals, for the fibres are longer than the spirals. The occasional coincidence of motion in the several compartments, would as often give the appearance of circulation. Although between each ring of the tube there is a spiral, I do not know that there are any divisions across, so as to form separate cells.

Whilst examining the dissected male blossoms, I have frequently seen bodies like fig. 12 floating about among the spirals and having a similar agitation: where they come from I do not yet know, but have only found them along with the separated parts of the blossom. They are so near of a size with the clear central cells, that I have suspected they might come from amongst them; they appear to be perfectly clear vesicles shrivelled, with very clear minute globules adhering to them, and seem as if made of the purest glass.

I have now described the very extraordinary actions that accompany the various parts of the male blossom whilst they are visibly alive. When circulation has ceased in the stalks, its fine studded membrane shrinks like other cells of the plants, and ultimately disappears; and myriads of extremely minute atoms are seen crowded together in whatever part of the cell happens to be lowest; these are in as rapid motion as their crowded state can admit, yet are affected by gravity, as they take the lowest place. Also in the segments, the clear parts begin to be stained, as though many of the red particles were burst, and the whole cell appears as if filled with life, for every minute rapidly agitated atoms are seen every where; they are much smaller than even the minute particles that compose the coloured masses, and being of the same colour, I conclude that they come out of them. I will now give the dimensions of some parts of the plant and blossom. The principal stalk of the globule, fig. 8, is the $\frac{1}{120}$ part of an inch long; the smaller end is the $\frac{1}{450}$ of an inch thick, and surrounded by fifty-four red vesicles, which, deducting the spaces between them, leaves them about the $\frac{1}{12000}$ of an inch thick. The segment-stalks, figs. 5 and 6, are the $\frac{1}{200}$ of an inch long, and $\frac{1}{1000}$ of an inch thick. The long vessels, figs. 7, 9, 10, and 11, are $\frac{1}{1800}$ of an inch thick, the spirals within them $\frac{1}{18000}$ of an inch, and the long vibrating fibres *r r*, near the $\frac{1}{200,000}$ part of an inch thick. The seed without its tubes is about the $\frac{1}{40}$ of an inch long, and $\frac{1}{80}$ of an inch thick. In fig. 1, I have mentioned a mass that was seen revolving at top of one of the spiral tubes. Fig. 13 is part of a cell at the upper end of an arm, bearing fruit at the lower joints; but this cell having no surrounding tubes, had no fruit, and therefore grows much longer and thicker in this cell; and in several other similar ones in the same vial were many very lively revolving clusters, as shewn with arrows around them. These were larger and better defined than the cluster in the top of one of the spiral tubes in fig. 1. They were not in the central fluid, but in the circulating fluid, and therefore appeared to slide up and down close to the side; *s s* are the marks parting the two currents; the clusters here shewn rising came down in profile, as at *t t*; those that went up near to the right side came down at the middle of the back, and when they had slid over the top, their inner side was presented to view, which, of course, made them appear to revolve the other way. I followed these many times up and down. There was no retarding influence to make them roll up; for, in the same tract, different clusters revolve different ways, and with different speed,—in fact, they appear to travel quicker than their fluid, for I watched a long taper particle *v* that preceded a revolving cluster; the cluster overtook it, and sent it aside like the second and third *v*; and when quite past, that particle resumed its former position, as at the lowest *v*. This shews that there were no whirls in the stream: the particles forming these clusters were decidedly green. Now, from the various facts, I am induced to believe, that in plants there are many vesicles possessing a directile power; if these should cluster with their foremost ends in similar tangents (which it is most likely they would, if they had positive and negative ends), they will revolve that way; if placed the reverse way, they will revolve the other way; if few predominate one way, they will revolve slowly; if many, quickly. I see nothing in all these various motions like the self-will of animalcula. Electro-magnetism causes bodies to move and revolve; so I expect it will ultimately be found that these are caused to revolve, to vibrate, and to move forward by its influence.

The appearances above described are so remarkable, that I am very desirous of having them confirmed, or, if need be, corrected by other observers; and as circumstances do not permit me at present to resume this investigation, I am induced to offer it, in its present state, for insertion in the Society's Transactions.

NITELLA HYALINA.

At the meeting of the British Association held at Cambridge in 1833, Professor Henslow having taken a party of naturalists a botanical excursion down the Cam, pointed out to them a species of *Chara** or *Nitella*, which he had first observed in Bottisham Fen about six years ago, and had always considered to be either a very distinct variety of *Chara* or *Nitella gracilis,* or not improbably a species new to Great Britain; and Professor Agardh, of Lund, who was present, pronounced the plant to be his *Nitella hyalina*.

As I am not aware that any account of this plant has ever been published in England,† nor any representation been given of its appearance as seen through the microscope, I hope the Society will consider the following description of it as an interesting addition to my former communications on *Nitella* and *Chara*.

Mr. Slack having brought up with him from Cambridge some of this plant in a bottle, which he gave to Mr. Solly, I have, through his kindness, been supplied with the specimens from which the engraving was made that accompanies this communication.

* The whole of the plants included in the natural order *Characeæ*, constituted but one genus, *Chara*, which has been divided into two, *Nitella* and *Chara*. Those plants, the stem of which, between the joints, consists of a single transparent tube, constitute the genus *Nitella*; while in genus *Chara*, this tube is surrounded by many other much smaller tubes, which only cease to cover the central tube towards the extremities of the branches. —See Linley's *Introduction to the Natural System of Botany*.

† Mr. Curtis has given an engraving of this plant in his British Entomology.

I have had the pleasure of shewing this pretty little plant to many of the members of the Society at the Tuesday evening illustrations, and I have got some of the plants now growing in a glass jar, which I hope to be able to keep alive during the winter, as they appear at present to be in very good health.

Fig. 14, Plate VII., represents a portion of this new and very beautiful plant, as seen in the vial microscope through a lens of $\frac{1}{10}$ of an inch focus. In consequence of its being confined between the side of the vial and a slip of glass, it appears more spread out and flattened than it does when growing naturally. *Nitella translucens* is the largest of the three plants of the *Chara* tribe described in the Society's Transactions. Its stem is a plain tube, about the $\frac{1}{30}$ of an inch thick. The stem *Chara vulgaris*, with its surrounding tubes, is the $\frac{1}{40}$ of an inch thick, while the stem of this new plant, *Nitella hyalina*, is a plain tube of only the $\frac{1}{150}$ part of an inch thick, the measurement being taken in each case from the main stem of a full-grown plant. *Nitella hyalina* agrees with *Nitella translucens* in having six arms at each knot of the main stem. The arms which *Nitella translucens* and *Chara vulgaris* send out may be compared to leaves and fruit-stalks; those of the *Nitella* only dividing into forked ends, and some sending out a cluster of blossoms; those of *Chara vulgaris* send out a few sprouts with the blossom, whereas the arms of *Nitella hyalina* appear very like branches, as they divide three times. The first knot divides into five or six, the second into three or four, and the third into two or three; and all the numerous ends are sharp-pointed, or conical terminating cells, much longer in proportion than in *Chara vulgaris* or *Nitella translucens*; and the *Nitella hyalina,* in addition to the roots which descend from the knots of the main stem, will occasionally send down roots from the knots of the branches, as at *u u*. The *Nitella* always sends out its blossoms in a cluster, on a short blossom-stalk, the male being red. The *Chara vulgaris* produces one red blossom, and one or two fruit at each joint of the arms. The red, or male blossom, is below the sprouts, apparently unprotected by them, while the fruit is always in the midst of them; but here the male blossom is pale green, and always seated between the branches, as at *w w*, and the fruit *x* pushes out either below or on one side. *y y* are additional stems, growing at the knot of the main stem from the axilla of the branches. At *z* is a second and third length of this stem, still less developed.

I have not yet had any opportunity of examining the male blossom beyond what is shewn in fig. 14, but it differs from the other plants in having no red colour, but is of a pale *yellowish green*, the outer sides of the cells being clear and colourless, like the male blossoms of the other plants. Fig. 15 shews the fine tubes of a young fruit making just one half-turn: they were so very transparent as to be seen through each other. From its proportions, there is evidently some internal space, so I suppose the young seed to be there, though I could not see it; for the *Chara vulgaris* always shews its young seed, like fig. 3, extending the whole length. Fig. 16 is a fruit more matured; its fine tubes make just one whole turn around it. It was still very transparent; and the globular form of its meal or flour was visible by the light which came through it. As an opaque object, the tubes appear beautifully transparent, and the seed white, like a ball of flour, the separate globules which compose it being quite visible. Fig. 17 is a fruit come to maturity, though not to any decay. Its tubes make one turn and a half, and remain transparent, still shewing the circulation in them; but the seed is opaque, from its skin turning to a pale brown. Without the surrounding tubes, it is the $\frac{1}{100}$ of an inch long. Fig. 18 shews two globules of the flour from the seed; they are so clear as to shew a good image of the window-bars in them. One of these is represented as a little shrivelled, which occurs to many after being long in the microscope. Their diameter varies from the $\frac{1}{800}$ to the $\frac{1}{1600}$ of an inch. Fig. 19 is a top view of the end of a root, quite clear from deposit, circulation continuing to the very end: it was lying on the level stage, and though it is only the $\frac{1}{1000}$ of an inch thick, the particles in its central fluid are affected by gravity; for, whilst they were proceeding along, they would fall or push one another into the returning current, and thus circulate to and fro, as shewn by arrows, instead of proceeding from end to end.

In this, as well as in the other plants of the *Chara* tribe, the ends of the roots are frequently filled with the thickest portion of the circulating fluid. On this matter I tried the effect of gravity, by placing the vial, and consequently the root, upside down; when, in about three hours, a considerable quantity of this matter had descended with the fluid.

This minute plant appears more transparent than the others, from the green vesicles that are arranged on the lining not being placed so near to each other; therefore its circulation is easier seen, and is always very lively in every part, except the terminating cells, which in all the *Chara* tribe is very slow. This plant obeys the same law as the others in the direction of its circulation, for it is up on the outside of the branches, and down on the inner side, or that towards the axis; and all the divisions of the branches obey the same law in regarding the part from which they have divided as an axis towards which the currents descend.

C. VARLEY.

CIRCULATION IN OIL OF TURPENTINE, SPIRIT OF WINE, &c.

IN April last Mr. C. Varley presented to the Society a short paper, illustrated by drawings, of the circulation which he had observed in drops of the above liquids.

The manner in which he made the observations was to place a small drop of the liquid on the glass tablet of his animalcula-cage, and then to screw down on it the disc of mica, or thin glass, till it touches the drop, and compresses it to the thickness of about one-fifteenth of an inch, its diameter being about a quarter of an inch. A lens from one-tenth to one quarter of an inch focus, will shew the circulation. As the particles of the above liquids are transparent in their pure state, and consequently not to be distinguished one from another, the circulation can only be shewn, or rather inferred, from the apparent motion of minute foreign particles floating in the liquid, and of nearly the same specific gravity with it. If the liquid to be examined is quite clear, it may be fitted for observation by grinding with it a few particles of common coal, so as to render it slightly turbid.

1. A drop of spirit of wine, or of naphtha, placed as above mentioned, exhibits two, three, or four, vortices or

centres of circulation, according to the size of the drop; and if these vortices are viewed laterally, the lines of particles will be seen forming oblique curves from top to bottom of the drop.

2. Oil of turpentine shews a rapid circulation in two continuous spirals, one to the right, the other to the left, around the drop. These meet in the opposite diameter, from which the particles are slowly carried across the diameter to the place of starting; and this continues while there is fluid enough to let it be seen.

3. If, however, the drop does not exceed one-tenth of an inch in diameter, it presents the appearance of particles continually rising up in the middle, and radiating in gentle curves to the circumference.

4. If the liquid be put into a very small vial, similar motions are perceived; the particles, when they have reached the side of the vial, going down, to rise up afterwards in the centre or axis.

5. If a bubble of air be enclosed in the liquid, motions, similar to those described in No. 2, are observed in the part immediately in contact with the bubble.

6. In a flat drop of new wine, laid on the tablet, but not compressed by the mica, the motion was a regular uniform circulation; the particles rising from below at one end of the drop, then passing straight across on the surface, and descending at the other end.

Chara vulgaris.

Nitella hyalina.

Examin'd & drawn by C. Varley. Engraved by G. Gladwin.

Letter addressed to R. H. SOLLY, Esq., from H. BOWERBANK, Esq., respecting his method of obtaining Specimens of Wood for exhibition and examination in the Microscope.

19 *Critchill Place*,
SIR, 8*th April*, 1834.

IN compliance with your request, I send you my little machine for cutting sections of wood for microscopic objects.

It will be seen to consist simply of a table having a triangular receptacle, through the bottom of which a micrometer-screw, of about fifteen turns to the inch, works, for the purpose of elevating the carrying-box, in which the wood to be cut must be firmly fixed, by means of the screw passing through the curved front.

The woods to be cut should not be operated upon either in their green or dried state, but should be first prepared in the following manner: —

If it be a green wood, cut it into convenient lengths, and immerse it in strong spirit of wine for a few days; then change the spirit, and again immerse it for a few days or a week, for the purpose of extracting the whole of the resinous matter. After which, let it soak for a week or ten days in a sufficient quantity of water to deprive it of the whole of its gummy matter. It should then be stored away in weak spirit and water for use.

If the wood to be cut be dry, it should be fully expanded in water before it is immersed in spirit of wine, and then proceed with it as for green wood.

In cutting, the piece to be operated upon should not project more than one-eighth of an inch above the carrying-box; and previous to making each cut, the surface should be moistened with spirit of wine. This facilitates the operation, and prevents the slice taken off from curling up.

The instrument used to cut with is a razor, with the side which is to be next the machine ground flat. I have found the slices made by cutting from you with a forward and diagonal motion at the same time the best. In conclusion, I should observe that no wood which has been once dry makes such good cuttings as that prepared from the green state.

I am, Sir, &c.

R. W. Solly, Esq. H. Bowerbank.

LONDON:
PRINTED BY JAMES MOYES,
Castle Street, Leicester Square.