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The American Quarterly Microscopical Journal.

"Go forth, under the open sky, and list
To Nature's teachings."—*Bryant.*

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NEW RHIZOPODS.

BY PROF. WILLIAM S. BARNARD, B. S., PH. D.

(*Received Nov. 4th, 1878.*)

In studying American Rhizopods representatives of most European genera are found, and it is seldom, indeed, that a new species is discovered. This wonderfully broad distribution is probably due to their being so exceedingly small that they may be carried from place to place by moving water or air, or in the moisture on the surfaces of aquatic animals, as well as to the fact that the numerous germs, and even adult forms of many, are capable of being dried and wafted, like particles of dust, from one part of the earth to another. Wherever they chance to fall into the water, under favorable conditions, they may revive, live, and multiply.

Most Rhizopods are extremely interesting and curious, but the following genus is very remarkable.

Echinopyxis, Clap. et Lachm. (*Centropyxis*, Stein). Claparède and Lachmam characterize it as having "a shell furnished not only with a round opening, giving passage to locomotor pseudopods, but also with tubular prolongations open at their extremities. Through each of these prolongations can pass out a slender pseudopod, which does not seem to be of any value for locomotion." They describe the only species known as *E. aculeata* (Syn. *Arcella aculeata*, Ehr., *Difflugia aculeata*, Perty). "Diagnosis: Shell oblong, opening eccentric, like the mouth of a *Spatangus*." This genus and species, described a few years since in Europe, also exists in America, where I have observed it several times. Externally, the shell (Plate VIII., Fig. 3, *a. b.*) seems to consist entirely of agglutinated sand-grains, and bears several (4-6) tubules near its larger end. These minute tubes have the shape of horns, but by strong magnifying power are seen to be open at (what with lower power seem to be) their points, from which very slender pseudopods are occasionally projected. Their substance appears like diatomin, and is an outward continuation of an inner lining, upon which the sand-grains are incrusted, as may be best observed on the margins of broken shells. The question arises, for what purpose are these small, spiny tubes? They probably serve as spines or bayonets for weapons of defence, as do the diatom shells I have observed fixed erect upon the shell of another species of rhizopod, probably *Difflugia bacillariarum*, Perty, but it is likely that they also serve some other purpose not now understood. Besides this, I have studied, in this country, several specimens representing two well-marked new species as follows: *Echinopyxis tentorium*, nov. sp. (Plate VIII., Fig. 1, *a. b.*). The test conical with a concave base, and bearing one tubule on its apex; opening subcentral. Its only decidedly specific characters belong to the shell, which presents the general form of a tent, or inverted funnel, and is so opaque that nothing can be seen of the amœboid animal within, except its pseudopods, which are sometimes, though seldom, extended from beneath, serving especially for locomotion and prehension. Also, a delicate plasmic point is occasionally projected from the single tube above. Specimens of this species are found on the muddy and sandy bottoms of creeks and ponds in New York. *Echinopyxis hemisphœrica*, nov. sp. (Plate VIII., Fig. 2). Test hemispherical, depressed; tubules several (3-7), more or less elongated and crooked, with large distal openings; the main aperture subcentral. This form is found also on the muddy and sandy bottoms of ponds and creeks in the same locality. The

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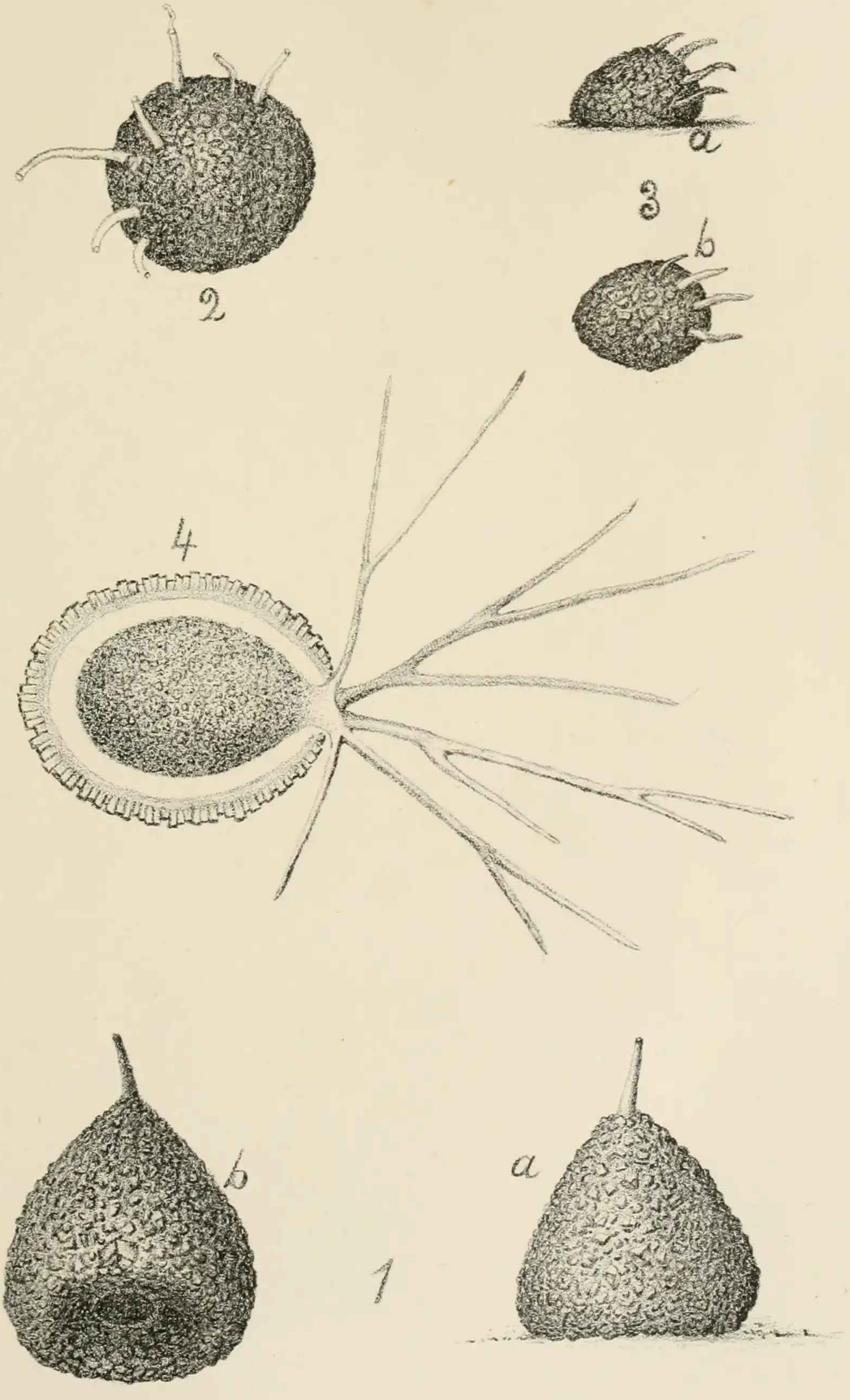
DESCRIPTION OF PLATE VIII.

Fig. 1. Test of *Echinopyxis tentorium; a*, elevation view, *b*, showing pseudopodal orifice in concave base × 450.

Fig. 2. Test of *E. hemispherica* as seen from above, showing seven hollow tubules, one with pseudopodi projecting × 450.

Fig. 3. Test of *E. aculeata; a*, lateral, *b*, dorsal view, showing four hollow horns × 200.

Fig. 4. Sectional view of *Euglypha tegulifera*, with its protoplasm, pseudopods, nucleus, and nucleolus, granulus, etc.


2
a
3
b
4
b
a
1

irregular or variable number of tubules is probably due to the fact that sometimes one or more become accidently broken off. If we admire the instincts of birds and bees, and wonder that such low animals as tubiculous worms can construct for their protection encasements of united particles of sand, how much more marvelous is it that we find organisms so low as the amœba, almost structureless masses of living protoplasm, endowed with this wonderful, inherited habit of constructing artificial houses for themselves!

Another admirable exhibition of Rhizopod architecture is shown in the genus *Euglypha*, to which I shall add one new form.

Euglypha tegulifera, nov. sp. (Plate VIII., Fig. 4). This is a beautiful little Rhizopod, and is characterized by a peculiar and interesting shell. It occurs among fresh-water Algæ, as I have seen it in New York, with an ovoid test, glistening in strong light from the effect of a layer of crystalline blocks of unequal height, which pave the external surface. The inner homogeneous capsule upon which the pavement lies, is quite thick, exhibiting the color of diatomin, and forming a smooth (not dentate) margin about the pseudopodal orifice. Protected within this hard, rough case lies the delicate, granular, plasmic, amœboid body, which does not entirely fill the shell, but presents a large nucleus and several small vacuoles, at times extending itself outwards by long, usually branching, sometimes anastamosing, pseudopods.

From among the great number of our fresh-water Rhizopods which I have studied, and which are mostly varieties of known species, only the few above mentioned are presented because they are new.

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A STUDY OF ONE OF THE DISTOMES.

BY C. H. STOWELL, M. D.

(*Received October 17th*, 1878.)

VAN BENEDEN says: "The parasite is he whose profession it is to live at the expense of his neighbor, and whose only employment consists in taking advantage of him, but prudently, so as not to endanger his life. He is a pauper who needs help, lest he should die on the public highway, but who practices the precept not to kill the fowl in order to get the eggs. It is at once seen that he is essentially different from the messmate who is simply a companion at table. The beast of prey kills its victim in order to feed upon its flesh : the parasite does not kill ; on the contrary, he profits by all the advantages enjoyed by the host on whom he thrusts his presence." Again : "Every animal has its own parasites, which always come from without. With some few exceptions, they are introduced by means of food or drink."

This gives us a better idea of a parasite than any single definition that could possibly be given.

They are animals :—

1. Entirely dependent on other animals for support.

2. They do not usually reproduce themselves in the animal which they inhabit.

3. They may locate themselves in any organ of the body, having been found in the brain, spinal cord, eye, ear, heart, blood, &c.

4. They vary in size ; some requiring the microscope to reveal their presence, while one has been reported to have a length of three thousand feet.*

5. They may exist in great numbers in one individual. Prof. Berthold, of the University of Göttingen, in a memoir on the abode of parasites in man, says that a case was reported in 1699 where a boy twelve years of age voided 164 millipedes, 4 scolopendræ, 2 living butterflies, 2 worm-like ants, and 32 brown caterpillars. Two months later he voided 4 frogs, several toads, 21 lizards, and sometimes a live serpent was seen for a moment at the bottom of his mouth. Van Beneden remarks : "Happily for science, we do not see such things seriously related in books at the present day." He says that sixty millions of eggs have been counted in a single nematode, and in a single tape-worm, or rather in a colony, even a thousand millions of eggs.

6. They inhabit every part of the globe.

7. As a rule, they are not hurtful ; an excess *is* hurtful.

It is said that the Abyssinians never take medicine when they have Tæniæ, being in a better state of health at that time.

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* *Tænia solium.* Reported at the Academy of Copenhagen.

Yet in Iceland, a cestode causes the death of the third part of the population, and we are all aware of the excitement Trichinæ have produced.

8. They are not easily killed. Some can be dried completely and returned to life by moistening. Eggs preserved for years in alcohol, chromic acid, and other destroying agents bring forth embryos when placed in proper surroundings, such as water or damp earth.

9. They have a great tendency to roam ; "Migration is the very soul of their prosperity."

The parasite under consideration is found in the bladder of the frog ; and in order that we may understand the position he holds among the Helmintha, we append the following standard classification :

Helmintha	Sterelmintha (*Sub-Class I.*)	Turbellaria (*Order I.*)	
		Trematoda (*Order II.*)	Entozoa.
	Cœlemintha (*Sub-Class II.*)	Nematoda (*Order III.*)	
	Anenterelmintha (*Sub-Class III.*)	Acanthocepala (*Order IV.*)	
		Cestoda (*Order V.*)	

The first sub-class is characterized by having solid or hard bodies ; the second, by having hollow or cavitary bodies ; and the third, by not being provided with an intestinal canal.

The Sterelmintha, we see, are divided into two orders :

1. TURBELLARIA, having ciliated epithelium covering the entire body, and receiving their name because of the peculiar rotatory motion communicated to the water as they swim through it.

2. TREMATODA, which, as their name suggests, are characterized by certain holes or pores.

It is to the latter order that we must give our especial attention. They are, as a rule, visible to the naked eye, ranging from .25 mm. to 6 and 8 centimeters in length. Thus viewed, there is nothing about them to attract attention ; but upon closer examination, bringing the microscope to our aid, we are astonished at their beauty and the complexity of their organization. They are not parasitic during their whole lives, for we find them at certain periods of their existence inhabiting low, moist grounds, and open waters. There are about 400 species, yet rarely are they found in man or monkeys. None have been discovered in the lion or tiger, and only two in the cat: one for the domesticated, and one for the wild state. They exist quite abundantly in bats, reptiles, and fishes, and display great partiality for frogs and toads.

The order is easily classified, as follows :

Trematoda	Monostomidæ,	Family	I.
	Distomidæ,	"	II.
	Tristomidæ,	"	III.
	Polystomidæ,	"	IV.
	Gyrodactylidæ,	"	V.

The first three families are so named because they have respectively one, two, and three suckers ; or, as was formerly supposed, "perforated mouths."

In the fourth family a particular number of suckers need not be insisted on, while the fifth family are characterized by having peculiar hooks around the posterior disk.

Plate IX., Fig. 1, represents a distome from the bladder of a frog. This animal, visible to the naked eye, can be readily obtained, and but few frogs will be sacrificed in vain.

The first thing noticed is its smooth integument, composed of muscular substances, always of the non-striated or smooth variety.

At the anterior extremity is the anterior or cephalic sucker (*A*), perforated at the bottom (*C*), which represents the oral cavity. A little posterior to this is a larger sucker called the posterior sucker, or acetabulum (*B*). This is not perforated, being used as an organ of locomotion, or as an anchor.

The oral cavity (*C*) enlarges to form the pharynx (*D*), to be continued into the œsophagus (*E*), which divides into two long blind tubes (*F*) extending nearly the whole length of the body. At *G* are seen little granular masses, doubtless food.

In order to study our distome in its native element, it was examined while resting on the exposed inner surface of the bladder of the frog. While thus situated, a blood-corpuscle (*H*) was seen to pass into the oral cavity, and by watching its course, the blind stomachs were traced quite satisfactorily. When the body was active, it would be driven toward the blind end of these tubes ; but as soon as motion ceased, and the body was comparatively quiet, then the corpuscle would invariably be driven to the pharynx and there remain till

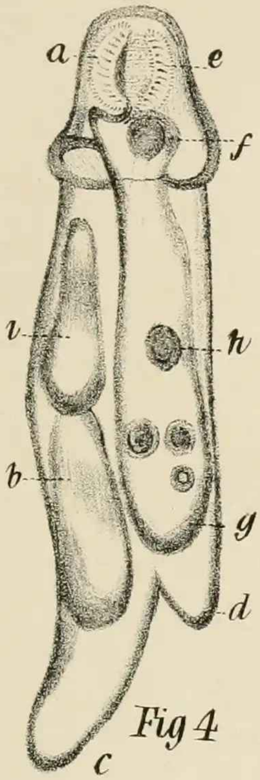

Fig 4

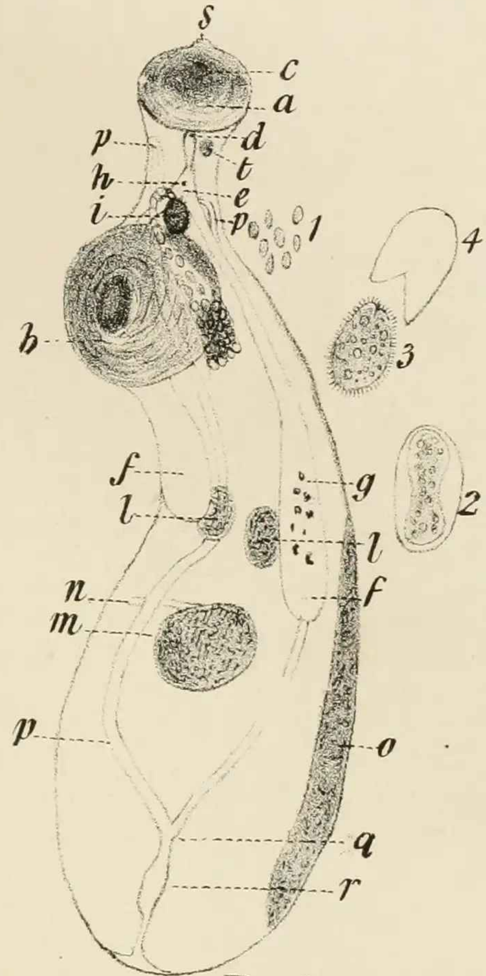

Fig 1

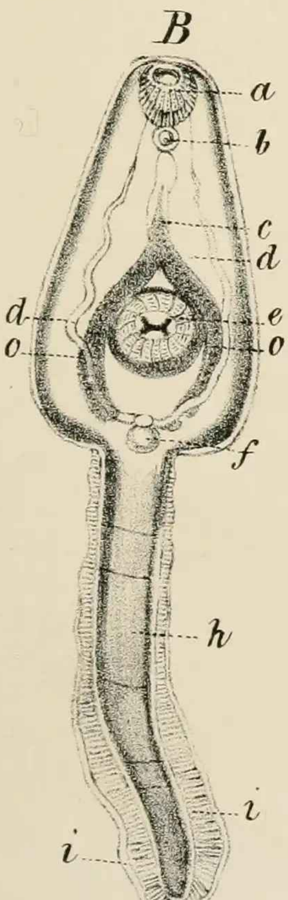

Fig 4

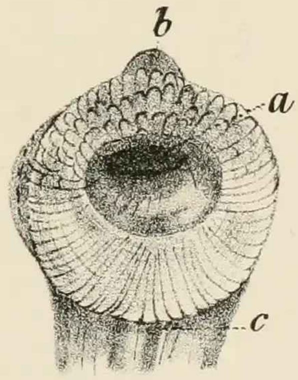

Fig 3

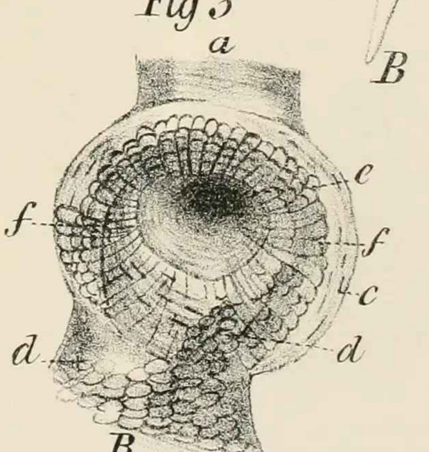

Fig 2

pushed down again. Although watched for some hours it did not get past the pharynx, neither did it appear to suffer any change.

The small body (*I*) situated immediately in front of the posterior sucker is the opening of the reproductive organs. It communicates with a long, tortuous tube (*K*), strongly colored and filled with ova. This is the greatly elongated uterus. The whole of the body posterior to the acetabulum is occupied by this long uterus, which is filled with thousands of ova in various stages of development, purposely omitted in the drawing that other parts may appear the more distinct. With this exception, the drawings represent the object as actually seen.

Our investigations lead us to conclude that the uterus is lined with epithelium of the ciliated variety.

Directly behind the acetabulum are two bodies, the testes (*L*). Still more posteriorly, on the median line, is a large, irregular body—the ovary (*M*)—and passing off from either side a narrow, slender tube, seen in this case only at the left side (*N*). These tubes connect the ovary with a long, glandular mass, situated at either side of the body. These are the yolk-forming glands (*O*), seen well in this specimen.

Owing to the great number of ova, the one on the opposite side was hidden from view. Lastly we have the true excretory and water-vascular system (*P*). This is composed of two long, slender tubes, which coalesce in the median line to form the sigmoidal duct (*Q*), which suddenly enlarges to form the contractile vesicle (*R*). We see that one of these tubes crossing the acetabulum turns back upon itself just behind the anterior sucker and terminates in a small indefinite point.

The little projection (*S*) from the cephalic sucker has all the appearance of being an organ of prehension, serving the same purpose to this animal that the tongue does to the frog. Such, however, is not the case, for it is used as a lancet to pierce the parenchyma of the animal it infests, and thus open a passage for the whole body to enter. If our distome is slightly compressed, or in any way made uncomfortable, this organ is thrust out suddenly at about the distance represented in the cut, to be as suddenly withdrawn, over and over again. A careful examination reveals the fact that this lance does not come from the mouth, but from the dorsal surface at a point nearly opposite. Examined after death it is nearly always found protruding. It is easily seen with a 1-in. objective, and studied profitably with a $\frac{1}{5}$-inch.

Has our distome a nervous system—any special sense? The demonstration of anything like a nervous system has entirely failed in our hands. It was supposed that the pigmentary spots just below the cephalic sucker represented at *T* were eyes, but most authorities hold to the opinion that they are simply an aggregation of pigment cells.

The digestive apparatus is exceedingly simple. The food enters the mouth at the base of the cephalic sucker, and, passing through the pharynx and œsophagus, enters the blind intestinal tubes.

The circulation of a colorless fluid containing granules, appears to be due to the general contractions of the body and walls of the vessels, yet one is surprised at the regularity of the oscillations. A complete oscillation occupied seven seconds. This was true at one examination for eleven consecutive oscillations. The oscillations were not so regular in all cases. Some specimens did not present them at all, while the time in others varied for each oscillation from four to thirteen seconds.

Fig. 2 represents the posterior sucker magnified 1000 diameters and reduced. We see two sets of fibers covering the body, the one longitudinal and the other circular. These are very intimately blended in some parts of the body ; when not so, the circular fibers constitute the outer layer. Around the border we notice the longitudinal fibers, showing their nuclei very distinetly (*C*).

Toward the bottom of the sucker the circular fibers are greatly in excess (*E*). The center looks perforated, but the dark color is due to the close and compact fibers stained here with carmine. This center is never seen to open and close as does a similar point in the cephalic sucker. Neither are foreign bodies ever seen to enter it. At this point it is imperforate, and owes its appearance to the mechanism of its fibers. The peculiar arrangement of fibers at *F* is very strange and difficult to describe. At the right is a diagrammatic section of these fibers. They are bundles of smooth muscle-fibers with one end (*B*) attached at the bottom of the sucker, while the other terminates in a free, rounded, blunt point. They appear to lie beneath the two sets of fibers composing the general covering of the body. A multitude of these bundles united surround the sucker, and when the animal is active they extend out, at nearly a right angle with the long axis of the body, and thus come very much nearer the center of the sucker than here shown. In fact, in some cases they appear to meet completely, and the whole sucker seems made up completely of these bundles. The cut shows these fibers relaxed and flattened, a result of death and manipulation. The fibers of this sucker are so arranged that when applied to any soft surface they must, during their full action, tend to create a vacuum in the center, thus serving as a hold-fast or anchor to the body.

The cephalic sucker (Fig. 3) is similar to its fellows in construction, only it is perforated, and has the addition of the lance (*B*). We recognize the well developed fibers forming the walls of the pharynx at *C*. When our distome desires to move from place to place, the acetabulum becomes fixed, and by the contraction of the circular fibers between it and the anterior sucker, the distance between them is increased, this part of the body being reduced to one-half its former transverse diameter and increased accordingly in length ; thus the cephalic sucker is pushed ahead. Now it, in turn, becomes fixed by a mechanism precisely like that of its fellow. The acetabulum and the fibers relax their hold and the body is drawn up a distance of nearly one-fifth the length of the animal. While the acetabulum is fixed that part of the body in front of it will swing from side to side, showing the greatest degree of contractility.

One will very rarely fail to see the distome casting its eggs. It is a most beautiful and instructive sight. It can be seen sufficiently well with a ¼-inch objective, with the process of segmentation going on.

Fig. 1,[1] represents these eggs as they appear when first cast off. By the general contractions of the body, aided by the cilia at the upper part of the uterine tube, these eggs are thrown off, usually three or four at a time, to be followed in a few seconds by as many more. At a single examination over two hundred were cast off, yet to all appearances as many were in the body as before. Some of these eggs should be removed to a very shallow cell, normal saline solution added, and high powers employed, and the process of segmentation carefully studied. The ova vary in size, but are quite uniformly oval in shape. At the right of Fig. 1 are some of these ova magnified 1000 diameters and reduced. One is undergoing segmentation (Fig. 1, [2]). This will keep contracting and expanding rapidly, each contraction making the center narrower and narrower, until separated completely into two parts, each part whirling about at a terrible rate. The embryo ([3]) has just left its covering ([4]), an appearance obtained by pressing gently on the cover-glass, causing the rupture seen here and the escape of the embryo. The embryo at [3] was from the distome at its left, and in shape is not unlike a jug. It is covered completely with ciliated epithelium. These cilia are very active, and, as a result, the body revolves on its axis at a high rate of speed. Their motion is so rapid that with high powers it is exceedingly difficult to keep them in the field. Evidently they have no idea where they are going, for they will strike some obstruction with force sufficient to give them a considerable rebound, when for a moment they will remain perfectly quiet, only again the next moment to go whirling about. Examined closely we see the commencement of a cephalic sucker.

After a time this embryo develops in its interior another organism, a sporocyst (Fig. 4, upper figure, after Cobbold). At first the appearance of this sporocyst is very simple, having a faint semblance of a head, body, and a short, straight tube for a digestive canal. The figure represents the sporocyst in an advanced condition. There is a well-developed head and body, with a very prominent tail (*c*). We see an oral sucker in front (*e*), communicating with the bulb of the œsophagus (*f*), which passes directly into the blind digestive tube, or stomach (*g*), which contains here particles of food (*h*). At *b* and *i* are irregular bodies which will develop into organisms called cercariæ. After their more complete development and escape from the sporocyst, we have the appearance given in Fig. 4 (lower figure). Here we have no difficulty in recognizing the several parts. The cephalic sucker (*a*) is plainly seen with the pharynx (*b*) communicating with the œsophagus (*c*). The digestive tubes or stomachs (*o*) are seen, also the posterior sucker, or acetabulum (*e*). The water-vascular and excretory system (*d* and *f*) are here shown. The tail (*h*) is prominent, and has a marginal fringe (*i*).

The cercaria now loses its tail and becomes encysted,* either on or within the body of some mollusk or aquatic animal. This is known as the pupa condition. In this state it passes into the stomach of some higher animal, where it loses its covering and acquires all those organs which entitle it to be called a sexually mature distome.

Thus we see the embryos, as they escape from the eggs, are not at once transformed into individuals like their parents, but they in turn produce other larva-like forms, capable in their turn of producing still other larvæ, which alone resemble the parents. This form of development is called "Alternate Generation." As we have seen, the embryos are sometimes developed before the eggs are cast, and, indeed, may escape from the eggs while they are still within the uterus.

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ON THE PROBABLE ERROR OF MICROMETRIC MEASUREMENTS.

BY EDW. W. MORLEY, M. D., PH. D.

(*Received Nov. 29th, 1878.*)

To some of the readers of the QUARTERLY MICROSCOPICAL JOURNAL it may be interesting, or possibly useful, to have an estimate of the degree of accuracy attainable in those micrometric measurements demanding the highest precision. The statements in this article apply directly only to measurements of objects fulfilling certain conditions; they would not apply rigorously to the measurement of anything but fine, straight lines ruled on a transparent medium, and viewed by transmitted light.

Professor William A. Rogers and the writer have made numerous measurements of the intervals between lines ruled on glass plates; the object being to see how near the professedly equal spaces were to actual equality. Care was taken to make our results absolutely independent of each other's work, by keeping ourselves in absolute ignorance of each other's results. Professor Rogers has examined the question pro-

*It is supposed these cysts are formed by means of a special, secreting organ, with the help of the epidermis.