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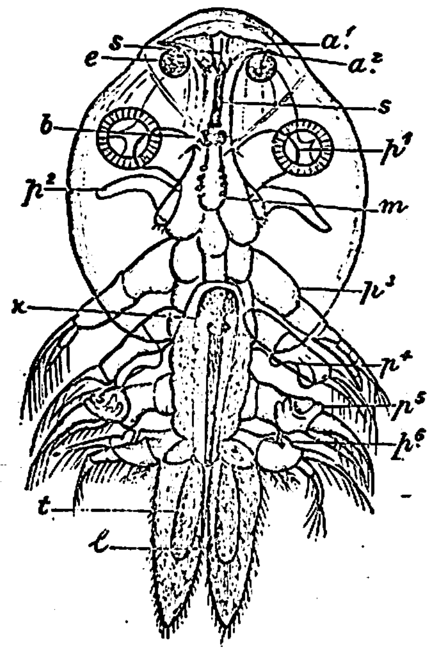

Fig. 1.

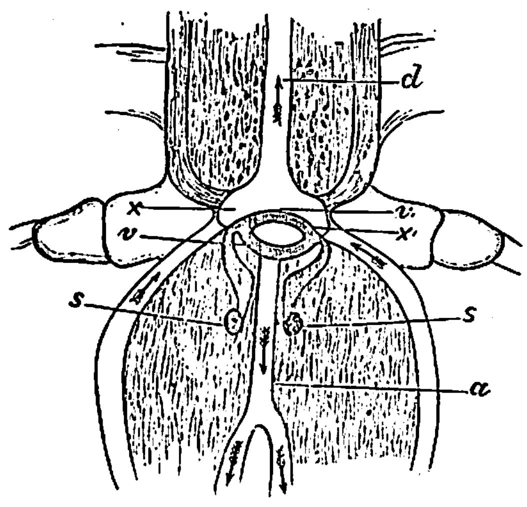

Fig. 5.

ARGULUS STIZOSTETHII, N. S.

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Argulus Stizostethii, N. S.

BY PROF. D. S. KELLICOTT, BUFFALO, N. Y.

FISHERMEN accustomed to take the Blue Pike, *Stizostethium Salmoneum* Jor., from the Niagara River at Buffalo, have at different times told me, in answer to inquiries about "fish lice," that this fish, during midsummer, is always lousy. They account for it by saying, that when the water is warm it gets too lazy to take food, that it then gets poor, and through its inertness becomes infested with lice. After giving this fish especial attention for several months, I conclude that the fishermen are correct, so far as the habits of the pike are concerned, and it was not until August of the present year that I found the creature referred to by my friends. It proves to be an *Argulus*, and considering the number of fish of this species that I have examined expressly to discover external parasites, finding none until this time, I conclude that they are at least not common at other seasons. After comparing the parasite with such species as are known to me, with all species described in North America, and with such European forms as can be obtained, I conclude that it has not been described. I present in this paper an account of it by which it may be recognized in the future, adding more or less of the detailed results of my observations and study of the species. I have had a fairly good opportunity to study it, as I have had numerous living examples of both sexes; moreover, it is a transparent species of considerable size. I have been obliged to write without the privilege of the monographs of Leydig and Claus on the anatomy of these forms, save such general statements and conclusions as appear in our manuals and in the English microscopical journals. This is a disadvantage, the only compensation for which resides in the fact that my paper expresses the results of the independent observations of an observer without predilection.

The figures were engraved from drawings made under the camera lucida, and are mostly confined to illustrating parts of organization peculiar to the male. As the figures most commonly met with in our books are of the female, these may on that account, prove to be more useful to the readers of the journal.

The parasite occurs usually on the top of the head of the fish; when there are several, they are, as a rule, huddled together, often in heaps, so the knife may remove a number at once; it occurs also on the fins; none have been found in the mouth cavity. During August and the early part of September, I took a good many examples of the fish, scarcely one of which was without one or more of the parasites; some gave many, twenty were taken from one lean and tormented host. I have taken pains to examine other sorts of fishes taken along with these, but have not found the parasite on any other species. Still when put into my aquarium with a small specimen of *Lepidosteus osseus* and some minnows, they shortly locate on them, fastening, as before, to the head and fins of the gar-pike, but to any part of the minnows: these latter soon die, killed apparently by the *Argulus*. When they were first put into the trough, the small fish would pursue and catch them, but would eject them with a suddenness and a queer expression of frustration that was most amusing; in a few minutes *Argulus* could swim about unmolested by the minnows. The gar also expressed his dislike for the new comers by recoiling in evident fear from one seen approaching. The parasite seems to retain its hold without often moving, e.g., a large female fastened to the end of the long nose of a gar, where it clung for several days despite the vigorous efforts of the fish to dislodge it. I have examples of another species in my aquarium, which have now remained attached to the same spot of their host for two weeks. I find that as the water of the river gets colder, late in September, and along into October, the pikes are in better condition—not so many "razor-backs"—and fewer are infested. The fishermen assure me that after "frosts" these fish get fat, and then no lice are found on them.

The aversion, or dread, fishes exhibit for these parasites, the fact that the least examples of the blue pike are the ones principally troubled, and that the minnows supposed to have been killed by them, had their scales removed from places where the parasite had been attached, with the denuded surface in some instances congested, may point to the conclusion by Leydig, viz: that the proboscis, or spicula, is a poison organ (Siebold's Com. Anat., 329, note).

It seems quite appropriate that this species, if unnamed, should bear that of the fish from which it has been so plentifully taken, even if it should prove to occur on other hosts of different genera; therefore, I propose to call it Argulus Stizostethii.

Size. Length of adult, male, .33 to .38 of an inch; length of abdomen .12 of an inch (average); length of female, .45 to .55 of an inch; length of abdomen, .17 of an inch, (average). Individuals are often taken which show well the characteristics of their sex that are not above one half the size of the adult.

Color. The males and immature females, are nearly colorless, with special organs brown; the mature females have the carapace, legs and abdomen pale pea-green, the upper side of the thorax rendered quite dark by many oblong spots in the integument; these appear as the eggs begin to mature in the ovaries. There is a light line along the dorsum; under side of thorax rendered white by mass of ripening eggs.

The carapace is broadly ovate, deeply cordate, somewhat more rounded in the males. In the females it barely covers the third pair of natatores, in the male the second pair only.

The abdomen is about one third the entire length, divided almost half its entire length; the lobes narrow, subacute in the male, apex slightly more rounded in the female, and the lobes relatively broader. At the bifurcation on the upper surface, stand two prolonged tubercules whose rounded terminations bear five hairs each; these bodies set backwards and outwards, (Fig. 1, l.) The surfaces of the abdomen, the under surfaces of the legs, and especially the borders of the shield, are beset with pointed, short teeth.

Antennæ. First pair two (or four) jointed, the basal piece seen from below triangular, chitinous, with a strong hook on the inner posterior angle; second joint chitinous, ending in a long slender hook turned downwards; on the basal part are two hooks; a little beyond the middle of this uncinate part, articulated to its upper surface, is an auxiliary two-jointed part, (third and fourth antennal joints) the first part of which is cylindrical, slightly curved, reaching to the end of the terminal hook of previous joint. It bears a short segment which terminates with six setæ; there is a robust seta at the articulations of these pieces. The second antennæ are four-jointed, the basal joint is thick, with hook at base, the second joins it in a knee-like joint at right angles, the last three pieces successively diminish in size and length with setæ at the articulations.

Limbs. The first pair end in the usual form of cupping disc; the second are five-jointed, the last terminating with two hooks; the basal joint has a thick cushion covered with setaceous teeth. There are three stout brown teeth on its posterior margin; the four pairs of swimming legs, or natatores are also of the usual form; the first, second and third are each three-jointed; the fourth, two; each terminates with fingers, or pinnulæ; of these feathered oars the upper ones consist each of one piece, the lower one of the first pair is three-jointed, the two end ones are short, cylindrical, without plumes, the final one bears three pointed pieces which seem to act as pincers; the lower finger of second pair is undivided; those of the last two pairs are two-jointed, the articulation being near the middle. *There are no recurved pinnulæ on any of the natatores.* In the male, the outer divisions

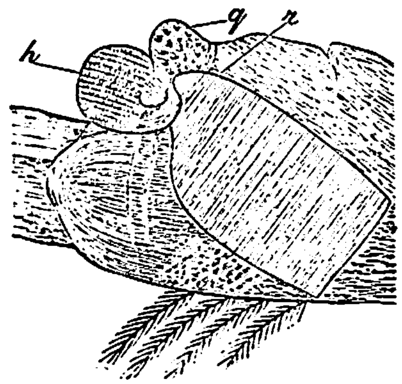

Fig. 2.

of the third and fourth, and the middle one of the second pairs of natatores, carry distinctive sexual appendages. I describe them as follows: That of the fourth pair (Fig. 2) consists first of a robust brown body, (h) arising from the front margin at outer angle; it turns downwards and obliquely forwards; it is almost opposed by a second similar, but colorless organ, (g), arising from the same margin; there is a third piece, a chitinous tooth (n) springing from lower border, pointing towards the first men-

..oned organ; this organ (h) has its surface covered by scale-like elevations. The third pair have special parts on both the inferior and superior surfaces. In the median line on the sternal face of the segment bearing this pair, is a chitinous ridge which sends lateral branches to the limbs; on the basal joint this ridge is prolonged into a blunt tooth which is met by a similar one on the succeeding segment; these seem to prevent the limb from being bent downwards at this articulation. The whole upper surface of the last segment is occupied by a complicated set of organs (Fig. 3); on the an-

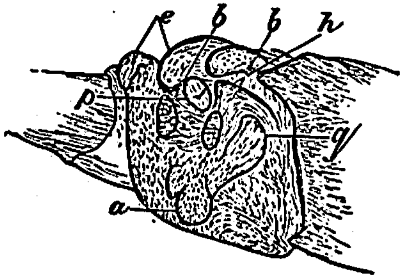

Fig. 3.

terior border are, three fleshy protuberences directed obliquely outwards (e); at the base of the first of these, is a pointed brown piece; just back of it another similar part (h); in front of this, and back of the first and second protuberences is a deep cavity (p), which may be traced beneath h; posteriorly to p, stand two clavate bodies (b, b); foreshortened in the figure as they stand vertically, they arise from a common base and can be approached like the blades of pliers. They are apparently clasping organs; the surface is similar to that of h, Fig. 2. Back of these is a blunt fleshy piece directed back (a), at its base there is another turned front (g). The surface of the organs represented at a, e, g, and the general surface of the segment are clothed with short stiff hairs. The organ of the second pair occupies the lower surface of the middle segment; it projects back beyond its posterior margin; it is a fleshy body, its surface clothed with setaceous teeth, it can be, at least, nearly closed hand-like by the approach of its extremities, (Fig. 4.) On the basal part

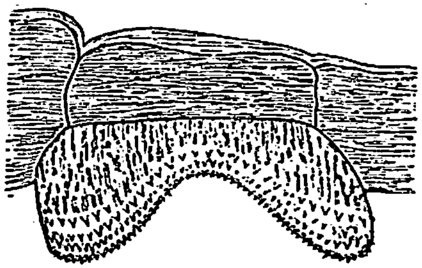

Fig. 4.

of the last pair, are heel-like organs, larger in the female than in the male. Whatever office besides they may perform, they are used by the female to place her eggs in order, when they are left to the warmth of rocks and water for incubation. The pointed "narrow laminæ" at the base of these organs in female of other species, are wanting in this. There is a capitate papilla situated in the median line at the termination of the thorax of the male.

In the basal part of each abdominal lobe is a well marked brown sexual body (Fig. 1, t.) In the female they are small egg-shaped vesicles (spermathecæ). In the male, they are long cylindrical sacs, (testes), pointed at their upper extremity, rendered conspicuous to the eye by brown spots in the tissues of the sac. Under a considerable magnifying power they appear striated in the direction of their length. In the back of the male, in the notch of the carapex, is another distinct brown ovoid organ, (seminal vesicle); there are tubes (ductus deferens) of same color extending from its anterior extremity to vesicles (accessory glands ?) of irregular form situated in the last thoracic segment near the insertion of the last natatores, concealed by the muscles moving these limbs; the abdominal sacs communicate with the same; this dorsal body and its lateral prolongations often exhibit peristaltic movements (Fig. 1, x.) The three organs last mentioned, after the death of the Argulus, often change their color to light purple. These bodies are easily removed by the dissecting needle. When thus removed and crushed under the cover glass, there exude a fine granular matter and hosts of spermatozoa. These latter are enormously long rods, or threads. I can make out no distinctive characters, except that one end is possibly coarser than the other. Those from the sacs and dorsal body of the male are in some examples, as a rule, coiled into rings, .0008 of an inch in diameter. In a few instances I have seen the coils—from the dorsal vesicle—in motion, slowly uncoiling and again coiling, or the coil turning about. When the fluid dries on the slide, the coils appear invariably to unwind. Those from the spermathecæ of female I have always found unrolled.

The spherical ova are placed in irregular patches of single layers, glued to supports by a frothy cement. They are at first white, changing to yellow, in from two to six days. They measure .016 of an inch in diameter. They hatch after sixty-eight days incubation

With regard to the union of the sexes, I have to say that the statements of authors to be found in our manuals and Zoölogical dictionaries, have been in great part verified, still, I can not in the least reduce the hiatus as to the real office of the several complex auxiliary organs of the male natatores. I have at different times seen the spermatic filaments entangled among the bristles and parts of these organs. While the male remains fastened to the carapace of the female with his sucking feet, he continues at intervals to bring into contact these organs. Copulation is accomplished by passing the third and fourth natatores beneath the base of the abdomen.

In regard to the circulation, I can verify what may be found stated by various observers, at least, that pertaining to the streams to eyes, antennæ, limbs and carapace, but I find less definite observations relating to that part that may be called truly vesicular. I have indicated in Fig. 5, the organs which appear to me to control said circulation. In the figure, d, is the dorsal vessel, a tube of uniform diameter until it reaches a point a short distance back of the brain where it is constricted to one-half or one-third its general size; v and v^1 represent two positions of a thick membrane which moves with every pulse from position v to v^1, and return; x and x^1 are valves, they seem to me to be mere pouches, but I am undecided as to their true nature; the arrows indicate the direction of the blood currents. These are as follows: When the pulsating membrane is at v, currents pass into the space in front of it, from the lateral or border currents of the abdomen, through the valves x and x^1; as the membrane moves to v^1 these close and the blood is forced along the dorsal tube; there is, also, an isochronal dilation posterior to v of a vessel that is deeper in the tissues, and receives the blood coming from the body; this abdominal vessel (a) divides at the division of the abdomen, it also sends lateral divisoss the under surface of the lobes narginal streams. The presence ion of the valves at x and x', may to the best advantage when the s is under sufficient pressure to vent the heart from driving the orward; it then moves back and hrough the apertures exhibiting vular membranes.

aware that "Leydig denies that amellæ, [abdominal lobes,] thus sed, [1st, of simple glands; 2nd, muscular net work; 3d, of a lacunal ork;] have peculiarly a gill function still, on general grounds, I am led ik that they have this function to er degree than any other part. As the circulation, all of it concen- from the body into this organ, it spreads out over the surface with innest of membranes separating it water currents; from thence it is ed by the heart, and distributed to hole organism. The corpuscles are orm; when seen by high powers, exhibit an appearance similar to of the white corpuscles of higher s.

e alimentary canal I make out as vs: first, a short œsophagus; it is ealed for the most part by the bulb; xpands into a broad flask-shaped ach, which exhibits at its upper —beneath the upper pair of sternal s—a transversely corrugated band; its general surface there are color- glands; the muscular walls are firm, the organ often displays vigorous staltic motion; the intestine opens the stomach on its upper surface a rt distance above its posterior ex- nity; this point is between the first atores. The entrance to intestine ns to be guarded by longitudinal ls; this intestinal tube gradually ex- pands, attaining its extreme diameter ju above the insertion of the third swim- ming feet; from this it contracts to th uniform tube, which begins with the abdo men and ends at the division of the same. In the part from the stomach to the rec- tum there is a lining layer of granular o glandular brownish matter; when to great pressure is put upon an individual the part which I call the rectum, some- times snaps at its upper end, then pro- truding from the anus between the lobe.

I have omitted many particulars of structure and habits, which I have h upon during my acquaintance with th species, keeping to such as I have though would be most useful to the readers of this journal.

The Microscope and Its Parts.*

BY ED. BAUSCH.

IN a society like this, where there a different stages of advancement i the knowledge of microscopy, it is a di ficult task to speak intelligibly on a sub- ject and at the same time make it inter- esting to all. In the topic I have chose I will offer facts which I hope will pro useful to the majority, and which ma reveal new phases to those more co versant with the principles of optics. I will omit, as much as possible, points th may be gleaned from books, and wi confine myself in a concise form to tho which experience teaches me are of th greatest importance. I hope that, if i the course of my remarks, I should n be sufficiently explicit, the membe will not refrain from asking for an ex planation.

We all know the derivation of th word microscope, but few of us perhap have dwelt long upon the thought what it actually is. From our first ac- quaintance with the compound micro- scope, we have the impression that it is composed of several mechanical and opti- cal parts, the latter of which give us highly magnified images, and we some- times forget that it is the latter only which really form the microscope. In its modern construction it is composed of an eye-piece and objective, having correlative distance and combined by a tube, while the stand or mechanical ap- pliances are merely accessories for the easier attainment of the work.

I see no reason why we should not, in ordinary parlance, call the entire instru- ment a microscope; but take from it its optical parts, we have then simply a sample of good or bad mechanical in- genuity and workmanship, as the case may be.

I will devote my first attention to the stand.

The first requisites in it are stability and entire freedom from liability to vibration. The proportions and weights of its parts should be such as to bring the centre of gravity as near as possible to the base, so that, with or without in- clination of the body it will remain steady. The bottom of the base or foot should not present an unbroken surface, as with this it is evident that when it comes in contact with an uneven surface it becomes unsteady. The modern and certainly only true form is to have three projections, which present the only points of contact. I would advise those having an instrument with a flat base to cement to it at proper distances three rubber pads. I prefer rubber as in case of a slight tremor the vibratory motion is transmitted to it, while the stand re- mains steady.

Whatever is the form or construction of the stage, it should be able to bear the slight pressure used during manipu- lation. No stage has yet been made which, under sufficiently high magnify- ing power, can not be shown to give way under a strong pressure. In many stands this quality serves the purpose of a fine adjustment.

The coarse adjustment or quick motion is gained by a sliding tube, a screw ar- rangement or a rack and pinion, the latter of which is the favorite form in this country.

The fine adjustment or slow motion is constructed in various ways, but no mat- ter how, it should be faultless in its work. Nothing exasperates more and proves a greater hindrance to good work than a poorly made fine adjustment. The form which varies the distance between the eye-piece and the objective, will, I think, become obsolete, as it should. We all know that any change in the length of the tube causes a difference in the mag- nifying power, and it is evident that when this principle is involved in the fine adjustment, it makes it unreliable for accurate measurements.

In the first construction of the micro- scope, the eye-piece and objective con- sisted each of a single lens. As it gradu- ally developed, the Huyghenian eye-piece, which had previously only been used with the telescope, was successfully ap- plied to it, and the application of achrom- atism to the objective finally gave it the construction which, with modifications, characterises it to-day.

It is an error to suppose that the rating of objectives has any connection with working distance, angular aperture, or diameter of front lens. It merely indi- cates the equivalent of a single lens hav- ing the same magnifying power. For in- stance, an objective marked one half inch,

* A paper read before the Rochester Microscopical Society, Thursday Feb. 9th, 1880.

The next column gives the diameter of field which often varies considerably with the objectives of same nominal power. The next column shows the flatness of field, indicated by an arbitrary standard of 1 to 6—the latter representing an *absolutely* flat field which I have not yet found in any objective I have examined. The next column shows the chromatic correction. I have been unable to devise any numerical method which would fairly represent the quality, and have been forced to content myself with such vague notes as "slightly under," "slightly over," etc.

The next two columns give the number of the diatom on Möller's balsam mounted "*probe platte*" clearly and fully resolved by the lens with light from lamp and mirror, and the number of lines per .001 inch as determined by Prof. Morley's measurements. The next two columns, the number of the diatom on same "*platte*" which could be just glimpsed under same conditions, and the number of its striae per .001 of an inch. The last column is for remarks.

It is of course understood that many of the results given would vary with different eye pieces, but all, except the actual amplifying power, have been obtained with Tolle's ½ inch solid eye piece, the field of which is small enough not to be affected by the size of the tube of the microscope.

I present herewith the results of my examinations of forty objectives of various makers. It was intended that the table should be as complete as possible, but at least two important omissions have been discovered as the work progressed—

1st.—The diameter of the exposed face of front lens should have been given.

2d.—The number of the diatom on the Möller platte resolved with direct *central* light should also have been recorded.

There are probably other points which have been overlooked, but the table is submitted as an earnest and honest endeavor to remove the examination of objectives from the domain of mere opinion to that of carefully ascertained and accurately recorded *fact*. The attempt has been to ascertain and record the details of the best performance of each objective for itself rather than to express an opinion as to its excellence or defects as compared with some standard, ideal or actual, and it is hoped that, not only these records but more especially the *method* may prove of interest and possibly of service to users and makers of objectives.

In conclusion I wish to express my thanks to the owners, dealers and makers who have kindly placed objectives in my hands for examination, and my regret that my limited leisure has prevented me from making the present exhibit more complete by including the work of other makers.

OBSERVATIONS ON LERNEOCERA CRUCIATA.

BY D. S. KELLICOTT.

Mr. A. M. Norman, in the *Zoologist* of London in 1864, remarks as follows: "Little has been done, as yet, in Great Britain among the external parasites of fish. The only work that treats of them is Dr. Baird's 'History of the British Entomostraca.'" It is fifteen years since the statement appeared, and yet it has

recently been repeated in substance by a writer in *Hardwick's Science Gossip*, and the remark applies with equal or greater force to the state of our knowledge, and to our literature of these strange creatures; while observations, researches and papers have appeared concerning higher forms of crustacea, those treating of these lower forms are characterized by their poverty. Few species have been described, especially among such as are parasitic on our fresh water fishes, while the habits and history of still fewer have been published. In this paper, I have attempted to state briefly the results of my study of the species *Lerneocera Cruciata*, of Lesueur, prefacing it with some general remarks about the group.

"Of all the curious creatures which the naturalist meets with in his researches," says Dr. Johnston, "there are none more paradoxical than the *lernæ*; none which are more at variance with our notions of animal conformation, and which exhibit less of that decent proportion between a body and its members which constitutes what we choose to call symmetry or beauty." This *outre* appearance pertains to the female principally, for the male, as a rule, is less monstrous than the female, and sometimes of as "decent proportion," as beautiful in outline, and as graceful in its movements as most others of the numerous forms of the free *copepoda;* this is true also of the females, until after they have passed some time, with the males, as free swimming crustacea. In the meantime, having undergone several moults, it is not until they reach maturity, the end of existence then being the perpetuation of the species, that they undergo the wonderful change which naturalists have been pleased to call a retrograde development. She increases enormously in size; the segmentation becomes almost wholly obliterated; the thoracic and abdominal appendages remain as minute organs, as rudimentary organs, or are transformed into powerful organs of attachment. To the females of the species of the group to which our lernæan belongs, the expression must apply if at all. Instead of the free-swimming, active individual, the female becomes fixed, the head and upper part of the thorax with the thoracic appendages, are buried beneath the skin and muscles, or other soft parts of the host, depriving her of the slightest power of locomotion; in fact, the females are so modified by the loss of apparent articulation and reduction of external organs that they were classified with worms, until the observations of M. Surriary and Alexander Nordman; the former in 1822 discovered the true nature of the external egg tubes, the latter, a little later, traced the life history of one species; since the appearance of the works of Milne-Edwards and Dr. Baird, their place among the *crustacea* has been generally understood. They certainly afford a remarkable example of adaptation of means for securing ends; an example of as complete passivity as it is possible to find amongst animals.

The adult female *cruciata* is a parasite upon the ROCK BASS (*Amblöplites rupestris,*) taken in the great lakes and tributaries. The species was described by C. A. Lesueur from specimens taken at Erie, Pa., in 1824, in the Journal of the Academy of Natural Sciences of Philadelphia. His description is as follows: "Body rectilinear, clavate, terminated by five tubercles which are rounded behind; head armed with four subcorneous appendices in the form of a cross and a little curved before."

Besides the formal description, he states some facts and conclusions. I introduce these: "Body slender toward the head, and gradually dilating behind, and so transparent as to exhibit the interior parts distinctly. At the extremity of each of the head appendices is a small, black, impressed, somewhat oblong point, which may be an opening communicating with the interior. The intestinal canal extends the whole length of the body without folds or dilations, but gradually enlarges towards the posterior extremity. At a distance of about two-thirds the length of the body from the head, an annulated vessel originates and passes downwards on each side of the intestinal canal; this double vessel seems to unite at its superior part. The conformation of this vessel seems to indicate that it is an ovary, there being no appearance of such appendices to the posterior part of the body as exist in that of the following species, *L. radiata* and *L. Blainvillii*, and which probably perform the function of branchia. I have been led to suppose the existence of other openings in the tubercles through which respiration may be effected."

Concerning the transparency of the body walls, I observe that the older individuals are not sufficiently transparent for advantageous study of living examples; that the chitinous exterior together with the external load of confervæ and infusorial life which they usually bear, render them too opaque for satisfactory examination, but a young specimen, *i. e.*, one having recently completed its final change is beautifully transparent. It was from such that I was able to make my drawings with the camera, of the body, thoracic organs, and external ovary. With regard to the "small, black, impressed, somewhat oblong point" at the extremity of the head appendices, I must say that I have sought for it, without finding it, or anything else which could have been thus characterized.

There is no doubt that the "annulated vessel originating two-thirds of the length of the body from the head end, is the ovary," or rather, as they do not appear to be "united at the superior part," they are the ovaries; by a reference to the drawing it will be seen that they originate at, or reach to, about the middle of the body, and are at their anterior extremity, folded back upon themselves for about one-third their length. For the distance they are each double, they overlie the intestinal canal, and sometimes each other, which fact, no doubt, led to the expression, " unite at the superior part." Under favorable circumstances, the ova which gives them their annulated appearance, may be well made out. The absence of "appendices to the posterior part of the body" was due to an accident, for these are, as is well known, the external ovaries. I have, at different times, taken several females of this species with well-filled egg-sacs; still a majority of the older ones taken in July and August are without them, while those fertile ones taken at mid-summer have the eggs loaded with algæ and infesting infusoria. So I suspect the most favorable time for studying the embryology and preliminary stages is not during the summer months.

The Ovisacs.—The young specimens used for my drawings afforded clean pairs of egg-tubes which I describe as follows: Length 2.1 mm., greatest width .45 mm. The outline is fusiform, slightly curved inwards. There are about eight rows of eggs at the widest part, but two or three at apex (Fig. 1, *e*).

The place at which the parasite attaches itself to its host, is on the sides of the body; the majority occurring on the tail third. It is fixed thus: The body of the parasite issues from beneath a scale, or at the angle between two; the upper surface of the head and thorax resting close beneath the skin, with the upper side of the head, the mouth and appendages, together with the thoracic appendages resting next to, or within the flesh of the fish; about one-third the length of the body is inserted into the muscle, a *constriction indicating an articulation and bearing a pair of appendages*, marks the point to which it is concealed. This

oblique setting, together with the freer motion of the articulation, permits the body of the parasite to rest close to that of the fish when it moves through the water, exposing it less to injury from violent contact with objects.

After removal from the fish they exhibit little motion. The appendicular organs continue to move, and the intestinal canal continues to pulsate for some time; I have observed it twenty-four hours after removal. The alimentary canal, as said by Lesueur, can be traced from mouth to anus; it is a tube without folds, but somewhat dilated posteriorly; I am unable to detect accessory digestive organs. It contains a black granular matter, more apparent anteriorly. The canal is surrounded by a light, fine, granular mass, showing here and there oil globules; this mass moves back and forth with the canal, as adjacent parts of it thus move with its rhythmical pulsations; from the beginning of the ovaries to the head, this matter seems to fill the space between the canal and the body walls. In a fresh individual, I observed that the pulsations took place once in five seconds.

Appendages.—It still remains for me to describe the appendages of the head and thorax. I will begin by referring to the last pair (Fig. 2). This pair stands on the under side of the posterior border of a segment at the most constricated portion of the neck (Fig. 1, *z*,). They consist of a basal portion, protopodite (*a*), on which stand two lamellar organs which I designate as endopodite (*c*), and expodite (*b*). They are each three-jointed and bear long plumose setæ, for the detailed arrangement of which I refer to the figure; underneath the posterior border of the so-called head appendages is a similar pair (Fig. 1, *x*,); beneath the center of the head stands another pair quite like the other two (Fig. 1, *y*,). This pair is, however, smaller, and the parts stand quite near to each other; they are but a short distance back of the pair of foot-jaws (Fig. 3, *f*,), at the base of, or just below the mouth parts. These three pairs seem to be quite analogous in structure to the swimming feet of free *copepoda*. Their use may be to force from the wound such matter as the irritation produced by the action of the parasite may cause to settle there.

I first detected these organs in a female recently transformed; afterwards in older specimens after immersion for sometime in caustic potassa; finally in such specimens without treatment; in such, however, the two pairs nearest to the mouth are usually encumbered with foreign matter.

The Mouth.—The mouth appendages are arranged about a conical body, corresponding to the head, as I think, among higher forms, in the median line at the apex of the head; when under the compressor, it is bent under and then is directed backwards. I have been unable to define it in any other position so as to sketch it. This cone ends in a blunt point, at the opening of which several hooks appear, which I suppose represent the mandibles, although quite different in form from those parts in higher forms. On either side of the cone stand two organs, which I take to be the first and second pairs of antennæ. I describe them as follows: First pair, (Fig. 3, *a*,) three-jointed; the first joint as long as the other two, which are equal to each other; for arrangement of spines, refer to the figure. The second pair, (Fig. 3, *b*,) two-jointed; joints equal; setae at the termination long and hooked. Below the mouth opening, but reaching to it, is a pair of foot-jaws (Fig. 3, *f*). The articulations of these organs are hard to make out; the last joint bears at its apex five strong hooks; at its base is a thumb-like projection, and a styliform appendage. The specimens used in my observations were taken from rock bass taken in the Shiawassee river, the Upper Saginaw, at Corunna, Mich. About one-fourth of the fish taken had one or more of the parasites. They are taken occasionally from the Niagara at Buffalo. I have diligently sought for the male without, as yet, finding him.

EXPLANATION OF THE FIGURES.

Fig. 1. Dorsal view of female; *e*, ovisacs; *o*, ovaries; *a*, alimentary canal; *m*, mouth; at *x*, *y* and *z*, are the appendages shown in Fig. 2.

Fig. 2. Thoracic appendage; *a*, protopodite; *b*, exopodite; *c*, endopodite.

Fig. 3. Mouth; *a*, first pair of antennæ; *b*, second antennæ; *n*, mandibles; *f*, foot-jaws.

SOME OBSERVATIONS UPON THE DESTRUCTIVE POWERS OF CERTAIN INSECTS.

BY C. M. VORCE.

Almost every microscopist is familiar with that interesting object, the "*proventriculus*" or gizzard of the cricket, as well as the corresponding organ of the cockroach, and doubtless the first has impressed most observers with its appearance of destructive power; indeed, to view its hard, sharp, knife-like teeth or processes and its remarkably powerful compressor muscles, reminds the observer of the resistless force of the quartz crushing mill. The question at once suggests itself: what purpose is this highly developed organ designed to serve in the general economy of nature? Its specific object in the insect's organization is plainly to cut and crush, in fact to masticate, the food taken into the stomach. But the cricket is not commonly classed as a destructive insect and is rather considered harmless, and so far as economic ends are concerned it appears to be harmless.

These reflections invite comparison of the masticatory and digestive apparatus of the cricket with that of the notoriously destructive locust, or grasshopper, the cockroach, and other destructive insects.

Starting with the harmless cricket, we should expect to find its destructive relative, the locust, armed with a terrible enginery of destruction, but on examination this expectation is not realized. The gizzard of the grasshopper (*Caloptenus*) is weakly, armed with but a single circlet of inconspicuous teeth, short and blunt, seemingly capable of but little crushing or cutting action. Nearly the entire œsophagus, however, of the locust is set with rows of numerous small, sharp, thorn-like teeth, almost exactly the shape of pike's teeth, pointing backward, and underlaid by longitudinal muscles which are apparently capable of action independently of each other, thus giving exactly the feed motion of the sewing machine. Near the gizzard these teeth are set on separate chitinous plates, three to seven teeth on a plate. Nearer the mouth they are set in long rows on longitudinal chitinous ridges and are longer than those on the plates. These thorn-like teeth can, however, effect little, if any, comminution of the food, and so far as

Plate 1.

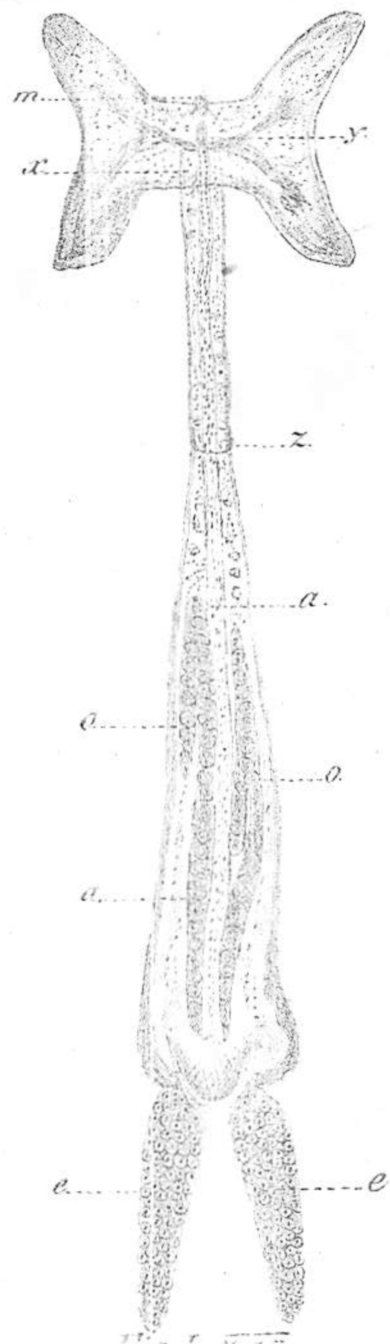

Fig. 1. X 15.

Wm. B. Burford, Lith. Ind[s]

Plate 2.

Fig. III. x 100.

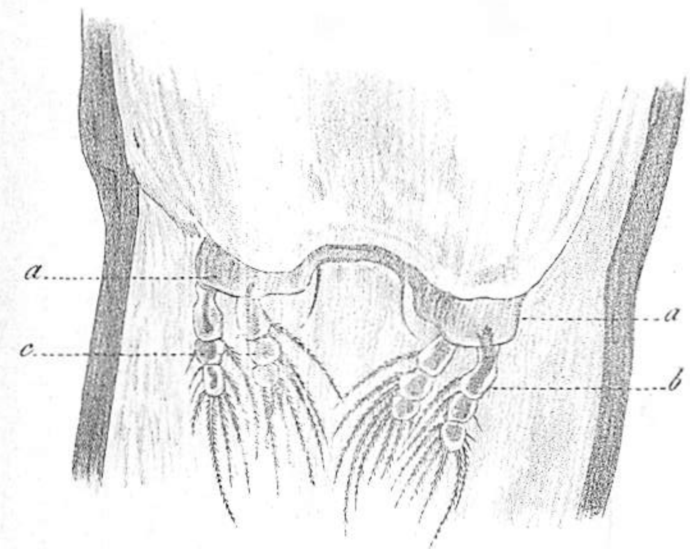

Fig. II. x 200.

Wm. B. Burford, Lith. Inds

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