

ZOOLOGICAL RESEARCHES.

MEMOIR VI.

Developement of Artemis Salinus, or Brine Shrimp ; demonstrative of its relationship to Branchipus and the other Crustaceous Phyllopoda, and to those enigmatical Fossils, the apparently eyeless Trilobites... with a new species of Artemis and of Apus.

Amongst the Fossil remains of animals, it may be remarked, that some have no *existing* type, that others present a doubtful character, while many are indisputably allied to some of the members of the *present* race... of this last description are the Trilobites with *evident eyes*, now forming the Genera of Calymena and Asaphus, and which are evidently related, through Apus (Pl. 6, f. 3), to the Crustaceous Phyllopoda ; of the first description, have been regarded, the apparently eyeless Trilobites of the Genera Ogygia, Bucephalithus, and Paradoxides, and which it is one of the objects of the present Memoir to show, are equally related to the same tribe, through Artemis, now for the first time described with the requisite detail.

The immense quantity and great variety of animal remains, imbedded in the rocks which compose the crust of our globe, has so identified the study of Geology and Zoology, that the student of the former science, can no longer prosecute it in a satisfactory manner without the aid of the latter, neither will a slight knowledge of Zoology avail, as may be learnt from the substance of the present Memoir, and from the unavailing guesses of the older Naturalists, as to the type of the Trilobites, many believing them to be *trilobed shells*, (as Schreber, Lehmann, Klein, Luyd, Wolstersdorf, &c.)... others likened them to the Chitons (Sclotheims), others to the Onisci (Walch), and some even regarded them as aquatic larva, and the Bucephalithus (Pl. 5, f. 1) in particular, as having some affinity with the Scolopendra ! (Beckman).

Satisfactory as it may be to the Philosopher, the Geologist, and to the Natural Historian, to be able to discover and point out the analogies which connect the fossilized with the existing race of animals and plants,* we shall perceive, that it is no less important to determine the exact species which any particular bed or formation presents to our view, these bodies being found to determine with much greater certainty, the *identity* of mineral deposits, than characters taken from the Rocks themselves, which every experienced Geologist knows to vary considerably in colour, density, and many other particulars, even within a very limited distance ; they declare even more in regard to strata, by pointing out the respective Epochs of their formation, and hence, have been emphatically termed, the Medals of Creation.

* See my Memoir on Pentacrinus Europeanus.

Taking a general view of the existing Phyllopoda, they present us with two distinct types, the one, *Apus* (Pl. 6, f. 3), with the series of members, numerous (upwards of 20) and close, the first pair constituting a trifid kind of rowers or feelers, the eleventh bearing on each side a bivalve oviferous cell; the body in this type is covered in great part by a dorsal clypeus, attached only to the head, furnished with a pair of approximate sessile eyes above, and with a pair of minute antennæ beneath; to this type the Eyed Trilobites *Calymena* and *Asaphus* most approximate, the principal difference being in the comparatively short Clypeus, covering only the head and mouth, and in the posterior part terminating with the last pair of members, and not being produced into a tail; as we know nothing of the structure of the under side of these fossils, which is invariably engaged in the rock upon which they repose, it remains undetermined whether they were provided with rowers and antennæ, it is certain, however, that the Dudley Trilobite is sometimes accompanied by subulate jointed bodies, which have been supposed the remains of these members.* The other type, *Artemis*, (Pl. 1), has eleven concordant members, less closely set, a tail of eight joints, no clypeus whatever, peduncled moveable eyes, conspicuous antennæ, and both sexes with a pair of horns, or rather appendages, sometimes remarkably large in the male, smaller in the female, which has a single oviferous sac attached beneath to near the root of the tail; to this type the existing Genera of *Branchipus*, *Eulimena* and *Chirocephalus* belong, with an approximation in the fossil Genera of *Bucephalithus* (Pl. 5, f. 1, 2, 3), *Ogygia* (Pl. 6, f. 1, 2), and *Paradoxides*, (Pl. 5, f. 4, 5, &c.); these differ, however, from the existing race much in the same manner as the former type, in the want of a tail, as well as in the members being much more numerous. Linnæus has given a figure of *Bucephalithus Spinulosus* with antennæ, the existence of which may be presumed, together with that of the pedunculate eyes, which have not as yet however been noticed even detached.

What principally distinguishes this tribe of Crustacea, is the total deprivation of proper feet, which are entirely converted into a kind of leaf-like complicated fins, solely adapted to swimming, hence the term *Apus* applied to one of the Genera. We shall be the less surprized at this, when we recognize a similar conversion of feet into fins even in some of the higher classes of animals, as, for example, in the *Trichecus* of the *Mammalia*, the whole of the *Cetacea*, and in the *Marine Turtles*.

Of Artemis, or Brine Shrimp.

The minute and rare animal which constitutes the type of this Genus, being very imperfectly known, and consequently its place in the class Crustacea indeterminable, induced me to procure some from the Lymington Salt Pans, which was effected with considerable difficulty, the few that reached Cork being dead, and the Brine

* It having been lately announced in several Journals, that an American Gentleman had discovered and brought home from the Falkland Islands, specimens of an animal supposed to be the existing type of the Trilobites, I may just observe in the absence of details, that the animals in question are most likely to be the *Oniscus Paradoxus* of the *Systema Nature*, "*Antennis quaternis, segmentorum lateribus falcato spinosis*," an inhabitant of the same seas near Terra del Fuego, and long ago pointed to, as probably related to the animals in question.

reduced to a few drops ; as there were several females amongst them with mature ova, and conceiving that the remnant of Brine might still contain the requisite number of its peculiar animalcula to originate a sufficient stock of appropriate food for any of the Brine Shrimp that might hatch, I put it, together with the oviferous conceptacles of the females, into an artificial Brine, and had the satisfaction to see my hopes realized by the birth of several individuals, some few of which lived, went through their several stages of evolution, and finally attained to near their full growth.

The *Artemis Salinus* or Brine Shrimp, is a very small and delicate animal, when full grown about half an inch in length, of considerable transparency, slightly tinged with yellow, and with a highly polished surface ; nature having constructed them with members solely adapted to swimming, they seem to be in perpetual pursuit of prey, gliding with an almost even motion through the water, and moving with equal indifference and facility on the back, belly or sides ; the shape of the animal, the undulating movement of its fins, and the glossy appearance of its coat, render it an object of a very interesting description, more especially when apprized that analogous animals appear to have been the first created conspicuous inhabitants of the primitive fluid, of which these may be regarded as a degenerate or pigmy race. Hitherto the only localities in which these little animals have been observed, are some salt lakes in Siberia, and the Salt-pans at Lymington ; in these situations, however, they occur in the greatest abundance, and at the last named place, making their appearance in the early part of spring, multiplying beyond conception during the summer and autumn, and disappearing during the winter months, a phenomenon common to many of the smaller Crustacea. As in all salt works the pits have different destinations, it must be observed, that they are not found indiscriminately in all, but principally in the tanks called clearers, in which the brine acquires such strength as to furnish 4 oz. of salt to the pint measure ; by the account with which Mr. Racket has favoured us, (Linn. Trans., vol xi.), it would appear that the workmen attribute to them the property of assisting in the clearing of the brine, and hence transport them to such tanks as seem to be without them. How they came originally to the Salterns at Lymington, and what animalcula live in so strong a solution to afford them food, must be left to future investigators placed under more favourable circumstances.

If closely observed, the head appears furnished with a pair of spreading eyes, easily distinguished by their black colour, with a pair of filiform antennæ, and further with a pair of lateral appendages, of considerable size in the male, inclined towards the belly of the animal ; the anterior half of the body shews a close row of lateral fin-like members, and deeply fringed ; the posterior half is linear, extended, and ends in a fork.

The gradual developement of the Embryo, and the metamorphoses it undergoes from its first production until arrived at a perfect or adult state, will be found to correspond with those noticed in *Branchipus*, *Chieroccephalus* and *Apus*, animals with which its alliance can no longer remain doubtful.

The *Ova* are suborbicular in form, and of a dark brown colour, and in giving birth to the animal, split at one side, and so allow it to escape; at this stage the embryo appears of an orange colour, and a pyriform figure, and still remains attached to the opening by its narrow end, (Pl. 2, f. 6, *b*), all its members being enveloped within a second tunic, in which state it is *buoyed up in the water* above the flocculi which rest upon the bottom of the vessel, and shortly makes its escape from the enveloping tunic, and swims about, but with no great vivacity, under the form represented, Fig. 7, viz. that of a Monoculus of the Genus *Amymone* of Muller; here we have a singular instance of the provident care of nature for the preservation of the young, well worthy the attention of the philosophic naturalist, for were they to be born at the bottom of the water, and enveloped in sediment and flocculi, scarcely any would escape that destruction, which we observe to await such as incautiously become entangled in it. In this first stage of the animal's existence, it is of an ovate form, with three rowers on each side, which move in concert; the anterior pair of rowers are the smallest, composed of three joints, and terminate in three bristles, these are probably the masked antennæ of the perfect animal; the second pair of rowers are the largest of all, composed of three broad confluent joints, lobed and fringed beneath with bristles, these, as we shall see, become the horns of the perfect animal; the third and last pair of rowers are also slightly lobed beneath, and furnished with a few bristles. At the end of several days, no other alteration takes place in the animal than the more complete developement of its rowers, and the elongation of its tail, which appears slightly indented at the sides: Pl. 2, f. 8, it is still a Monoculus, or provided with but one sessile eye.

As its growth and evolution go on progressively, it is observed to acquire a pair of sessile eyes, *in addition* to the original one, the great rowers become remarkably larger in proportion, the body and caudal extremity elongate, and the permanent members gradually unfold themselves, and become effective, the anterior pairs first (Pl. 2, f. 8); before the whole of these are perfectly developed, the lateral pair of eyes become more salient, and at length pedunculated, the whole of the original rowers become immoveable, the tail bifurcates at its extremity, and the animal only awaits the last change to acquire its perfect form, or nearly such as we see (Pl. 1, f. 2)... During these progressive changes, like all the analogous Crustacea, it no doubt throws off its exuvium very frequently, in order that its crustaceous covering may be suited to the change of form and size of the animal, but from the large capacity of the glass-vessel in which the observed specimens were kept, the flocculi with which its bottom was covered, and the fondness of the animal during its latter stages to perforate through these in every direction, neither the exuvia nor the act of throwing them off, could be perceived, with the exception of one or two of the last casts.

With regard to the period occupied by the entire evolution of the animal, it must be observed that those subjected to notice, came to hand at the commencement of winter, the most unfavourable season to judge of the more common length of this period, as cold weather has been found to retard the progress, and warmth to hasten it, in many of the other Entomostraca; another circumstance which un-

doubtedly contributed to render the period longer than usual, must have been the absence or deficiency of the requisite kind of food or animalcula; bearing in mind these considerations, it may be stated, that during six weeks the larva retained its original rowers and its sessile eyes, as in fig. 9, while the permanent members were not fully developed; at the end of two months, dark excrementitious matter first appeared in the intestinal canal, the lateral eyes became pedunculated, the whole of the members were complete, and the great rowers were first converted into horns, and the antennæ shewed a considerable degree of elongation, but it required full two months and a half to render the animal perfect, and capable of propagating its species.

Although many of the Entomostraca will be found to present themselves first under a similarly masked form (*Amymone*), yet the peculiar changes noticed above are confined to the Phyllopoda with pedunculated eyes, which alone furnish the singular spectacle of *Monoculi*, *Trinoculi*, and *Binooculi*, or in other words, of an animal possessed of one, three, and at length of but two eyes, during the life of the same individual.

Other Species of Artemis.

Amongst several minute Crustacea sent me by the Rev. Lansdown Guilding, from the West Indies, was one female probably of this Genus (Pl. 1, f. 11, 12); to that gentleman, after whom I have named it, and who is one of the most zealous and intelligent Naturalists the West Indies had ever to boast of, I must leave its natural history. See Explanation of Plate I. for details.

The *Eulimena* of Latreille, which Dr. Leach considers a species of *Artemis*, found in the Mediterranean, seems to require further elucidation.

The *Branchipus Paludosis*, (Pl. 3, f. 6), I consider as a fourth species of *Artemis*.---This, which is a native of swamps in Greenland, attains to the length of three quarters of an inch, has smaller horns than *A. Salinus*, the tail terminated by a pair of plumose setæ, and the oviferous sac of the female of an elongated form.

Chierocephalus.

This Genus, instituted by Prevost, is distinguished from *Artemis* by the very complicated apparatus situated between the basis of the Great Horns in the male (Pl. 3, f. 4 and 5, Pl. 4, f. 1), and in the horns being much smaller; for details I may refer to Prevost's *Memoir*, p. 201, pl. 20, 21, and 22. Desmarest makes this synonymous with *B. Paludosis*, and it appears to have been confounded with the *Branchipus Stagnalis* by most authors. This would appear to be the most common and widely distributed of the whole of this peculiar tribe: it seems to be that species first described by Mr. Ed. King, in the *Phil. Trans.* 1667, vol. 57, p. 72. 74, being discovered by that gentleman in a ditch near Norwich, and has been more lately elucidated by Dr. Shaw in the *Linneæan Transactions*. In France it has been noticed in the marshes of Fontainebleau and Bondy, in ditches about Meudon near to Paris, and in ditches which border on the route from Castillon to Sainte-Foi.---Both Shaw and Prevost

have given its progress from the egg, which corresponds with the changes observed in *Artemis*, and indeed the latter author has favoured us with such full and accurate details of its structure, and such excellent figures, as to leave little to desire on this subject.

Branchipus.

By the removal of the two former animals, this Genus will be restricted to one species, viz. *B. Stagnalis* (the *Apus Pisciformis* of Schœffer), Pl. 3, f. 1, 2, 3, the male; Pl. 4, f. 2, head of female. This, which appears to be a comparatively rare animal, is distinguished by what seem to be *two pair* of antennæ in the male. The Horns are rather small, and bifurcate at the extremity; the tail terminating in two taper ciliated scales. Found by Schœffer in a ditch by the road which leads from Ratisbon to the town of St. Nicholas.

Apus Guildingi; a new species.

This, I received together with the *Artemis Guildingi* from the West Indies, and having as yet no details, must leave its history in the hands of its distinguished discoverer. It is of a light blackish colour, the clypeus translucent, almost membranous, and shorter in proportion than in any of the known species, with the extreme branch of the anterior member extremely long; in other respects it differs from them but little. . . I may here observe, that there appears to be two European species confounded under the specific name *Cancriformis*, viz. Schœffer's and Dr. Leach's, which most resemble the above species, and that detailed by Mons. Savigny, in which the elongated Clypeus entirely covers the natatory members.

Of the Fossil Genera, Bucephalithus & Ogygia, &c.

The Fossils which constitute these Genera, and the other Eyeless Trilobites, which form Mons. Desmarest's Genus *Paradoxides*, are but little known to British Geologists, are only found in a particular part of Sweden, and in one locality in France, and are extremely rare in Collections, even in those countries; interesting as they are from these circumstances, and their appearing to have been the first created animals, they come doubly recommended to our notice since the discovery of the living type in *Artemis*, which seems to connect them with the present race. Unlike those almost microscopic Crustacea, however, these present us with animals of gigantic size in comparison, many of them having exceeded a foot in length; and as all the other individuals of this tribe are provided with a distinct organ of vision, even in their larva state, analogy will not permit us to believe that they were absolutely deprived of sight, which to an animal of such size, and possessing locomotive powers, must have been indispensable to the pursuit and capture of its prey. When it is considered, that these fossils are very rarely found entire, but almost always in detached portions, it is not surprising that these delicate members, seated on a narrow pedicle, and articulated to the sides of the head by membrane only, should have been lost, and their point of attachment rendered incenspicuous.

Bucephalithus, &c.

A knowledge of the structure of *Artemis* has enabled me to propose this Genus, Pl. 5, f. 1, 2, 3, to which it shows a considerable approximation. It is composed of the *Entomolithus Paradoxus* of Linnæus, Pl. 5, f. 1, the *Entomolithus Bucephalus*, f. 2, and *Spinulosus*, f. 3, of Wallenberg. As these, together with the other Eyeless Trilobites which constitute the Genus *Paradoxides* of Desmarest, are only found in a particular formation in Sweden, it will be advantageous to describe this formation before entering into further details.

The Transition formation in Sweden, appears to consist of three kinds of stratified rocks, viz. 1st, Alum-slate, containing beds of swine-stone, this, which is the lowest in position, contains the Eyeless Trilobites, which are not found in any other stratum, and are associated with a very small ammonite. . . 2d, a dark coloured Transition Lime-stone, placed over the former, the most essential of the three strata, containing a variety of fossils, but principally large *Orthoceratites* and *Entomostracites*, . . and 3d, Argillaceous Shistus, very different from the aluminous shistus, never containing swine-stone or other calcareous matter. Its fossils are as it were derived from the calcareous stratum, over which it is placed, but they are so reduced in size and so thin, that they mostly appear as impressions (*Grapsolithes*). This last stratum is found but in a single Province.

The Alum works Mr. Wallenberg points out as the most productive of these extraordinary fossils, are as follows, viz. "Those which are opened on the eastern side of Mount Faredalsberget, and particularly that called Olstrop, in the parish of Dimbo, which have yielded the largest individuals. But it is particularly in a new Alum-work named Damman, opened on the north side of Mount Billigen, where they can be procured at the present time."

The *Bucephalithus Tessini*, Pl. 5, f. 1, Mr. Wallenberg, from its fragments, says it must have attained to above a foot in length; front semilunar, furnished with large recurved horns; (the dotted line in the figure is from that given in Desmarest's Work on the Trilobites.) A great peculiarity in these *Bucephalithi*, is the whole of the members being perfectly distinct, and unconnected at their extremities. This species is only found in the Aluminous Shistus of Westrogothland, and at such a depth as the quarries scarcely attain at the present time (1818,) the shist being too hard for the purpose of procuring alum.

The *Entomostracites Bucephalus* of Wallenberg, of which f. 2 is the anterior portion, I should regard as the female of the former, differing in the horns being much smaller, and extending outwards. With the former species, it is found in the *inferior* aluminous shistus, and in the adjacent swine-stone, but as yet, only the Head is known. The impressions obtained at Dimbo indicate an animal of large size, as the Horns are as long as four inches!

Bucephalithus Spinulosus, Pl. 5, f. 3, is the Trilobite figured by Linnæus as provided with Antennæ, Vest. Act. Handl. 1759, p. 22, t. 1, f. 1. Mr. Wallenberg has never seen any trace of antennæ and Mons. Desmarests endeavours to explain this supposed error of the

illustrious author of the *Syst. Naturæ*. Entire specimens are only found in the Quarry of Alum-slate of Andrarum in Scania, (that figured by Mons. Desmarest is upwards of two inches in length) ; fragments, on the contrary, are abundant over the whole of Westrogothland. I must not neglect to point out a semicircular inscription at the side of the head, Mr. Wallenberg says, almost as in the *B. Tessini*.

For the benefit of Geologists who have not seen Mr. Wallenberg's Essay on these animals, nor the transcript in the *Journal de Physique* for July 1820, nor Mons. Desmarest's work, I have added figures of the other Eyeless Trilobites of Sweden, viz. *Paradoxides Scaraboides*, Pl. 5, f. 5, and *Paradoxides Gibbosus*, Pl. 5, f. 4. both of these appear to be very common in the Aluminous formation, and particularly in the included swine-stone.

Ogygia.

This Genus, so named from appearing to possess the greatest antiquity of all the Fossils of the Transition formation, like the former, is extremely local, and has never been observed but in the roofing slate of Angers, in France. Whether the *two* species met with, are really such, or only indicate a sexual difference, is doubtful; I incline to the latter opinion, and consider *O. Desmaresti*, Pl. 6, f. 2, as the male, *O. Guettardi* as the female, which is rendered more probable by Mons. Desmarest having observed in a full grown specimen, an oval pad on each side of the tail, much thicker than the rest of the body, and hence corresponding, in some measure, with the oviferous conceptacles in *Apus*.

This Genus differs from *Bucephalithus*, in the members being apparently connected together, or perhaps covered by a membranous expansion. There is a division in front between the Horns, and another flexuose articulation at the side of the Head, as in the former Genus, the Horns being extended backwards along the sides of the body, from which they are, nevertheless, quite separate... What Desmarest considers as oculiform protuberances, I consider, as the places of the mandibles.

Ogygia Guettardi, Pl. 6, f. 1, rarely found entire in the roofing slate near Angers, its fragments, on the contrary, are very common; varies in size from about 4 inches to near a foot in length !

Ogygia Desmaresti, found with the former, I consider as the male; it is altogether much broader in proportion, and the Horns very broad but rather shorter and more spreading... probably attains the length of near 15 inches ! but has not been met with entire.

Explanation of the Plates.

✓ PLATE I.

ARTEMIS SALINUS.—Fig. 1. Of the natural size.

- Fig. 2. Male, magnified, from beneath.
- 3. Do. fore parts, from above.
- 4. Do. Head with the Horn-like appendages forced forwards, out of their natural position.
- 5. The labrum, more magnified.
- 6. The left Maxilla.
- 7. One of the Mandibles, still more amplified.
- 8. The second pair of Maxilla.
- 9. One of the limbs; *a*, basil joint; *b*, ciliated paddle; *c*, pectinated scale; *d*, digitated lobuli; *e*, branchial sac; *f*, ciliated scale.
- 10. Do. in a different position: the same letters mark the corresponding parts. In this view the branchial sac is better seen.

ARTEMIS GUILDINGI.—Fig. 11. Female magnified.

- Fig. 12. Under side of the abdominal portion, showing the biarticulate oviferous sac.

✓ PLATE II.

ARTEMIS SALINUS.—Fig. 1. Head of the female, magnified, from beneath.

- Fig. 2. One of the Horn-like appendages more magnified.
- 3. The oviferous sac, attached to the upper part of the abdominal portion.
- 4. End of the tail in the female.
- 5. Tail part, of a younger individual, showing distinctly, its joints; which appear preternaturally contracted.
- 6. *a*, Ovum greatly magnified; *b*, giving birth to the Embryo.
- 7. Larva when fully expanded, still more magnified.
- 8. Do.. after some days' growth.
- 9. Do.. showing a greater approximation to the perfect animal.

✓ PLATE III.

BRANCHIPUS SCHCEFFERI (*Stagnalis*).—Fig. 1. Male of the natural size.

- Fig. 2. Magnified, with the horn-like appendages thrown forwards, to show the labrum and mandibles.—Fig. 3. Front view of the head.

CHIEROCEPHALUS PREVOSTII.—Fig. 5. Male of the natural size, from beneath.

- Fig. 4. The curious and complicated apparatus, extended, which is situated between the roots of the Horn-like appendages, greatly magnified.

ARTEMIS FABRICII (*Branchipus Paludosis*).—Fig. 6. Female, magnified.

✓ PLATE IV.

CHIEROCEPHALUS PREVOSTII.—Fig. 1. Female of the natural size.

- Fig. 5. Ova, 6. Much magnified.
- 7. Larva in its first stage, magnified.
- 8. Do. second stage.
- 9. Do.. approximating to the perfect animal, of seven days' growth.

BRANCHIPUS SCHCEFFERI.—Fig. 2. Head of female magnified.

- Fig. 3. Ova of do. 4. Do. more magnified.

✓ PLATE V.

BUCEPHALITHUS.—Fig. 1. B. Tessini.

- Fig. 2. Head of Entomostracites Buchephalus of Wallenberg, probably the female of the former.

- 3. B. Spinulosus, of medium size.

PARADOXIDES.—Fig. 4. Gibbosus. 5. Scarabæus.

✓ PLATE VI.

OGYGIA.—Fig. 1. O. Guettardi.

- Fig. 2. Part of the head and fore part of the body of Ogygia Desmaresti, of large dimensions, probably the male of the former.

APUS.—Fig. 3. A. Guildingi, magnified nearly three times.

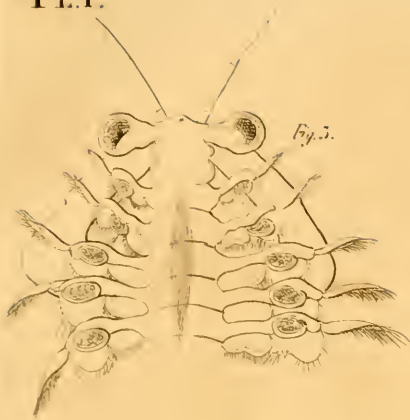


Fig. 1.

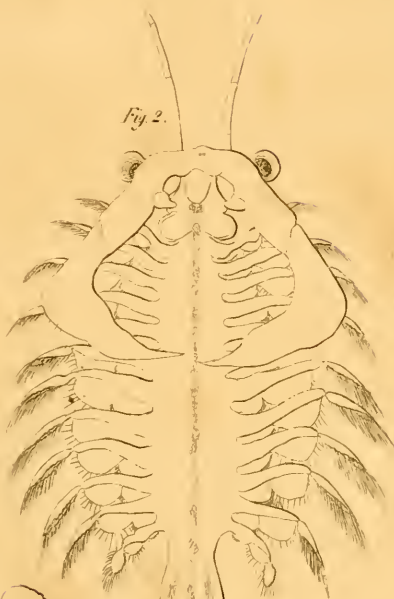
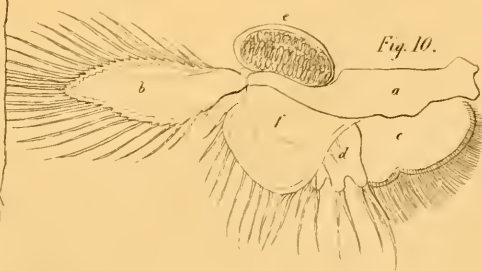
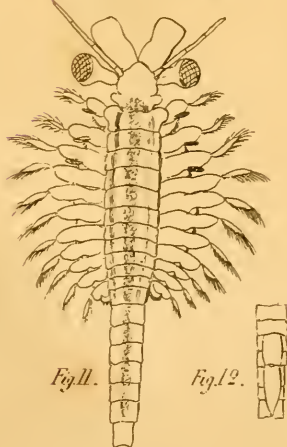
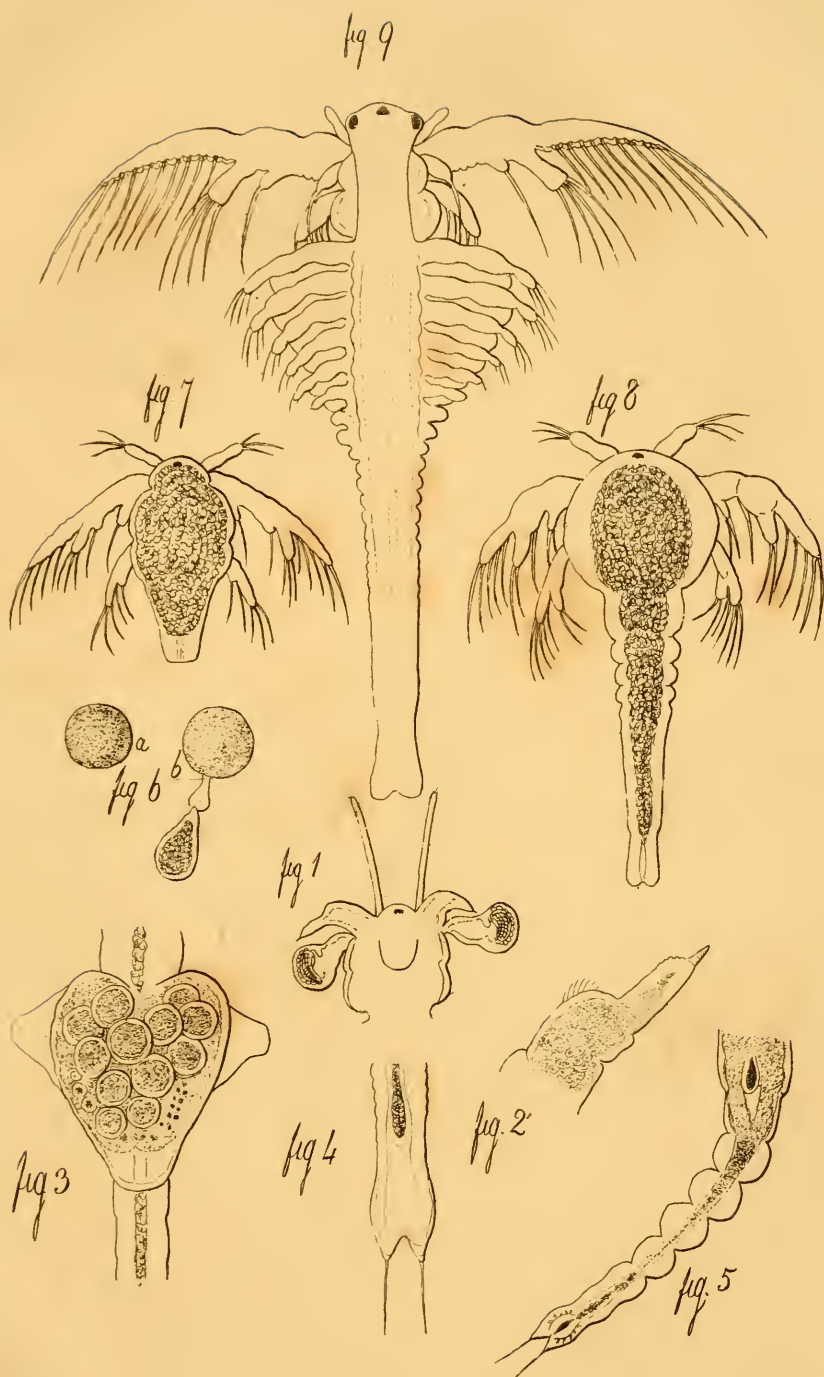


Fig. 8.

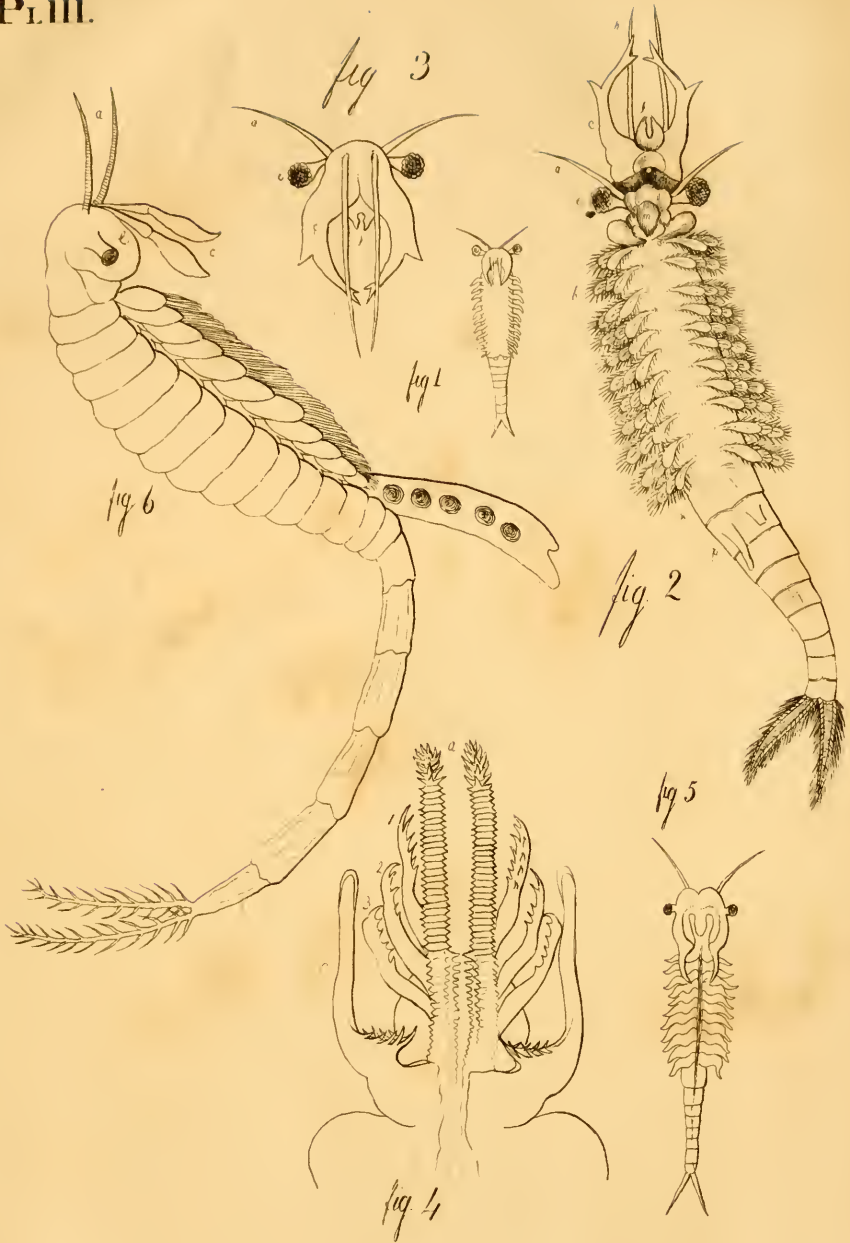


Fig. 9.



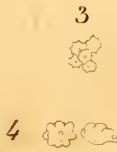
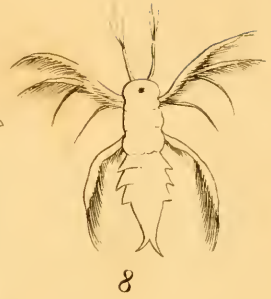
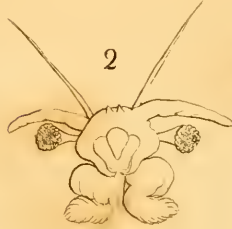


ARTEMIS.
N. H. J. 1841

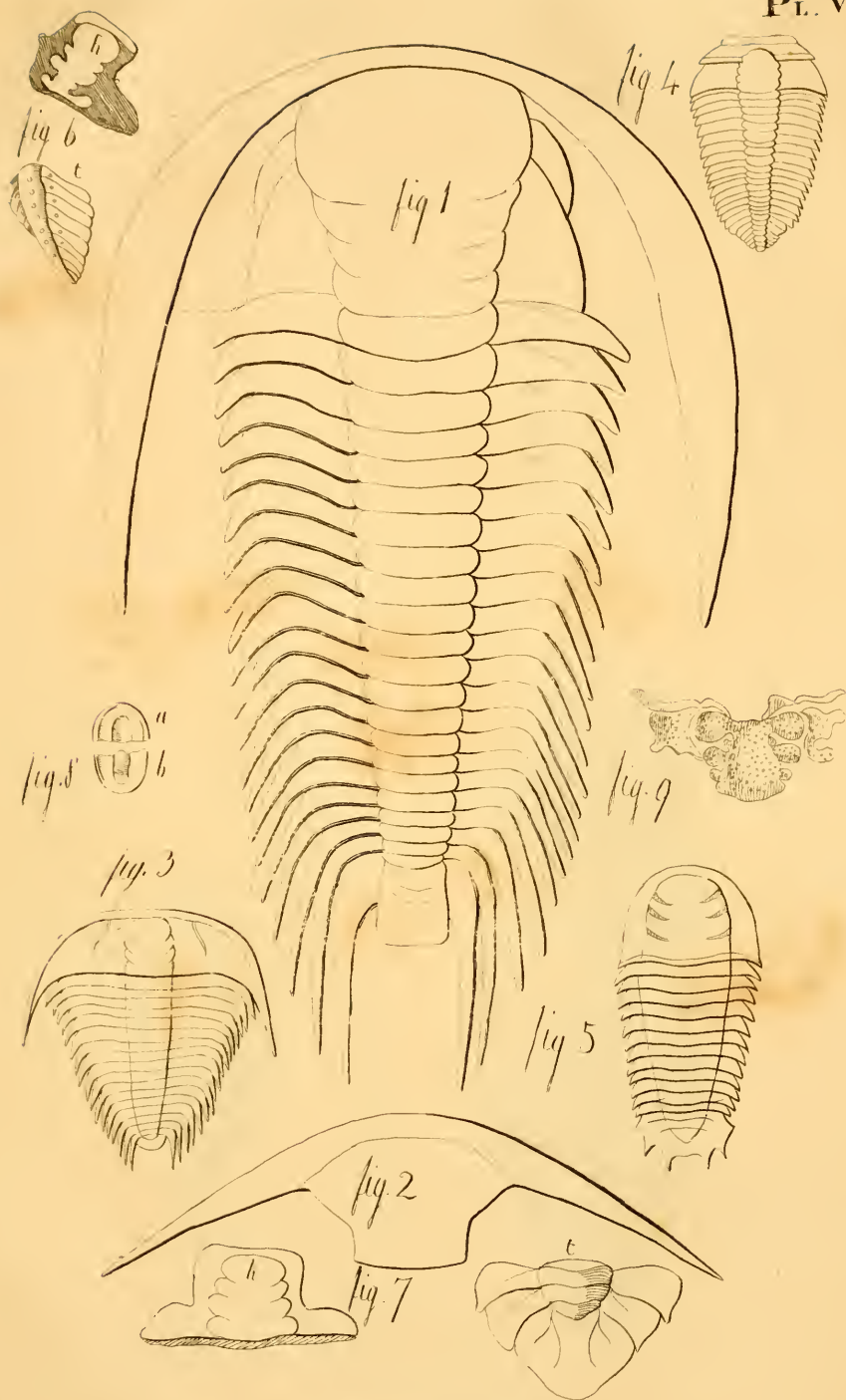


PL. IV.

fig 1



J. L. B. fecit.



BUCEPHALOTRITUS.
J. T. S. fecit.

fig 2



fig 3

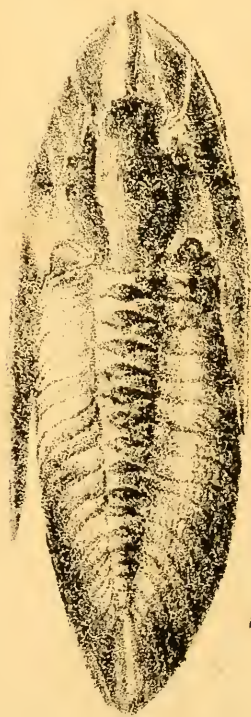


fig 1

