



XXX.—Upon the Anatomy of Phalangium Opilio (Latr.)

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or suctorial birds; but the latter are distinguished by the length of the tongue no less than by that of the beak, and this arrangement cannot therefore be called a natural one. Baron de la Fresnaye, while retaining both *Irrisor* and *Upupa* among the *Tenuirostres*, connects the latter with *Upucerthia* and its allied genera (*Cinclodes*, *Geositta*, *Limnornis* and *Furnarius*). But these last are merely a subfamily of the great S. American family *Certhiidae*, modified in accordance with their terrestrial habits, and the resemblance which they bear to *Upupa* is very remote, and seems to be one of analogy only.

Where then are the *Upupidae* to be placed? This question cannot I think be answered satisfactorily till more facts are collected respecting the food, habits and anatomy of this group and of others with which it may be compared. It may however be conjectured that they are allied in one direction by means of *Epimachus* or *Astrapia* to the *Paradisidae*, and in another by *Merops* to the *Alcedinidae*, as shown in 'Ann. Nat. Hist.,' vol. vi. plate 8, and as originally suggested by Mr. Vigors in 'Linn. Trans.,' vol. xiv. p. 466. In a third direction they are perhaps connected through *Lamprotornis* with the *Corvidae*.

XXX.—Upon the Anatomy of *Phalangium Opilio* (Latr.).

By ALFRED TULK, M.R.C.S., M.E.S.

[Continued from p. 165.]

[With a Plate.]

INTERNAL ANATOMY.—*Muscular System*.—As might be anticipated from the disproportionate length and slenderness of the extremities, as contrasted with the body in *Phalangium*, and that the latter is elevated and balanced between them during rapid flight, when the creature has often to make its way over an irregular surface of stones and herbage, the muscles required for such exertions are of large size, and constitute by far the most important portion of the class of organs to which they belong. They consist of numerous strong fasciculi, which arise from the interior of the coxal joints, and pass forwards, filling up the latter cavities almost completely, and are inserted into the trochanter. The transverse striæ upon them are remarkably distinct and well-defined, and the ultimate fibrils of considerable size, as both the one and the other may be seen under a magnifying power of between thirty and forty linear. The sarcolemma investing them may be also perceived, either raised occasionally from their surface, or connecting their extremities when torn across. The succeeding joints of the legs are too small to admit of the precise distribution of the flexors and extensors being traced, but by sepa-

rating them carefully at their articulations, the muscular fibre is observed to be continued from one to the other, as far as the distal end of the second portion of the tibia, where two long and delicate tendons are given off, which traverse the entire series of tarsal joints, running along their under surface. The chief muscles of the chelicere and palpi consist of an elevator and depressor for each of these organs, the latter being somewhat the larger of the two. The remaining fasciculi, connected with the other organs of manducation, are too minute to admit of any satisfactory demonstration. Pl. III. fig. 12. **, however, represents a pair of these, attached to the margins of the second pair of jaws. The other muscles of *Phalangium*, as connected with the performance of some special functions, will be considered in speaking of those structures of which they form a part: I have already alluded to the probable use of the longitudinal and oblique fibres of the corium, that they may serve, in other words, to diminish the bulk of the animal's body, more especially that of the abdominal cavity, which must be necessary to aid in the expulsion of the fæces, the extrusion of the ova, or of the external generative apparatus in both sexes.

Organs of Nutrition.—Like the alimentary canal of the true Spiders and of the *Scorpionidæ*, that of the *Phalangia* consists of a straight intestine passing from one extremity of the body to the other, but which, instead of being more or less narrow, as in them, throughout its entire course, dilates within the abdominal cavity, to form a wide and capacious sac, occupying nearly its whole breadth. It commences in front by a membrano-coriaceous pharynx (Pl. IV. fig. 15. *ph*), which opens externally, between the first and second pair of maxillæ, and is lodged within the concave structure, described above as the epipharynx (*ex*). Its upper surface is curved, to adapt itself to the interior of the latter, and presents in the middle an elongated horny plate (*), the anterior half of which (Pl. IV. fig. 16. *dp*) is narrow, deflexed, and constricted in front, towards the apex, where it terminates by forming a corneous lip (*l*), which is opposed to two others (*l'*), placed laterally and beneath it, the three nearly meeting, so as to leave a narrow and somewhat triradiate opening into the pharynx superiorly, while below them the latter expands into a wide transverse aperture (*a*). It was probably an imperfect view of the above lips, which appear but as dark spots when seen under a low power, that led Savigny† to admit the existence of two, and subsequently three pharyngeal orifices in the *Phalangia*. The posterior moiety of this plate is emarginate behind and nearly three times the width of the preceding one, and deeply grooved

† Mém. sur les Anim. sans vertèbres : Paris, 1816.

along its under surface, the sides of this groove projecting into the cavity of the pharynx, as two sharp incurved ridges. The anterior half of the plate appears also to be provided with a minute channel continuous with the above. Upon either side, and superiorly to this plate, the pharynx is raised into two longitudinal and linear ridges, which are continued, almost parallel with each other, as far as the commencement of the œsophagus, and are furnished externally with elongated conical projections, which give attachment to the tendons of numerous transversely striated muscular fasciculi, some of which pass upwards, others obliquely downwards upon the side of the pharynx. Upon each side of the pharynx is a pair of short horny teeth (Pl. IV. fig. 15. *t*) lying close to each other, and which project inwards and slightly upwards towards the posterior half of the dorsal plate. Upon their outer sides are similar ridges for the insertion of a horizontal set of muscular fibres (*m*); besides which, other muscles extend transversely (*m'*) over the pharynx, as far as its posterior termination. The pharynx is broadest in the middle, and narrows again towards the commencement of the membranous œsophagus (*œ*), which, after bending downwards from the above, passes over the thoracic ganglion and forms a slight dilatation (*d*), previous to expanding again into the large gastric sac (Pl. IV. fig. 18. *G*).

Connected with the above conditions of the pharyngeal tube in *Phalangium*, it is interesting to find corresponding modifications in the process by which these creatures derive their aliment. The Araneida, from the extreme minuteness of that structure and of the œsophageal canal, are enabled to live only by sucking the juices of the different insects upon which they prey. The harvest-spiders, carnivorous also in their habits, combine, however, the power of mastication with that of suction,—a double operation, which would appear to be performed in the following manner. It will have been seen, in treating of the maxillary organs, that owing to the continuity of the first pair of jaws with the margins of the epistome, and of the second pair with those of the labium, the horizontal action of these parts against each other, as in insects, must be, to a certain extent, prevented, and they work accordingly in the reverse or vertical direction, the anterior, the most moveable, playing to and fro in the concavity formed by the second pair with the lower lip, and thus crushing the food “by friction,” as was observed by Treviranus. In addition to these peculiarities, the horny bow of the first maxillæ is united to the anterior part of the pharynx upon either side, so that when the muscles of the latter act they may probably stretch upon it, and thereby render tense the hollow pouches upon which it rests. By these, as by a couple of pads, the body of the captured insect may then be compressed and crushed, so as to cause the fluids, aided by the capil-

lary action of the soft hairs upon the surface of the maxillæ, to flow through the trilabiate opening into the channel of the dorsal plate of the pharynx; while the hard and solid parts, already much softened, will be received by the larger aperture into the general cavity of the latter, and undergo further trituration between its lateral pairs of teeth previous to entering the œsophagus. I state these opinions relative to their uses, as they have appeared to be deducible from the arrangement of the parts in question, it being scarcely possible, from their minuteness, to test this subject by actual observation. The reader is referred to the very interesting paper by Captain T. Hutton* upon the habits of a large species of *Galeodes*, as affording evidence that other genera of Tracheary Arachnida also devour their food whole. The harvest-spiders, at least the present species, are nocturnal in their habits, and capture their prey, consisting of flies, musquitoes, and small lepidoptera, by stealing cautiously towards it, and making a gliding spring upon the victim when within reach. Herbst† has well described their predatory actions, when he says, "Sie springen und stürzen auf die Beute, wie die Katze auf die Maus, und halten sie mit den Palpen wie mit Händen selbst." I have repeatedly seen individuals of *P. cornutum*, when in confinement, pursue each other with the utmost pertinacity, the larger generally pouncing upon the smaller, and having brought them within reach of the chelicæ and palpi by grappling them with their long legs, proceed to devour the body, leaving the extremities untouched. They use one of their legs occasionally, to support the food to their mouth. It may be also, that the appendages to the second pair of coxal joints serve some similar purpose.

I proceed now to consider the remainder of the digestive apparatus, so remarkable from the numerous cæcal pouches which are given off from it, and which completely conceal the continuation of its canal upon the upper surface. These *cæca* may be conveniently divided, as regards their position, into those situated upon the *dorsal* surface of the canal, those upon the *ventral*, and others upon the *sides*, and, as to size, into *large* and *small* cæca. Beginning with the superior group, the first are a pair of large oblong sacs (Pl. IV. fig. 17. A A), situated one upon either side of the median line, and extending the entire length of the abdomen. They are somewhat broadest posteriorly, and occupy each about a fourth of the width of the abdominal cavity. They are attached, as are two other pairs of long cæca, to the intestine throughout their entire length, being formed, as it were, by diverticula of the coats of the latter, the edges of which, adherent,

* Annals of Nat. Hist., August 1813.

† *Op. cit.*

merely leave an opening of communication at the anterior extremity of the sacs. Between these two cæca is a groove or depression, which expands in front, and lodges the posterior division of the trilocular heart, upon either side of which, resting partly upon these cæca, is the upper pair of biliary vessels. Directly in front of these large cæca are four rows of small ones, reaching as far forwards as the anterior part of the thoracic cavity. The two anterior (*a'a*, *u'u*), which lie against the sides of the middle optic nerve, consist each of a pair of globular pouches; the third row, appearing to be formed of two upon either side (*c'c'*), has, in reality, only one like the preceding, but divided by a deep constriction. The fourth and last row (*d'd'*) seems also to be made up of the same number, but the double character is here due to the projection upwards of the rounded extremity of a pair of cæca (*ee*), which open into the anterior end of two long inferior sacs (Pl. IV. fig. 18. *ee*) presently to be described. Between the four posterior pouches lies the middle chamber of the heart (Pl. IV. fig. 17. II), and upon them the loop of the upper biliary tubes. The anterior division of the heart rests between the two succeeding pairs. Inferiorly, but upon the sides of the alimentary canal, is the pair of long cæca (Pl. IV. fig. 18. C C) alluded to above. They are longer and narrower, less flattened than the superior pair, and widen out behind, upon either side of the rectum (*r*). Between them the gastric sac (G) forms a considerable dilatation downwards. Upon either side of the intestine is a row of four small flask-shaped sacs (Pl. IV. fig. 17. *a*, *b*, *c*, *d*), bent downwards, when "*in situ*," against the sides of the abdominal cavity, and which, commencing opposite to the anterior end of the large superior cæca, diminish in size from before backwards, and reach to their opposite extremity. Treviranus has described them as opening into the two long inferior cæca, which is certainly incorrect. They lie in the interval between them and the superior pair, but are attached to another pair of elongated lateral effusions (B B) of the intestine, perfectly distinct from either of the former, though partly concealed by them, and which have been figured by Ramdohr† under the title of the "*grosse gefranzte Seitenzotten*," in allusion to their series of appended sacs. By making a transverse section through the middle of the abdominal viscera, as has been done at fig. 19, the relative position of these (B B), and of the two other pairs of large cæca (A A, C C), to the stomach is very well seen, as also the extent to which they surround the cavity of the latter. It may be observed likewise, that, owing to the pressure of these cæca, the upper two-thirds of the gastric sac (S) presents an irregularly pentagonal form, while below (*) its surface is convex. Upon the outer side

† *Op. cit.*

of the three anterior pairs of small cæca are three other dilations: the two anterior (Pl. IV. fig. 17. *hg*), one of which is slightly longer than the other, appear to unite and open by a common neck into the intestine; the posterior, nearly twice their length (*ff*), curves backwards, and terminates distinct from the other two. There are thus *thirty* cæca to the alimentary canal of *P. Opilio*; not thirty-one, as stated by Ramdohr, who represents an azygos pouch as arising between the two most anterior cæca, but which, with Treviranus, I have been unable to detect. Posteriorly, the alimentary canal terminates by a short and wide rectum (*r*), which opens externally between the last of the dorsal and ventral segments of the abdomen, the anus being situated upon a level with the latter.

With regard to the probable function which the above numerous cæcal appendages may perform in the process of digestion, it is difficult to offer any very satisfactory conjecture. Characteristic as they appear to be in general of the alimentary canal in those creatures which live exclusively upon the fluids of others, such as the *Planaria*, the leech, the *Aphrodite*, the *Nicotthoe*, and in the *Arachnida*, the spiders and scorpions, with the *Acaridean* genera *Ixodes* and *Gamasus*, one would have expected to have found these organs less developed in the present group, from the very circumstance, already stated, of their mouth being adapted also to the purposes of mastication; and yet, strangely enough, their number and size is greater even than what is met with in the purely blood-sucking *Araneidans*. By some writers the parts in question have been regarded as so many reservoirs, in which the nutriment may be stored up, so as to serve the animal for some length of time, but this is an opinion which seems scarcely applicable to *Phalangium*, from the following facts. The dilated stomach usually contains a smooth, black and oval mass of excrementitious matter (Pl. IV. fig. 20. *f*, nat. size), and what is singular, this (*e*, magnified) is inclosed in a distinct membranous covering (*m*) which surrounds it continuously, and is thrown into slight transverse folds. The mass still adheres together after the latter has been removed, and, upon being broken up, is found to consist of the debris, or undigested hard parts of various insects, such as the eyes, legs, wings, antennæ, &c., imbedded in a granular substance. If, on the other hand, the contents of the cæca be examined, it will be seen to be a granular substance also, exhibiting under the microscope a similar appearance to the above, with this difference, however, that along with it no traces of organic remains can be detected. May it not be inferred from this, that one office at least of the cæca is to secrete this matter, which, discharged into the stomach, agglutinates the particles of food together? The investing membrane of the feces may serve

to protect the delicate coats of the intestine from laceration, by the sharp and often spiny nature of their contents.

Of the two pairs of vessels described by Treviranus and mentioned above as biliary tubes (Gallgefässe), the superior (Pl. IV. fig. 17. *sv*, *sv'*), after forming a loop upon the posterior rows of small cæca, winds round the intestine from the dorsal to its ventral aspect, where it crosses part of the ovarium in the female, and is in relation with the origins of the tracheal trunks, and returns into itself to form a single tube, which passes directly forwards, and is lost among the muscles of the manducatory apparatus. The second pair (Pl. IV. fig. 18. *sv'* *sv'*) are situated more to the sides of the alimentary canal, but I have been unable to trace their course. Treviranus states that it is shorter than the preceding one, and ends between the cæcal pouches. It is, however, probably also continued onwards to the cibarial organs, and the two pairs together may, perhaps, exercise some salivary function in relation to those complex parts.

The structure designated by Treviranus as the fatty mass (*f*) consists of a series of longitudinal and parallel intestiniform bodies, formed by membranous tubes, containing granular matter in their interior, and which lie upon the under surface of the stomach. They may fulfil the function of a liver.

Organs of Circulation.—These in *Phalangium* are as simple as the other structures are complicated. They consist of a heart divided into three chambers, lying in a groove upon the upper surface of the alimentary canal. The posterior division (Pl. IV. fig. 17. *p*) is situated, pyriform in shape, between the anterior extremities of the two large superior cæca, its broad end forwards, being received into a corresponding expanded portion of the groove. The middle chamber (*H*), about the same size as the two terminal, is contracted in the middle like an hour-glass, and placed between the two posterior rows of small cæca, being in relation, upon either side, with the longitudinal portion of the loop of upper salivary vessels. The anterior division (*a'*), of the same shape as the posterior, lies in a depression between the two anterior rows of cæca, and is prolonged downwards obliquely as a minute vessel, which, curving again upon itself, runs horizontally forwards. The structure of the heart is composed of a series of transverse, curved and muscular bands, leaving between them light and membranous intervals. It is plentifully supplied with nerves, which take a longitudinal course over it.

Generative Organs.—Were the anatomist familiar only with the anomalous conditions of the generative system in the Pulmonary Arachnida, with the singular transference of the means of fecundation to the extremities of the palpi in the male spider, and the termination of the internal organs, in both sexes, by a simple

transverse outlet upon the under surface of the abdomen, he would hardly be prepared to find, in dissecting one of the present group of animals for the first time, not only well-developed internal organs, but an external male and female apparatus for reproduction, comparable even, from its size and complexity, to that met with in insects. To such a degree may important differences in the structure of internal parts be masked by analogies of outward form.

The organs of generation in the male of *Phalangium Opilio* consist of a penis inclosed within a sheath, a vas deferens, and certain excretory glands, the analogues of the testes. All these parts are situated within the cavity of the abdomen towards its anterior extremity, lying along its under surface, immediately beneath the integument.

The testes are formed by a cluster of elongated, narrow and slightly tortuous cæcal tubes (Pl. IV. fig. 21. *st*), situated above the sheath of the penis when the latter is "*in situ*," and which, converging towards a central point, combine to form a single spermatic duct (*s*), which is continued onwards to the extremity of the male organ. The above cluster of seminal tubes is in relation above with the medio-abdominal nerve, which crosses over it, and the under surface of the gastric sac; on either side of it are seen the long inferior cæca of the latter, and emerging from among the lateral tubes, the nervous ganglia (*ng'*) which supply these organs.

The duct or vas deferens (*v*), given off as already stated, passes in a tortuous direction above the testes, which it resembles in texture very much in the posterior half of its course, and extends to about twice their length within the abdominal cavity. Its anterior half is tough and horny (*v''*), and surrounded, nearly as far as its entrance into the penis, by an oblong ovoid body of considerable density and thickness (*v*).

The penis (Pl. IV. fig. 22. *p*), though simple in its structure, is remarkable from its length, nearly equalling the half of that of the abdomen. It is composed of two distinct portions, a body (*p*) and glans (*g*), both of a very firm coriaceous texture.

The body, which constitutes by far the largest portion of the organ, is slightly curved throughout its entire length, the concavity being directed upwards, and broad behind at its commencement, gradually narrows towards its anterior extremity. It is compressed from above downwards and grooved upon the upper surface. At its base it presents superiorly a large crescentic opening (*o*) for the passage of the continuation of the spermatic duct, or the ductus ejaculatorius, which traverses it throughout as a rigid horny tube (*t*), and opens into the base of the glans. The termination of the body of the penis in front is somewhat

dilated, and exhibits two small, oval and concave plates (*ps*), situated upon its upper surface, and diverging obliquely from the dorsal groove upon either side. They are darker in colour than the rest of the body, and separated internally from each other by a narrow space. Their outer margin, dark brown, is prolonged in the middle in a triangular shape, and curved towards the median line. The second piece of the male organ or glans (*g*) is articulated to the former in a ginglymoid manner, and rests obliquely downwards upon the two above-mentioned plates. It is widest behind where it projects in a rounded base, which has two slender elevator muscles attached to it, is concave upon its upper and lower surface, and furnished at the apex with a small, acute, slightly bent and moveable hook, at the base of which, inferiorly, is a minute triangular aperture for the exit of the seminal secretion.

The whole of this penis is contained in a *sheath* (Pl. IV. fig. 23. *sh*) of similar contexture, which is situated partly in the hollow of the sternum (*s*), and partly against the ventral parietes, being about twice the length of the former. It is broader than the organ it incloses, and being more or less transparent, admits of the outline of the penis (*p*) being very distinctly seen through its parietes. Though described by Treviranus as a simple sheath, this organ consists of two elongated pieces with well-defined margins, connected to each other by a membrane, which is very easily torn through in dissection if care be not used, and gives the idea at first, of the structure in question being formed by a couple of separate valves. The lower of these pieces is carinate in form, to adapt itself to the corresponding surface of the penis against which it rests, and is continuous behind with the inferior part of the margin of the opening in the base of that organ; its lateral borders become thicker towards their anterior extremity, and terminate by curving outwards as two horny projections or hooks (*h*), which are connected upon either side to the edges of the sternal plate, with an inflection of which the inferior part of the sheath is confluent anteriorly (*a*). The second portion of the sheath, attached to the remaining edge of the urethral opening, extends almost flat over the upper grooved surface of the penis, and ends in front by a rounded free border (*). From the opening between the two conjoined pieces the glans of the male organ protrudes.

The relative position of the above parts "*in situ*" is precisely as follows:—Inferiorly, lying within its sheath in the concavity of the sternum, is the intromittent organ. Above, covering the anterior half of the sheath, the divergent angles of the latter, and the glans penis being partially visible, is the cluster of seminal vessels. Immediately behind the latter is the horny portion of

the vas deferens in its surrounding body, lying lengthways upon the upper surface of the posterior half of the sheath, but not extending quite to its base, so as to leave the opening into the penis perfectly visible. The two structures called by Treviranus the ligaments of the sheath, are, without doubt, a pair of retractor muscles (Pl. IV. fig. 21. *rm*). They arise, broadest, upon either side of the opening in the base of the penis, and passing backwards along the under surface of the abdomen, where they come into relation with the two branches and their ganglia of the medio-abdominal nerve (*ng*), diverge to be inserted into the lateral angles of the penultimate dorsal arc. Part of the fibres of these muscles are continued onwards from their origin to form a muscular sheath, apparently composed of large and detached ultimate fibrils arranged side by side in a single layer, over the sheath of the penis, the vas deferens and seminal tubes.

Behind the testes, extending across the under surface of the stomach, is a broad intestiniform tube (*), curved in the shape of a Z, and constricted in five or more distinct places, which is supposed by Treviranus to belong to the generative system of the male, as it is met with only in that sex, and to perform some function connected with the elaboration (*Absonderung*) of semen. It is membranous, and contains a granular-looking substance, and terminates by its extremities in two long filiform tubes, which are said also by Treviranus to lose themselves among the blind appendages of the alimentary canal. I have examined the direction of these minute ducts with great care, and find that they pass forwards and curve round the tracheal trunks near to their origin from above downwards, and are lost at the inner extremity of the spiracular groove, where they may probably open externally. The function assigned to this part is thus rendered extremely problematical.

It is doubtless preparatory to the intercourse of the sexes, that, during the autumn, many male specimens of *Phalangium* may be taken, having the penis and its sheath completely extruded from the cavity in which they before lay concealed (Pl. IV. fig. 25.). In this operation the sheath is turned inside out, and the curved and flexible hooks upon either anterior angle turn also over, from above, downwards and backwards, towards the latter end of the process. But not only do the external organs of generation thus undergo a remarkable change of position, but the internal are, to a certain extent, displaced. The horny portion of the vas deferens and its surrounding body, appended close to the root of the penis (Pl. IV. fig. 23. *v*), and the muscles upon either side of the latter, are thrust out of the abdomen along with that organ, and as it quits its investing sheath enter the latter, but are in contact then with its external surface, changed by eversion, to within. The

first of these organs (Pl. IV. fig. 24. *v'*) may be readily seen through the extruded sheath, where its presence is indicated by a dark line, shadowed externally, and may be even drawn into it, when the parts are all in their natural position, by laying hold of the extremity of the penis with a fine pair of forceps. The extrusion is, I believe, effected by the contraction of the fibres of the corium, which, by diminishing the abdominal cavity, press upon the generative organs from behind and cause them to spring out, while the retraction of the penis, and with it, of course, the sheath, is performed by the two special muscles above described. I may observe, that, owing to the protrusion of the anterior part of the vas deferens, the whole of it is placed in a more direct position in relation to the seminal cæca, and the passage into it, of the secretion from the latter, thus greatly facilitated.

EXPLANATION OF PLATE IV.

- Fig. 15.* Inferior view of the epipharynx, to show the pharynx lodged in its interior, and the commencement of the œsophagus; *A A* are the first pair of maxillæ with their horny bows; *2 2*, second joints of the palpi; *s*, the vertical septum.
- Fig. 16.* Anterior opening into the pharynx; *dp* is the deflexed termination of the dorsal plate of the latter, forming at its apex a corneous lip; *m m* are muscular fasciculi.
- Fig. 17.* The alimentary apparatus, seen from its upper surface, the pharynx and œsophagus having been removed.
- Fig. 18.* The same, from below. The corresponding cæca are lettered the same in both these figures.
- Fig. 19.* An oblique transverse section of the abdominal viscera through their middle in a female *Phalangium Opilio*. The epidermis has been removed, leaving only the membranous layer *m'm'* beneath it, with the fibres of the corium, *m m*, resting thereupon; the relations of the ovary, *O*, and ovipositor, *or*, are also seen.
- Fig. 20.* Oval mass of fæces, inclosed in its membranous* capsule.
- Fig. 21.* The male generative organs dissected out, and seen from their under surface; *c c* are the pair of latero-inferior long cæca; *a*, the anus.
- Fig. 22.* The penis, the sheath having been removed, viewed from above.
- Fig. 23.* The same, lying within its sheath, *sh*, in the concavity of the sternum, *s*.
- Fig. 24.* The sheath and penis extruded from the sexual opening, seen from their inferior surface; *1, 2, 3, 4*, coxæ of legs; *B* is the second pair of jaws; *D*, appendages to second coxal joints.
- Fig. 25.* A male *P. Opilio*, viewed from the side, with the sexual organs extruded. The legs have been cut off, through the extremities of the third joints.

The preceding figures are magnified as in Plate III.

[To be continued.]

* I have been unable to discover with the microscope any traces of a distinct structure in the membrane forming this sac, the texture of which is smooth, homogeneous, and so thin as to be transparent. Its existence has been very constant in the many specimens of *Phalangium* which I have examined.