

III. *On Pauropus, a New Type of Centipede.*

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(Plate X.)

Read December 6th, 1866.

THE little creature which I am about to describe in the present Memoir was found by me during the course of the last autumn, and exhibited to the Entomological Society at their first meeting in these rooms.

It occurs in considerable numbers among dead leaves, and in other accumulations of decaying organic substances, in company with the various species of Thysanura, mites, worms, &c. which frequent similar situations. Though not exactly sociable in their habits, and though I never saw them take any notice of one another, still they exhibit none of that extreme ferocity which characterizes the Chilopoda, and do not appear to avoid one another's presence. It may, however, have been owing to their frequency that I have often found many of them together.

In my garden, indeed, they are very common; and it is surprising that they should have been overlooked so long. Of course it is quite possible that their abundance with me this autumn may have been merely a local and temporary accident; they may be rare as a rule, and thus have escaped until now the notice of the naturalist. On the whole, however, I feel rather disposed to think that, from their minute size, their small number of legs, and general appearance, they have been looked on as larval forms. This would probably be the first impression of any naturalist; at any rate it was my own; but it is clearly untenable. In the first place, we have no group of Centipedes in this country to which *Pauropus* could be referred. The young stages of most genera belonging to the Diplopods are well known, and very different from my little creature. We might say almost the same of the Chilopods, from which, moreover, it differs in the structure of the mouth, as well as in the arrangement of the legs. Secondly, I have had many hundreds of specimens under examination, and am well acquainted with the earlier forms, which I shall presently describe. I have even one specimen which has lived in confinement from the 18th of August*; and yet I have never had any which exceeded, either in size or in the number of legs, those now to be described. Thirdly, I have on several occasions met with specimens containing numbers of spermatozoa (Pl. X. fig. 16), and which, therefore, may be regarded as mature males.

However much, therefore, we may be surprised at the existence of so small a Myriapod, there can, I think, be no doubt on the subject. There are other points in which the present form differs greatly, as will be seen from the following description, from all

* This specimen lived until the middle of December. It was lively and apparently in perfect health until within a few days of its death.

other known Centipedes, among which it must certainly constitute a new family, Pauropodidæ, and, I think, even a new order, which might perhaps be called Pauropoda.

I will now proceed to describe this curious form.

PAUROPUS HUXLEYI, n. sp. Corpus e segmentis decem, setis sparsis. Pedum paria 9.

Antennæ 5-articulatæ, bifidæ, appendicibus tribus, longis, multiarticulatis.

Body composed of ten segments, including the head; convex, with scattered hairs. Nine pairs of legs. Antennæ five-jointed, bifid at the extremity, and bearing three long, jointed appendages.

The body consists of ten segments, the first two of which compose the head. In form it is slightly conical, each of the first eight segments being somewhat broader as well as longer than that which precedes it. The two caudal segments, again, are somewhat smaller than the antepenultimate. There are only nine pairs of legs, and their distribution is peculiar. The third segment, or that immediately following the head, bears one pair, while the fourth, fifth, sixth, and seventh segments have two pairs each. These segments, however, may be regarded as double. The posterior legs are the longest. Each segment, from the third to the seventh inclusive, has on the side margins of the back a pair of strong bristles. The pair attached to the third segment (Plate X. fig. 1) point forwards, those of the fourth are at right angles to the body, and the posterior ones point backwards. Besides these long bristles, the body bears on each of the larger segments two transverse rows of short, stiff, club-shaped hairs, which are most numerous on the head.

The body is quite white and colourless, but towards the head and tail it has sometimes a slight tinge of yellow.

Length $\frac{1}{20}$ of an inch.

Pauropus Huxleyi is a bustling, active, neat, and cleanly little creature. It has, too, a look of cheerful intelligence, which forms a great contrast to the dull stupidity of the Diplopods, or the melancholy ferocity of most Chilopods.

It lives throughout the year, among dead leaves and other decaying vegetable matter. It is active in its habits, continually running about, and sometimes giving a rush of surprising velocity. Throughout the winter I found it on the warmer days. It often cleans its feet and antennæ with its mouth. In the latter case the antennæ are held to the mouth by the front legs, a habit which may possibly be an indication that this pair of legs is homologous with the jaw-feet of Chilopods*. The head is composed of two segments, which have received the names of cephalic and basilar (See Newport, Linn. Trans. vol. xix.). Seen from below they are nearly equal in size; but from above the posterior edge only of the basilar segment is visible, the rest being covered by the cephalic. In the same manner, when seen from below, the separate segments to which the legs are attached are plainly visible; the last segment also is evidently treble. Thus there are indications of fourteen segments.

On the upperside of the head are two oval figures, which I presume to be eyes (Plate X. fig. 3). They are, however, very unlike those of other Centipedes, and show no trace whatever of facets. On the head are a number of short, club-shaped, ringed hairs.

* In *Lithobius*, however, these are attached to the basilar segment of the head.

The antennæ (Plate X. fig. 7) are 5-jointed, and bifid at the extremity. The four basal segments are simple and short, but increase slightly in length from the base. The fourth segment bears at its extremity two branches, each consisting of a single segment. One is slightly longer than the fourth segment, and rather thinner (*a*). The other (*b*) is nearly twice as long, and half as broad; it bears at its extremity a very curious appendage, consisting of an immense number of rings, the first and last of which are larger than the others. The first branch (*a*) terminates in two similar but somewhat shorter appendages. These curious appendages remind one very much of the toy-snakes, which consist of a number of saucer-like appendages united by their middles. Between them lies a small pear-shaped appendage (*c*). The fourth segment of the antennæ bears also three hairs at its extremity, two on one side and one on the other. The latter is much shorter than the other two. Each of the three basal segments supports a pair of rod-like, almost clubbed hairs, which are divided by a number of lines, almost like the curious ringed appendages. These ringed hairs are no doubt connected with sensation. Between the two appendages of the branch *a* is a small rounded body.

The animal, as already remarked, often cleans the terminal portion of the antennæ with its mouth. In the structure of the mouth *Pauropus* appears not exactly to agree either with the Chilopods or the Diplopods. I found two pairs of organs: the mandibles (Plate X. fig. 4) are somewhat elongated, and have several teeth at the extremity; the other pair of appendages (Plate X. fig. 5) are minute and conical.

The legs are eighteen in number, twenty-two being the smallest number in any previously known Myriapod. They are simple, and increase in size from in front backwards, the last pair being about twice as long as the first. The anterior legs (Plate X. fig. 10) are $\frac{1}{125}$ of an inch in length, and consist of five segments, which, according to analogy with other Myriapods, we may regard as coxa, femur, tibia, and two-jointed tarsus. The coxa is short, and has on its underside a curious, triangular, leaf-like appendage. The femur is rather longer, and bears on its underside a somewhat similar leaf-shaped appendage. The tibia is shorter than the femur, and about as broad as it is long. The first segment of the tarsus is about as long, but thinner than the femur; it bears a stiff spine on its anterior margin. The second tarsal segment is still longer, thinner, and slightly tapering. There are indications of a division near the middle.

The structure of the foot is not easy to make out. There seemed to me to be a pad, a claw, and a very short tenent hair.

The second pair of legs (Plate X. fig. 11) are rather longer than the first, which they much resemble, with, however, one remarkable difference—namely, intercalation of a new segment between the first and second tarsal joints. This raises the number of tarsal segments to that usual among Myriapods. The new segment bears a short spine on its anterior side.

The posterior legs (Plate X. fig. 12), which are the longest, are $\frac{1}{65}$ of an inch in length. Curiously enough, they resemble the anterior legs in the number of their segments. They possess, however, the additional seta. The leaf-like hair on the femur is branched (Plate X. fig. 13).

Between the second pair of legs are two appendages (Plate X. fig. 19), which are

probably the generative organs. They do not appear to be present in all specimens, and belong to the male sex, as in one case I saw them distinctly in a specimen which was full of spermatozoa. In one case I traced two tubes opening into them. On the under-side of the anterior segment of the body, in front of the first pair of legs, are two pairs of leaf-like hairs, like those on the coxæ and femora of the legs. These evidently indicate the presence of an anterior aborted pair of legs.

The dorsal hairs are also remarkable. The long ones, of which there are a pair to each segment, are ringed and delicately plumose. The lateral setæ, however, are short and extremely delicate. The short scattered bristles are arranged in rows across the back; except the first two and last two, each segment has two rows of them; there are about six in each row; they are stiff and club-shaped (as shown in Plate X. fig. 6).

At the posterior end of the body (Plate X. fig. 17) are several other stiff spines, and two minute forked processes.

Several specimens contained large numbers of spermatozoa, which are filiform (Plate X. fig. 16) with a small head at one end. I never saw them in motion.

Though the animal is tolerably transparent, and the digestive organs are plainly visible, I never could see any trace of tracheæ. Being so small and delicate a creature, it is probable that the respiration is carried on through the skin: but if this is the case, *Pauropus* presents us with another very important peculiarity,—all other Myriapods, so far as we know, possessing tracheæ.

The smallest specimens which I have met with were about $\frac{1}{7_2}$ of an inch in length, and possessed three pairs of legs only (Plate X. fig. 18). The first pair was attached to the third segment (*i.e.* the one immediately succeeding the head), the other two to the following one. Beyond the legs were two other segments, making six in all, as seen from above, and counting the head as two. The fourth and fifth segments each bear a pair of long bristles, as in the full-grown form: the first pair point outwards and forwards, the latter outwards and backwards. The general arrangement of the hairs and of the short caudal processes is the same as in the large specimens; and the antennæ are formed on the same plan.

I found the first of these six-legged ones on the 11th of September; but I am not prepared to say that they might not have been met with earlier if they had been looked for. They continued tolerably numerous throughout the autumn, and occurred in the same localities as their parents.

The development of *Pauropus*, at least in captivity and during winter, is far from rapid. A specimen with three pairs of legs, captured on the 24th of October, has not yet undergone any change*. It remains to be seen whether under more favourable circumstances the growth may not be quicker.

* This specimen died on the 6th of December. Another, captured on the 23rd of November, lived for a month without change. A third, caught on the 3rd of November, survived until the 20th of February. A specimen with six pairs of legs, caught on the 20th of October, also lived till the 8th of February, without change. Another, with eight pairs of legs, lived from the 30th of September to the 5th of November, when it met with an accident. I observed also in *Chloëon* that my larvæ remained with scarcely any change during the winter months (see Linn. Trans. vol. xxv.).

I have never met with a specimen possessing four pairs of legs, and am persuaded that none such exist. Indeed in one case I had the opportunity of watching a six-legged specimen in the act of moulting. It was standing over the old skin, in which its legs and antennæ were still entangled. In about an hour it walked off, carrying the old skin attached to one of its posterior legs. There was no great change except the addition of another large segment and two more pairs of legs—making altogether five pairs. Its length was $\frac{1}{64}$ of an inch.

It is curious that two pairs of legs should be acquired at this moult, because in the subsequent ones only one new pair are formed. The changes indeed are slow, and as yet I have only succeeded in breeding any up to the stage with six pairs; but as I have met with many specimens possessing respectively seven pairs and eight pairs, we may, I think, safely conclude that a new pair are added at each moult after the first, until the full number are acquired.

PAUROPUS PEDUNCULATUS (Plate X. fig. 20).

I have also met with another species of *Pauropus*. In habits and time of appearance, in form, and size it resembles *P. Huxleyi*, but appears to be much rarer; at least, among several hundred specimens I only observed half a dozen of this form. These appeared to me to be rather yellower in tint; but the difference was very slight, and I am not sure if it was constant.

The principal difference between the two species, and that by which they may be distinguished at a glance, resides in the antennæ (Plate X. fig. 20).

The basal portion, indeed, is alike in both. The apical part, on the contrary, differs considerably. The two processes (*a* and *b*, Plate X. fig. 20) are nearly of equal length. One of the long ringed appendages of *a* is situated at, and occupies the whole of the extremity; it is longer than that in the other form, and nearly as long as the similar appendage of *b*. The other ringed appendage is situated at the side of *a*, and is much shorter, while in the other form the two appendages of *a* are of equal length. The small pear-shaped body between the two appendages is much larger in this than in the other form, and is seated on a stalk.

Colour white with a tinge of yellow.

Length $\frac{1}{25}$ of an inch.

Found in autumn, among dead leaves &c. Not common.

There has been much difference of opinion among naturalists as to the value which ought to be assigned to the group of Myriapods,—Leach, Gervais, Newport, Strauss Durckheim, Busk, and Huxley ranking them as a distinct class; while other eminent naturalists, such as Linnæus, Lamarck, Latreille, Siebold, Cuvier, Owen, Brandt, and others, have regarded them as constituting an order only. Again, there has been great difference of opinion as to their affinities; for while the majority of the last-named naturalists classed them among the true insects, Siebold and Oken placed them among the Crustacea, and Lamarck among the Arachnida, while Latreille regarded them at one time as forming part of the Crustacea, at another as Arachnida, and lastly as insects. To these illustrations many others might have been added; but enough have been cited to

show how greatly the most eminent naturalists have differed in opinion as to the true position of the Myriapods.

Nor can we wonder that it should have been so. In their development the Myriapods resemble Annelids, from which, however, their articulated legs and organs of respiration clearly separate them. With the Crustacea they agree in possessing numerous legs; but, again, they are distinguished from them by the possession of tracheæ. In this character, as well as in their antennæ, they resemble true insects; but the number of legs, as well as the manner in which they are acquired, renders it difficult to regard them as constituting an order in that class. Finally, they agree with the Arachnida in the possession of more than six legs, though their development and antennæ are sufficient to exclude them from that group also.

We must therefore, I think, regard the Myriapoda as forming a class, separated from the other classes of Annulosa by characters of at least equal importance with those by which those classes are distinguished from one another. I say, of at least equal importance, because, while the higher families of the Crustacea and the Arachnida are clearly separated by the nature of their respiratory organs, the lower ones, which have neither evolutions of the external integument forming branchiæ on the one hand, nor involutions on the other, approximate in their characters so much as to render any satisfactory diagnosis very difficult; so that some genera, as for instance the *Pycnogonidæ*, are actually classified by some eminent naturalists among the Crustacea, and by others among the Arachnida.

As regards the Myriapods no such difficulty has ever arisen. There is no species about which there has ever been a doubt whether it belonged to that group or not. The curious form described under the name of *Peripatus* by Guilding, may perhaps, indeed, be cited in opposition to this; but although Gervais* and de Quatrefages† have expressed the opinion that this genus forms an approximation to the Myriapods, the former does not even mention it in his work on the Myriapods (among the "Suites à Buffon"), and the absence of articulated legs is quite sufficient to remove all doubt on the point.

Strauss Durckheim considered that *Polyxenus* would conduct us to the Annelids through *Nereis*, while other naturalists have regarded the Geophilidæ as forming an approximation to the same group, and Glomeridæ to the Isopods, and especially, of course, to the Oniscidæ. With Gervais and Walckenaer I regard all these resemblances as merely analogical and by no means as expressing true affinities, except, indeed, of an extremely remote character.

It is a remarkable fact, that, so far as we at present know, all Myriapods have at first, like the mites, three pairs of legs, and three pairs only. It might at first be supposed that these three pairs represented those of insects, and that other pairs were subsequently added on behind—a process which in the Arachnida was arrested after the production of a single new pair, while in the Myriapoda it was carried on to a variable but much greater extent. Although, however, there has been much difference of opinion as to the homologies of the first three pairs of legs in mites and spiders, there seems to be a

* Ann. des Sci. Nat. 1837.

† Hist. Nat. des Annelés ("Suites à Buffon"), vol. ii. p. 675.

general agreement of opinion that they do not represent the three pairs of legs among insects. Savigny regarded them as abdominal appendages; Leuckart considered them to represent the mandibles and two pairs of maxillæ in insects; Siebold and Zaddach, though differing as to the true nature of the anterior appendages, agreed in regarding the first three pairs of legs in Arachnida as corresponding with the second pair of maxillæ and first two pairs of legs in insects, while Huxley refers them to the two pairs of maxillæ and the first pair of legs. The same opinion has been adopted by Claparède; and it must be admitted that these two eminent observers have brought forward very strong arguments in favour of the view advocated by them. Moreover it must be remembered that the six embryonal legs of Myriapods do not belong to three consecutive segments, as ought to be the case if they represented the three pairs of legs in insects. In *Iulus*, for instance, the three pairs are situated on the second, third, and fifth segments*. This agreement in the number of legs between the insect and the young Centipede has not, then, that significance which we might at first sight be disposed to attach to it.

Nevertheless the fact that Centipedes commence life with no more legs than other Arthropods, and only acquire by degrees their most obvious characteristic, is very important; and as what is true of all the species may be reasonably concluded to have been true of the whole group, we might have inferred *à priori* that, although, in the words of Newport, "there are never fewer than twelve segments and eleven pairs of legs in any genus of Myriapoda"†, still there must have been at one time species possessing a smaller number of appendages.

The genus *Pauropus*, which I am now describing, is in fact such a form, and possesses only nine pairs of legs, which is less by two pairs than any form previously known, and tends therefore to a considerable extent to fill up the gap. The paucity of legs, however, is only one of the very interesting peculiarities which it presents.

In fact the mere possession of a small number of legs need not by itself indicate such a link; for we might reasonably expect to find this character, not only among the transitional forms which must lead up to the typical Myriapod, but also at the other end of the series, among the more highly organized and fully developed members of the group. Such I take to be the case with the Scutigeraidæ and Lithobiidæ, which, among all the hitherto known species, possess the smallest number of legs. "The form of the head," says Newport, "of the Scutigeraidæ, the long setaceous antennæ, the prehensile forcipated mandibles, the elongated palpi, the projecting compound organs of vision, the elongation of the limbs, and the more compact form of body are all indications of a higher degree of organization in this family than in others of the same class, and place it as much above the other genera of Myriapoda as the most complete organization of the predaceous *Cicindela* places that genus at the head of true insects"‡. If *Scutigera* represents *Cicindela*, *Lithobius* may be regarded as holding the same relation to *Carabus*; and in the one as in the other the small number of legs must be regarded as a result of adaptation, and not as an indication of affinity; they are the highest and most developed forms of the

* In *Polydesmus*, on the contrary, they are on the second, fourth, and fifth segments. The second pair of legs, apparently, therefore, belong to different segments in the two genera.

† Trans. Linn. Soc. vol. xix. p. 269.

‡ L. c. p. 349.

Chilopoda, and occupy a position further removed from other Articulata even than those species in which the legs are more numerous.

It must be admitted that in some important characteristics *Pauropus* closely resembles *Scutigera* and *Lithobius*; the structure of the legs and the mandibles show, however, I think, that these resemblances are analogical only, and do not indicate any close affinity. In fact the Scutigeridæ are, as we have seen, highly developed Chilopoda, which is by no means the case with *Pauropus*. If, however, the Myriapods are descended from ancestors having a smaller number of segments and of legs, then we must expect to find that the links by which we shall eventually be able to connect not only the two great orders of Centipedes together, but also the Myriapods as a whole with the other classes of Articulata, will possess a small number of appendages. The Scutigeridæ, as we have seen, do not constitute such a group; *Pauropus*, I think, does.

Here perhaps it may be as well that I should quote the distinctive peculiarities which characterize the two known orders of Myriapoda*, the Chilopods and Diplopods; of which the first are active and carnivorous, the second, on the contrary, sluggish vegetarians.

CHILOPODS. Antennæ 14-jointed at least. One pair of legs modified into powerful jaw-feet. Generative organs opening at the posterior extremity of the body. Legs in single pairs.

DIPLOPODS. Antennæ with not more than seven segments. No jaw-feet. Apertures of the generative organs in the anterior part of the body. Legs, after the first six, arranged in double pairs.

Pauropus is, as already mentioned, a neat, active little creature, and at first sight certainly looks like a Chilopod: indeed the compactness of the body, the dorsal plates, and the elongation of the posterior legs give it much resemblance to a small *Lithobius*. A closer examination, however, at once shows that it differs in very important points from the Chilopods: the antennæ possess only five segments, the powerful jaw-feet are absent, and I believe that the openings of the generative organs are situated in the anterior part of the body.

Nor will my new genus find a more natural place among the Diplopods. It is true that the eight posterior legs correspond to four dorsal segments; nevertheless it is evident that in reality each pair belongs to a separate segment, as may clearly be seen if we look at the animal from the underside, as in Plate X. fig. 2. It may be said that, in one sense, this is true of the Diplopods; but they always have the pairs of legs attached by twos, which is not the case in *Pauropus*, where, as will be seen by the figure, they are equidistant. Moreover in all Diplopods the first three pairs of legs are distinguished from the rest by being each attached to a single apparent segment, whereas in *Pauropus* this is only the case with the first pair. Again, in the Diplopods the legs are equal in size, or, if there is a difference, the posterior pairs are rather smaller than the others, while in the present genus they are decidedly larger. In all Diplopods, again, the feet

* I omit for the present the suctorial Myriapods, which require further study.

terminate in simple claws, which, as we have seen, is not the case in this genus. The mouth-parts in *Pauropus*, though very different from those of the Chilopods, appear to resemble those of that group in a rudimentary condition, rather than those of the Diplopods. Lastly, the eyes and antennæ are very unlike those of the Diplopods.

This little genus, therefore, does not possess the characteristics of either order of Myriapods, but forms a link not only connecting the Chilopods and Diplopods together, but also bridging over to a certain extent the great chasm which separates them from other Articulata. It must at any rate be regarded as a new family, even if it does not constitute the type of a third order among the Myriapods.

Pauropus, moreover, possesses several other peculiarities, which are of the more interest because the Myriapods hitherto known present a homogeneity in their characters which is very remarkable if we consider the value of the group, their extensive geographical range, and the number of species. In its general appearance, in its minute size, in the character of its antennæ, in the possession of clubbed hairs and long setæ, *Pauropus*, on the contrary, does something to relieve the disagreeable monotony of the class.

The antennæ are particularly remarkable, and the more so because, in all known Myriapods, these organs are simply filiform, and short, almost invariably seven-jointed among the Diplopods, longer and possessing more numerous segments among the Chilopods. The antennæ of *Pauropus*, on the contrary, in their bifid character, and in the possession of long, jointed appendages, offer peculiarities which can be found, so far as I am aware, among no other terrestrial Articulata, and which remind us strongly of the types presented by the antennæ of certain Crustacea.

I exhibited and named this little creature at a recent meeting of the Entomological Society. On that occasion Mr. Westwood remarked that, with the exception of the genus *Iapyx*, described by Mr. Halliday, *Pauropus* was the most interesting addition to the Articulata which had been made for many years. I may perhaps attribute too much value to it; but, considering the importance of the groups which it serves to connect, and the numerous as well as important points in which it differs from all hitherto known species, I cannot help thinking that even the genus *Iapyx*, interesting as it undoubtedly is, presents fewer peculiarities and is less instructive than the little creature which I have now had the pleasure of describing.

Note.—As I have already observed, one of the specimens which I captured early in August, lived until the middle of December. Until within a few days of its death, it was lively and apparently in good health and spirits; but it did not increase in size, or undergo any change. Throughout the winter I have found other specimens in their usual haunts. Like the Thysanura &c., they retire into the most sheltered places, and are difficult to find in very severe weather, but reappear again on the return of a milder temperature. I have carefully watched them during the spring, and have kept several specimens in captivity, but have seen nothing which would lead me to suppose that they undergo any further development. As I have therefore had them under observation for very nearly a year, I think we may safely conclude that it is not a mere immature form, but is really a new type of Myriapod.—July 22, 1867.

DESCRIPTION OF THE PLATE.

PLATE X.

- Fig. 1. *Pauropus Huxleyi*. Seen from above, $\times 70$.
 Fig. 2. " " Seen from below, $\times 70$.
 Fig. 3. " " Outline of head, $\times 125$.
 Fig. 4. } " " Mouth-parts, $\times 250$.
 Fig. 5. }
 Fig. 6. " " Hair on head, $\times 250$.
 Fig. 7. " " Antenna, $\times 250$.
 Fig. 8. " " Base of appendage.
 Fig. 9. " " Portions of appendage.
 Fig. 10. " " Anterior leg, $\times 250$.
 Fig. 11. " " Second leg, $\times 250$.
 Fig. 12. " " Posterior leg, $\times 125$.
 Fig. 13. " " Appendage on underside of posterior leg.
 Fig. 14. " " Appendage on underside of antepultimate leg.
 Fig. 15. " " Appendage at the base of second pair of legs, $\times 250$.
 Fig. 16. " " Spermatozoa.
 Fig. 17. " " Posterior segment seen from above, $\times 250$.
 Fig. 18. " " Young.
 Fig. 19. " " Base of second pair of legs, $\times 125$.
 Fig. 20. *P. pedunculatus*. Termination of antenna, $\times 250$.