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TRANSACTIONS OF THE SOCIETY.

I.—*Observations on the Special Internal Anatomy of Uropoda Kramerii.*

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PLATE I.

THE anatomy of the exo-skeleton, and of the trophi, of *Uropoda* has already been studied and figured by M. Megnin,* who selected *U. vegetans* for his purpose; and in many particulars by Dr. Kramer;† and lately in the undermentioned paper by Herr W. Winkler. I therefore confine these observations to the internal anatomy, and I shall only mention such parts of the external structure as it may be

EXPLANATION OF PLATE I.

c, Œsophagus. *cæ¹*, Enlargement of same before entering the ventriculus. *v*, Ventriculus. *c*, Colon. *r*, Rectum. *a*, Anus (seen through the rectum from the transparency of the latter). *cæ*, Larger cæca of the ventriculus. *cæ¹*, Smaller ditto. *mv*, Malpighian vessels. *mv¹*, Ditto, narrow neck where the vessel arises. *mv²*, Ditto, enlarged chamber. *mv³*, Ditto, narrow part between the chamber and the lateral enlargement. *mv⁴*, Ditto, lateral enlargement. *mv⁵*, Ditto, anterior narrow portion. *mv⁶*, Ditto, reflexed portion. *mv¹*, Ditto, blind end. *m*, Muscles with tendinous attachments. *m¹*, Attachment to the side of the body. *t¹, t²*, Testes. *vs*, Sack-like organ (vesicula seminalis?). *g, g*, Oil-glands. *de*, Ductus ejaculatorius. *p*, Penis. *ar*, Protecting armature of same. *ov*, Central ovary. *od*, Oviducts. *e, e*, The fully, or nearly fully, developed eggs contained therein. *va*, Vagina. *res*, Vestibule. *gp*, Genital plate. *br*, Brain (so called).

All the figures represent *Uropoda Kramerii*.

- Fig. 1.—Under-side of adult female × 55. The genital plate would fill up the genital aperture exactly. The small space necessarily left between the two in the figure is to keep the lines distinct.
- „ 2.—Epistome and oral tube of adult, seen from above, × 175. The basal joints of the palpus are indicated on the left side only.
- „ 3.—The same, seen from the side; same amplification.
- „ 4.—Chelate portion of the right mandible of adult male, seen from the right (outer) side, × 350.

* “Mémoire sur l'organisation et la distribution zoologique des Acariens de la Famille des Gamasidés,” Journ. de l'Anat. et de la Physiol. (Robin), 1876, pp. 288-336.

† “Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden,” Archiv für Naturgesch., 1876, pp. 28-105.

necessary shortly to refer to, in order to explain the organs connected with them.

The *Uropodinæ* are a subfamily of the *Gamasidæ*, but are in many important respects exceptional: the position of the first pair of legs, the coxæ whereof are inserted within the oral tube, the position of the male genital organ, and the slender mandibles form well-marked distinctions. The general appearance also is different from that of most of the *Gamasidæ*, so much so indeed that Hermann * included the species discovered by him (*U. cassideus*) in his genus *Notaspis*; a genus intended to be entirely composed of what we now call *Oribatidæ* (Latreille's earlier name of *Oribata* having excluded Hermann's *Notaspis*).

During the summer of 1888, when staying at a farmhouse in Derbyshire, I found *Uropoda Kramerii* (Canestrini)† in great abundance on the floors and walls of an old barn used for storing hay. This

Fig. 5.—Claw and caruncle, highly magnified.

„ 6.—Larva.

„ 7.—General view to show the arrangement of the principal internal organs of the adult female, $\times 65$. The whole of the dorsal chitinous plate has been removed, except the striated band round the periphery, and a small portion within this, which is shown by its broken outline. The masses of fatty matter and almost all the muscles have also been removed. For the sake of clearness, the respiratory system is shown on the left side only, and the tendons and commencement of the muscles whereby the Malpighian vessels were attached to the dorsum and side, are shown on the right side only.

„ 8.—Alimentary canal and Malpighian vessels seen from above, $\times 70$. The drawing is made from a large and apparently well-nourished specimen immediately after dissection. The Malpighian vessel is shown on the right side only, its commencement being indicated on the left.

„ 9.—The alimentary canal seen from below, $\times 70$. This drawing was made from a smaller and possibly less well-nourished specimen, after the dissection had been partially prepared for permanent preservation.

„ 10.—Internal sexual organs of adult male seen from above, $\times 70$.

„ 11.—The same from below; same amplification.

„ 12.—Penis in its ordinary position resting in its armature, $\times 175$.

„ 13.—Penis withdrawn from its armature, $\times 175$.

„ 14.—Internal genital organs of adult female seen from below, $\times 70$.

„ 15.—Vestibule looking straight upwards into the mouth from below, $\times 160$.

„ 16.—Genital plate seen from within, $\times 75$.

„ 17.—Point of the same, showing the thin lanceolate termination, $\times 300$.

„ 18.—Genital plate and vestibule, $\times 70$. General view to show the relative size, and the mode in which they would fit against each other. The vestibule is turned to the right and backward; the oviduct being thereby twisted.

„ 19.—Respiratory system of the left side, highly magnified, seen from within the body. *ac*², acetabulum for reception of 2nd coxa. *ac*³, ditto for 3rd coxa. *d*², depression for reception of 2nd leg. *d*³, depression for reception of 3rd leg. *st*, stigma. *pt*, peritreme. *tr*, main tracheal stem. *bt*, *bt*, *bt*, bundles of fine tracheæ.

„ 20.—Brain (so called), and œsophageal ganglionic collar. The hole near the centre is where the œsophagus passed through; it has been removed.

* 'Mémoire aptérologique,' Strasbourg, 1804.

† I believe the species to be *U. Kramerii*; I have not, of course, Professor Canestrini's type specimen to compare the anatomy, but the creature appears to agree with his description and with Professor Berlese's drawing, which is stated to be taken from that specimen. 'Acari Miriapodi e Scorpioni Italiani,' fasc. xi.

seemed to me a favourable opportunity for ascertaining something about the internal anatomy. As I investigated the matter I found it very interesting; especially from the numerous resemblances to the corresponding organs in the *Oribatidæ*, which I had previously studied. The main features of the internal structure turned out, as might be expected, to be essentially of the Gamasid type, still there were found to be many points in which there was an approach to the organization of the *Oribatidæ*; thus showing that the external resemblance which deceived Hermann was accompanied by certain modifications of the internal parts, producing a condition somewhat intermediate between the types of the two families.

The investigations were carried on entirely by dissection, in the same manner as I had previously conducted those relative to the *Oribatidæ*.* Preparations of the actual organs therefore remain in my possession for reference, and as proofs of the correctness of these mine. All dissections have been frequently repeated.

Upon my return to London, I found that during my absence an important and excellent paper upon the anatomy of the *Gamasidæ* had been published by Herr Willibald Winkler.† This paper, although it principally treats of the anatomy of the genus *Gamasus*, deals also to a lesser extent with that of *Uropoda obscura* (Koch). Herr Winkler's investigations were clearly prior in date to mine, but of course mine were conducted, and this paper written, and the drawings made in entire ignorance of them. Under these circumstances our observations necessarily cover a portion of the same ground; but on the other hand, large parts of the two works do not overlap. Herr Winkler's treatise is greatly devoted to the histology of the subject and to the mouth-parts, the nerves, &c., which I have not touched upon; while I think a good deal will be found in the following pages that has not been included in Herr Winkler's investigations, and, indeed, many of the organs may differ, or may not exist, in the species which he has selected. I thought at first that it would be better to eliminate from this paper such portions as were covered by the German memoir, but I found that doing so would render the remainder obscure, the connection of subjects being broken. I have therefore thought it best to retain them, making this acknowledgment of Herr Winkler's priority, but I have usually mentioned where he has described the same thing, and of course I have pointed out any differences which have struck me, although these are not numerous nor specially important.

General Arrangement of the Organs. Fig. 7.

When the dorsal shield, and the fatty matter which underlies it are removed from *Uropoda Kramerii*, and the muscles of the mandibles, &c., so far cut away as to enable the operator to see the other parts clearly, the arrangement of the principal organs is found to be that

* 'British Oribatidæ,' Ray Soc., 1884, p. 142.

† "Anatomie der Gamasiden," Arbeit. Zool. Inst. Univ. Wien, vii. (1888) pp. 317-45.

shown in fig. 7, which is a female; but it must be remembered that no two specimens agree exactly in the relative size, shape, and arrangement of the various organs; indeed the two sides rarely absolutely correspond. Moreover, in consequence of the highly elastic and extensible nature of some of the parts, considerable differences occur in the appearance of the same side of the identical specimen from time to time; the general arrangement is, however, naturally always similar. The mouth-opening in *Uropoda* is in the ventral plate, some little distance from the point of the rostrum, and consequently the alimentary canal does not commence at the anterior end of the body-cavity, the space in front of it being occupied partly by muscles and tracheæ, and being partly unoccupied. The ventriculus may be seen lying nearly centrally and occupying a large portion of the entire space; the œsophagus proceeding from it forward and slightly downward. The great supra-œsophageal ganglion is seen in the central line near the ventriculus, while the hinder portion of the canal is entirely concealed by the central ovary. A very large Malpighian vessel on each side may be seen, usually filled with white opaque matter. The posterior ends of these tubes are concealed beneath the central ovary, while the vessels run at the side of, or slightly under, the ventriculus, but extend as far forward as the mouth-opening, or even a little beyond its commencement; and then turn sharply backward so as to fall over the anterior edge of the ventriculus and lie upon it. The larger eggs in the oviducts may commonly be just seen, below all the above-named organs, projecting at about the middle of the ventriculus. The tracheæ will also be seen, arranged at first in three principal bundles, and then separating out, as explained below.

The Alimentary Canal. Figs. 8-9.

The canal has a great general resemblance to that of the *Oribatidæ*, but is composed of finer and more delicate tissues, which renders it very difficult to get the whole canal out perfect without breaking it, although there is comparatively little difficulty in dissecting it out in pieces.

There can scarcely be said to be any pharynx in the sense of an enlarged chamber, such, for instance, as the pharyngeal sac of Huxley in *Scorpio*; a hardly perceptible widening of the œsophagus before it enters the mouth-cavity being all that exists; but if the anterior portion of the œsophageal tube, i. e. the portion to which the dilator muscles for suctorial purposes are attached, although scarcely if at all enlarged, is to be regarded as a pharynx; which appears to be the mode in which Herr Winkler uses the term in this instance, then of course it would exist, but not be distinctly divided off from the œsophagus. This is practically a question of nomenclature: I have used the word "œsophagus" for the whole, which appears to agree with its use by MacLeod, Henkin, Nalepa, and others, in other families.

The œsophagus (α) is long, about half the length of the ven-

triculus, and is quite straight and very thin and small in diameter; it has exceedingly delicate, semitransparent walls, without the conspicuous circular bands of muscle so commonly found embracing the corresponding part in the Oribatidæ. The œsophagus proceeds upward and backward from the mouth to the anterior edge of the ventriculus, which it enters on the ventral aspect of that viscus, and a trifle behind its anterior margin. There is a slight enlargement of the œsophagus before entering the ventriculus, but not anything of the nature of a proventriculus, or sucking stomach. During life, slow, regular, peristaltic movements may sometimes be seen passing along the œsophagus in a backward direction.

The ventriculus varies considerably in form; it is a large organ in comparison to the size of the creature, occupying nearly half the length, and nearly two-thirds of the width of the body. It is com-proceed dorso-ventrally. The principal mass is more or less trapeze-shaped, the anterior margin is, however, always somewhat the wider, and appears more so than it really is in consequence of the arrangement of the cæca. The hind-margin is rounded (fig. 8), or prolonged in the central part (fig. 9), so as to extend somewhat backward. The whole organ is much stronger and more muscular than any other part of the canal. The cæca of the ventriculus, particularly during life, are comparatively shallow, and widely open; often almost losing the character of cæca and becoming mere lobes or pockets. They are arranged as follows, viz. there are four principal lobes (cæ), these proceed from the dorsal level, and are rounded projections of the corners of the ventriculus, irregular in form, and often having the outlines more or less divided into secondary very shallow lobes, or wrinkles. Of these four lobes the anterior pair project outward, while the posterior pair are directed rather backward, and often have a tendency to curl inward. The anterior margin of the ventriculus, between the front pair of larger lobes, is almost wholly occupied by five smaller lobes; the three central of these are rounded and very shallow, and are indeed little more than undulations; they proceed from the dorsal part of the anterior edge. The remaining pair are a little longer, although still short, and are curious horn-like structures curving toward the median line and pointed (cæ₁); they arise from the ventral part of the anterior edge. In addition to the eight above named there are usually a pair of small, rounded, mamillary projections from the ventral surface (fig. 9).

In the large size of the ventriculus, and the shortness of the cæca which proceed from it, the ordinary Gamasid type seems to me to be departed from. In the genus *Gamasus*, &c., the ventriculus is often a comparatively small and narrow organ, which appears as if its chief office were to form a point of communication between its own enormous cæca and the hind-gut. These cæca often extend quite from the anterior to the posterior extremity of the body, and are irregularly placed, intertwining with the Malpighian vessels to some

extent, and forming the largest and most conspicuous organs of the body. The large ventriculus of *Uropoda Krameri* much more resembles that of some of the *Oribatidæ*. It is true that in the latter family also the cæca, although only two, are usually large, and form much more important organs than in *Uropoda Krameri*; but in the typical forms of the genus *Damæus* (*Oribatidæ*) the cæca are in a similar condition, having become mere lobes of the ventriculus, even less developed than in the *Uropoda* here spoken of. The ventriculus is the "Mitteldarm" of Winkler. Kramer in 1876* indicated somewhat of this difference between *Uropoda* and *Gamasus*. Winkler is inclined to deny it, but Winkler's *Uropoda*, which he speaks of as having long cæca to the ventriculus, must be very different from *U. Krameri*, of which species I have dissected large numbers, and always found the ventriculus in the condition above described.

There is not any small intestine in *Uropoda Krameri*; the colon proceeds direct from the ventriculus, arising from the ventral surface of that organ, very near to, but not quite at, the posterior margin. The colon is almost globular, but not quite, being slightly elongated; it is directed almost perpendicularly downward; it is sharply constricted, both anteriorly where it arises from the ventriculus, and posteriorly where it communicates with the rectum. These constrictions are like gatherings-in of the walls of the canal, appearing folded or wrinkled at these points as if a loose sack were drawn in by a circular tie. A very short and narrow neck connects the colon with the rectum; it is this neck which receives the Malpighian vessels, as mentioned hereafter. The rectum is very similar to the colon, usually a trifle smaller and less globular in form; it is also less sharply constricted at the posterior end where it surrounds the anus (fig. 8), which is a very small lenticular opening in the chitin of the ventral plate. It can be closed by somewhat chitinized folds of the inner cuticle, and is protected exteriorly by an elliptical chitinous ring in the ventral plate; this ring touches the anal opening at the ends, but not at the sides.

I have purposely left the above description of the hind-gut as I wrote it before seeing Winkler's paper. I have adopted the same nomenclature as I formerly employed relatively to the *Oribatidæ*. I find, however, that what I call the colon Winkler calls the hind-gut ("Enddarm"), and what I call the rectum he also states to be the rectum, but he usually calls it the excretory collecting bladder ("Sammelblase der Excretionorgane"), and he considers it to be a portion of the excretory system (Malpighian vessels), not of the alimentary canal.

It would probably be more convenient if words such as "rectum," "colon," "oesophagus," &c., which are used in describing the higher animals, were excluded from works on the lower creatures, such as the *Arthropoda*, altogether; but if this be not done the question of

* "Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden," Archiv für Naturgesch., 1876, p. 63.

nomenclature becomes somewhat arbitrary, and is probably of little importance so long as it is clearly indicated exactly what the organs are like; but the question of whether the sack-like organ adjoining the anus is a portion of the alimentary canal or of the Malpighian vessels is possibly more substantial. There cannot be any doubt that the organ in question is, so to speak, a cloaca, into which both the systems discharge, and which conveys the excremental matter from both to the anus. In the *Gamasidæ* the amount of matter discharged by the Malpighian vessels is large, and that furnished by the canal is small compared to what it is in the *Oribatidæ* and many other families; thus the former is sometimes in excess in the contents of the organ in question. Herr Winkler also gives histological reasons for considering this viscus to be part of the former system; but on the other hand, the hind-gut of *Uropoda Kramerii*, as I have so frequently seen it, if this organ, which I call the rectum, be included as part of it, agrees almost exactly with that of the *Oribatidæ*; in which family the Malpighian vessels do not exist in this situation, and do not communicate with this organ nor with the hind-gut at all. Moreover, this rectum, as I call it, follows what I call the colon in the ordinary manner in the species I am treating of, and constantly, indeed usually, contains balls of the rejected portions of the digested food, similar to those in the colon, and similar to those found in the rectum of the *Oribatidæ*; also it seems to me more consonant with one's ordinary ideas to consider the viscus by which the alimentary canal discharges to the anus as being the rectum in the usual sense of the word. I think, therefore, that this organ should be regarded as primarily a portion of the alimentary canal, although functioning as a cloaca. I do not gather from Herr Winkler's description at what exact point the canal and Malpighian vessels discharge into this organ, which I call the "rectum," nor how the discharged matter passes through it to reach the anus; but if I understand his drawings correctly, there must be some difference in these respects between his species and *Uropoda Kramerii*.

The Excretory System. Fig. 8.

This is entirely of the *Gamasus* type, and does not in any way resemble that of the *Oribatidæ*; it consists of two very long sack-like organs, which may probably be correctly called Malpighian vessels (fig. 7, *m v*); they are arranged bilaterally, one on each side of the body, and are usually more or less filled with opaque white excremental matter from end to end. These vessels arise, one on each side, from the narrow neck of the alimentary canal which connects the colon with the rectum. Each vessel commences with a short tubular portion of small diameter (fig. 8, *m v*¹), which, indeed, is a necessity to enable it to spring from the very constricted part of the alimentary canal where it is placed. This narrow part leads into an elliptical chamber (*m v*²), which is far the largest portion of the

vessel in diameter and capacity; it is often as large as, or larger than, either the colon or rectum. From this chamber a second narrow portion ($m v^3$), which is considerably longer than the first, but not so sharply defined, leads to a lateral enlargement slightly constricted in the middle ($m v^4$); this portion is in shape like two elongated pyriform organs with their larger ends together and fusing; but, of course, the lumen is continuous. From this enlarged lateral portion another narrow part ($m v^5$) of the vessel, much longer than the previous narrow parts, and more undulated, runs forward nearly to the articulation of the second leg. Up to this point the Malpighian vessel has been placed at the side of, or slightly under, the ventriculus: the extent to which it passes under varies in different specimens, and probably in the same specimen at different times, depending on the relative distension of the canal and the Malpighian vessels respectively, and on the precise form and position of the latter, which are not by any means constant. After attaining the point to which it has been described, viz. about the articulation of the second leg, the course of the vessel entirely changes; it turns sharply upward and then backward, so that it folds over the anterior edge of the ventriculus, and the remainder of the vessel is a reflexed portion ($m v^6$), which lies upon the ventriculus and runs straight backward. It gradually enlarges towards its distal end, which is blind and rounded ($m v^7$). A powerful fasciculus of muscles (m) which arise from the sides and dorsal cuticle, are inserted by tendinous attachments into the wall of the vessel just behind the lateral enlargement, and probably assist in the peristaltic movements. The vessel is also attached to the side of the body at m^1 , but in this case apparently merely as a tie, not by muscles of any importance. The peristaltic movements and the transfer of excretory matter, of course, proceed from the blind end of the vessel toward the rectum, and are stronger than those of the canal; this is usual in the *Gamasidæ*, but the movement is not so strong as in *Dermanyssus*, and many other members of the family. The Malpighian vessels are generally more or less distinctly seen through the dorsal shield in living specimens, and are the most conspicuous organs in the body; they are equally conspicuous in the nymphs and larvæ, and may even be clearly seen in the advanced embryo while still within the egg, and at that early period they are already filled with the white matter.

The Reproductive Organs.

This system is another of those which bears a strong resemblance to that of the *Oribatidæ*, but naturally there are differences of considerable importance, as will be seen in the following description.

As in most other families of the *Acarina*, these organs, during the period of activity and maturity, are extremely large in proportion to the whole size of the creature; so much so that they often appear to push all the other organs out of place; this, as might be anticipated, is more especially the case with the female when the eggs are ripe.

The annular form of the system, taken as a whole, which is so well known in the *Arachnida*, and which is so conspicuous in that of the *Oribatidæ*, is equally clearly shown in the female of *Uropoda Kramerii*; but in the male this form is more lost, in consequence of the absence of the long vasa deferentia which form an element of the ring in the *Oribatidæ*. Probably it is only those who know how the ring is formed in the males of the last-named family who would recognize some vestige of it in those of the *Uropoda*.

The Male. Figs. 10-13.

The male organs lie almost immediately below the ventriculus; they consist of a central chamber, six more or less sack-like organs, and a large single duct leading to the penis. The most conspicuous of these is the central chamber (*vs*), a large heart-shaped organ compressed dorso-ventrally, and having the broader end turned forward; this organ is the nearest to the ventral level, the other parts of the system lying slightly above it. I take it to be partly glandular in its office, and also to some extent to function as a vesicula seminalis; in which case it would agree with the corresponding organ in the *Oribatidæ*; and this appears to be Winkler's view with regard to the organ in his species, *U. obscura*; in which case, however, the organ appears from his description to be more globular.

Four long, sack-like, glandular organs (*t*¹, *t*²) take their origin immediately above the central chamber, and near its anterior margin. They do not appear to communicate directly with the central chamber, but all seem to open into a small median antechamber. The sacks are pyriform, smallest where they enter the antechamber, and largest at the blind, free ends. One pair, which are usually somewhat the larger, are nearly straight, and are directed almost backward. The corresponding organs in *U. obscura* are regarded by Winkler as being the true testes. The second pair, the mouths of which are placed above those of the first pair, are more curved, or comma-shaped; they are directed almost transversely across, and partly under the central chamber; their distal ends curve backward. If these correspond to the second pair of sacks figured by Herr Winkler in his diagram he regards them as accessory glands, not testes; but as he only mentions four sacks in his species, and I find six in mine, it is probable that his accessory glands correspond to the smaller sacks (oil-glands) mentioned immediately below, and that the pair of organs now treated of are rather to be regarded as a second pair of testes; at all events they greatly resemble the first pair. In addition to these four there are the two other sacks above referred to (*g*), they are much smaller and almost globular. These organs have thin walls, and contain only a highly refractive oily liquid. They are placed one on each side of the ductus ejaculatorius, and apparently communicate with the small median antechamber. Somewhat similar organs exist in a few of the *Oribatidæ*, but not in all.

The ductus ejaculatorius, as it may probably be called, is a large, straight tube, running forward and downward in the median line; it enlarges a little, gradually, before reaching the external genital armature, which it surrounds. The penis (*p*) is a short, chitinous, pyriform or gourd-shaped organ, situated exteriorly on the ventral surface in the median line, between the coxæ of the third pair of legs. It is protected by a chitinous armature (*ar*) formed of a circular ridge, sufficient of the circle being cut away to admit the broad end of the penis, and of a thinner, but still stout, lamina within the circle. This lamina is also cut away to fit the penis, the distal end and edge of which, however, when the organ is not in use, slip under the edge of the lamina, the whole organ then presents the appearance of a chitinous ring surrounding a thin circular plate with a gourd-shaped opening in it; the chitin of the penis, when seen through from the side, being much thinner than that of the lamina. This is represented by figs. 10, 12, while fig. 13 shows the intromittent organ withdrawn previous to erection.

The Female Organs. Figs. 14–18.

The female reproductive organs consist of a central ovary; two long, paired oviducts; an unpaired vagina; and the vestibule. The organs, as before stated, practically form a ring; and they greatly resemble the corresponding parts in the *Oribatidæ*; but there is one very marked difference, viz. the entire absence of the long, protrusible, and collapsible ovipositor, which forms so conspicuous a feature of the system in that family; and its replacement to some extent by the vestibule, which, however, is strictly an internal structure. The central ovary (figs. 7–14, *ov*) is placed in the median line, almost at the posterior end of the body; it naturally varies in size and form, but it most commonly has the general appearance of a bunch of grapes with the small end the nearer to the posterior margin of the body. This ovary looks as though entirely composed of eggs in an early stage of development; the eggs are not by any means all the same size, but it seems strange that, in all specimens which I have dissected, the smaller eggs have been clustered round the entrance to the oviducts, while the larger eggs were chiefly at the hinder end and periphery of the ovary; this would be comprehensible enough if the eggs were placed dehiscence into a body-cavity, but this does not appear to be the case; one is therefore led to suggest that the eggs may possibly work backward along the periphery of the mass, and then forward to the mouth of the oviduct through the centre of the mass. Even the largest eggs in the ovary show the nucleus clear and undivided, not the least sign of yolk-division. The oviducts are thin, transparent tubes of moderate length, and considerably curved or undulated, but they cannot be called convoluted. They are evidently very capable of distension and contraction, and when not distended by eggs are generally strongly corrugated. They almost

always contain two eggs (*e, e*), one on each side. I have not ever seen more than one egg in each oviduct at once, sometimes I have found the oviduct on one side without any egg in it. These eggs are extremely large in proportion to the size of the creature; the chorion is thin and almost transparent, and the embryo within may generally be seen, often apparently fully-formed and ready to emerge; but I have not ever noticed any motion of the embryo as a whole, the position with the legs folded closely to the body being always the same. Winkler appears only to have found a single, short, unpaired oviduct in *Gamasus*; he does not say what there was in his species of *Uropoda*. The two oviducts of *Uropoda Kramerii* terminate in the median line, where they enter the short, and rather wide, azygous vagina (*va*). This organ is also much corrugated, and is evidently capable of considerable distension, it terminates in the vestibule (*ves*). I have again used the nomenclature which I employed when I described the corresponding parts in the *Oribatidæ*. What I call the "vagina" Winkler calls the "uterus." I avoided that term because it conveyed to my mind the idea of an organ wherein the ovum was matured or developed; now this is not the case with the part in question; the development of the egg within the body, after leaving the ovary, takes place entirely in the oviduct; the passage through what I call the "vagina" must be very rapid, for I have not ever found an egg in it either in *Uropoda Kramerii* or in the *Oribatidæ*, although I have dissected very large numbers. As the oviduct of Winkler's *Gamasus* is unpaired it is not easy to say for certain where the corresponding part ends, and where the part corresponding to his "uterus" begins in *Uropoda Kramerii*; possibly his "uterus" may include the homologue of a portion of the oviducts of my species, particularly as he says that the egg is to some extent matured in it. What Winkler calls the "vagina," apparently corresponds to what I call the "vestibule," but the organ in *Uropoda Kramerii* differs greatly from anything which Winkler describes in his species; it is singular and somewhat complicated, it may, perhaps, be said to be broadly lenticular in the general form of the chitinous bar which surrounds its mouth, and which would be called a "ring" if it were round; but it is not truly lenticular, because, although the curved sides meet sharply so as to form a point anteriorly, yet they meet more vaguely so as to form a curve posteriorly. A little behind the centre is a slight chitinous projection from the exterior of the bar on each side, and from the inside of the bar, just opposite the projection, a much slighter bar runs across the ring. The transverse bar, although its direction is straight, as regards its course across the body, yet curves upward a little in a direction perpendicular to the ring. This transverse bar practically forms the thickened edge of the plate hereafter mentioned as forming the roof of the vestibule. An extension or continuation of the thin membranous walls of the vagina is attached round the outside of the chitinous ring, and a stouter convex portion stretches across, and entirely covers the hinder half of

space inclosed within the ring; thus the whole organ looks like an old-fashioned watch-pocket. This will be understood most easily from figs. 14. 15. It must be remembered that those figures are drawn as though the spectator were looking straight upward from below. In consequence of this formation only the anterior half of the ring is really open for the passage of the egg, but it is, of course, possible that at the moment of the egg passing the transverse bar may bend a little and the membrane stretch a little; but even then the opening would be very much smaller than the egg that has to pass through it. The inside of the parietes of the pocket is provided with several transverse rows of long, closely-set teeth or villous processes, not probably hard enough to be properly called teeth or spines, but yet stronger and firmer than ordinary hairs. The roof of the vestibule above the open (anterior) half of the ring is covered by a thin chitinous plate, of which the transverse bar before mentioned forms the posterior edge. The median portion of this plate is plain, without processes, the plain part forms about one-third of the width. The outer portion, all along the lateral and anterior regions of the plate, is occupied by a series of radiating lines of processes similar in nature to those above described, but larger. Sometimes these processes spring from slight ridges, and the part of the plate which carries them is slightly convex, although the form of the plate taken as a whole is concave. The large, but more or less soft, egg must be forced through the comparatively small opening of the vestibule and between all these processes. I am not able to say with certainty what the office of these processes is, as I have not ever succeeded in seeing one of the creatures in the act of oviposition. Winkler suggests that the office of certain scattered chitinous spines, which he found in what he calls the "vagina," is to hold, and prevent the escape of, the spermatophores or balls of spermatozoa which he found in that organ. I am fully aware that some species of the genus *Gamasus* are fecundated by the introduction of spermatophores into the genital opening of the female; indeed, in the year 1886 I pointed out that this was the case in at least one species of the genus, and I also described the process by which it was effected, which I had been fortunate enough to observe.* I can scarcely think, however, that the retention of spermatophores is the sole office of so elaborate an organ as the vestibule of *Uropoda Kramerii*; an organ very different apparently from the female genital opening in Winkler's species; particularly as I have not noticed spermatophores or balls of spermatozoa in the vestibule of *Uropoda Kramerii*. Three possible further uses suggest themselves, viz. firstly, that the processes are simply to exclude dust, &c.; this, however, is not altogether probable, as the vestibule is covered exteriorly by the closely fitting genital plate; and, moreover, neither this idea nor that of retention of spermatophores, would explain the presence of similar processes on the inside

* "Observations upon a Species of *Gamasus* supposed to be unrecorded," Journ. Quek. Micr. Club, ii. (1886) pp. 263-4.

of the genital plate (as mentioned below). Secondly, the processes may hold the egg in position so as to assist in its being forced out by spasmodic contractions of the vagina. Thirdly, it is not impossible that *Uropoda Kramerii* may be ovo-viviparous, the young larva escaping from the egg at the moment of deposition. If this be so, the forcing of the egg through the narrow opening of the vestibule, between these numerous processes, would probably serve to break and strip off the thin chorion of the egg, allowing the larva to escape. This last explanation is rendered more probable by the very advanced state of development in which the eggs are found in the oviducts, and also by the fact that where I found this *Uropoda* so plentifully there were numerous larvæ and nymphs, but I was not able to find any eggs. I tried keeping a number of the *Uropoda* in confinement in a cell, but I did not get any eggs. The creatures, however, are difficult to keep in good condition in confinement, which may possibly explain the absence of eggs from my cell.

The genital plate (fig. 16; and figs 1, 18, *gp*) is the external door in the ventral surface by which the egg, or larva, if the creature be ovo-viviparous, emerges from the body of the mother. It is a triangular plate with curved sides, and is slightly convex externally and concave internally. Its lateral margin is thickened and slightly turned in. The posterior edge is almost straight, with very slightly rounded corners. At this hinder edge the plate is attached on the interior to the ventral plate by the quasi-membranous lining common to both; thus a ginglymus hinge is formed. The genital plate exactly fits into the opening in the ventral plate, but the anterior end of the genital plate is prolonged so as to form a long chitinous point; this has not any opening or depression in the ventral plate to receive it, but lies wholly outside the latter. The lateral edge of this genital plate has a thin, chitinous, curved, more or less triangular lamina standing on edge slightly within the lateral margin of the inner side of the plate (fig. 16); the broad part of this lamina is the hinder part, and to its upper angle the ocluser muscles of the plate are attached by tendons which unite to form one long and very substantial tendon, which is inserted at the above-named point of attachment, in the manner so frequently found in the *Acarina*, especially the *Oribatidæ*. The size of the genital plate is really surprising; it occupies almost the whole space between the legs; its posterior edge is considerably behind the coxæ of the fourth pair of legs, while its anterior point reaches those of the first pair of legs, and almost touches the singular tactile organ found in most *Gamasids*, and which Kramer has called the ventral palpus ("Bauch-Taster"), and Winkler considers to be the labium. Of course this plate greatly more than covers the opening of the vestibule, indeed that opening only corresponds to about the anterior half of the genital plate. This anterior portion of the genital plate is strengthened by a thin interior plate about the size and shape of the opening of the vestibule; and all this plate, except a small part at the hind margin, is thickly set

with processes similar to those described as arising from the interior of the vestibule. In fig. 18 the genital plate and vestibule are shown. They have been artificially turned rather away from each other on their left sides, the vestibule being somewhat twisted on the vagina. The drawing is intended to give an idea of how they would fit against one another if the vestibule were allowed to return to its natural position facing the genital plate.

The Respiratory System. Fig. 19.

So far as is known, in all *Gamasidæ* the breathing-organs are tracheæ; those from each side communicate with the exterior by a single stigma, which is usually placed between the second and third pairs of legs. This stigma does not open directly to the exterior, but into a long tubular peritreme in the thickness of the chitinous cuticle. This peritreme varies in form according to the species, and is often much undulated or tortuous; it most frequently opens to the exterior in front of the second pair of legs.

In the typical species of the genus *Uropoda*, and indeed in all species if Kramer's definition of the genus be adopted, the ventral plate has large shallow depressions in it within which the respective legs, when folded up, can be laid so as not to project below the body. These depressions are wide, and there is one for each leg of the second, third, and fourth pairs; they occupy almost the whole of the ventral surface of the body between the coxæ of the legs and the lateral margin. Being wide, the depressions come close together, and are only divided from each other by a ridge formed by the narrow strip of the ventral plate which is not depressed. These depressions—if that word can be allowed—are bendings-in of the ventral plate; so that although each depression is concave when seen from without, yet it is convex when the ventral plate is seen from the dorsal side, i. e. from within the body (of course in order to see it thus it must be dissected off, or else the dorsal plate and all the principal interior organs must be removed). When seen thus, what from the exterior appear ridges between the depressions assume the form of narrow trenches between convexities.

The stigma on each side of *Uropoda Krameri* is situated in a small plate-like thickening near the middle of the interior of the depression for the third leg. The peritreme (fig. 19) runs diagonally forward and outward until it reaches the trench (the ridge externally) which divides the depressions for the third and second legs; the peritreme runs along the side wall of this trench and turns round the end of it in a hook-like manner, terminating by a very fine ending in the depression for the second leg.

From the stigma a short, single tracheal trunk curves backward and upward (into the body); from the hinder end of the trunk the whole of the tracheæ which supply the body proceed. The tracheæ are long and excessively fine; they are *entirely unbranched*, being only simple tubes of extreme tenuity. This unbranched condition of

the tracheæ is similar to that of the same organs in the *Oribatidæ*, although the number of tracheæ is far larger, and each trachea much finer, in the *Uropoda* than in the *Oribatidæ*, but it is not always, nor, I think, usually, found in the *Gamasidæ*. I have not examined any large number of species belonging to this family, for the purpose of ascertaining this point, but certainly in *Dermanyssus*, the tracheæ, although not branching so frequently as they usually do in insects, do branch in a very clear and decided manner, sometimes dichotomously, sometimes into three branches, and almost always enlarge so as to form a slight swelling immediately before branching. Herr Winkler expressly notices the branching of the tracheæ in the genus *Gamasus*, which agrees with the cases where I have noticed the tracheal system in the same species. Herr Winkler does not mention the unbranched condition in *Uropoda*, probably he did not examine it for that purpose, or else his species differs from mine.

The tracheæ of *Uropoda Kramerii*, when they start from the end of the tracheal trunk, are in three bundles (*bt*), one of which is directed forward, one backward, and one across the body. Each bundle might easily be mistaken for a single trachea, but if a bundle be lifted up with a hair and allowed to fall on a minute drop of water then all the tracheæ will float and spread out, and the whole will present the appearance of a skein of floss-silk which has been separated by a puff of wind. Of course the bundles finally separate and supply the various parts of the body.

The walls of the tracheæ are extremely delicate. I have not been able to trace any spiral filament or thickening merely by looking at the tracheæ, but probably some kind of spiral structure might be demonstrated by other methods.

The Brain, or Œsophageal Ganglia. Fig. 20.

As is usual in the *Acarina*, the great ganglia in *Uropoda* are round the œsophagus. A very large supra-œsophageal ganglion (the so-called brain in the *Acarina*) lies immediately above the œsophagus near where it enters the ventriculus; this "brain" is compressed dorso-ventrally, and has a somewhat convex anterior margin which is considerably wider than the hind margin. From under the edge of the supra-œsophageal ganglion a very wide commissure runs perpendicularly downward on each side of the œsophagus, and joins a sub-œsophageal ganglion which is large, but considerably smaller than the supra-œsophageal ganglion. These ganglia and commissures are so substantial, and so closely joined together, that they form a solid collar round the œsophagus, the commissures, if commissures they be, not being distinctly differentiated, and with care the œsophagus may be pulled out from the centre of the nervous collar, which then shows a distinct and well-defined hole, or tunnel, through which the œsophagus passed.
