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C. GOULD

THE COMPANION TO THE COMPOUND

1839

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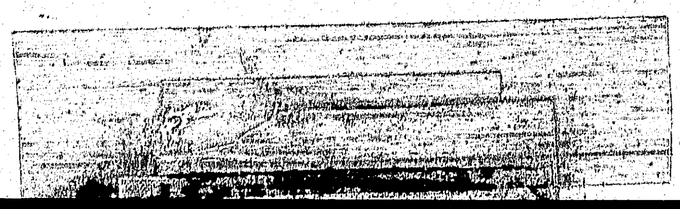

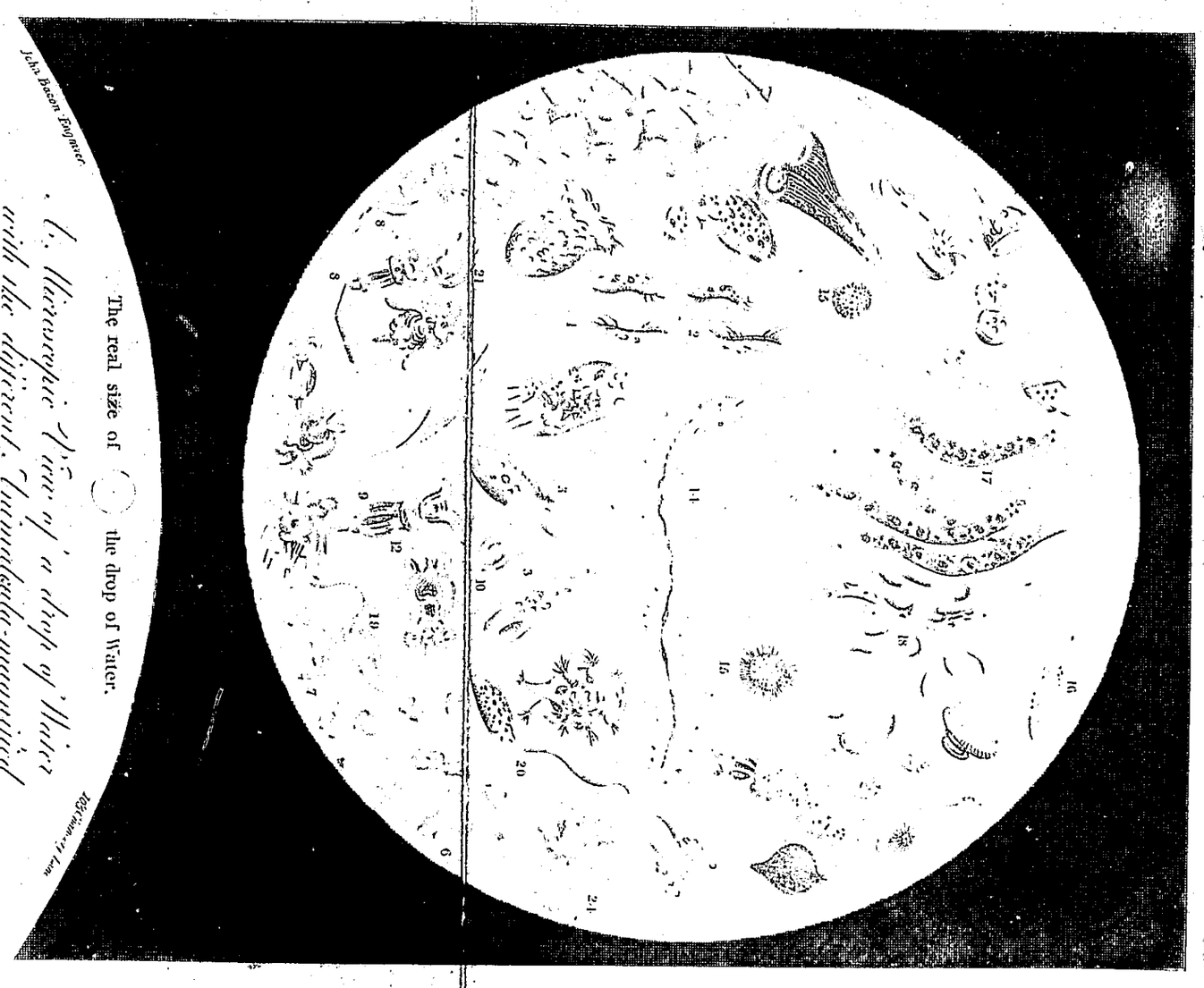

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THE COMPANION

TO THE COMPOUND, OXY-HYDROGEN, AND SOLAR

MICROSCOPES

MADE BY W. CARY, 181, STRAND,

WITH

A CATALOGUE AND DESCRIPTION

OF ALL THE NEW AND MOST INTERESTING OBJECTS;

The best Method of procuring them,

AND OF PREPARING VEGETABLE INFUSIONS TO PRODUCE ANIMALCULES;

WITH PLATES;

TOGETHER WITH

AN ACCOUNT OF A SIMPLE APPARATUS FOR EXAMINING THE PHENOMENA OF CHEMICAL ACTION,

AND A DESCRIPTION OF

C. GOULD'S

Improved Pocket Compound Microscope,

Which has all the Uses of the Single, Compound, and Opaque Microscopes, with a Magnifying Power of 62,500 Times.

By C. GOULD.

THIRTEENTH EDITION, WITH AN ADDITIONAL PLATE, AND DESCRIPTIONS OF ALL THE TEST OBJECTS.

LONDON:

SOLD BY W. CARY, 181, STRAND;

SIMPKIN AND MARSHALL, STATIONERS' HALL COURT; AND BY ALL BOOKSELLERS.

1839.

G. DAVIDSON, PRINTER,
SERLE'S PLACE, CAREY STREET.

THE COMPANION

TO

THE MICROSCOPE.

MANY persons who have purchased Microscopes, after entertaining themselves and friends with the slides which accompany the instrument, have found themselves at a loss for new objects, and, consequently, have laid it aside as of little further use: but no invention is capable of affording more entertainment and instruction than the Microscope; it opens a new world, and displays the most extensive scenes of creative power, wisdom, and design. This small treatise, it is presumed, will be the means of showing an extended field, as it contains every direction with regard to procuring and applying the most interesting subjects for examination by the Microscope: also the method of producing those wonderful objects of the minute creation, the animalcules in vegetable infusions; it comprises, likewise, a list of upwards of two hundred different objects, and a description of C. GOULD'S New Improved Pocket Compound Microscope. The extreme portability and great magnifying power of this Microscope will recommend it strongly to

the naturalist, mineralogist, and botanist, as it has sufficient powers to discover the most minute animalcule and seed vessels; it combines the uses of the Single, Compound, Opaque, and Aquatic Microscopes: and has been found, upon comparison, by several scientific gentlemen, superior in power to, and more distinct than many of the largest and most expensive instruments of the kind;—it shuts up in a case, three inches by three and a half, and may be carried in the pocket without the slightest inconvenience.

DESCRIPTION OF THE PLATE.

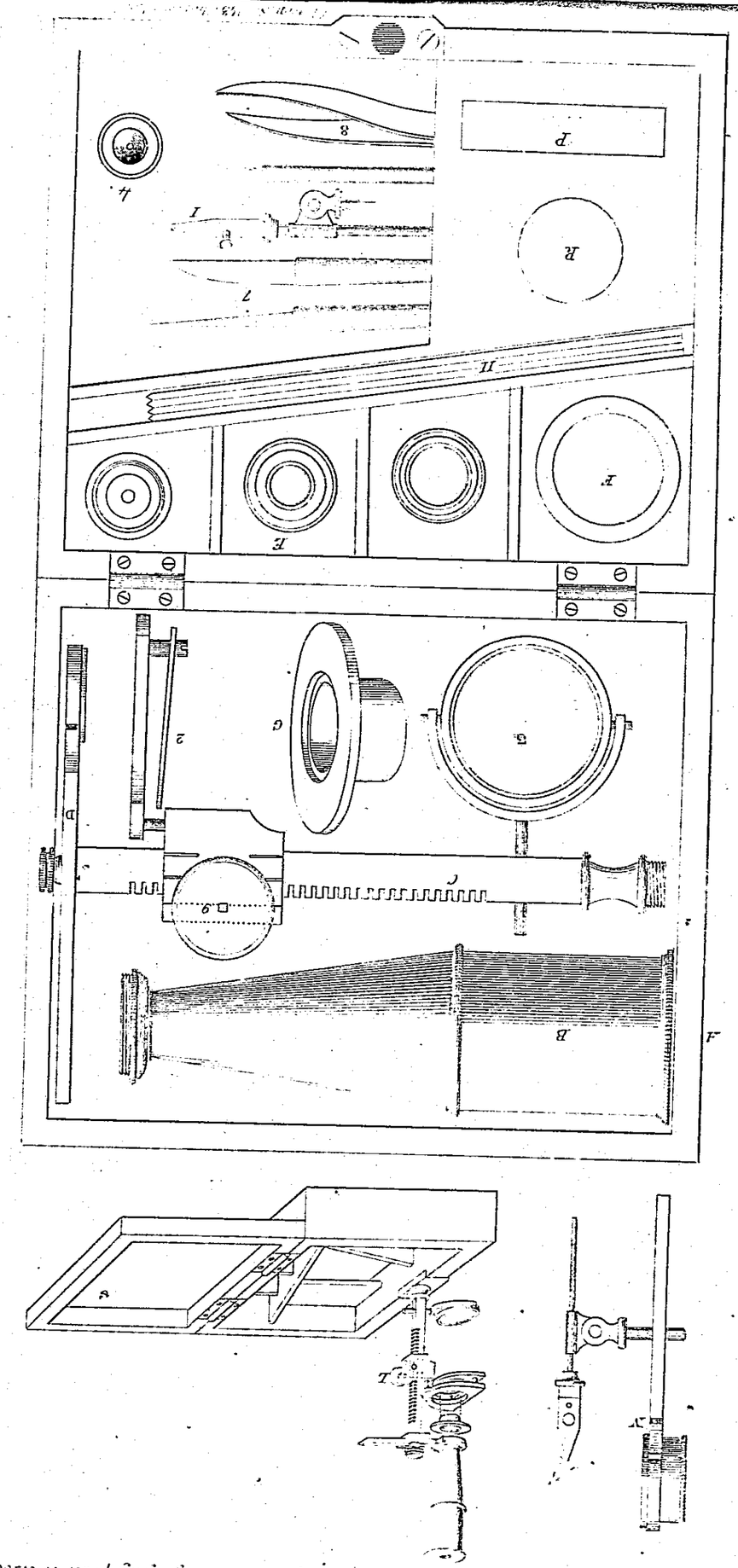
A—The Microscope, as it lies in its case, the body and pillars taken out, to show the apparatus beneath.

B—The Compound Body.

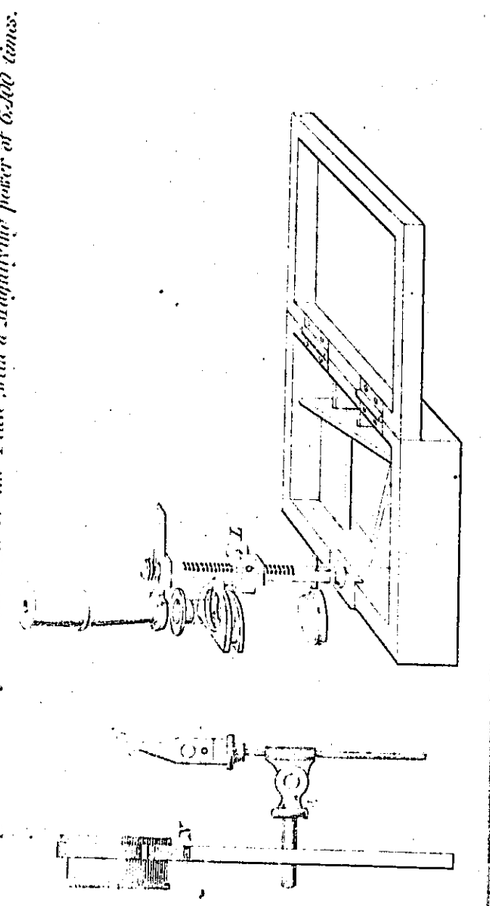
C—The Pillar on which is fixed the stage—Fig. 2, and reflecting mirror—Fig. 3. These remain on the pillar when put into the case, for the convenience of packing.

D—The Arm may be taken off and used as a Hand-Microscope—Fig. N.

E—The different powers, Nos. 1, 2, 3. These are screwed on to the arm, and in them the body, but each may be used singly for large or opaque objects without the body. Nos. 1 and 2 may be combined; No. 3 is not to



Smith's Improved Pocket Compound Microscope.
Answering the purpose of the single Compound Opaque Aquatic Microscope,
Stands in a case 3″ by 2″ the size of the Plate, with a Magnifying power of 6400 time.



Smith's Improved Pocket Compound Microscope.
Answering the purpose of the single Compound Aquatic Microscope.
Shuts up in a case 3" by 2" the size of the Plate with a Magnifying power of 6,400 times.

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be combined with either, but used singly; the No. 4, in the small flat cell, is the higher power, and is to be used with or without the body for extremely minute transparent objects.

F—The Object-Box, which unscrews to place live objec s in, such as mites from cheese; this is placed on the stage.

G—A moveable piece, to place on the stage, Fig. 2, for holding objects.

H—Slides filled with curious objects.

I—A pair of Steel-pointed Forceps, which open by pressing the two brass pins, for holding flies, or pieces of card with opaque objects on them; this is placed in the hole on the stage or on the arm, when used as a Hand-Microscope—Fig. N.

K—A Dissecting-Knife and Point; a pair of Brass Forceps, for taking up small objects, with a spoon at the end for taking up a single drop of water, for placing between the two glasses to view the animalcule; a small brush for taking the mites from cheese, farina from flowers, and other delicate objects.

L—The whole instrument put together for use.

N—The Arm converted into a Hand-Microscope.

P—Two Pieces of Glass sealed together for holding a drop of water.

R—A circular Piece of Glass for placing on the stage G. to hold any object.

DIRECTIONS FOR PUTTING THE MICROSCOPE TOGETHER.

FIRST take out the pillar, on which is fixed the stage and reflecting mirror; screw it on the brass-piece on the side of the box; turn the mirror to face the light, and move the stage to the centre of the pillar by means of the rack and pinion; place one of the powers on the body, and screw it into the arm: you must now get a clear and distinct field; this you will obtain by moving the mirror to the proper angle to reflect the light, at the same time looking through the microscope; now place the object to be examined on the stage; get the proper focus of the lens by moving the stage up and down by means of the milled head, Fig. 9. To place the slides in the stage, press down with the fingers the brass spring underneath; as an improvement for viewing objects generally, the moveable piece G. is placed upon the fixed stage, fig. 2; it may be moved by the finger and thumb, with the greatest delicacy, in any direction; the object to be examined being placed upon the circular piece of glass. To place the pillar again in the case, let the stage be brought close up to the arm, and the mirror turned round; they will then fit into their place without being separated from the pillar. It is more difficult to get the reflected light with the candle than by day-light, but many of the objects appear to much greater advantage; the candle should be placed at the distance of about twelve inches, not too high, and in a straight line with the mirror.

DESCRIPTION AND APPLICATION OF THE DIFFERENT POWERS.

THIS Microscope has five different powers, so arranged that objects may be viewed, from the size of a large beetle or moth to the most minute animalcule. These powers are marked Nos. 1, 2, 3; No. 1 is the lowest power, and is calculated for viewing opaque and large objects, and should be used without the body; No. 2 is the next power, and is calculated for viewing all the objects of the size of those in the slides; the next power is produced by combining the Nos. 1 and 2 together, which may be called the third power; it magnifies 2,500 times, and is adapted for viewing the animalcules, &c. The fourth power is in a conical cell, marked No. 3; with this power an object is magnified 26,000 times with the body; the fifth or greatest power is in a flat cell, and magnifies an object 62,500 times with the body, which is equal to the largest compound Microscopes; it should only be used for extreme minute objects, and without either of the other powers: as the object and the lens come extremely near when it is used, care must be taken, by a very delicate movement of the stage, that they do not come in contact with each other in getting the proper focus. To prevent this, if a drop of water is to be examined, place it between the slips of glass and if these will not admit the lens to come near enough, place a piece of thin talc upon a piece of glass. Objects should first be viewed with the low powers, that the whole of them may be seen, and the higher ones can then be used in gradation.

OBJECTS FOR THE MICROSCOPE.

IN the summer months, the waters, as well as the hedges, abound with living wonders for the microscope, and afford an endless amusement to the admirers of the works of nature in the minute creation.

BEST METHOD OF PROCURING AQUATIC INSECTS.

In the ponds and ditches that are covered with duck weed, surprising insects may be found; some of the weed should be procured, and put into a white earthen vessel; it will yield a never-failing supply of living and most entertaining objects for the microscope, and may be kept the whole of the winter months, as the leaves have the valuable property of keeping the water fresh. Every proprietor of a microscope, who would wish to secure a supply of a great variety of interesting living objects in constant readiness, should adopt this method of obtaining them. The decayed leaves will be found best for the purpose; two or three of these being taken out, with a small portion of water, on a piece of glass, gently press them, and the wheel animal, as well as many others, will come out from the cells in which they have taken up their abode. The bell-shaped polype, the proteus, and other smaller kinds of animalcules, may thus be had in great numbers.

Those that are visible to the eye may be easily procured by the aid of a small landing-net, made with stout wire and book muslin; bend one end of the wire into a circle and secure it by twisting; the other end will serve for a handle, by which it can be attached to a stick; when used, suffer the water to drain away, then reverse the instrument, touching the water (into which the insects are to be transferred) with the muslin, by which means they can be so transferred without injury by handling; a small instrument, (about 1½ inch diameter,) will be found very serviceable, upon the same plan, in fishing out the insects; when about to be exhibited, put some clear water in a watch-glass, and reverse the net with the insects into it; any one of them singly may be taken out by means of the small spoon or brush, for examination.

BEETLES, MOTHS, &c.

Numbers of these may be found by attentively examining the hedges in lanes; almost upon every leaf you may discover some minute living creature. On the grass a great variety of the beetle tribe may be procured, under stone, in the old trunks of trees, in the bark among the heaths and mosses, and in sand-pits; and a great variety of wings and other parts of insects may be found on the webs of the field spiders, most beautifully dissected for the microscope, in a way that could not be done by any other means. Insects of the beetle class are found in the greatest abundance upon heath. Mosses and vegetation on old walls, contain many rare and curious microscopic insects; a quantity of this moss should be procured, put into boxes and afterwards carefully shaken over a sheet of white paper.

APPARATUS FOR COLLECTING OBJECTS.

These are simply as follow:—A net of wire gauze for taking insects on the wing. It may be held, also, expanded under a tree or bush, whilst the branches are beaten with a stout stick, which will cause a number of curious insects to fall into it.

A Landing-Net, for aquatic insects.—A Knife for extracting objects from the roots of trees, bark, &c.

A strong phial, corked, with a quill passing through it, for water insects.

A Tin Box, the cover pierced with small holes.

A few Chip Boxes.

DIRECTIONS FOR DISSECTING OBJECTS.

In dissecting minute insects, as the flea, louse, &c., in order to examine their internal structure, it is necessary to observe great care; they should be placed in a drop of water, and examined instantly, or the parts will shrink up. A delicate lancet, with a pair of the finest scissors and forceps, are generally used for such purposes.

METHOD OF PREPARING AND APPLYING OBJECTS FOR THE MICROSCOPE.

Most objects require a little management in order to bring them properly before the glasses; if they are flat and transparent, put them between the talc in the slides,—the scales of fishes, for instance, &c. In making your collection of objects, if you wish to fill a number of slides, care should be taken to arrange them as near the size of each other as possible in the same slider, in order that they may be examined by the same power. Minute living objects, such as mites in cheese, small insects on vegetables, &c. should be delicately brushed off into the object-box, and shut up; flies and small beetles may be held by the forceps.

To view the circulation of the blood, &c., in aquatic insects, place them in a small portion of water on a piece of flat glass; two pieces of glass may be made open enough to receive any sized objects of this kind, similar to the animalcule apparatus.

METHOD OF VIEWING ANIMALCULES IN FLUIDS WITH THE GREATEST FACILITY.

The great difficulty of viewing animalcules in fluids must have been felt by all who use microscopes. A drop of water placed on a piece of glass forms a convex surface, and when a high power is used, the animalcules are continually getting out of the focus by diving to the bottom, and the drop very soon dries up.

The following contrivance effectually removes these obstacles when the focus of the power in use will admit one of the pieces of glass to intervene between the surface of the lens and the object.—It consists of two pieces of glass fixed with a small portion of sealing-wax between them, and left open at the top. For viewing animalcules, these pieces should be pressed as close together as possible, but for larger insects they may be left more open. If a single drop of water is taken up by the small spoon at the end of the forceps, and spread over the orifice, it will run in between the two glasses, by which means the surface of the water is rendered perfectly even, and the animalcules are distributed more truly, and confined in a more limited space, whereby their forms and movements become more discernible. This plan also prevents evaporation from the surface, which often dims the lens and perplexes the observer: a single drop of water may be kept for hours in this way, with any curious animalcule alive in it. The glasses can be cleaned out by introducing a piece of thin writing paper between them, and a drop of pure water. By leaving sufficient room between the glasses, the larger aquatic insects may be viewed; such as small tadpoles, the ephemera, and the water flea. When animalcules and other minute objects are viewed with a lens of short focus, the following contrivance is simple and useful; upon a suitable piece of glass describe a circle with white paint; when dry, place the drop of water within the circle, and cover it with a very thin piece of talc, the space between the talc and the glass, pro-

duced by the paint, affords sufficient room for the animalcules to move—the talc (if sufficiently thin) offers no obstruction in bringing the object to the focus of the lens.

SLIDES FOR TRANSPARENT AND OPAQUE OBJECTS.

You will find clear slips of glass preferable to talc in forming the slides for transparent objects; they may be prepared in the following manner: take two slips of glass about the size of the ivory slides; then get a piece of writing paper, with holes of the same size; wet one side of the paper with gum water, and lay the glass upon it, suffering it to dry; then place your objects in the holes, wet the other side in the same manner, and lay on the other glass: any curious objects may be preserved in this way without danger of their perishing; talc may be applied, as in the preceding article, for deep powers. Cabinets are fitted up in this manner, containing from forty to two hundred beautiful und interesting opaque and transparent objects, from 9s. to 30s.

OPAQUE OBJECTS.

OPAQUE objects may be prepared for examination in the following way: cut a card or piece of stiff paper the size of the object to be examined; put a little gum water upon it, and the insect will adhere to it, and may be viewed by placing it under the microscope, on the stage: or, by means of the steel forceps, it may be held in the hand, as in fig. N. For viewing minute opaque objects with a high power, with the body, a strong light must be condensed and thrown down upon them by means of a lens, but the single power or lens is better adapted for that purpose.* To preserve curious opaque objects, they may be fixed on some slips of glass with gum-water, and another glass placed over them, cemented together with sealing wax.

* A condenser can be applied to this microscope, by which means a greater power can be used with the body for viewing opaque objects.

ACTIVE MOLECULES.

In Organic and Inorganic Bodies, discovered by Robert Brown, Esq. F.R.S. &c. &c. &c.

THIS indefatigable gentleman, in prosecuting his elaborate researches into the vegetable kingdom, was led to infer, (from circumstances connected with the investigation of the pollen plants suspended in water,) that the same active molecules might likewise exist in inorganic bodies; he has not been disappointed, having succeeded in separating them from almost every known substance, such as minerals, glass, common dust, soot, &c. &c.; indeed the principal exceptions are oil, resin, wax, sulphur, such of the metals as could not be reduced to that minute state of division necessary for their separation, and finally, bodies soluble in water.

The process of obtaining a satisfactory view of these minute active molecules is exceedingly simple, and is as follows: with the head of a pin place a small drop of distilled or filtered water upon a slip of glass, then apply the head of the pin, (again dipped in the water,) to the substance from which the molecules are to be separated, which is effected by a slight friction: afterwards immerse the head of the pin in the water upon the slip of glass, gently agitating it; this will occasion the molecules to be transferred to the water upon the glass, which is then in a state to be submitted to the deep powers of the microscope: to separate the molecules from the glass itself, either pound it very fine, or gently rub together the unpolished edges of two pieces, having previously wetted them—the produce can then be transferred to a drop of water.

The figure of the molecules is spherical: they are so minute, that four hundred millions of them would not occupy greater space than a superficial square inch. Their motion is very vivid, and consists, not only of a change of place in the fluid, manifested by alterations in their relative positions, but also, not unfrequently, of a change of form in the particle itself; each molecule appears to revolve upon its axis: in fact, the whole of the motions are very similar

to those of the most minute kind of animalcules inhabiting water.

Some persons have considered the motion to result from the evaporation of the fluid and the action of the breath of the observer upon its surface: this is proved not to be the case, by covering the water with a thin piece of talc, when the motions continue unaltered; it has likewise been urged that these spherical molecules may be hollow, and that the motion is produced by the water entering them, thereby displacing the air contained in them—were this the case the action must soon subside, which does not take place: besides, the molecules are proved to be suspended *within* the fluid, by bringing the surface to the true focus, when a variety of *irregular* particles (distinct from the molecules) will be discovered, evidently acted upon by exterior causes.

When it is considered that there is not the slightest difference in the general figure of these active molecules (let the substance be what it may from which they are separated,) it will be conceded that their identity gives them a character which makes it difficult to prove their figure and motions to be the result of mere chance, exterior mechanical causes, or optical delusion; this has been kindly shown by Mr. Brown to the editor, who is perfectly of that gentleman's opinion.

INFUSORIA, OR ANIMALCULES IN VEGETABLE INFUSIONS.

THE smallest living creatures we are acquainted with are the animalcules in fluids; they afford a wonderful scope for inquiry, and nothing is more capable of affording instruction combined with amusement, than researches into the secrets of Nature in the more minute parts of her works; and they present to view most surprising wonders hitherto unknown; for who would or could have imagined that, in a single drop of water, thousands of living creatures are found, most of them invisible to the naked eye, and so extremely minute, that many thousands of them will not cover the space of a grain of sand; the littleness into which Nature descends in these productions, nevertheless, offers

one of the most agreeable subjects for instruction and admiration; for by comparing one of these minute living creatures with a larger animal, whose appearance is terrific, what a disproportion is observable, and what efforts of the imagination does it not require to conceive the smallness of the parts of this minute living creature, for it will appear they are furnished with as many or more members than the largest animal. They possess the apparatus necessary for the circulation not only of the blood, but the atmosphere through their bodies, and the patient experiments of Professor Ehrenberg, of Berlin, have proved, that these exceedingly minute and interesting animals, to whom naturalists (the great Cuvier not excepted,) had hitherto denied the possession of any chymifying apparatus whatever, asserting that they were nourished and sustained by imbibition, or absorption, through their entire surface, have no less than from four to forty sacks or stomachs. The mode of verifying this fact is extremely simple, and consists in the following process: a drop of water containing animalculæ is to be placed on a slip of glass, and a small quantity of solution of vegetable coloring matter added to it with a camel-hair pencil, the creatures will feed on this substance, and consequently distend their stomachs. Another drop of *clear* water must now be placed near the first, and by drawing a fine point from one to the other, the animalcules from the colored drop will escape into the clear drop, where they may be examined with facility, and the colour of the food will enable the observer to count the stomachs. If the experiment be repeated with *another* colour, the creatures will feed again, and other stomachs will be filled in like manner. Care should be taken that the coloring be *purely vegetable*, for, if it contain any mineral particles, the animalcules will die, or at least instantly reject the food, so that the experiment will fail. Indigo, carmine, sap-green, are found to answer best;—in a word, this little world contains objects of the number and variety of which we cannot have the smallest idea without the assistance of the microscope.

CLASS OR DIVISION OF THE ANIMALCULA INFUSARIA.

Those that have no External Organs.

1. Monas punctiforme ; a mere point.
2. Proteus mutabile ; mutable or changeable.
3. Volvox ; spherical.
4. Enchelis Cylindraceum ; cylindrical.
5. Vibrio elongatum ; long.

Membranaceous.

6. Cyclidium ; oval.
7. Paramæcium ; oblong.
8. Kolpoda ; crooked.
9. Gonium ; with angles.
10. Bursaria ; hollow like a purse.

Those that have External Organs.

11. Cercaria ; with a tail.
12. Trichoda ; hairy.
13. Kerona ; horned.
14. Vorticella ; the apex ciliated.

EQUIVOCAL OR SPONTANEOUS GENERATION.

Equivocal or spontaneous generation, that is, the production of plants without seeds, and of living creatures without any other parents but accident and putrefaction; such was the absurd opinion that prevailed of the production of the minute living creatures, before the microscope overturned it, by demonstrating, that all plants have their seeds, and all animals their eggs, whence the same species are produced. Nothing seems more contrary to reason, than to suppose that chance should give being to regularity and beauty, or that it should create living animals, fabricate a brain, nerves, and all the parts of life ; and, as Mr. Baker observes, we may as well suppose that the woods generate stags and other animals that inhabit them, as that a cheese generates mites without the egg. The growth of animals and vegetables seems to be nothing more than a gradual unfolding their parts till they obtain their full size. Though water, by merely standing a few days, will be found to contain them, yet they will not be found in any degree so numerous as when vegetable bodies have been steeped therein, for no living creatures seem to subsist upon water alone : but when it is stored with their proper food, myriads may be found in every drop, of the greatest variety in their forms : some are round, some oblong, and others spherical, and the greatest part of them transparent : motion seems to be their greatest delight ; they pervade with ease and the greatest rapidity the whole dimensions of the drop of water, in which they find ample space ; sometimes they dart forwards, and at others move obliquely, then again in a circle, and though hundreds may be seen in a single drop, yet they never strike against one another : they differ in their size ; some are barely visible to the eye; some so minute as to resist the action of the microscope ; and appear only as moving points ; of this description is the monus ; it is so extremely delicate and transparent, as sometimes to elude the highest magnifying power : some are, no doubt, inhabitants of the water, and others turn into small flies, and deposit their eggs in any kind of fluid producing proper nourishment for their young ; the eggs being hatched, they live a certain time in this element, then take wing after a complete change in their forms ; this may often be observed, for when they grow to a certain size, of a sudden you will find them gone, and a small race supply their place.

As these infusions, to produce them, are all prepared in a similar manner, and as the two following substances may be procured without much trouble, and generate the most remarkable subjects, we shall describe the necessary preparations.

HAY.

THE infusion of hay produces the greatest variety of animalcules, and by far the most curious; all those described in the plate may at different times be found in this infusion. Twist up a little hay, and press it down into a tea-cup, or any other vessel; cover it with water to the top, and if it absorbs the water, put fresh in; in a few days, in summer, a scum will appear on the top; take from the surface, with the spoon at the end of the forceps, a single drop, and place it between the glasses; it will be found to contain extremely minute animalcules: in a few days they increase in size, and in about ten days they obtain their full growth. It is impossible to enumerate the variety that may be discovered at different times in this infusion; the most numerous are in the shape of an egg, fig. 1; and with a high power a great number of small feet may be discovered, and at the head a number of fibrillæ, which are continually in motion, creating a vortex in the water which brings their prey towards them, which may be discerned many hundred times less than themselves; they use their legs in running as well as swimming, for by placing a human hair across the water, as fig. 2, a number of them will be seen running along it. We shall find another sort in the shape of a sole, without the appearance of any legs, fig. 3; and many others, which are described in the following pages. The eggs or spawn may be seen, with a high power, attached to any small portion of matter in the drop of water.

PEPPER.

PUT common black pepper bruised into an open vessel enough to cover the bottom, pour water upon it about an inch deep, stir them together when first mixed, and afterwards let them remain still. In a few days, in warm weather, a scum will appear on the top; take a single drop from the surface, and place it on the glass. It sometimes

happens that such multitudes are in a single drop, that it becomes quite opaque; in this case, dilute it with a drop of pure water.

The following substances produce different descriptions of animalcules: senna, Indian wheat, cabbage, raspberry-stalks, all kinds of flowers, grasses, &c., oatmeal, bran, &c. Also water in which flowers have been standing for any length of time.

BELL-SHAPED POLYPE.

DURING all the months in summer, and particularly in April, a great abundance of these curious insects are to be found on the shells of the small water-snail, duck-weed, and other water plants, and on the larvæ of the larger insects, in such multitudes, at times, as to appear like a fine down upon them; they are extremely minute, and generally fasten themselves by their tails in groups of twenty or more, extending themselves in every direction in search of food, and are not unlike a bunch of tulips; they spring back with a sudden contraction, which is no doubt when they have caught their prey; if they are touched or disturbed, the whole of them contract themselves, as fig. 24. The various species are nearly alike as to the above particulars, but greatly differ with regard to their size; but none are more interesting than those shewn in the plate fig. 6; when these little animals stretch themselves out, and open their anterior ends, each appears like a bell, with a rim or lip furnished with a number of fibrillæ, and vibrate so quickly, that it requires a strong power to see them; it creates a vortex in the water, which reaches to a great distance, in proportion to its size. But though they are found thus joined together in colonies, each head is a perfect insect, and can detach itself from the rest, live separate, and become the parent of a new colony, as most of them do after a certain time; for by attentively examining them, they may be seen swimming about the drop of water separately. When a number of them are fixed to a body, they appear of a whitish colour to the

naked eye, but through the microscope transparent, with spots upon them.

BELL-SHAPED POLYPE FOUND IN HAY.

After hay has been infused for some weeks in water, extremely minute bell-shaped polypi are found, among a variety of others, as in fig. 4, and require the greatest power of the microscope to discover their form, for their tails must be many thousand times less than the finest hair of the head. As seen in the plate, they are magnified in bulk six thousand four hundred times, whereby we may form some conception of their minuteness; yet, small as they are, they live upon animalcules many hundred times less than themselves.

THE SMALL SNAIL WITH SPIRAL SHELL.

This description of snail may be procured in ponds and ditches; the more transparent the better. They may be kept alive for months in a large glass vessel; and it is common for them to fasten their spawn in little masses against the sides of the glass, where the eggs hatch in about three weeks or a month. The spawn appears like a transparent jelly; but, examined by the microscope, you may discover a number of oval pellucid bodies, having each of them a dark speck: this speck becomes a perfect snail, and, a few days before hatched, may be seen, in a perfect state, turning about in the fluid that encloses it; the heart also may be distinctly seen, the pulsation proceeding under the eye with great exactness and regularity, forming a most beautiful spectacle; a number of the bell-shaped polype generally attach themselves to the snail.

THE PROTEUS.

None of the many different animalcules I have yet examined have afforded so much pleasure, perplexity, and

surprise, as the curious insect I am about to describe, which has so wonderful a capability of assuming different shapes, that nobody, without actually seeing its changes, would believe it to be the same creature; it may be found in water where any kind of vegetable bodies have been infused and which has stood for several weeks; if it is in a glass vessel, a slimy substance will be collected about the sides: some of this being taken off with the point of a knife, and placed on the slip of glass in a drop of water, it will be found, upon looking at it through the microscope, to harbour several kinds of animalcule; the proteus will most likely be seen among them, and is thus described by Mr. Baker: "After having been examining some of this matter for some time, which I found plentifully stocked with various kinds of animalcules, a little creature suddenly made its appearance among them, whose figure was entirely new to me, moving about with great agility: the body was elliptical, with a slender fine proportioned neck, similar to a swan's. Fig. 19 is a representation of this extraordinary insect. It moved its head backwards and forwards, seemingly in search of its prey. After viewing it for some time with a lower power, wishing to change it for a greater, which took up some time, it was lost to view, and nothing was seen the least resembling it. Some weeks after, examining some more of this slimy matter, again the same kind of insect made its appearance; after watching it for some time, it suddenly changed its form,—it drew in its neck and only the body appeared; another change then quickly took place; it thrust out its head, as in fig. 20, with wheel-work machinery."

THE HYDRA, OR POLYPE.

The nature of this insect is extremely singular, and contrary to the general principle of life; for if the polype be cut into any number of pieces, each piece will become a perfect creature, having all the functions of animal life. They were first discovered by Mr. Trimley, who took them for plants, and saw, as he imagined, young shoots or branches

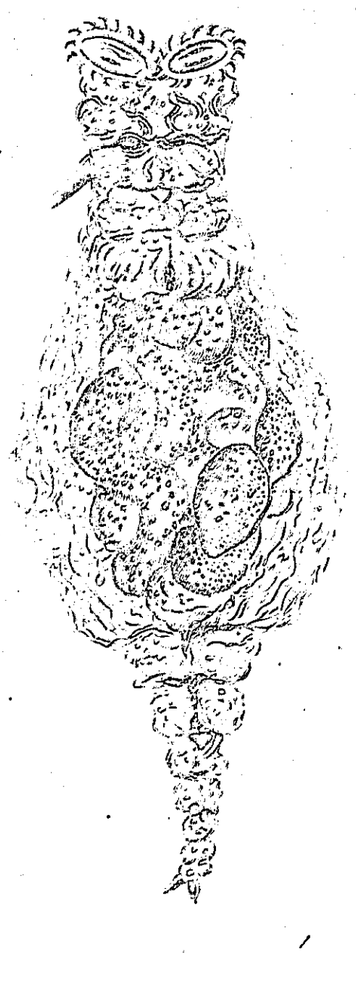
coming out; at last he perceived them devour smaller insects; he cut one of them in two, and, in a few days, new arms were growing out of the part he had cut away; these insects have since been divided in every way with similar effect. The green polype, which is most common in this country, is about a quarter of an inch in length, and its arms are placed in a circle round its mouth. This kind is found crawling on the ground in clear running water, or on water plants, hanging by its tail, and extending its arms in search of food. The hydra, or polype, (put into a glass vessel with other water insects, and a quantity of duck weed,) may be kept alive for months. When hungry, it spreads its arms in a kind of circle to a considerable extent, inclosing in this, as in a net, every insect which has the misfortune to come within the circumference. While the animal is contracted by seizing its prey, the arms are observed to swell like the muscles of the human body when in action. Though no appearance of eyes can be observed in the polype, they have certainly some knowledge of the approach of their prey, and show the greatest attention to it as it comes near them. It seizes a worm the moment it is touched by one of the arms; and, in conveying it to the mouth, it frequently twists the arm into a spiral, like a corkscrew, by which means the insect is brought to the mouth in a much shorter time than it otherwise could be; and so soon are the insects on which the polypi feed killed by them, that M. Fontana thinks they must contain the most powerful kind of poison. When taken out of the water, they all contract so much that they appear only like a little lump of jelly. The arms have the same power of contraction or expansion that the body has; and they can contract or expand one arm, or any number of arms independent of the rest, and they can likewise bend their bodies or arms in all possible directions.

LUMINOUS WATER INSECTS.

The Rev. Mr. Baker, in his observations on luminous insects in water, says, that he has been surprised sometimes

A MICROSCOPIC VIEW of the WHEEL ANIMALCULA,

Magnified 26000 times by C.Gould's improv'd Compound Microscope.



J.Bacon, Engraver 103, Chancery Lane.

at the sparks of light to be seen on the shells of oysters, on removing them when fresh taken from the sea. He bestowed some pains to find out the cause, and was perfectly convinced, after many examinations, that it arises from a minute insect, the length of which is about one-eighth of an inch; the head is armed with a pair of forceps; the body consists of twenty-eight joints or divisions, each having a pair of feet belonging to it. This little insect can emit or conceal its light, and is very similar to the glow-worm.

SEA-WATER.

ANOTHER account is given by Dr. Veanella, of Chioggea, in Italy. In his inquiry into the shining of sea-water in the night, which, he says, is seen with wonder in the lakes of Chioggea, where sea-weeds abound, he relates that he brought from thence, one summer's night, a bottle of the water, which, being stirred in the dark, sparkled; but after being filtered through a cloth, afforded no light at all, while the cloth was covered with shining particles, which, being examined by the microscope, were discovered to be living insects, formed something like a caterpillar, with ringlets on the body; from the head issued two horns, and the tail appeared twisted. These insects are entirely luminous, and when at rest do not shine at all, but send forth a great light as soon as they become agitated.

VORTICELLA, OR WHEEL INSECT.

THIS surprising insect is found in leaden gutters, not exceeding the size of a grain of sand; you may often discover it in ponds, ditches, upon duck-weed, &c., and in water that has stood some time in vessels in the house, adhering to the sides, and in the infusion of hay; if the water or the sediment in gutters has a red appearance, you will most likely find some: the minuteness of these insects makes it impossible to know whether you have them or not without examination with the glasses. The best way of

discovering them is by placing some of the sediment under the low power of the microscope: If you find any there, then screw on a high power, and watch their motions with attention. This little creature shows itself first like a transparent maggot, lengthening out its body at times, and at others contracting it,—changing again its form in an instant, as figs. 9 and 21. Every part seems capable of great extension and contraction: to examine the wonderful mechanism of its parts will afford hours of amusement; it being transparent, the motion of the heart and other internal parts may be seen: it appears continually to be hunting after its prey, has a large mouth, and is furnished by nature with an amazing piece of machinery or wheel-work to procure its food; the wheel-work projects from the head, and turns round with great velocity, causing a rapid current of water to be brought from a considerable distance to its mouth, and by this means supplying it with food; as these wheels are transparent, it is very difficult to determine by what contrivance they move, or what their real figure is. Though they seem exactly to resemble wheels moving round upon an axis, as the insect is capable of thrusting these parts out or drawing them in at pleasure, their figure is completely altered by so doing, and they appear in the various forms represented in figs. 8, 9. 10.

Sometimes they turn themselves into round globules or balls when done feeding: they then draw in their wheels, and their tails remain fastened to the slip of glass they were placed on, as in fig. 7. All their actions seem to imply sagacity and quickness of sensation, for at the least touch or motion in the water, they draw in their wheels: though small creatures, they may be compared to whales in proportion to some of the animacules in the same drop of water; these are their prey, which they draw towards them by the current of water which their wheels excite, fig. 9. None of them can cross this current without being drawn into its mouth. Some of them have eggs or spawn attached: and by procuring a number of them, and watching them attentively, the young one may be seen to burst the egg, and gradually force its way out fig. 12, in doing which, it

is greatly assisted by the tail of the parent, for by moving it to and fro, and striking the shell, it breaks the egg, and the young one, by the assistance of its wheels, is thus enabled to force its way.

A small species of the wheel insect is found in the infusion of hay, after some time standing, as in fig. 5. This animalcule possesses the wonderful property of retaining life for years when out of the water; in this state, life may be said to be latent, but, shortly after the insect is placed in water, it resumes its functions and becomes as active and vigorous as before.

THE SATYR, OR SMALL WATER-SPIDER.

In the ponds, and in several infusions, a little crustaceous insect is to be found, fig. 13. The shell is so exceedingly transparent, that it can hardly be discerned—it covers the whole of its back. Four legs or fins serve it to walk or swim; but it generally creeps along at the bottom of the drop.

Fig. 14 represents an aquatic animal; its appearance to the naked eye is like a slender worm, about one-tenth of an inch in length; but the microscope shows its real form; from the head a long proboscis extends, and is moved every way with great readiness; the head is of a yellowish colour, the rest of the body transparent, and long tufts of hair grow from it; the blood circulates in the middle of the body, running towards the tail.—*See Baker.*

Before we proceed further in our description of aquatic insects, we must call our readers' attention to Mr. Cary's Gas-Microscope, which shows this class of objects with wonderful effect. This clever invention has already excited the marked attention of the public, and will be recorded as one of the many striking improvements which particularly characterize the present epoch.

THE OXY-HYDROGEN GAS MICROSCOPE.

THE application of this light to microscopes originated with Messrs. Cary and Cooper, who, after great trouble and expense, constructed that splendid instrument in Bond-street, which was the first of the kind, and was exhibited to upwards of twenty thousand people. It magnifies one hundred thousand times, making a flea as big as an elephant, with distinctness and semblance of reality. The image is presented on the disc, and appears suspended in space instead of shadow.* The instrument is very simple in its construction, and is as easily managed as a common magic lantern. It is certainly far preferable to the solar microscope in many respects; you get a brilliant light without the intense heat you have in the solar, which almost instantly destroys the living objects; but the great advantage is in having it always at command, night or day, without waiting for sunshine.

The beautiful scenes displayed of inanimate and animate objects baffle all description: the elytra and wings of a number of foreign insects with all their variegated colours and texture, strike the spectator with astonishment; the delicate plumage of feathers; a piece of wood, size of a split pea, magnified to ten feet in diameter, the air and sap vessels finely displayed; the finest pieces of cambric or linen appear like a fishing-net, and the hair of the head as large as a man's arm. The eye of a fly is magnified to six feet, each of the lens as large as an egg. The crystallization of salts forms another interesting object: a drop of water holding salts in solution is placed on a piece of glass, the shootings or rather the crystalline formation of the salts, as the water evaporates, assume every kind of form; in fact an endless variety of objects may be shown in this splendid instrument; and in particular we must notice a numerous group of water insects, animalculæ of all kinds mixed together, in a small vessel or slide, the

* These instruments are fitted up with a beautiful collection of objects, for public exhibitions or private use, by Mr. Cary, 181, Strand; who has recently constructed the instruments now exhibiting at the Polytechnic Institution and the Adelaide Gallery.

space they occupy not larger in diameter than a shilling, appearing to cover the surface of a screen, or disc, of two hundred feet. Here are generally seen the dytiscus or water-lion, the hydropholus or water-devil, destroying the smaller class of insects, such as the ephemera, libellula, &c. &c. and when this is accomplished they devour one another; in a few minutes a scene of carnage takes place, producing one of the most imposing and magnificent microscopic effects that the eye can witness or imagination conceive. *

THE GLOBE ANIMACULA.

THIS animalcule is not larger than the hundreth part of a grain of sand, and perfectly round, having no appearance of head or tail. The whole body is transparent, the surface of it appears to be beset with short hairs, which, when put in action, no doubt, forms its means of motion; it can turn round, as it were upon an axis, without moving out of its place: from seven to eight black spots are observed, which are its young, and, if attentively observed, these will be found to have motion round an axis: these animalcules appear, through a common magnifier, like moving points; in the compound microscope, about an inch in diameter, when their delicate structure is seen. A number of these wonderful creatures may be placed in the slide of the gas microscope, and are magnified to two feet in diameter, presenting to the eye one of the most interesting spectacles, appearing like so many globes in motion. They are found generally in ponds, where there is a species of conferva, of a hair-like appearance; they are very delicate and require to be kept in pure water. I generally make use of a small phial, with a string attached, dipping some water into it, and examine it by holding it against a strong light, with a common magnifier; you may discover by these means, what kind of insects the pond contains,

* A smaller apparatus for private use, has recently been constructed not only for microscopic display, but for chemical purposes, the whole being simple, easily managed, and soon put into action, sold by Cary, 181, Strand.

AQUATIC INSECTS, LARVA, &c.

THE following form an interesting class of objects for the gas and solar, as well as the compound microscope, and are magnified in these splendid instruments to an enormous size, many of them as large as the crocodile, and appear as destructive. Most of these insects may be procured in the ponds about London, and a small net may be used for procuring them; they may be kept for weeks in a large bason, with fresh water every two or three days; I find the readiest way when I want them for the microscope, to take out a few with a small net from the vessel they are kept in, and turn them into a white dish; you may then select some of the most transparent, by means of a small feather. To view them with a compound microscope, a single one may be put into a watch-glass with a small portion of water; in the gas or solar microscope, a number of these may be put into the proper water slides.

ONISCUS.

A GENUS of insects of the order Aptera. The body is oval, consisting of about fourteen transverse segments, and it has fourteen legs. There are forty-three species: they all feed upon animal and vegetable matter, and cast their skin. Their motions in the water are rapid, for besides the feet they are assisted by lateral threads which push them forward like the oar of a boat.

NOTONECTA GLAUCA.—THE BOAT-FLY.

A GENUS of insects belonging to the order Hemiptera. This insect is very common in all the ponds; it moves with great rapidity, and its body has much the appearance of a boat.

LARVA OF THE EPHEMERA

IS found in canals and ponds all the year round, adhering to the grass. On each of its sides are paddles, which are continually in action, and are, no doubt, the organs of respiration as well as motion; its tail has three plumes, and resembles that of a bird. The circulation of the blood

through the head, and pulsation of the heart, may be seen. One of the ephemera only should be viewed at a time in the compound microscope, but in the gas microscope, where they are magnified to three feet, a dozen or more may then be put in, with a little piece of moss or sea-weed, when the habits of these creatures may be discovered. They may be kept alive for months in pond water with a little duck-weed. In their perfect, or fly state, they are not much larger than the common gnat.

On the banks of some of the rivers in Germany, Reaumer describes them as arising from the water in their perfect or fly state, in such myriads that when they fell they covered the ground three or four inches deep, and every part of his face, mouth, &c. were filled with them. At eight o'clock they began to rise from the water, at nine there appeared the greatest number, and at ten there were scarcely any to be seen; so that, in less than two hours, this host of flies emerge from the water, perform their appointed work, and die.

LARVA OF THE LIBELLULA OR DRAGON FLY.

THIS insect belongs to the order Neuroptera, their forms and colours are elegant, but their inclinations are of the most murderous kind. Far from feeding on the honeyed juice of fruits and flowers, they hover aloft in the air, ready to dart down on all the winged insects which they can discover, as the raptorial birds come pouncing on their prey. This insect keeps wheeling round and round, and backwards and forwards, over a considerable portion of the pool which it frequents. If one of the same species comes in its way, a battle ensues; if other species of libellulinæ presume to approach, it drives them away; and it is continually engaged in catching case-worm flies and other insects (for the species of this tribe all catch their prey when upon the wing, and their large eyes seem given them to enable them the more readily to do this,) that fly over the water, pulling off their wings with great adroitness, and devouring in an instant the contents of the body; even the larger butterfly falls a prey to them.

THE LARVA OR THE COMMON GNAT.

THE common gnat is the little creature we see fly over our heads on a summer evening. It deposits its eggs in water: from the egg comes the larva, which is quite a different creature from the perfect insect; it is an inhabitant of the water, and cannot exist out of it; it is found in ponds, ditches, and water-butts, and in the country is often found in water brought to table. The body is covered with tufts of hair, it has a large head with horns, and has every appearance of the head of a bull. It has a curious apparatus at the mouth, which, put in motion, causes a vortex in the water, and brings the smaller animacule towards it, which it feeds upon. It raises itself to the surface of the water suspended by the tail; as it respires from the extremity of the tail, there is no doubt it has a valve that opens when it arrives at the surface, and shuts when it wishes to descend. In some countries their sting is dreadfully annoying. We are told, in this country, that gnats in the year 1736, were so numerous that vast columns of them were seen to rise in the air from Salisbury cathedral, which, at a distance, resembled columns of smoke, and occasioned many people to think that the cathedral was on fire. In the year 1766, in the month of August, they appeared in such incredible numbers at Oxford, as to resemble a black cloud, darkening the air, and almost totally intercepting the beams of the sun. Their bite was so envenomed, that it was attended by violent and alarming inflammation. It is curious to observe gnats in the gas or solar microscope: you perceive twenty of these creatures magnified to the size of crocodiles, with heads as large as bullocks.

The skeleton larva of a straw-coloured gnat strongly solicits the attention of the admirers of nature, and is so remarkably transparent, that, with a microscope, we are enabled to view every part of its structure, and is a most interesting object for contemplation; it is nearly as pellucid as water, and very difficult to be discovered unless held up against a strong light; hundreds of them may be

drank in half a pint of water without being discovered, yet the alimentary canal, with its contents, the process of digestion, and circulation of the blood, are quite perceptible. This larva, in size, is not larger than a fine hair, but in the gas microscope it is magnified to twenty feet in length, and to the thickness of the body of a man.

MONOCULE, OR WATER FLEA.

So numerous is this insect, in the summer months, that the ponds they inhabit appear tinged with red or green, owing to the myriads of them upon its surface. When full grown, the water flea is about the size of the common flea, it produces its young a perfect insect, but appears to have but one eye. For a microscopic object choose one that is most transparent, you will find it as interesting as any of the insects already enumerated. The pulsation of the heart, the eye moved as the human eye by muscles, and, at times, the young perfectly formed in the parent, may be seen. In the gas microscope it may be magnified to six feet, and the heart to the size of the human heart.

THE DYTISCUS, OR WATER BEETLE.

THE larva of this creature, as a microscopic object, is called the water lion; it is found in ponds and ditches, and is one of the most formidable of the water insects. It has a long slender body, the head armed with a pair of fangs, or forceps, in which it holds its prey, which it seizes like a lion, nor lets it go till devoured. At the extremity of the tail are the organs of respiration. A scene is often witnessed in the microscope of two of these creatures seizing one object, when a conflict ensues, which frequently ends in the death of one of them. There are several species of the dytiscus; the larva of the large kind is only found from April to July, the smaller all the winter.

HYDROPHILUS.

THE larva of this insect, like the dytiscus, is of the most voracious and formidable description; it is armed with fangs at the head, the body is covered with hair, with tufts on each side, and it attacks any insect that comes within reach; no doubt their bite is as venomous as the scorpion's, for its wounded victim instantly dies; they respire at the extremity of the tail, and, like the dytiscus, watch for their prey.

GORDIUS AQUATICUS, OR HAIR INSECT.

THESE creatures are found in multitudes in the sediment of the Thames water; they are about the diameter of a horse hair, and are generally found congregated or coiled up in masses, but are enabled to stretch out to a great length, by means of a spiral vessel, which, in the microscope, is beautifully shown; in the gas microscope they appear the size of boa constrictors. A great body of them cause a red appearance upon the mud of a river, when the tide is down.

PASTE EELS.

THOSE who are desirous to be furnished with a curious living object for the microscope, should be provided with the eels in paste; they are, after the paste has been made for some weeks, so numerous, that the whole surface of it appears alive, and by taking from the surface with a point of a needle the smallest particle, and putting it in a drop of water, it will be found to contain a number of these minute eels, fig. 17, with a continual regular motion swimming about the drop of water. A curious experiment may be performed by separating one of the larger sort from the rest, by placing it in another drop of water, by means of a fine point of a quill; it may then be easily cut asunder by a fine lancet, and if the division is made about the middle of the animal, several oval bodies will be seen to come

forth as in fig. 18; these are the young, curled up in a fine membrane: the largest and most forward break through it, unfold themselves, and swim away; numbers have been seen to issue from one single eel which accounts for their great increase. The question is, by what means do they first get into the paste. If the eggs were in the flour, the operation of boiling the paste would certainly destroy them; but it is a most extraordinary fact, that they will live in a degree of heat above one hundred, and in paste too hot to bear the finger in. In viewing the paste eel with deep powers, there is no necessity to produce an elevation between the glass and the talc, as the paste, although diluted with water, answers that purpose—place a drop of water upon the glass, into which introduce a small quantity of the paste, covering both with a very thin piece of talc; prepared in this way, any power may be applied with effect; in fact, the paste eel is a good object for the deepest powers.

VINEGAR EELS.

A SMALL eel may likewise be found in the dregs of vinegar that moves much quicker than the above.

EELS IN BLIGHTED WHEAT.

THESE animalcules are not usually lodged in such blighted grains of wheat as are covered externally with soot-like dust; but abundance of ears may be observed in some fields having grains that appear blackish, as if scorched, and, when opened, are found to contain a soft white substance. This, examined attentively, seems to be nothing else but a knot of threads lying as close as possible to each other. This fibrous matter exhibits no sign of life, but, upon applying water to it, the supposed fibres separate, and prove to be living creatures, by motion, at first, languid, but gradually more vigorous.

BUTTERFLIES AND MOTHS.

We cannot enumerate all the different sorts of these beautiful insects, and it is impossible to describe the variety and splendour of their plumages, surpassing all the magnificence of the richest and most costly dress. All the butterfly and moth tribes are bred from caterpillars. The number of these insects is very great; Linnæus reckoned eight or nine hundred different kinds, some of which are extremely rare, and only found in particular places. The legs, antennæ, the eyes, in fact every part, when examined, afford the highest entertainment.

DUST ON THE FEATHERS OF A BUTTERFLY'S WING.

The wings in themselves are, like the common fly's, transparent, but owe their opacity to the beautiful minute feathers which cover them; and, examined by the microscope, nothing can exceed the beautiful and regular arrangement of these little substances, which, by their different colours, serve to paint the wing, and by their regular layers, resemble the tiles of a house-top. Carefully brush some of the dust off on your slide, between two pieces of talc, place it under the microscope, and you will be richly rewarded for the trouble taken. With a high power and strong light, beautifully prismatic colours and lines may be discovered.

THE OAT ANIMAL.

In the sediment of water from seeds may be found the oat animalcule, so called from its resemblance to a grain of oats; it is enclosed in a shell, which it opens and shuts, but can change its place only by sudden jerks or leaps. This little creature is so extremely small, that it requires the greatest magnifier to examine it. It is shown in fig. 16.

A MICROSCOPIC VIEW of a CHEESE MITE & the EGG,

Magnified 20000 times by Gould's improved Compound Microscope.

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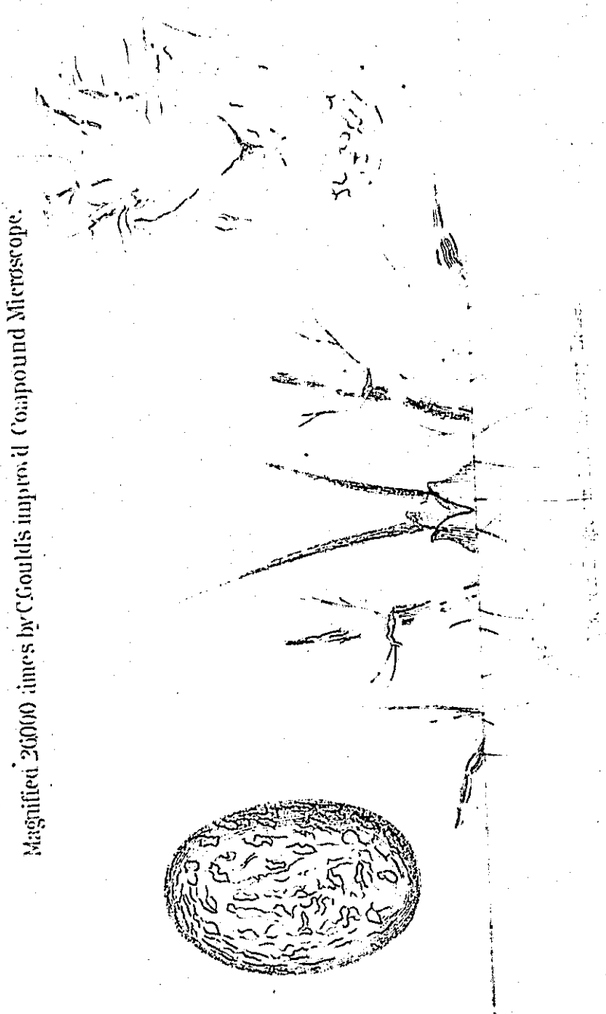


A MICROSCOPIC VIEW of a CHEESE MITE & the EGG,
Magnified 20000 times by C Goulds improved Compound Microscope.

MITES, &c., IN SEEDS.

VARIOUS species of mites, and other curious insects, may be found in the siftings of seeds, particularly a very peculiar one, in those of the common poppy; this insect is furnished with two fangs of a very formidable description, having joints like the claw of a lobster—with these fangs it seizes its prey and conveys it to its mouth. I would recommend every person possessing a microscope to provide himself with some of these siftings, which may be procured at any of the seed shops.

CHEESE MITES

ARE those minute creatures found in old cheese. To the eye they appear like moving particles of dust, but the microscope discovers them to be animals, perfect in all their parts, having as regular a figure, and performing all the functions of life as well as those animals which are many million times their size. The head is formed like a pig's, they have two small eyes, and are extremely quick-sighted. Each leg has six joints, with claws. The body is covered with long hair. These creatures are male and female, are produced from the eggs, and come forth perfect insects; though extremely minute, you may sometimes see them break the shell and force their way out. The egg itself is a curious object for the microscope. The mites may be kept alive for months, between two glasses, or in the object box. The best method of preserving them for the microscope is to put some bits of old cheese into a small phial, and pierce some holes in the cork for air: by gently heating the bottle, they will crawl up the sides, and through the holes of the cork, and can be brushed off with a camel's-hair brush, free from dirt, on to the glass. Mites may also be found in stale flour, or in the dust of the dried fig. I have succeeded in dissecting the jaws of one of these insects, and have displayed them most beautifully between two pieces of glass: they are, as may be supposed, extremely delicate, but can be seen very distinctly.

BEETLES.

So great is the variety of the beetle tribe, that it would be impossible to enumerate them in this little work. They come from a grub, or maggot, deposited in the earth by the female; many of the water-beetles are interesting microscropic objects.

THE CIRCULIO REGALIS OR DIAMOND-BEETLE.

It is impossible to conceive any thing more beautiful under the microscope than in this insect. It is found in the Brazils, and other parts of South America; it is decorated with large brilliant gold colour patches, dispersed in rows, over the wing-covers, which are of a jet black; these patches owe their brilliancy to innumerable scales or feathers, and, through the microscope, exhibit the varying lustre of the most brilliant gems; these feathers are similar to those on the wings of the butterfly, &c.; a few may be placed on a piece of glass, and when examined with a high power, parallel lines will be observed, extremely fine, forming an excellent test of the goodness and power of a microscope.

THE CIRCULIO ARGENTATUS.

A small species of the diamond-beetle found in this country. It is about a quarter of an inch in length, and, viewed with the microscope, exhibits a splendour of the diamond character, produced by a covering of scales of a beautiful gold green colour; it may be found in the fields and gardens in the summer months, or on the leaves of trees, particularly the oak.

CATERPILLARS.

The caterpillar is one state of the butterfly. If the silk-worm be observed in every stage, from the caterpillar

to the moth, it will give a correct notion of this class in general.

The body consists of twelve rings, and the changing its skin is effected by its withdrawing from the old one as from a sheath; and to accomplish which seems to be the work of time, but which they do successively three times before they arrive at their perfect state. The skins which they shed may be viewed by the microscope to much greater advantage than the real insect, and are well worth procuring; one in particular, having four tufts of yellow hairs, and covered with smaller ones; these, when examined, appear like feathers.

INSECTS ON THE BARK AND LEAVES OF THE ASH.

On the bark and leaves of the ash and other trees a small insect is found, inclosed in a dark spot, not larger than a pin's head; each spot serves as a covering for thirty or forty ova, which, on removing a fine silken covering, may be seen of a scarlet colour, but extremely minute; and it is pleasing to see them creep out of their cases.

THE FLEA.

This well-known insect is covered all over with a shining armour, or scale, curiously jointed, and folding one over the other, with long spikes in regular order: its neck is finely arched; it has two large black eyes, and a pair of horns, or feelers. Its head is very extraordinary: from the front part proceed two legs, and between them is its sucker, or piercer, by which it penetrates the skin of animals, and draws out the blood. It has, also, four other legs, and when it takes its amazing leaps, it folds the short one within the others, and exerting its spring at the same time carries itself to a great distance for so small a creature. These insects are male and female; they deposit their eggs

on the hair of cats, dogs, &c. sticking them on with a kind of glutinous matter. When hatched they are not perfect, but are small maggots, which feed on the juices of the body; from this state they change to the perfect flea. By keeping a few of them in a glass tube, you may procure their eggs. The best method of dissecting a flea is in water; and to examine the sting, cut off the head, and place it under the glass,—by gently pressing it, you force out the sting; this sting, or lancet, is lodged between the fore legs, and after it has made an entrance, the blood flows freely from the wound.

THR LOUSE.

THE louse has so transparent a shell, that we are able to discover the circulation of the blood: the head has two large black eyes; the legs, six in number, with hooked claws, act as a thumb or finger; the body and legs are covered with hair. It lays its eggs in human and other hair; these are what are generally called nits, and are worth while examining: they are stuck on firmly to the hair with a glutinous matter. The young one comes forth from the nit a perfect animal. We cannot wonder at their increase, when one female will lay fifty eggs in a day, and these come to life in six days.

SPIDERS.

EVERY one is acquainted with the general form of a spider without the assistance of a microscope. We shall give a description of the different parts of this insect which are only to be discovered by it. As the fly, the spider's natural prey, is extremely cautious and nimble, it is necessary that the latter should be able to look in all directions, and the number and disposition of the eyes are wonderfully adapted for this purpose; it has eight eyes, and as it cannot move its head, they are placed round it so that it can see in all directions. The weapons that it uses to kill its

prey are well worthy of attention,—they consist of a pair of claws, or forceps, in the forepart of its head. It is hairy round the mouth, and it has two rows of teeth. Spiders frequently cast their skin, which may be found in cobwebs. The spider's web is formed by a gummy liquor proceeding from the tail, which adheres to any body that it presses against, hardens in the air, and becomes a thread of so fine a texture, that it is calculated that it would take ten thousand of them to make a single human hair. The eggs of the spider are curious objects,—flat at one end, with a circle round them: the young spider comes out perfectly formed. The egg, which the female guards with the greatest care, is deposited in the web. The number of eggs in one nest, are several hundred. There are two or three kinds particularly worthy of notice,—a small white field spider found among new hay; the leaping spider; another with two tufts of feathers in its fore paws, and spotted; and a small red spider, found on trees. The eye, mouth, and leg, when examined with the microscope, will be found most beautiful and interesting objects.

THE COMMON FLY

BECOMES an interesting object by dissecting it, and placing the different parts under the microscope, particularly the foot; the body is covered with long hair; the head contains two large eyes, and is one of the most curious objects under the microscope that can be conceived, for it is found to contain a number of lenses, or eyes, and, like the spider, it cannot move its head: the trunk consists of two parts, sheathed in the mouth. It deposits its eggs in any kind of flesh; these are generally called fly-blows, but if examined will be found perfect eggs: from the eggs proceed minute worms, or maggots, which in a few days become flies.

THE CLOTHES MOTH.

MANY are not aware to what extent of mischief this little creature is capable: all kinds of fine woollens, furs, and feathers, if not entirely destroyed, are rendered perfectly useless in a short time, by this diminutive enemy. The perfect insect is a small moth, not so large as the common fly, of a pearly appearance, which may often be observed to fly out on opening the doors of wardrobes, boxes, drawers, &c In the summer months they deposit their eggs in woollen substances, where they in a short time, become small caterpillars, and immediately begin their work of destruction; they creep into the folds of the cloth, and remain undetected till the cloth is held up to the light, when it is found as full of holes as if it had been perforated with shot. They are covered all over with minute scales, the stria on which form one of the most severe microscopic tests. There is no better way of getting rid of them than by putting camphor bags in those places where you detect them.

THE SNAIL.

THE eyes of the snail are placed upon its horns, in appearance like two black spots; the mouth resembles a hare's, and the heart may be seen beating under the neck by dissection. It lays its eggs with great care in the earth and comes forth with the shell perfect. By confining it under a flower-pot, you will most likely find some of its eggs in a few days, about the size of pea and of a beautiful regular form.

THE ANT.

THE ant is well worthy of notice: it is a creature of a very singular habit and structure; its head large, with pearled eyes; its mouth opens wide, which enables it to

carry bodies much larger than itself: the head, body, and tail-part are held together with a very fine ligament; the tail is armed with a sting, and the eyes are covered with hair. The opening an ant-hill throws the whole community into confusion, some carrying pieces of stick, and others their young in the aurelia state. Ant's eggs are about the size of a grain of sand, and produce maggots, which spin themselves coverings, and in a certain time become ants. The ant's affection for its young is so strong, that when danger is near, it will run away with them, and sooner die than leave them. The following account of these insects is taken from Baker's Employment for the Microscope:—"Every nest appears to have a straight pole leading to the centre; then another sloping off to the magazine, where the grain they collect is stored up; the corn, being under ground, would grow, did they not use the precaution to bite out the germ, or bud, before they lay it up; this they constantly do, for, if, examined, none will be found: it would likewise be liable to rot, but this they remedy in the following manner:—they gather small particles of dry earth, and place them in the sun, every one bringing a particle; and in this manner a vast number is accumulated round the hole: their corn, when it is properly dry, is laid up in this earth under ground. The author of this account found a nest of ants in a box of earth, standing out of a window two stories high; some corn lay at the bottom of the house, which obliged them to come down for it to supply themselves with food: they regularly came down from the top of the house to the bottom, and never went up without something in their mouths: some even travelled to the farthest part of the garden, and brought a load from thence. By frequent observations he found that it took one four hours to carry a load from the latter place to the nest. Sometimes they would become weary before they reached home; in this case it was common to to see a stronger ant coming to meet them, and carry home their load." The following curious circumstance came under my own observation:—Having occasion to keep a quantity of ants in the earth for the food of a nightingale, they were put into a large earthen pan; in turning them out from the

bag, a number of them had lost their lives; a day or two after, I observed a number of dead ants in one particular spot, about the size of a half-crown, placed in regular order at the extreme edge of the pan: on looking more closely, I discovered a number of live ants coming up from the bottom with dead ones in their mouths, making all of them towards this particular spot, depositing their load, and returning again, till they were all brought up to the surface. All these facts show the wonderful instinct of these little creatures.

THE PEACH, OR RUBY-TAIL FLY.

THE most beautiful description of flies we have in England is the peach-fly, found in gardens, which settles generally on the peach-tree. The head is of a very beautiful blue, and the body of crimson. This fly cannot be caught without considerable dexterity. Upon dissection, it will be found to have a very small sting.

INSECTS ON THE LEAVES OF VEGETABLES.

NOTHING is more common, in the beginning of summer, than to see the leaves covered with a blight: examine it, and you will see minute insects of a most delicate form; some are black, others green.

ROSES, PINKS, AND OTHER FLOWERS.

AMONG roses, pinks, and other flowers, a small insect may be found almost constantly. It is a little, long, nimble insect, the body like a wasp's, with yellow wings.

A little insect likewise is found in what is termed cuckoo spittle, or froth; it has very curious eyes.

A small white oblong insect sticks to rose-tree leaves, which turns into a little yellow locust.

There is, also, a curious insect on sweet-briar leaves, in April and May, the horns of which are very remarkable.

LEPISMA, OR SMALL BOOK-WORM,

Is a very nimble little creature, with a long body, taper at the tail, like a fish; it is covered with minute scales, which reflect the light, making it appear like pearl: the scales themselves are of the most delicate description, and form one of the best test objects. See fig. 11. It is found in old libraries; it feeds upon the paper and covers of books, making holes in them.

THE MULTIPES, OR SCOLOPENDRA,

HAS a very long and slender body: its mouth is armed with a pair of forceps. In hot countries, where it is of a large size, it is venomous. It has fifty-four joints, and every joint a leg from each side, with two at the tail-part, —in all, one hundred and ten. When it moves, the legs follow regularly. There are several sorts of these curious insects; they are found under stones and wood that have been lying for some time.

THE PERLA, OR PLANT LOUSE LION, AND APHIS.

THESE singular and beautiful insects attach their eggs to the edges of leaves, suspending them by minute threads. They choose such leaves as the aphis have laid their eggs upon, and thus keep them out of the reach of the young aphides, which otherwise would destroy them in the egg state. The young aphides, on issuing from the eggs, commence feeding upon the juices of the leaf, and, under the microscope, present the appearance of a flock of sheep in a field. While they are thus luxuriating, the plant louse lions, also issuing from the egg, crawl up the slender props on which they were suspended, and, like wolves, commence devouring the aphides, plunging into their delicate bodies a

pair of powerful fangs, and sucking the juices. The wings of these insects are beautiful microscopic objects.

STINGS OF INSECTS.

THE sharp and penetrating instruments in tails of bees, wasps, &c., are distinguished by the name of stings,—weapons given them by nature to defend themselves against their enemies; whereas the proboscis of flies, gnats, &c. is to procure them food. The sting ejects a poisonous liquor; the proboscis sucks the blood. As the stings of all are nearly alike, by describing one the rest will be understood.

THE STING OF A BEE,

HAS a horny sheath, and is shaped like a dart, with a barb similar to a fish-hook. The bee strikes so hard, that, if disturbed, it cannot withdraw its sting from its object; but when undisturbed, it closes the barb and draws it out. To view the sting of a bee, cut off the bottom part of the body, press it, and the sting will come out: it may be nipped off with a pair of scissors, and kept for observation. The bag containing the poison generally comes out with the sting. The barb at the point of the sting is a most interesting object.

EYES OF INSECTS.

"IN dissecting the eyes of a variety of land and water insects, I find their construction differs materially from the human eye, and that nearly the whole of the insect tribe have compound or clusters of eyes, varying in numbers according to the species. I have found in some forty, in others a thousand, and so on in progression, until I have met with upwards of thirty thousand distinct eyes in some species. I shall endeavour to explain to you the result of my investigation, by confining myself to the dissection of the large dragon-fly, whose eyes, speaking in round numbers, exceed twenty thousand. The cornea I found composed of several thin plates; each plate was studded with minute lenses fitting into each other. Under the cornea I discovered a fine membrane full of minute ramifications which I presume to be blood-vessels, and immediately under this membrane I found a corresponding number of tubes which fitted the lenses in the cornea. I then removed the tubes, and came to the retina, in which there was the same number of divisions as the above lenses, so that each lens had a tube attached to it, which conveyed the image of any object formed on the lens to the divisions in the retina, and was from thence conveyed by numerous optic nerves to the sense of seeing in the brain."

The pearly eyes of insects are amazing pieces of mechanism, whose structure, without the assistance of the microscope, would have remained unknown to us. Butterflies, bees, ants, and many others, have two immovable caps, containing a number of hemispheres, placed in lines with the utmost regularity, resembling lattice-work. These are a collection of eyes, like so many polished mirrors, that reflect the object; for example, the image of a candle may be distinctly seen in each.

EGGS OF INSECTS.

THE eggs of insects are remarkable for figure and colour, and for the regularity and exactness in which they are placed. We sometimes find a sort eemented round a twig of the sloe-tree, damson-tree, &c.: the variety of them is innumerable. They are found likewise in the water in spring, and on water-cresses and other water-plants appear to the naked eye only as slime. The common fly will deposit her eggs on meat with the utmost regularity, which, with the assistance of the microscope, will appear in their true form. The same may be observed with respect to nits on the human hair; and if fleas are kept for a few days in the object-box, some will be found to have lain their eggs, which may be examined under the microscope.

WINGS OF INSECTS.

THERE is such an infinite variety in the contexture and form of the wings of insects, and such beautiful ornaments upon them, that none but those who have observed them can have any conception of their form and colour—as the dragon-fly, which is very transparent, dividing as it appears in long squares. The wing of the female dragon-fly is different, in being more opaque, and forming itself into curious angles and shapes. Some are covered with bristles, as all kinds of flesh flies; others with feathers, as butterflies and moths. Many have their wings folded under a case, as beetles, earwigs, &c.—most of them extremely beautiful when brought before the microscope. All these wings have ribs, and blood-vessels branching out at different parts of them. Under the wings of insects is a small bladder, or poise: with this they balance themselves in flying. This, carefully taken off, is a very curious object.*

THE CIRCULATION OF THE BLOOD.

IN order to view the blood circulating through its vessels, we must procure animals the skins of which are transparent, and no object is better calculated for this purpose than the small tadpole. The circulation of the blood in this little animal is a most wonderful spectacle. In order to view it to advantage with the microscope, place a piece of window-glass (about 2 inches by $1\frac{1}{4}$) upon the stage. Upon this the animal is to be laid without any further preparation†. The tail will now lie flat, and, being

* The wing of the earwig in the gas microscope is magnified to twelve feet.

† When the animal is first placed upon the glass, it usually wriggles about, but soon becomes quiet, and remains so for some time. Should it repeat its motion, there will always be sufficient intervals of quiet for re-adjustment and examination, which makes this mode of submitting to the microscope preferable to any attempt to confine it. A small quantity of the water should be placed upon the glass. The power No. 2. is the most suitable.

very transparent, the innumerable channels contained in it will be perfectly visible, within which the blood (consisting of globules suspended in serum) will be perceived coursing with extreme rapidity in all possible directions.

Along one side of the longitudinal tapering substance in the centre of the tail, a main conduit proceeds to the extremity thereof, returning towards the body, at a very small distance from the salient part, and in a parallel direction. From this, branches proceed laterally, which subdivide themselves to infinity. The subdivisions of each of the branches are joined at the extremities, thereby forming a perfect connection between the whole. The blood proceeds from the main conduit by each alternate branch, and, after passing through the various subdivisions of one branch, enters those of the next, on each side of it, by which it returns into the main conduit, and this process is repeated, until the mind is bewildered in its attempts to trace its course in all its minute ramifications.

In this description the usual terms of arteries and veins have been avoided, as, in this animal, the distinction seems to be lost in consequence of the blood appearing to issue from and return into, the main conduit, both in its salient and returning part, although it is probable, that the returning main conduit is really a vein, receiving the returning branches (or veins) which must, in that case, pass either above or below, (and not into) the salient part of the main conduit or artery. As the substance in which these main conduits are inserted is much more opaque than the rest of the tail, the phenomena cannot be so well observed, and it is in consequence, difficult to arrive at a safe conclusion; however, enough is to be perceived to excite the wonder and admiration of every beholder.

THE BLOOD.

UPON submitting the blood to the microscope, it is immediately perceived to consist of globules suspended in a

white transparent serum. A remarkable fact will strike every observer, viz. there will be seen a continual motion of the globules, as if they were acted upon by some unknown agency. This motion appears completely vibratory, like a balance which has received an impulse. It is difficult to account for this phenomenon, but the following hypothesis is hazarded; this seeming tendency to motion in the globules, may be a material assistance to the impulse given by the heart, whose mere mechanical force (however great) appears hardly sufficient to propel the globules through such inconceivably minute ramifications, through which we know it does pass previous to reaching the organ of circulation by the large veins.

Place a small drop of water upon a slip of glass, into which introduce a drop of warm blood; by which means the globules will be separated, and become distinctly visible. Use that power which will most enlarge them without taking away from their distinctness.

CIRCULATION IN THE CHARA.

THIS genus of aquatic plants includes two species, in which the circulation is seen to great perfection under the microscope, viz. the Vulgaris, (common chara,) and the Translucens, (transparent chara.) The exhibition of this circulation is quite a recent discovery.

These species are found in ponds, &c., and are very local. The principal places where they have hitherto been met with, near London, are, at Lee, (near Blackheath,) Totteridge Green, Paddington, and in rivulets, &c., connected with the Croydon Canal. The most prominent parts of these plants consist of long fibres, about one-thirtieth of an inch in diameter, which grow from the muddy bottom of water, from two to three feet under the surface; knots (or joints) are formed in each fibre, at intervals of half an inch to five inches: from each of these principal joints, nine jointed shoots radiate, (about an inch long,) having two or three very minute finger-like shoots at each joint; independent of these radiating shoots, other leading fibres take

their origin from these principal joints, in which the same process is repeated and continued, so that a plant, as it becomes advanced in growth, appears (in its principal fibres) to be like tangled twine; its colour is green, and the fructification is by flowers and seeds.

The circulation is carried on in as many separate parts as there are intervals between the joints, that of each interval being quite distinct from all the rest, which affords great facility for viewing the phenomenon under the microscope, as short intervals, (either in the shoots or fibres,) may be selected for the purpose, only taking care that the joint at each end is perfect.

A glass slide, with a cavity about one-thirtieth of an inch deep, and in the centre of the slide, is the best apparatus for placing this object under the microscope; the cavity being filled with water, the piece of chara can be introduced, and being afterwards covered with very thin and clear talc, the preparation will be fit for use. If means are used to renew the water as evaporation takes place, the same object will vegetate until it fills the slide, and, during its progress, afford a gratifying opportunity to view at leisure the various phenomena attending the process.

The trouble of procuring fresh supplies of the object, can be avoided by filling a glass jar (having some garden mould at the bottom,) with water, and, when settled and perfectly clear, a few joints of the chara may be dropped in; when at the bottom, one end of each joint may be forced into the mould with a twig, when, in a short time, they will all vegetate and increase, until the whole of the jar is occupied by it: it is obvious a fresh stock in other jars may be procured from the first. The jars should be covered with gauze or net, to prevent insects laying their eggs within them, and to keep out extraneous matters, which have a tendency to produce the conferva, (or hair-like green filmy substance, which, by adhering in abundance to the chara, will entirely spoil it for use, if it do not quite destroy it. The best powers for viewing this superlatively beautiful object, are from the tenth to the thirtieth of an inch focus.

The whole plant is composed of hollow tubes within

which the circulation proceeds: it consists of myriads of minute opaque particles, apparently suspended in a fluid, and moving in a body along one side, and returning by the other, both currents being visible at the same time: a membrane is attached to the inside of the several tubes, which undulates in a surprising manner, and seems in some measure to be identified with pulsation.

PULSATION OF THE HEART.

THIS wonderful phenomenon may be seen distinctly in several small insects; in a bee it is observable near the neck, but the best insect to view it in, owing to its transparency, is the water-flea.

FEATHERS OF BIRDS.

THE feathers of birds afford a variety of beauty, and differ greatly from one another, not only in their form, but in the structure of each particular part. The feathers of foreign birds have the most beautiful plumage. The handsome and delicate feathers of the humming-bird, and the tail of the peacock are well worth observation.

SCALES OF FISHES.

THE scales or outward coverings of fishes, are formed with surprising beauty and variety of shape and texture—as the perch, sole, barbel, cod, &c. The scales of eels in particular are very small;—the way of preparing them is to take them off with the forceps, and put them between a sheet of paper to keep them flat till dry. The arrangement of the scales of fishes bears a resemblance to that of the feathers of birds. The snake and lizard have likewise scales. The scales of soles and dace are well worth preserving for the microscope.

HAIRS OF ANIMALS.

HAIRS of animals are very different in their appearance, before the microscope, and will furnish a great variety

of pleasing observations; they are composed of small tubes, or pipes. There are also in the hair of many animals spiral lines; a mouse's hair is of this description: the human hair is a good specimen.—See *Test Objects*, p. 52.

FARINA OF FLOWERS.

THE farina, or scaly powder, found on the top of every flower, deserves the strictest examination. This powder, whose colour is different in flowers of different kinds, was formerly supposed to be an unnecessary part of the plant; but the microscope has also made surprising discoveries here, by showing that they are minute uniform bodies, constantly of the same figure. This powder is produced and preserved in vessels, wonderfully contrived to open and discharge it when it becomes mature; there are, likewise, seed vessels in the centre, ready to receive them: and on the powder depends the fertility of the seed, for if the farina-vessels were cut away, the seed would become barren. In the farina of the melon it appears as opaque black balls; in the sun-flower, surrounded with sharp points; in the tulip, like the seed of cucumbers. Gather the farina on a fine sun-shining day, when the dew is off; be careful not to squeeze or press it. Gently brush it off, with a soft hair pencil, upon a piece of clean paper or slides prepared with a little gum-water.

DOWN ON PLANTS, &c.

NATURE has supplied the seeds of the thistle and many other plants with a down, which serves instead of wings, to convey them from one place to another. The figures of such down are very different when examined by the glass, some plain and smooth, others rough, and some with little hooks or clasps, to catch hold of any thing.

SEEDS.

MOST kinds of seeds must be prepared by steeping them in warm water, to discover the minute plants they contain.

The seeds of strawberries rise out of the pulp, and appear like strawberries. When viewed, seeds of the poppy, lettuce, thyme, parsley, and a thousand others, afford delightful entertainment. The fungus, or puff-ball, when crushed, seems to the naked eye like smoke or vapour; when examined with the highest power, it is found to be composed of little globules of an orange colour.

LEAVES.

THE leaves of plants are full of veins, or ramifications, which convey the juices. The leaves of the yew are full of holes like the honey-comb. The sage-leaf appears full of knots or little beads. A dissected leaf,—that is, the pulpy part taken off,—showing the fibrous structure of the leaf, is highly interesting.

CUTTINGS OF WOOD.

THE air-vessels and pores of wood appear wonderful in their figure and variety when shaved off as thin as possible. All the kinds of wood may be rendered fit for this purpose. It is advisable to have different slides filled with different kinds of wood, both English and foreign. In a piece of cork no larger than the eighteenth part of an inch, sixty cells were numbered in a row; whence it follows, that one thousand and eighty are in the length of an inch; one million, one hundred and sixty-six thousand, and four hundred, in a square inch. From the pith of trees, cut so that they become transparent, the vessels may be seen.

MOSSES.

MOSSES of all kinds are agreeable objects, and appear by the microscope to be as perfect in their parts as the largest trees; those that grow on the rocks and coast of the sea exhibit amazing beauties. From the Highlands of Scotland many interesting specimens are procured.

SANDS AND MINERALS.

THERE are many sorts of sand on the sea-shore, or within land; their varieties are very agreeable to examine; some have angles and rough coats; others, the most beautiful polish, and as transparent as the diamond. Antimony, copper, ores, lapis lazula, are some of the most beautiful of the minerals for the microscope.

RICE-PAPER.

CUT a thin slice of rice-paper, you will find the structure very beautiful.

SPONGE.

SPONGE is a plant, and appears to be composed of minute tubes or vessels, which, by their capillary attractions, are the cause of its absorbing so much water. The fibres should be examined separately.

MOULDINESS.

ALL kinds of mouldiness on decayed fruit, bread, &c. the microscope discovers to be exceedingly minute plants, bearing leaves, and, in every respect, developing the same beauty and regularity as the leaves of the trees, &c.

THE METHOD OF PREPARING SALTS FOR VIEWING THEIR CRYSTALLIZATIONS.

AFTER dissolving the salt in water, sufficient to saturate it, being perfectly dissolved, let it rest for a few hours; the solution being thus prepared, take up a single drop and place it on the slip of glass: spread it gently over the glass, as level as possible; hold it near a fire or candle, to give

it a gentle heat. When the edges begin to look white, having your microscope ready, place the glass, and you will see the formation of the crystals; when the action once begins, the eye should not be taken off, for the figures, in forming, alter every instant till perfect. If you provide yourself with several small bottles, a collection of the solution of the different salts may always be in readiness for the microscope, and, by a variety of combinations, you may produce several thousand subjects for examination—a sight no one can behold without delight. As soon as they become formed, they are either cubes, rhomboids, pyramidical, or certain regular figures, showing always the same sides or angles, in different substances; and the following are the best for this purpose;—nitre, rock-salt, Glauber's salt, ammoniac, hartshorn, green vitriol, white vitriol, and salt of amber.

ALUM.

THE configurations of the salt abound with beauty and variety.—"Place a drop of the solution on the glass, and, gently heated, it exhibits, at the beginning, a dark cloud, which appears in motion near the edge, and runs swiftly through to right and left, till they join; these, when examined, appear to be salts shot into slender lines, which cross one another at right angles."

CRYSTALS OF SILVER.

THESE form a beautiful opaque object; in a drop of nitrate of silver put a fine piece of copper wire, or the point of a pin; place it directly under the microscope, and the crystals will extend till the fluid is evaporated; this object may be permanently preserved:—take a piece of Bristol card-paper of the required thickness and of the same size as the glass on which it is to be fixed; punch an aperture in the centre of the card, then with gum or paint, fix it upon the glass, place a drop of the solution of nitrate of silver within the aperture, into which drop a small particle of copper; when

the crystals have formed and the evaporation subsided, cover the aperture with glass or talc.

By dissolving any mineral in muriatic or nitric acid, and placing it under the microscope, you will perceive beautiful crystals formed.

COMMON SALT, &c.

PLACE a single drop of water in a glass, and put a few particles of common salt in it; give it a gentle heat till the water is evaporated, and you will have beautiful crystals, in the form of cubes, Epsom salts in six-sided prisms, alum in octagons, crystals of nitre, saltpetre, and green vitrol. To obtain crystals of camphor, place a drop of spirits of wine on a glass, hold it over a candle; when evaporated, place it on the microscope, and they will be seen.

MISCELLANEOUS.

THE underside of the leaves of vegetables displays the wonderful organization of their parts.

If a small portion of any leaf is placed between two slips of glass, by wetting the inside of each with a little water, and sliding the one slip over the other, backwards and forwards, the water produces a clearness, and detaches the outside covering from the other part.

To examine the stem of any flowers, particularly the mucilaginous matter which adheres to the stalk of a stock-gillyflower, place it as above described, between two slips of glass with a small portion of water, and after washing away the turbid water, and putting some fresh, a most beautiful object is furnished in the spiral or helical sap vessels.

A small portion of straw, steeped in a solution of pearl-ash, and then washed in water and dried, on being placed between two pieces of glass, (which must be one over the other,) will be found to separate under the microscope, and display its structure, composed of long slender filaments with rings round them.

TO FIND THE MAGNIFYING POWER OF THE MICROSCOPE.

PLACE a micrometer upon the stage, (one of the two hundredths of an inch will be the most useful for this microscope,) and adjust it to the focus of the power in use: in order to ascertain how many times the squares are magnified, no more will be necessary than to ascertain the size of the magnified image of one of them, and the best method to do which is the following:—on several pieces of card rule a few squares that bear a known proportion to an inch, beginning at about three quarters of an inch, and decreasing very gradually, until you arrive at a tenth of an inch. The use of these pieces of card is exemplified by the following example:—

Suppose the lowest power to be in use, with the above micrometer upon the stage, adjusted to the true focus; I compare the squares upon several of the pieces of card, and select that which contains squares of the same size as the magnified image; and having previously noted upon each piece of card the proportion each square bears to an inch, I immediately know the size of the magnified image, which in this instance is indicated by the card to be a tenth of an inch; and as the two-hundredth of an inch is contained twenty times in the tenth of an inch, so many times is the length of an object magnified; and as the breadth is magnified in the same proportion, the square of twenty must be taken, which is four hundred—the true magnifying power.

The following are the different magnifying powers of the microscope:—

	Single	With the Compound Body.
No. 1, the lowest power, magnifies ..	100 ..	625 times.
No. 2, second power ditto ..	144 ..	900
No. 1 & 2 combined together, 3d power	400 ..	2500
No. 3, fourth power ditto ..	4225 ..	26,000

No. 4, fifth power, magnifies 62,500 times with the body.

N. B. The *height* of an object being magnified in the same proportion as the length and breadth, the cubes of

the magnified diameters might be introduced in the above scale, although, it must be admitted, that the height is, in a great measure, lost to the eye, in consequence of its being perpendicular to the object; therefore, in estimating the magnifying power, the cube is usually rejected.

The Wollaston's doublet can be added to this microscope.

TO FIND THE MAGNITUDE OF A MINUTE OBJECT.

THE most correct and readiest way, on all occasions, to find the magnitude of an object is to take a piece of glass, divided in any number of parts, or lines, of 100 or 200 to the inch; it may be placed on the stage, and a drop of water or any other object put upon it. Find what proportion the object bears to the space within the two lines, and if it takes the whole space, it is one or two-hundredth part of an inch, according to the scale.

NEW AND INTERESTING MICROSCOPIC OBJECTS.

(DISCOVERED BY THE AUTHOR.)

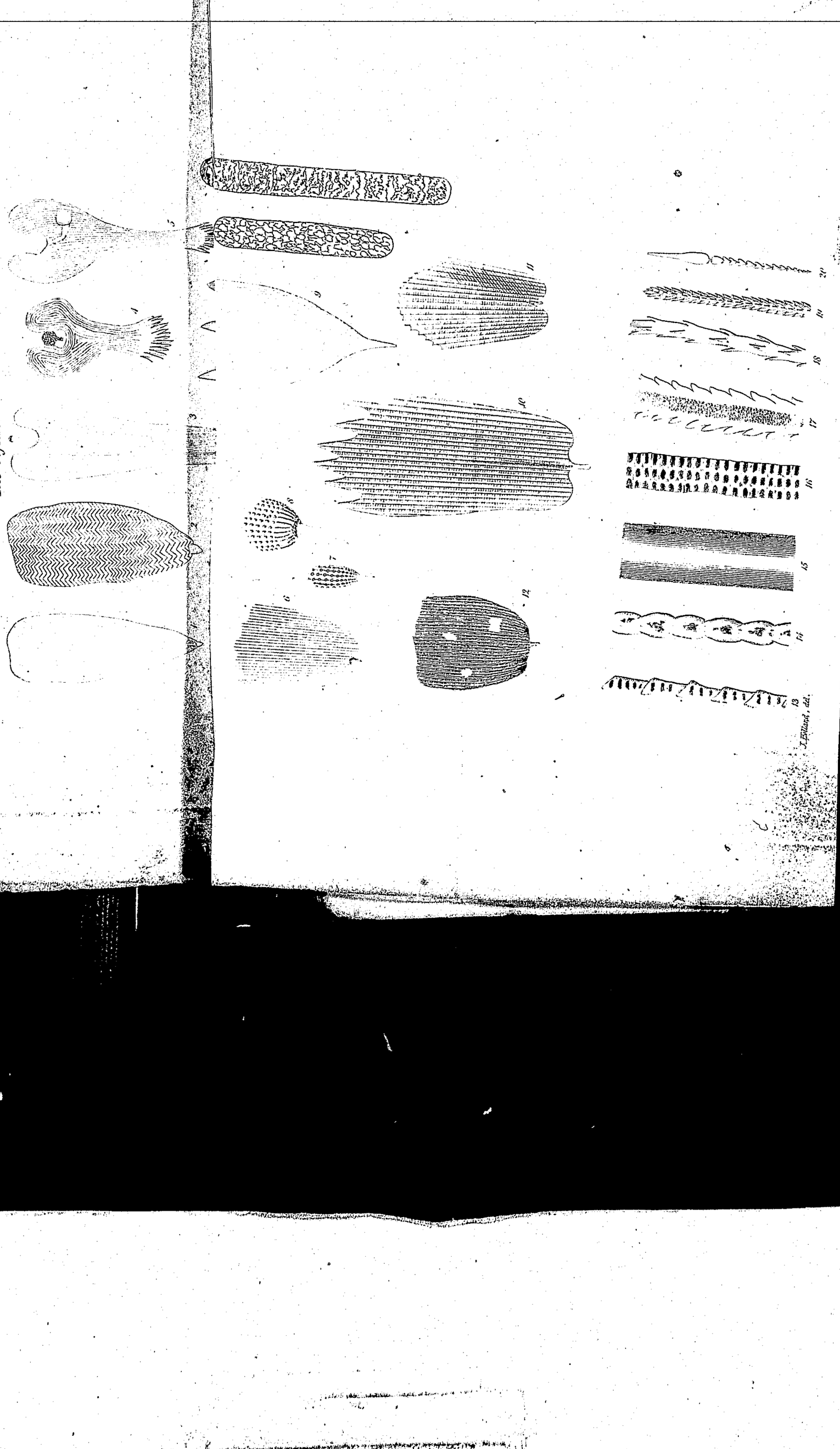
IN preparing the scales of different fish as transparent objects for the microscope, and in viewing one of them, (the scale of a fresh herring, as an opaque object, in a drop of water,) I observed a very curious phenomenon—a number of minute shining particles in motion, moving in all directions, appearing and disappearing on the surface of the fluid, reflecting the most brilliant prismatic colours, and producing a beautiful microscopic effect. I have examined them under different powers of the microscope, particularly under a fine *achromatic* object-glass of great power, belonging to M. De Joinville, and they have every appearance of animalcules. Several of my microscopic friends who have seen them are of the same opinion, particularly the above gentleman, who has examined them with great attention. Whether they are living animalcules

or not must be left for further investigation; it is introduced here merely as an interesting microscopic object; but it no doubt accounts for the luminous appearance of a fish in the dark, being nothing more than multitudes of those little shining bodies in motion, although it has generally been thought to be phosphoric light.

The readiest way of viewing them under the microscope is as follows: take a single scale from any fish,—the fresh herring is the best I have yet discovered,—place it on a flat piece of glass, then cover it with a drop of water, and put it on the stage of the microscope upon a black ground, for it must be viewed as a perfectly opaque object, with a moderate power; press the scale till it lies flat on the glass. A strong light must be thrown on the object by means of a condensing lens, and hundreds of shining particles may be observed in motion on the scale, which, however, appear best in that part of the fluid the scale does not occupy.

I have been favoured with a description of the following new and interesting microscopic object, discovered by M. De Joinville, in a pond to the north of Somers Town. The green appearance of the pond having attracted his attention, he placed a drop of the water under a microscope, and found a great number of small filaments, like threads, or small pieces of conferva, cut into different lengths. On examining them with a higher power, they appeared like tubes with spots of green matter in them, but in an instant they began to move very slowly, going backwards and forwards. At first they were supposed to be vibreos, as described by Muller and Adams, but, on referring to these authors, they describe the vibreos as having their extremities pointed, (the vinegar and sour paste eels are of this class.) Several other authors have been examined, but no description of this interesting microscopic object has been found.

M. De Joinville describes them as follows, with a drawing (see Plate, Test Objects, fig. 21,) as they appeared under the highest power of his achromatic microscope: filaments more or less long, like tubes, diameters one five-



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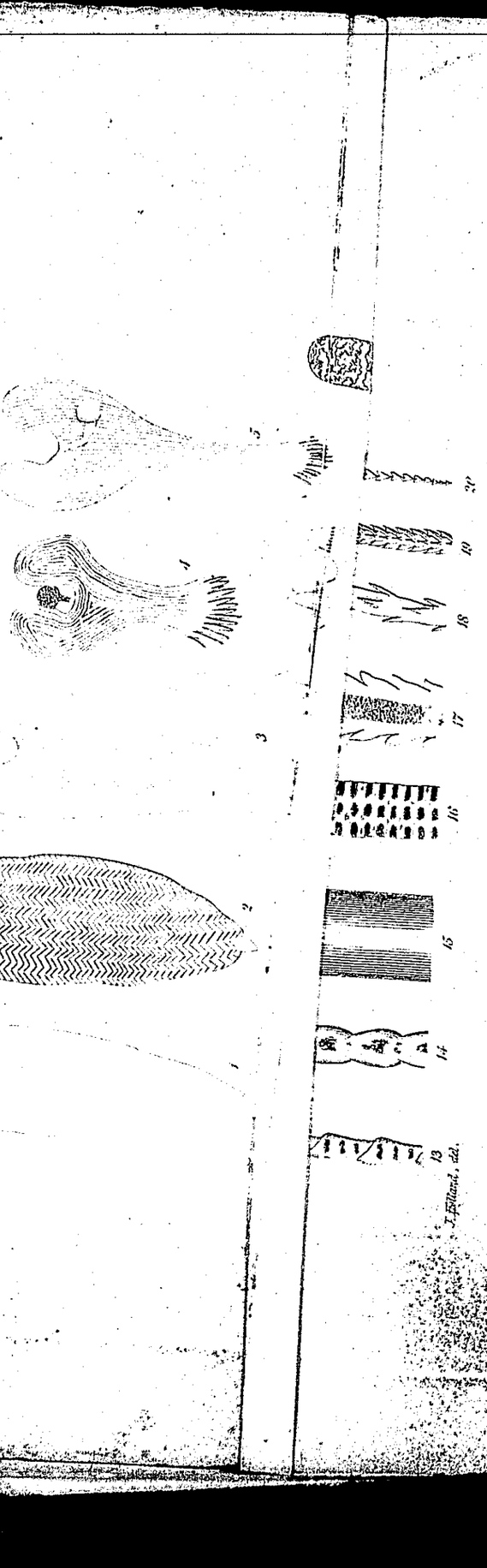

hundredth of an inch; extremities obtuse, motion very slow, sometimes starting at the distance of five times their diameters, filled with green spots, oval and round.

TEST OBJECTS FOR MICROSCOPES.

Ever since the invention of the microscope, these objects have been highly interesting to the observer, in consequence of the almost inconceivable delicacy of texture they display, but more particularly from the facility they afford of ascertaining the relative qualities of different microscopes, some of them being so easy as to be developed by any good microscope; but, on the contrary, others are so extremely difficult, as to require the utmost perfection in the instrument, in order to exhibit, satisfactorily, the delicate striæ and other minutiæ which they contain.

Figs. 1 *and* 2.—*Scales from the Podura.*—This insect is very small, and is commonly called the skiptail; it inhabits wine-cellars, &c. Although very minute, it is easily discovered, in consequence of being entirely covered with silvery scales which strongly reflect the light. When discovered, they are exceedingly active, and being very delicate, great caution is necessary, in order to avoid injury to their beautiful covering in the act of taking them. This is best performed as follows:—Take a wide-mouthed and clean flint-glass bottle, which, being held as near to them as possible, they may be lightly brushed into it by means of a large soft camel-hair pencil. When a sufficient quantity is procured, they can be ultimately killed by introducing, with a lighted match, *a little* vapour of the brimstone, when they can be turned out upon a piece of clean white paper, and removed with delicate forceps into a pill-box for use. As they are of a very moist and oily nature, there requires some tact in transferring the scales to the microscopic slide, to effect which, apply the forceps to the legs or antennæ, and gently move them upon the sur-

face of the glass, without pressure, in which operation the scales will come off.

Fig. 3.—One of the long scales from the upper side of the inferior wing of the Pontiæ Brassicæ (common cabbage butterfly.) This scale is very transparent, and of a peculiar form, being fibrous at that part which is usually inserted into the membraneous part of the wing, by means of a stem.

The striæ upon each of these objects form the most difficult test for the very best microscopes; indeed, it is only since the recent great improvements in this class of instruments, that they have been exhibited in all their delicacy: in fact, with the exception of the best Achromatic Microscopes, and the Doublet of Dr. Wollaston, no glasses exist which will clearly define them. Fig. 2 is the appearance of a scale from the podura, when applied to an instrument whose defining power is not sufficient to bring out the striæ straight and parallel.

Figs. 4 *and* 5.—Interesting varieties among the scales from the Pontiæ Brassicæ of the preceding article.

Fig. 6.—One of the light scales from that beautiful insect the Lycæna Dorylus, (common blue butterfly,) which abounds, in the summer months, in the neighbourhood of Windsor, and other places.

Figs. 7 *and* 8.—Curious varieties from the same.

Fig. 9.—The feather of the Tussock Moth.

Fig. 10.—One of the light scales from the Noctua Nupta, (red underwing.) The cross striæ in this specimen form the test object, and, when well brought out, each line appears like a string of beads; this peculiarity has not been before delineated.

Fig. 11.—A scale from the Lepisma Saccharina, (window fish;) a most beautiful object.

Fig. 12.—A scale from the upper sides of the wings of that superb insect the Menelaus, (foreign.) In this object, also, the cross striæ form the test, which, not being so strongly marked as in the scale from the red underwing, are, in consequence, more difficult.

Figures 4 to 12, (from not being so severe as 1, 2, and 3,) may be considered fair tests, and require a good microscope to define their minutiæ.

Hairs of Animals.—Great varieties in this class of objects form good tests. Figs 13 and 14, hairs of a bat; fig. 15, human hairs; figs. 16 and 17, hair of a mouse; fig. 18, hair of a caterpillar; figs. 19 and 20, hair of the daria of the dermestes. It is impossible to conceive any thing more delicately formed than the two latter, particularly the one in the form of a spear head, which is an excellent test of the defining power to prove the quality of a good microscope.

The microscope lately invented by the Rev. H. Coddington,* of Cambridge, with the addition of the Wollaston's doublet, we may venture to say is the most complete universal microscope of the present day, with the exception of the achromatic. The object-glasses of this instrument have the appearance of two cones, joined together at the apex, in shape not much unlike an hour-glass; the base of each cone is worked to a segment of the same sphere, by which means the effect of the combination of two plano-convex lenses is produced, with only one refraction. The defining power of these lenses is very beautiful on opaque as well as transparent objects.

THE WORKS OF ART AND NATURE COMPARED TOGETHER.

Upon examining the edge of a very sharp razor, it will appear as broad as the back of a knife, and full of notches. The point of a small needle, though extremely fine to the naked eye, will appear through the microscope full of holes and scratches; but the sting of a bee, viewed with the same, will appear beautiful, without a flaw or blemish. A piece of fine muslin or lawn appears like a coarse lattice, and the threads like ropes: the same with fine lace; but the thread

* This microscope is made and sold by W. Cary, 181, Strand, price 6*l.* 16*s.* 6*d.* Achromatic Microscopes, 12*l.* 12*s.* to 20*l.* The Coddington lenses may be had separate, mounted as single magnifiers, and are far superior to common lenses.

of a silk-worm or the web of a spider will appear perfectly smooth. The smallest dot made with a pen appears a vast irregular spot, rough and jagged.—Thus sink the works of art; but in those of Nature, even in her meanest productions, nothing will be found but beauty and perfection.

What we know at present of things near and familiar is so little, that there remains a boundless space for our inquiries and discoveries in the works of Nature; and the more we inquire into them, the more comprehensive and just will be our ideas of the power, wisdom, and goodness of the Deity.

MICROSCOPIC CHEMISTRY.

Communicated by the Rev. EDWARD CRAIG, M.A. F.R.S.E.

ANOTHER important field of inquiry by the microscope is chemical action. This opens an endless subject of investigation of a very rich order; and will probably lead, ere long, in the hands of some talented experimenter, to very valuable results. The mode of pursuing this class of observations is very simple. Prepare a few pieces of thin and very flat glass, about an inch long and three-quarters of an inch broad. They may be larger or smaller, according as is best adapted to the port-object of the microscope to be used. Some of them should be the eighth of an inch less every way than the others. A variety of chemical agents should be provided in small glass bottles with glass stoppers, and a few glass rods about four inches long, with a rounded end, for the purpose of taking a small drop out of any liquid. These should be kept in a glass of clear water, when they are not actually used, in order that they may be free from any particles of an extraneous substance. In experimenting, at the outset adapt the focus of the microscope to one of these glass plates. Then, upon one of the larger plates of glass, spread thinly any precipitate or other chemical agent with which you wish to work. Lay the glass upon the port-object, and examine leisurely the character and form of the substance. Then, upon one of the smaller glasses,

lay, with a glass rod, a small drop of any acid or other fluid with which you wish to act; and, having spread it on the glass, lower it down nearly upon the other glass, so that the edges of the upper glass shall not reach beyond the under one; as the upper glass, when once brought in contact, should never be disturbed. The two substances will thus, by pressure, be reduced to one uniformly thin film; and the action which takes place may be very accurately investigated.

For instance, let the first glass receive a very minute portion of the carbonate of copper, and the upper glass a drop of nitric acid; on contact, the carbonic acid of the carbonate will be seen coming away in globules, whilst the carbonate of copper breaks down and disappears. The field is gradually occupied with a solution of nitrate of copper; and this is seen to crystallize in minute rhombic crystals. Lift up the upper glass, and add a small drop of ammonia, and slip down the glass again; the crystals of the nitrate disappear; a new combination takes place; and you see the beautiful foliations of the nitrate of ammonia interspersed with groups of the still more beautiful prisms of the deep blue ammoniuret of copper. Or, instead of the ammonia, add muriatic acid; the nitrate is changed into a grass-green solution of the muriate of copper, which crystallizes in bundles of spears shooting in all directions across the field of vision.

These phenomena may be multiplied to any extent by the use of the numerous chemical agents to be obtained. Iodine presents an endless variety of aspects in combination with different agents. The crystallization of hydriodate of potass is very beautiful, if a drop of the solution is put on a glass. Put on the other glass sulphuric acid. When brought in contact, the acid takes the potass, and forms crystals of the sulphate of potass, and the iodine is developed both in solution, which passes off by evaporation, and in the crystalline form of the substance itself. Again: combine solutionof iodine with solution of sulphate of soda. The alcohol in the solution of iodine takes part of the water from the soda, and the rest of the sulphate of soda immediately crystallizes in prisms. The iodine, de-

prived of the alcohol, is developed in cherry-red drops of liquid and in dark rhombic crystals. In fact, in the endless variety of objects that can thus be brought before the eye, both the young student and the scientific chemist will find at once a means of amusement and of deep analytic investigation of the most fascinating and important kind. Evaporation or boiling may be carried on in the same way by extending one end of the glass over the port-object, and placing underneath it a small spirit-lamp, so that even the changes incident to this state may also be examined. The observations made by examining the effect of chemical agents on the juices of plants, offer a subject of very great interest and importance.

But the examination of chemical action may be carried still further by the application of the galvanic battery under the microscope. A small battery of thirty plates, two inches square, is sufficient for the purpose. Place any chemical agent, as liquor potassæ, on one glass plate; use a low power in the microscope to prevent vapour gathering on the lens, owing to its nearness; and then guide the two wires near to each other in the drop of liquid. The oxygen will go to one pole, and the potassium to the other. The dendritic foliations that form at one pole and grow out towards the other, in ammonia and nitrate of silver and other agents, are very beautiful. The effect visible in albumen, the white of egg, is very interesting. It has long been observed that albumen coagulated on the application of galvanic power: the microscope shows quite distinctly what this coagulation is. Albumen is a vesicular structure. The action of galvanism is to burst these vesicles, and draw out the liquid contained in them to one pole, while the vesicles all shrink up towards the other; and their approximation which gives the character of whiteness and solidity that appears. The arrangement of these vesicles, and the nerves or bands along which the cellules are arranged are easily distinguished beyond the possibility of mistake.

To these observations may be added, the examination of various crystallizations in polarized light. Between the reflecting mirror and the port-object insert a plate of tourmaline, so that the condensed light of the mirror be thrown

upon the object through the tourmaline. This polarizes the light received. Then, above the eye-piece, lay another plate of tourmaline. This serves as the analyzing plate for perceiving the changes produced by the polarized light. Many crystals so observed, as sulphate of potass, &c. exhibit the most beautiful colouring, according as the upper plate of tourmaline is turned round on its axis. Some crystals, as nitrate of potass, exhibit these colours without the upper or analyzing plate. The lamina of the crystal itself, as is the case with the mineral called iolite or dichroite, serve to polarize the light passing through it, and to make it visible. Instead of the upper plate of tourmaline, an analysing prism of Iceland spar may be used, which exhibits these colours of polarized light with still greater softness and perfection.

Now, simple as are these means of observation, so presented to our notice, they will serve very widely to extend our range of philosophical inquiry. The small port-object of the microscope becomes a very effective chemical laboratory, where phenomena connected with chemical action may be examined with an accuracy quite impracticable in larger masses; and for the purpose of analyzing unknown substances, innumerable experiments may be carried on in a short time where the quantities are comparatively insignificant. A door is thus opened into the arcana of nature which the man of truly scientific mind has only to enter, and he will be gratified by an intimate observation of phenomena, connected even with results which are, on the great scale, quite familiar to him, that he will view with unfeigned surprise. A microscopic acquaintance with the minute aspect of chemical changes will bring him into nearer intimacy with substances that he has long known, and guide him to conclusions which have hitherto only worn the dark character of conjecture.

A few other similar experiments may be mentioned:—

1. Add sulphuric acid to common salt or muriate of soda; or to carbonate of ammonia.

2. Add sulphuric acid to bichromate of potass or muriate of soda. The result is crystals of sulphate of soda and potass, with chloro-chromic acid.

3. Add acetic acid to biehromate of potass. The crystallization of the bichromate takes place in very beautiful forms.

4. Add sulphate of alumina and potass to muriate of cobalt. The crystals of the alum form in great perfection.

5. Add acetic acid to nitrate of copper. The biperacetate of copper forms slowly and crystallizes in great beauty.

6. Add terrocyanate of potass to sulphate of iron.

7. Add nitrate of potass or aqua potassæ to sulphuric acid. The sulphate of potass forms in solution. Raise the upper glass with a knife the smallest degree, and let it fall again; the crystallization is instant.

8. The smallest drop of any liquid containing lead may be examined by the usual tests for lead; and wine may, in the same way, be tested in a drop not bigger than a pin's point.

9. The bin-iodide of mercury is a beautiful cyrstal, and open to a variety of experiments.

10. Investigate the comparative purity of successive crytallizations of nitrate of potass.

In fact, every combination or decomposition which can be effected in the retort, may be carried on as easily on the port-object of the microscope, and the action more accurately observed than in any other way. A little of the manual facility and ocular keenness which are acquired by practice being all that is needful; and this is speedily attained.

A GENERAL LIST

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THE PRINCIPAL OBJECTS

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THESE Objects may be divided into the following Classes, viz.:—

I.—Such as have their whole Body, Form, and Parts magnified and exhibited in one Microscopic View; as—

The Louse.
The Flea.
The Bug.
The Mite.
The Eels in Paste, Vinegar, &c.
The Animalcules in Fluids.
Very small Flies and Insects of all sorts.
The smallest kinds of Plants, Mosses, Mouldiness, &c.

II. The small Parts of Animals, viz.:—

The Hair of the Head, Horse-hair, Mouse-hair, Hogs' Bristles, &c.
The Human Cuticle, or Scarf-skin.
The Papillæ Pyramidales in the Skin.
The Fibrillæ of Muscles, Nerves, &c.
The Ramification of Arteries and Veins.
The Lymphæducts, Lacteals, and other fine Vessels.
The Blood, &c.
The Circulation of the Blood in Fins of Fishes, the Tail of Tadpoles, and of Water-mewts—the best of all.

The Nails and Hoofs cut into thin Slices.
The Plumulæ or Plumage of Feathers.
The Pith of a Fea her cut transversely.
The Colours and Tints of Feathers, Eggs, &c. of Fowls.
The Eggs of all kinds of Insects.
The Antennæ or Feelers of Gnats, &c.
The Eyes of all Insects, Shell-fish, &c.
The beautiful Head of a Flesh-fly.
The Annuli, or the Rings, on the Bodies of Insects.
The Wings of Gnats, Flies, &c.
The Wings of Scarabæi, or Beetles.
The Wings of Butterflies, Moths, &c.
The Sting of a Bee, Wasp, Hornet, &c.
The Eyes of Spiders.
The Exuviæ, or cast Skins of Spiders.
The Apparatus in the Mouths of Spiders.
The spiral Proboscis in Butterflies, &c.
The Teeth in the Mouth of a Snail.
The Eyes on the Horns of Snails.
Young Spiders, Caterpillars, &c. just hatched.
The Web of Spiders, Caterpillars, Silk-worms, &c.
The Chrysalides, or Cases, of Insects.
The Thecæ of Moths, Cados-worms, &c.
The Scales of Fishes, Serpents, &c.
The Scales of Eels in particular.
The Transparent Fins of Fishes and Eels.
The Spiculæ, or Prickles, of Seal-Skins.
The Ovarium, or Sperm of Fishes.
The minute Sorts of Shell-fish.
The fimbriated Parts of Crabs, Lobsters, &c.
The Excrements of Scollops, &c.

III.—The Third Class of Microscopic Objects are of the Vegetable Kind:—

The Plantule in the Fruit, or Kernel.
The Corpuscules of the two Lobes macerated.
The Orifices of Air-Vessels in the Roots and Branches.
The Orifices of the Sap-vessels in ditto.
The Cortex or Bark of Trees in general.

The vesicular Substance of Cork in particular.
The ligneous Fibres in the internal Bark.
The Spiral Fibres of the Vessels in a Vine-leaf.
The Web-like Warp and Woof in rotten Wood.
The Pith of Elder and other like Plants.
The transverse Section of Kex, Bramble, &c.
The transverse Section of the Root of Fern, &c.
The Involucra, or covering of Gems or Buds of Trees.
The aromatic Balls on Leaves of Sage, Thyme, Mint, &c.
The catenery Pearls on Sow-thistle Leaves, &c.
The Pellicle, or thin Skin of macerated Leaves.
The Papillæ and Pores in the Pellicle of Houseleek.
The Particles of the Parenchyma of macerated Leaves.
The Ramification of Vessels in ditto.
The Duplicature of Vessels in ditto.
The transparent Blades of Grass, Corn, &c,
The Stings of Nettles, and their Juice or Liquor.
The unguiculated Tenters, or Hooks of Clivers, &c.
The Stamina on the young Shoots of Filbert Trees.
The Lanugo, or Down, on the Leaves of Plants.
The small Flowers of Plants in general.
The Colours of the Petala or Leaves.
The Farina or Dust on the Stamina.
The Style, Matrix, &c. in the Attire of the Flowers.
The succulent pulpy Part of the Fruit.
The small Seeds of Plants in general.
The Seeds of Fern, Hart's-tongue, &c. in particular.
The Seeds on the Stems of Mushrooms.
The whole of Sea Plants of every kind.
The Variety in the Surface of Corallines.
The particular Texture of Sponge.
The minutest Shells of every Sort.

IV.—The Fourth Class of Objects proper for the Microscope are of a Miscellaneous nature, the principal of which here follow:—

The Edge of a Razor, Penknife, &c.
The Point of a Needle, Pin, &c.
The polished Surface of Metals.

The Print, or Writing, on Paper.
The Substance of Paper itself.
The Contexture of Linen, Cloth, &c.
The finest Sorts of Sand.
The Particles of different kinds of Earth.
The various coloured Particles of Mundick.
The Surface and Substance of Ores and Metals.
The Efflorescences of sparry Exudations.
The Salts of Sea-water evaporated.
The Salts of Crystals of all Metals.
The Salts of Vegetable Lixivia.
The Salts of Animal Substances.
The Crystallization of Salts.
The Parts of the smallest Flakes of Snow.
The hexagonal Cups of White Frost.
The frosty Vegetation on Glass Windows.
The Effervescence betwixt Acids and Alkalies.
The ignited Particles in striking Fire.
The Ashes of burnt Paper, Linen, &c.
The Teeth of fine Files, Rasps, &c.
The Threads on the finest Screws.
The Smallest Microscopic Glasses themselves.

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A

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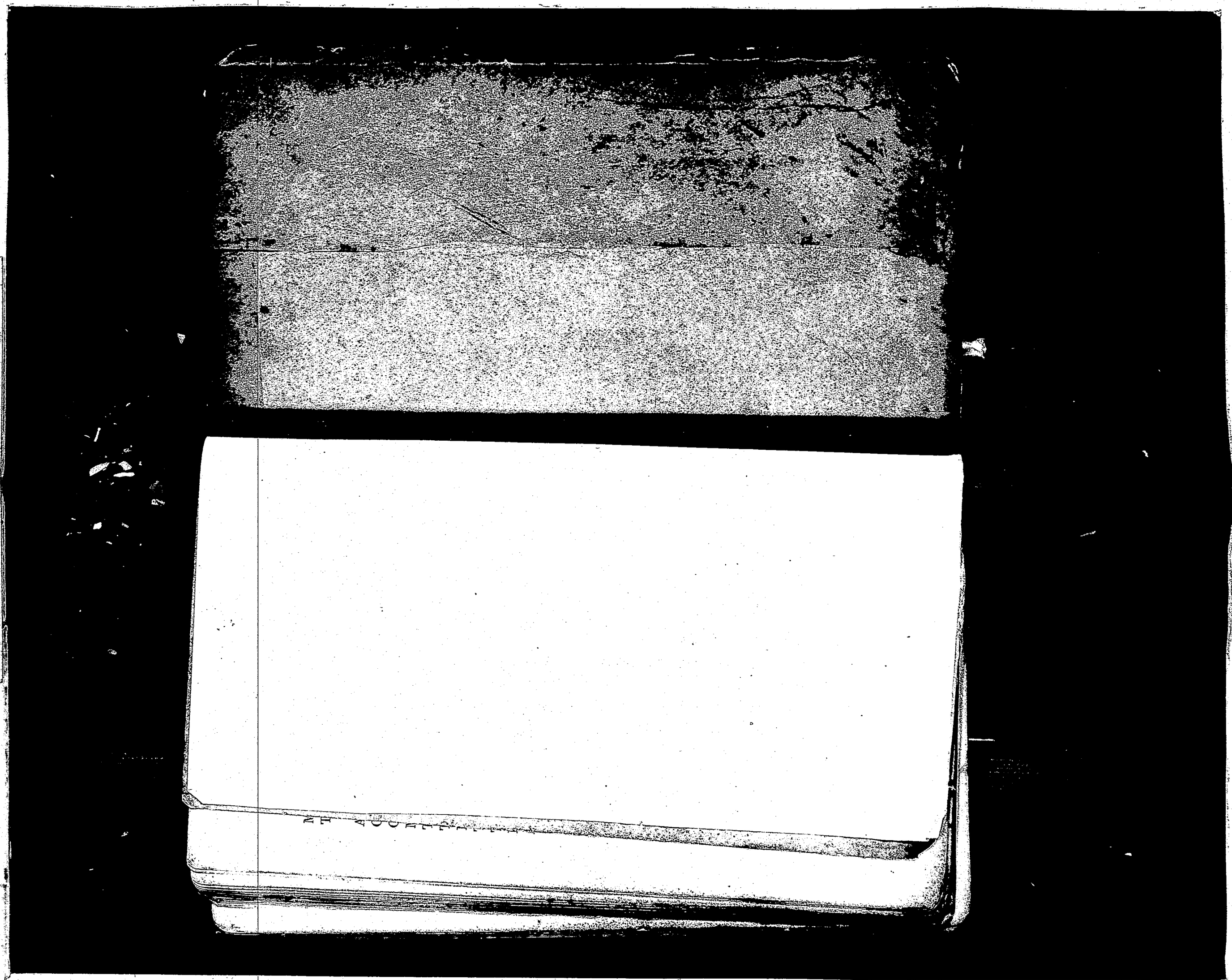

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