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XII. Notes on some new or little-known Species of Freshwater Entomostraca.

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(Plate XXXI.)

Read June 18th, 1863.

CYCLOPIDÆ.

CYCLOPS.

AT the time when Dr. Baird published his excellent work on the British Entomostraca*, although many species of *Cyclops* had been described, principally by Koch, yet the characters used by that author were not those upon which new species could in that group be properly established, and accordingly Dr. Baird exercised a wise discretion in uniting them under a single head. Since the appearance of his work, Continental naturalists have carefully studied the genus, and have ascertained certain differences which may be satisfactorily used as specific characters, and which, as I have already observed in the 'Transactions' of this Society (vol. xxiii. p. 176), are found principally in those organs which exhibit secondary sexual differences.

Considering that they are among the commonest inhabitants of our fresh waters, that probably there is not a weedy pond in the country which does not contain two or three species, it is somewhat remarkable that the genus should have been so completely neglected by our English zoologists; and yet I am not aware that any one has written on the Freshwater Cyclopidae of Great Britain since the appearance of Dr. Baird's work, or has attempted to compare our English forms with those described by the foreign carcinologists, and especially by Claus and Fischer.

I have now to record seven species which occur in our Kentish ponds; six of which, namely, *C. serrulatus*, *C. coronatus*, *C. tenuicornis*, *C. brevicaudatus*, *C. canthocarpoides*, and *C. brevicornis*, have been met with on the Continent; but the seventh appears to be new, and I have much pleasure in dedicating it to Professor Claus, who has contributed so much to our knowledge of the genus.

CYCLOPS SERRULATUS, Fischer, Bull. de la Soc. des Nat. de Moscou, 1851-52.

In this species the antennæ have only twelve segments.

Female. The figures given by Fischer and Claus of the anterior antennæ are not altogether correct. The hairs are not, as might be inferred from the figure given by Claus, inserted on both sides of the antenna, but, as usual, are, with the exception of the three apical segments, confined to the anterior side. The hairs on the basal segments are in the figures neither sufficiently numerous nor unequal. For instance, the basal segment has at least eight hairs of different lengths, the one at the apex being the longest. Again,

* 'Natural History of the British Entomostraca,' by W. Baird. Printed for the Ray Society, 1840.

the fourth segment, counting always from the base, has several more hairs than in Claus's figure. Besides the long seta at the middle of the segment, is another at the apex, which is quite as long, and had probably been accidentally broken off from Claus and Fischer's specimens. The three terminal segments increase respectively in length, and decrease in breadth. In the centre of the apical segment, on the posterior side, is a small notch and a minute hair. The terminal setæ are six in number, the central one being the longest. The penultimate setæ are correctly figured by Claus, except that he makes them a little too short, the anterior penultimate being in my specimens as long as the apical segment—though upon this point Fischer agrees with Claus. I could see no trace of the ridge described as running along the three terminal segments.

The antennæ of the second pair have, as usual, on the basal segment a long setose hair, which points backwards. The posterior margins of the two apical segments have a row of short hairs. The antepenultimate has some short spines, and the basal segment a row of fine teeth. The apical hairs differ in length more than they do in Claus's figure.

The figures given by Claus of the mouth-parts are very correct.

The posterior legs consist of a single segment terminated by three setæ, which, however, in my specimens, are by no means similar to one another, as they are represented in Claus's figure. On the contrary, the inner hair is flat, lanceolated, and provided with similar flat secondary setæ at the side. The other two hairs are simple setæ, the outer one being rather more than half as long as the other.

The abdomen* is as described by Claus.

The young, when one day old, is rounder than that of *C. brevicornis*; the appendages also are shorter. The anterior pair is inserted so far back that only the apical segment projects beyond the margin of the body.

It seemed to me that the anterior appendages had two equal terminal setæ, that the penultimate segment had one seta at the apex and one in the middle, and the antepenultimate one at the apex. This, also, agrees with the arrangement in *C. brevicornis*. In addition there were a few smaller hairs, none of which, however, appeared to me to be seated at the apex.

The large spine at the base of the second pair of appendages seemed to me to be single, but to give off one or two short and small hairs; in Claus's figure it is double; from which and from other indications I am inclined to think that the specimen figured by Claus was not in its first state. The second segment bears, as in Claus's figure, two short hairs. The lower branch is as in *C. brevicornis*. The larger branch consists of a large basal segment, followed by two or three imperfect divisions, and terminated by a longer, narrower terminal segment. The basal segment has a small hair, the second and third have each a long seta, the fourth again has a short hair, and the apex has a long seta and a shorter hair.

The third pair of appendages are formed on the same type as in *C. brevicornis*. The small branch bears three setæ, the middle one of which is the largest, and the inner

* While adhering to the views I have already expressed (Nat. Hist. Rev., vol. i. p. 29) as to the homologies of the so-called "thorax" and "abdomen" in Crustacea, I use the words here in their usual sense, being reluctant to complicate our nomenclature by any peculiar system of my own.

one the smallest. The shortness, however, of all the appendages in the young of this species makes it rather difficult to ascertain their form and the arrangement of the hairs. Between the caudal setæ is a fringe of short hairs.

This, which is one of the smallest species belonging to the genus *Cyclops*, was described by S. Fischer in the Bull. de la Soc. des Nat. de Moscou, 1851-52, p. 423. It appears to be a hardy species, and lives well in confinement.

Kent.

Podophrya Cyclopum does not appear to be very common in Kent; but I have found specimens of it on this species.

CYCLOPS CORONATUS, Claus, Wiegmann's Arch. 1857, p. 29. Antennæ primi paris septendecim-articulatæ, ultimo annulo crista præditæ serrata, corpus anticum (cephalothoracem) minime superantes: antennæ secundi paris magnopere elongatæ; annulus earum secundus brevis, margine inferiore convexus; ciliatus tertius tenuis, cylindricus, quartum longitudine fere superans. Long. fem. (inclusis setis apicalibus quatuor) 3-5 mm.

In the drawing of the anterior antenna, Claus represents the hairs much too uniform in length. Thus the fourth segment bears two long setæ, and the fourteenth one long seta, which are erroneously figured of the same size as the other setæ. The two posterior sub-apical setæ also are longer than the segments to which they respectively belong. At the centre of the terminal segment is a small seta, which Claus has wholly omitted; and he has also left out a good many of the setæ on the basal segments. The eighth, ninth, tenth, twelfth, thirteenth, and fourteenth segments have a row of spines at their anterior ends, as described by Claus.

The second pair of antennæ is correctly figured by Claus, except that the spine on the posterior side of the basal segment is, as usual, long and setose.

The upper lip has fifteen teeth, counting the two large ones as external, and omitting one or two slight eminences on the outer side of the large teeth. Three or four of the central ones projected very slightly.

The inner maxillary foot is as in Claus's figure, except that the terminal seta is much too small.

The outer maxillary foot also is as in Claus's figure, except that the small setose spine on the finger-like projection of the third segment is inserted on the outer side of the great spine. Both of the great terminal spines of the same segment are spinose on one side; and close to their base is inserted a short hair. The terminal segment has two great spines, one smaller one, and two hairs; but there is no hair at the base of the segment, as in Claus's figure.

The basal segment of the posterior legs bears a long spine, plumose at the free end. The three spines by which the second segment is terminated are in Claus's figure equal and similar to one another. This, however, is not the case in my specimens. The two outer setæ are plumose, and the central one is nearly twice as long as the other. The inner hair is flat, somewhat lanceolate, and provided with short lateral appendages. This hair is as broad at the base as the central seta, but is much shorter.

This segment strongly resembles, nay, is almost identical with the corresponding leg of *C. serrulatus*, which consists only of one segment; and we may therefore conclude that in this species neither the basal segment nor its spine are developed. As the peculiar arrangement and form of the three terminal setæ are the same in these two species, while in other nearly allied forms they are altogether different, we may, I think, conclude that this organ, though minute, still subserves some important function in the economy of the animal, and doubtless one connected with the reproduction, for which its minuteness is one of the necessary conditions, and therefore affords no reason for considering these appendages as truly rudimentary organs.

The abdomen and caudal setæ agree with the description and figures given by Claus. Chiselhurst. February.

Often of a dark greenish-blue colour.

CYCLOPS BREVICORNIS, Claus, *l. c.* p. 32. Antennæ primi paris septendecim-articulatæ, breves, primum cephalothoracis segmentum paullulum superantes. Pedes quinti paris rudimentarii, simplices, bisetosi. Abdominis segmenta in postremo margine parvulis dentibus prædita. Long. fem. 3-5 mm.

The figure given by Claus represents the hairs on the antennæ shorter and more uniform than they are in my specimens. For instance, the large hair on the fourth segment, counting as usual from the base, is longer than the six succeeding segments. Again, the seta on the antepenultimate segment is longer than the three terminal segments. The two posterior penultimate setæ, instead of being shorter than the two anterior setæ of the same segments, are at least twice as long. These latter are correctly represented by Claus, but the former are not half long enough. The apex of the antenna is terminated by the usual number of setæ, namely seven, while Claus only gives five.

The second pair of antennæ also is terminated by seven setæ.

The labrum is correctly figured by Claus: one specimen that I examined had eleven teeth, and another only ten.

Maxilliped as in Claus's fig. 4, pl. 3, except that the terminal segment had three spines and two hairs, instead of two spines and three hairs.

The abdomen and caudal setæ are as in the figure given by Claus, but the inner setæ are rather thinner, and the lateral spine is weaker. The lamellæ are $\frac{12}{1000}$ of an inch in length, $\frac{5}{1000}$ in breadth at the base, and $\frac{3}{1000}$ at the apex. The internal seta is $\frac{80}{1000}$ in length; the exterior of the four terminal setæ is $\frac{12}{1000}$ in length.

Common in ponds at Farnborough and Chiselhurst, in Kent, &c.

The egg-sacs are elongated and narrow.

CYCLOPS BREVICAUDATUS, Claus, *l. c.* p. 34. Antennæ primi paris septendecim-articulatæ, secundum cephalothoracis segmentum superantes. Pedes rudimentarii; secundus annulus bisetosus. Setæ apicales parum ciliatæ, brevissimæ, furcam longitudine paulo antecedentes. Long. fem. 2-4 mm.

This species is principally characterized by the shortness of the caudal setæ, which in

the above description are said to be a little longer than the lamellæ, though in Claus's figure, with which also my specimens agree, they are almost exactly twice as long.

Common at Chiselhurst.

CYCLOPS CLAUSII, n. sp. (Pl. XXXI. figs. 12, 13, 14.) Antennæ primi paris septendecim-articulatæ, secundum cephalothoracis segmentum non superantes. Pedes quinti paris parvuli, trisetosi. Furca caudalis longa, setis longis.

The first cephalothoracic segment is longer than the four following.

Female. The anterior antennæ are seventeen-jointed, and the segments are of the usual proportions. The terminal segment (Pl. XXXI. fig. 13) has, as usual, seven terminal setæ, one of which is quite short, five out of the six others are long and delicately plumose. At the centre of this segment, and on the posterior side, is the usual notch, with a short hair. The penultimate segment has three setæ at the apex—one at the posterior side considerably longer than the segment, and two at the anterior side somewhat shorter than the segment. They do not differ much in length, but one is stouter than the other, and plumose. The antepenultimate segment has only two hairs, which correspond in form and position to the two larger ones of the following segment. The fourth segment has one long seta, which is not inserted on the posterior side, but is generally bent over in that direction, as so often happens with this hair in the Cyclopidæ. The whole organ reaches about to the end of the second cephalothoracic segment.

The second pair of antennæ offer no special peculiarities. The three terminal segments are ciliated on the posterior side, and the basal segment bears, besides the usual long setose hair, a few very short and stout spines. On the anterior side the basal segment has two setæ, the second one, the third nine, and the fourth seven. The whole organ is stouter than Claus's figure of that belonging to *C. coronatus*.

The inner maxillary foot resembles Claus's figure of that in *C. gigas* (*l. c.* pl. 11. fig. 3). The terminal segment, however, has only three setæ, of which one is very large, one very small, and the third intermediate both in size and position. The third segment is somewhat shorter and stouter than in the figure given by Claus, and has two spines.

The posterior legs of the female (Pl. XXXI. fig. 14) are two-jointed. The basal segment bears one seta; the second has two, one of which is quite short, and has the form of a strong spine. The organ, therefore, most nearly resembles that of *C. furcifer*; but the terminal segment is more quadrangular, and the attachment of the long seta appears to vary slightly: sometimes the end of the segment was truncated, and the seta only occupied a part of the termination, at others it tapered slightly, and the seta occupied the whole extremity.

The shapes and relative sizes of the abdominal segments offer no special peculiarities; the posterior margin of the last is serrated, but the other segments have plain margins.

The caudal lamellæ (Pl. XXXI. fig. 12) are long, ciliated on the inner margin, and their length is between five and six times their breadth. The arrangement and proportions of the setæ resemble those of *C. gigas*, as figured by Claus (*l. c.* pl. 11. fig. 5); but the external seta is situated rather nearer to the end of the lamella, and is attached in a notch, from which a ridge proceeds to the hinder end of the lamella. Of

the four terminal setæ, the inner one is about twice as long, but no stouter than the outer. The two great medial setæ do not differ much in length, and are about twice as long as the lamella.

Male. The male is altogether slimmer than the female.

The second pair of antennæ and the parts of the mouth resemble the corresponding organs in the female.

The abdomen is longer and thinner than in the female; it is four-jointed, and the segments diminish progressively in size, the first being but little bigger than the second, while in the female it is as large as the other three put together. The caudal lamellæ also and the setæ resemble those of the female, but that the two larger terminal setæ are more unequal.

The posterior legs are in the form of a simple lobe, bearing three setæ, of which the one on the outside is the largest, and that on the inner side is the smallest.

The egg-bags are at first greenish, but gradually become light pink.

Common in a pond on Farnborough Common in Kent, May 1861; and also in a horse-pond at Reigate, in July; at Chiselhurst Common, in February, March, April, and September.

The male seizes hold of the penultimate legs of the female with his prehensile antennæ.

This species may of course be at once distinguished from all those with less than seventeen segments to the anterior antennæ; from *C. coronatus* and *C. tenuicornis* it may be known by the shortness of the antennæ and the form of the posterior legs; *C. pennatus* differs in the length of the antennæ, and in having the caudal setæ remarkably plumose; *C. viridis*, *C. crassus*, *C. brevicornis*, and *C. Leuckarti* in the shortness of the caudal lamellæ; and the two latter, as well as *C. bicuspidatus* and *C. gigas*, in the form of the posterior legs; *C. strenuus* and *C. vernalis* (if S. Fischer's figures are quite correct) in the setæ of the caudal lamellæ and of the anterior antennæ; *C. furcifer* has narrower and more elongated lamellæ, and the caudal setæ, as well as those of the anterior antennæ, are unlike those of the present species. Finally, *C. brevicaudatus* is described by Claus as having the second segment of the posterior legs bisetose, and the caudal setæ little longer than the lamellæ.

CYCLOPS TENUICORNIS, Claus, *l. c.* p. 31. Antennæ primi paris septendecim-articulatæ, elongatæ; ultimi tres annuli tenuissimi, cristam simplicem gerentes. Abdominis segmenta in longitudinem extensa.

Chiselhurst, in June and July.

This species is very nearly allied to *C. coronatus*, if indeed distinct.

CYCLOPS CANTHOCARPOIDES, Fischer.

This species may at once be known by its having only ten segments to the anterior antennæ, which are very short, and do not even reach to the end of the first cephalothoracic segment. The arrangement of the caudal setæ gives it the look of a *Canthocarpus*. The fourth abdominal segment is short; one of the two terminal setæ of the abdomen is much longer than the other, and the lateral ones are short.

Chiselhurst.

PONTELLADÆ.

DIAPTOMUS.

The remarks above made with reference to *Cyclops* are to a certain extent applicable also to the genus *Diaptomus*. Müller described three species, under the names *D. cæruleus*, *D. rubeus*, and *D. lacinulatus*; but the characters which he gives have been regarded as unsatisfactory by most of those who have subsequently written on the genus. S. Fischer, however (Bull. de la Soc. des Nat. de Moscou, 1853), has described two very distinct species, which he refers to Müller's *C. cærulea* and *C. lacinulata*. The *Cyclopsina lacinulata* of Fischer is probably our *D. castor*; and his *C. cærulea* resembles in many respects a new species, which I have now to describe, and which I propose to call after Mr. Westwood, the founder of the genus.

DIAPTOMUS WESTWOODII, n. sp.

The *cephalothorax* consists of seven segments, of which the second is the largest, and the last is quite short. Seen from above, the cephalothorax of the male resembles the figure given by Baird, but it ends in a small spine (Pl. XXXI. fig. 5.): in the female the posterior segment is expanded and ends in two spines (Pl. XXXI. fig. 1); it resembles, therefore, the figure given by Liljeborg (*l. c.* pl. 26. fig. 1).

The *anterior antennæ* consist of twenty-six segments, and are in the male as long as, and in the female rather longer than the body. The terminal segment is small. The apical and subapical setæ are subequal in size. The penultimate, antepenultimate, and the preceding segments have each of them a long hair at the posterior side. The hair at the anterior side of the apex of the penultimate segment is large; the corresponding hairs on the two preceding segments are about as long as the segments to which they belong, while that on the twenty-first segment is again much larger. All these hairs, except the usual lanceolate* one at the apex, are plumose. The left antenna of the male resembles that of the female; but the right is swollen and prehensile. The sixteenth, seventeenth, eighteenth, nineteenth, and twentieth segments are specially enlarged for the reception of the powerful flexor muscle; and most of the setæ on them are shortened and thickened.

The bend takes place between the twentieth and twenty-first segments. The twenty-first and twenty-second segments have coalesced so completely, that, but for the arrangement of the setæ and the analogy with *D. castor*, they might have been taken as a single segment. The twenty-third and twenty-fourth have united in a similar manner, and the latter bears a sort of tooth at its apex. On the seventeenth, eighteenth, and nineteenth segments one of the setæ assumes the form of a rod with a hook at the end.

* M. Schultze (Arch. für Naturgeschichte, 1862, p. 356) attributes the observation of these lanceolate hairs to M. de la Valette, in 1857, and Leydig, in 1860. As long ago, however, as the year 1853 (Ann. & Mag. of Nat. Hist. p. 160, &c.) I had called special attention to these peculiar appendages, and pointed out that they held certain definite positions, although I did not hazard an opinion as to their exact function. Again, Mr. Spence Bate, in his "Report on the British Edriophthalma," published in the Journal of the British Association for 1855, p. 29, describes them under the name of "membranaceous or auditory cilia"—a name which sufficiently indicates his views as to their use.

The two terminal segments have undergone no material alteration.

The *second pair of antennæ* closely resembles the figure given by Liljeborg (*l. c.* pl. 13. fig. 7); but the second segment of the branch "a" has four setæ, and the apex of the basal segment of the branch "b" has a row of small spines on the inner side.

The *mandibular palpus* is also well figured by Liljeborg (*l. c.* pl. 13. fig. 10); but the terminal segment of the larger branch has seven large setæ in addition to the smaller one, which does not in reality form part of the series. The mandibular teeth are nine in number.

The *anterior maxilla* is also well figured by Liljeborg, but the plate "a" had in my specimen seven large hairs, besides the small one.

The *second pair of maxillæ* offers no special peculiarity.

The *maxillipeds* consist of seven segments. The basal one has ten strong setæ, the second five, the third three, the fourth and fifth two each, the sixth two (one on each side), and, finally, the seventh four.

The *anterior pair of legs* also are correctly figured by Liljeborg; but in my specimens the setæ were longer in proportion to the legs themselves. The outer branch has three, the inner only two segments. In the other legs both branches consist of three segments.

The *fifth pair of legs* can easily be distinguished from that of the other species.

Like the other pairs, they consist of a two-jointed basal portion and two branches. In the *female* (Pl. XXXI. fig. 4 *a*) the inner branch is two-jointed, and is either cylindrical or club-shaped, according to the aspect from which it is regarded. It has two or three rudimentary spines near the apex. The outer branch (Pl. XXXI. fig. 4 *b*) is also two-jointed. The basal segment is rather longer than broad; the terminal segment is short, and ends in two great and two small spines. In the male they are quite unsymmetrical, one being more than twice as long as the other. Both of them, however, consist of the usual parts—namely, a basal two-jointed portion bearing at the apex two branches. The basal portion is in this case normal, and but slightly unsymmetrical. In the longer leg the inner branch is reduced to a simple cylindrical appendage (Pl. XXXI. fig. 3 *a*). The outer branch (Pl. XXXI. fig. 3 *b*) consists of two segments: the basal is cylindrical, and bears a strong spine on the middle of its outer side; the terminal segment is in the form of a long, narrow, sickle-shaped spine.

The shorter leg (Pl. XXXI. fig. 3 *c*) has a small one-jointed inner branch. The outer branch is also small, and bears a setose spine, which probably represents the terminal segment.

The *abdomen* in the female is three-jointed, and the basal segment has a spine on each side. The lamellæ are not longer than the last segment, and bear six plumose setæ, of which the five outermost are very stout. The inner borders of the lamellæ also are plumose. The abdomen of the male consists of five subequal segments. The inner seta is more than half as long as the others, but much narrower and not plumose. Near the base is a portion (Pl. XXXI. fig. 6 *a*) distinguished by the walls being suddenly and conspicuously thinner than elsewhere. At first I looked on this as an accidental variation, but I have since found the same structure in all the specimens I have examined, not only of this species but of *D. castor*.

Common in ponds in Kent.

It is generally colourless, but often red.

The females carry their egg-sac in spring and autumn, and generally float in a more or less perpendicular position.

Length $\frac{1}{8}$ of an inch.

DIAPTOMUS CASTOR, Jurine.

The anterior antennæ are shorter than the body. The apical seta on the anterior side of the twenty-third segment is large (Pl. XXXI. fig. 7 *a*), while in *D. Westwoodii* it is quite small (fig. 1 *a*). The right anterior antenna is very much like that of the preceding species; but a careful comparison of the figures will show several slight differences: for instance, there is in *D. castor* no tooth at the apex of the twenty-fourth segment.

The inner branch (Pl. XXXI. fig. 11 *a*) of the fifth pair of legs is in the female cylindrical, and consists of two well-marked segments. At the apex it bears three spines—one small, one large, and one of middle size. The large one is spinose. The outer branch is much larger. The inner margin of its second segment (*b*) is produced into a great spine; hence it comes to pass that the terminal portion of the branch (*c*) is apparently situated, not at the apex, but on the outer margin and not far from the base of the second segment. Unlike as this branch is to the corresponding organ in the other species, it is easy to see that it is composed of the same parts.

The fifth pair of legs in the male (Pl. XXXI. fig. 10) do not differ so much from those of the other species; they are, however, somewhat longer in proportion. The inner branch (*a*) of the right leg is two-jointed.

The posterior segment of the cephalothorax and the first of the abdomen resemble the figure given by Liljeborg (*l. c.* pl. 13. fig. 6), but the posterior angles of the cephalothorax are less expanded, and the angle α was in my specimens rounded off. These parts are somewhat unsymmetrical.

Colour reddish.

With the preceding, in Kent. The females carry their eggs in April.

Length $\frac{1}{10}$ th of an inch.

APODIDÆ.

LEPIDURUS PRODUCTUS.

The genus *Lepidurus* was founded by Leach. It differs from *Apus* in having the posterior segment produced into a plate or flap which lies between the caudal filaments, and in the shortness of the anterior legs. The species of this family, though found in large numbers wherever they do occur, are yet but seldom met with, and until last year I had never seen any of them alive.

During a visit to the north of France made last spring with Mr. Prestwich and Mr. Evans, principally in order to compare the river-gravels of the Seine valley with those of the Somme, we fortunately chanced to visit, among many others, a gravel-pit at Pont de l'Arche, near Rouen. After an ineffectual search for flint implements, I went

look at some nearly dried-up pools of stagnant water, when I was delighted to find them occupied by great numbers of this interesting species. Still *Lepidurus productus*, though not often met with, has been so well described that I should perhaps not allude to it, but that among the specimens I collected there are a considerable number of males, while, so far as I am aware, the female sex is the only one which has hitherto been met with. My specimens differ in some points from the descriptions and figures given by preceding authors.

Schäffer ('Abhandlungen von Insecten,' erster Band, p. 182, pl. 7), who was the first to describe this species, had before him, as he expressly says, only young specimens. The form of the caudal lamella, however, changes with age, and consequently the figures given by Schäffer and copied by Latreille (Hist. Nat. des Crust. et Insect. vol. v. p. 28) do not correctly represent the form which is characteristic of mature specimens. The figure given by Milne-Edwards (Hist. Nat. des Crust. pl. 35. fig. 5) represents a full-grown (or nearly full-grown) individual; but the form of the caudal lamella is not quite correct; at least in my specimens it is more regularly oval, the base being narrower, and the extremity sometimes entire, sometimes notched, as in the figure.

Dr. Baird, in his "Monograph of the Apodidæ" (Proc. Zool. Soc. 1852; Ann. & Mag. Nat. Hist. 1854, vol. xiii. p. 221), describes three species of the genus, and uses as one of his specific characters the extent to which the body of the animal is covered by the carapace. My specimens, however, varied a good deal in this respect; in some of them the carapace left the seven posterior segments uncovered, while in others of the same size it extended to the base of the caudal setæ, and in one it even covered a large part of the caudal lamella. The carapace, however, in all my specimens covered a larger portion of the body than appears to be the case in either of the two other species.

I mention these differences because they show that both the form of the median caudal lamella, which changes with age, and the relative size of the carapace, which appears to vary so much in different animals, are characters which, though very useful, must be employed with great caution in the establishment of new species.

Both Schäffer (*l. c.* pl. 2. fig. 5 *i*) and Baird (British Entomostraca, pl. 1. fig. *d*) represent the "triangular" plate of the anterior legs in *Apus* as rounded at the upper end, whereas in my specimens of *Lepidurus* it was pointed. The "rami" have a series of notches on each side, which give an appearance of joints. The longest filament has about twenty notches on each side, the second about fourteen, and the third only eleven, while in *Apus cancriformis* the two longer rami are described as having respectively about sixty and fifty segments.

On the other hand, as if to counterbalance the shortness of the anterior pair, the following legs are decidedly longer and stronger in *Lepidurus productus* than in *Apus cancriformis*. The pseudosegments, however, even of the longest appendage are not more than ten in number. Schäffer and Baird agree in representing the two terminal appendages of *A. cancriformis* as being nearly equal in size. In *L. productus* the outer one is much smaller, unjointed, broad below, and contracted above.

In the following legs the triangular plate and the oval appendage become gradually larger, while the other appendages become shorter and broader, with the exception of

the small one at the apex, which, on the contrary, becomes larger and larger, until in the seventh pair it is as long as its companion. It also develops on its inner edge a row of simple conical teeth.

The eleventh pair is in the females developed into an egg-cup, as is the case in *Apus*.

Apus cancriformis is described as having sixty pairs of legs, of which the first eleven correspond to eleven somites, the rest to seventeen or eighteen somites, leaving five or six segments to which no legs are attached. This makes thirty-four postcephalic segments. According to Baird, however, there are only thirty. In one of my largest specimens I found the number of segments to be twenty-eight, exclusive of the head. The pairs of legs were forty-two in number.

Male. After the first notice of the genus *Apus* by Jacob Frisch in the year 1732, more than a century elapsed before the male was discovered. Satisfied that all his specimens were females, and laying it down as an axiom that "aus einem unbefruchteten Eye eben so wenig ein lebendiges Thier werde, als aus gar keinem Eye," Schäffer assumed that the Apodidæ were hermaphrodites, although he was unable to discover any male generative organs. Berthold came to the same conclusion, but, in addition, considered that he had solved the mystery, and that the semen was secreted in certain sacs sometimes found among the legs. This supposition was refuted by Zaddach, who, however, thought that he had found the male orifice in two small eminences on the posterior segment not far from the median line of the back, and surrounded by three or four spines; these, though with some doubt, he considered to be the retracted penes.

At the meeting of the German Naturalists at Breslau in September 1833, Professor Retzius announced that M. Kollar, of Vienna, had at length discovered the male of *Apus*. Neither Baird, however, nor Zaddach has been able to find any further account of this interesting discovery; nor do I find any memoir on *Apus* attributed to Kollar in the useful 'Bibliographia Zoologiae,' published by the Ray Society in 1852.

Under these circumstances the credit of being the first to describe the male of *Apus* appears to belong to Dr. A. Kozubowski, Professor in the University of Cracow, who has published a memoir on the subject in Wiegmann's 'Arch. für Naturgeschichte' for 1857.

The males of *Lepidurus productus* may be distinguished from the females in the same manner as those of *Apus cancriformis*. In general form there is no apparent difference; but the eleventh pair of legs, which in the female is specialized into an egg-holder, remains in the male of the usual type, and is in size and form, as in position, intermediate between the ninth and the eleventh pairs.

Among 160 specimens Kozubowski found only sixteen males. Among mine they were much more numerous. I examined seventy-two specimens, of which thirty-three were males and thirty-nine females. This proportion, however, is probably but little to be depended on, since in my case most of the large individuals were males and almost all of the small ones were females. Though the greater number of my specimens were small, still as it is natural to take the large individuals first, the small ones were doubtless more numerous proportionally than my collection would indicate.

Kozubowski mentions that in *Apus* the male, though livelier and stronger than the

female, is about one-third shorter. So far as my observations at present go, this is not the case in *L. productus*. As I have just mentioned, of my largest specimens the great majority were males; on the other hand, it must be admitted that none of them were more than, or even quite so much as an inch and three quarters in length, and, as the species is stated to attain a length of two inches and a half, it is still possible that the full-grown females may be considerably larger than the males.

Homologies.—"The Phyllopoda" (says Prof. Dana) "in which the number of segments exceeds the normal number, offer a difficult problem to science, viz. the determination of the normal relations of the appendages. In *Branchipus* the number of segments is twenty-two, of which *nine* belong to the abdomen, *eleven* to the body posterior to the second pair of maxillæ, *seven* being the normal number for the former, and *eight* for the latter. In *Limnodia* there are eighteen or twenty-seven pairs of thoracic members following a pair of maxillæ and mandibles. In *Apus* there is a pair of mandibles, then two of maxillæ, then a large series of legs, all of which are more or less foliaceous, excepting the anterior. In *Nebalia* the abnormal character is the same, although their members are not as much multiplied."

And he offers the following explanation of the difficulty:—

"The most natural supposition," he says, "in view of the fact that the members of Crustacea consist normally of three parts or branches, a tiggellus, a palpus, and a fouet, is that the multiplication consists in these several parts (two of them or the three) becoming separate legs, and at the same time having separate segments in the body, the normal basal portions of each possibly corresponding to these segments; and possibly we see some analogy also in the multiplication of branchiæ, two or three being often appended to a single leg, in the Decapods."

Notwithstanding the ingenuity of this idea and the great weight of Prof. Dana's authority, I cannot bring myself to adopt this hypothesis. If we examine the relation which the legs bear to the segments, we shall find that the anterior eleven legs are each attached to a separate and well-marked somite. Though the position of the posterior appendages as regards their relation to the segments is not quite so easy to determine still a glance at the animal will show that the size of the dorsal arches does not decrease in proportion to that of the legs; so that while the twelfth segment has only a single pair, the number gradually increases until we find that the last nine pairs correspond to a single dorsal segment.

But it is evident that these legs are all homologous. Much as the extremes differ from one another, they are connected together by so gradual a series that no one who has examined them can have any doubt on this point. There is, indeed, one apparent exception, namely, the eleventh pair in the females; but this is evidently modified for a special purpose, and the corresponding pair in the males is, as we have seen, of the usual form. Moreover, even if we were to admit (for which, however, we have not the slightest reason, and which would indeed be entirely contrary to all evidence and experience) that this pair is of a different nature to the rest, still it would not be any support to Prof. Dana's hypothesis. Nor can it, I think, be maintained that the sternal segments do not really belong to the dorsal arches with which they appear to correspond.

the composition of the six posterior legless segments is a sufficient refutation of any such idea.

Moreover Prof. Milne-Edwards considers that in the branchial feet of the Phyllopods one can distinguish "trois portions principales ou branches qui semblent représenter les trois parties qui chez les Décapodes constituent la tige principale des pattes ou des pattes-mâchoires, le palpe et le fouet; mais ici toutes ces parties sont lamelleuses." Now, if this is true of the anterior legs in *Apus*, it is true of all; for they all consist of the same parts, however much they may be reduced in the posterior pairs.

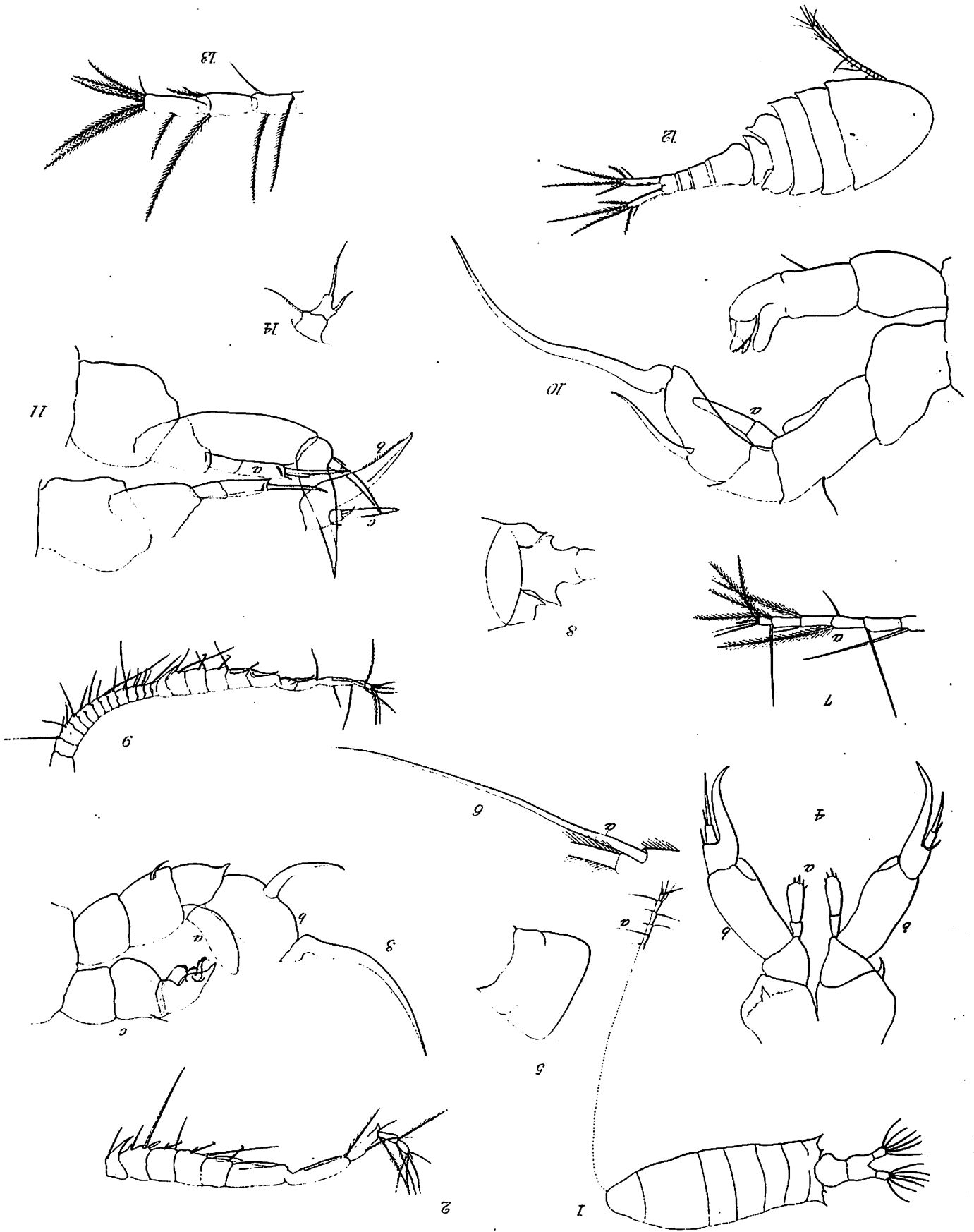
But even if we were to admit Prof. Dana's theory, it would not remove his difficulty. The appendages of *Apus* are, first, the eyes; secondly, the antennæ; then the mandibles and two pairs of maxillæ, which of course represent five segments, to which we must add one more for the second pair of antennæ. Now, if we divide the sixty pairs of legs by three, we shall still have twenty leg-bearing segments, which, added to the anterior ones, gives a total of twenty-six; and as Prof. Dana has adopted the theory of Milne-Edwards and Audouin, that the body of a Crustacean consists normally of only twenty-one segments, he has still five intruders for which his hypothesis does not account. But why should we be called on to account for the number of segments in certain Branchiopods? The same character occurs in the Crustacea of the earliest geological periods. In fact the Branchiopods hold the same position with reference to the Crustacea as the Myriapods do with reference to Insects. In conjunction with certain special characters of the Crustacea in the one case, of the Insects in the other, they retain the general Annulose characteristic, of a variable and often great number of similar segments.

We see therefore that the two principal divisions of the Articulata, the Insecta and Crustacea, were already differentiated before the number of segments was limited so strictly as we now find it to be; and we are, I think, thereby led to the conclusion that the posterior segments of *Apus* and its allies have no representatives in the higher Articulata. The body of a Lobster, in fact, corresponds not to that of a mature, but of a young *Apus*; and the forces, perhaps, which in the first have produced a high degree of differentiation have in the other spent themselves on an almost irrelative repetition.

DESCRIPTION OF THE PLATE.

PLATE XXXI.

- Fig. 1. *Diaptomus Westwoodii*. Female, seen from above, $\times 30$.
 Fig. 2. " " Right antenna of male, $\times 60$.
 Fig. 3. " " Posterior legs of male, $\times 125$.
 Fig. 4. " " " " female, $\times 125$.
 Fig. 5. " " Posterior cephalothoracic segments of male, $\times 60$.
 Fig. 6. " " Inner caudal seta, $\times 250$.
 Fig. 7. *Diaptomus castor*. Extremity of antenna, $\times 60$.
 Fig. 8. " " Extremity of cephalothorax, $\times 30$.
 Fig. 9. " " Right antenna of male, $\times 30$.
 Fig. 10. " " Posterior legs of male, $\times 125$.
 Fig. 11. " " " " female, $\times 125$.
 Fig. 12. *Cyclops Clausii*. $\times 30$.
 Fig. 13. " " Extremity of antenna, $\times 125$.
 Fig. 14. " " Posterior leg of female, $\times 125$.



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