DESCRIPTION OF A NEW KIND OF APTEROUS EARWIG, APPARENTLY PARASITIC ON A BAT.

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(Plates XVI., XVII., XVIII.)

THE insect which forms the subject of the present paper was discovered by Messrs. Ed. Gerrard & Sons, of Camden Town, "in the sack formed by the membrane of the wings of *Cheiromeles torquatus*," the naked bat of the Sunda Islands. The bat has an exceedingly strong and nauseous smell, and is known from the Malay Peninsula, Sumatra, Java, and Borneo. It flies at dusk, and sleeps in daytime in hollow trees and in fissures of the soil and rocks. Both sexes of the bat have a large gular pouch, which is said to be used for storing the young during flight—Mr. Gerrard informs me that one of the bats in his possession had a young one in the pouch—and it is suggested that, in the case of twins being born, the father and mother take each charge of one of the offspring. Besides the excretions of the gular glands there may occur at times an accumulation of the excrements of the young bat sufficient for insects to feed and thrive upon. Messrs. Gerrard received a number of specimens of *Cheiromeles torquatus* from Sarawak, where they were obtained by Mr. Chas. Hose. In the pouch of one of these specimens the new insect was found, which we name

Arixenia esau gen. et spec. nov.

At first sight we were inclined to attribute to accident the occurrence of such a large insect in the nursing-pouch of the naked bat. But the study of *Arixenia* has convinced us that the insect, which is related to the earwigs, is parasitic. Indeed, it does not require a great stretch of imagination to understand how a kind of earwig arrived at living in the pouch of a creature sleeping in fissures of rock or soil. The reduction of the eye and the structure of the mandible and of the inner lobe of the maxilla seem to indicate that *Arixenia* lives in a dark place, and feeds principally on matter which has already been masticated or requires little mastication. The contents of the alimentary canal consist of a soft amorphous matter and numerous fragments of insects. We obtained from the anterior portion of the oesophagus, within the head, two comparatively large pieces of chitin, which proved to be the apex of the tibia and the first and the base of the second tarsal segment of, we think, some small fly. The fragments have the appearance of being fresh, and we believe we detect some remnants of muscles attached to them, which, if correct, would justify the conclusion that *Arixenia* feeds, perhaps incidentally, also on live or freshly killed insects.

Arixenia is interesting not only on account of the peculiar place where it was discovered, but also for the morphological and anatomical characteristics which it presents. We received four specimens, two of them being half as large again as the other two. They were in alcohol, and very well preserved as regards the chitinous parts. But the soft inner organs are so much macerated that we cannot give any histological details. Moreover, none of the specimens are quite full grown, so that the account of the anatomy is incomplete also for this reason.

Our description and figures, however, will be sufficient, we trust, for recognising the species, and it is to be hoped that, now we have drawn attention to *Arixenia*, the peculiar interest attached to all parasites will induce naturalists residing or travelling in the Malayan countries to collect all the stages of development of the insect.

Since in the earwigs generally the young and adult do not differ very much in structure, especially in the wingless forms, we may assume that also in this case the adult specimens will present essentially the same appearance as the individual here figured (Pl. XVI. fig. 1). This assumption, we think, is the more justified as our smaller specimens of *Arixenia* differ from the larger ones in a similar way as do young earwigs from adult ones—for instance in having a smaller number of segments in the antenna.

The large specimens measure 18 mm. from the upper lip to the apex of the pygidium, the small specimens 12 mm. Head, thorax, mouth-parts, antenna, and legs ochraceous; sterna of thorax and the coxae pale buff; abdomen blackish tawny. The whole insect covered with pale ochraceous hairs, which are longest near the edges of the segments. The thoracic nota bear each seven elongate spaces which are devoid of hairs (Pl. XVI. fig. 1). There are no wings.

Head.

The *head* is broader than long, being widest posteriorly. In general outline it agrees with the head of the earwigs, being obtusely heart-shaped. The upper-side slants slightly downwards from near the hindmargin to the upper lip. In front of the antennae there is a curved depression, which extends from side to side and separates the anterior portion of the capsule of the head, the clypeus, from the central part or frons (= epicranium). The suture situated in this transverse depression is but vestigial. Another suture is found between the eyes ; it is much less distinct than in the earwigs. The occiput (or protocranium), which lies behind this second suture, is divided by a minute central longitudinal suture, as is also the case in the earwigs. The hind portion of the occiput is incurved and centrally depressed, so that the sides are somewhat globose and project backwards.

The eye is smaller than in the earwigs, and contains only eighty odd facets. It is situated close behind the antenna, and is a little more dorsal than ventral, only a small portion of it being visible in a ventral view of the head (Pl. XVII. fig. 1). It is elliptical and but little raised above the surface of the capsule of the head. The somewhat loose arrangement of the facets and their small number indicate that a reduction has taken place, the eye being on the way towards becoming vestigial and lost.

The antenna is lateral, being inserted where the dorsal and lateral surfaces of the head meet. The membrane connecting it with the capsule of the head is rather large, and allows a full play backwards and sideways. The antenna cannot be held straight forward. There are thirteen segments in the antenna of the large specimens. They are nearly circular in a transverse section. The first segment is much longer and thicker than any other, and somewhat curved, as shown in the figure. The second, on the contrary, is very short, and serves as a kind of condylus, the remaining segments forming a flagellum which is freely movable in all directions. The third segment is a little more than one-third the length of the first, while the fourth as well as the fifth are less than half the length of the third, the sixth and seventh being but little longer than the fifth.

Segments 8 to 13 are distinctly slenderer than the preceding ones, and are nearly equal to each other in length. All the segments, with the exceptions of the first and second, bear two patches of sensory pits near the apex (Pl. XVII. fig. 5), one patch being placed on each side, and each pit bearing a very short bristle. The number of pits is less on the proximal segments than on the distal ones. The same sensory organ exists in *Hemimerus*.*

In our smaller specimens the antenna consists of but eight segments instead of thirteen. The third segment is much longer than in the thirteen-jointed antenna, being about as long as the first segment. Segments 4 to 8 are each about two-fifths the length of the third, the eighth being the shortest. A comparison of the antennae of the large and small specimens proves that the increase in the number of segments as the insect grows takes place in the region of the third to sixth segments, *Arixenia* agreeing therein with the earwigs. The structure of the segments is practically the same in the large and small specimens. I think we may expect the adult *Arixenia* to have at least fourteen segments in the antenna.

The mouth-parts present several characteristic points. The membrane connecting the clypens with the upper lip or labrum is rather large and, like most membranes connecting the sclerites with one another, whitish and smooth, bearing no hairs. The *labrum* itself (*lr*, Pl. XVII. fig. 10 and Pl. XVIII. fig. 1) resembles that of the earwigs. It is transverse, with the angles rounded off. The anterior edge is feebly incurved and very slightly bent downwards, much less so than in *Hemimerus*. The hind edge, seen from beneath in fig. 10 of Pl. XVII., is straight, and the lateral angles are produced backwards. Numerous longitudinal muscles are attached to the labrum, as indicated in fig. 1 of Pl. XVIII.

The mandible differs remarkably from the ordinary type of insect mandible. The right and left mandibles are practically alike. They are but little longer than broad, and appear nearly flat (Pl. XVII. figs. 3, 4). Both the upper and under surfaces are convex along the centre and depressed at the inner edge. The upper-side is more convex than the underside and bears a small patch of hairs at the outer margin, while the under surface has no hairs at all. The inner and outer margins of the mandible are rounded. As in the earwigs, the apex is armed with three teeth, which remind one of the claws of a mammal, their apical surface being convex and the proximal surface concave. The whole inner margin is densely clothed with bristles. This edge is quite narrow and is not at all suitable for mastication, as it is in *Hemimerus* and *Forficula*. The bristles placed near the apex of the mandible are thick, rigid, and somewhat curved in hook-shape, whereas those of the more proximal portion of the edge are like ordinary bristles, being longer and more flexible and becoming gradually thinner towards their tips. The bristles are not placed in a single row, but stand closely packed on the whole narrow surface of the edge of the mandible. It is clear from this peculiar armature, which closely resembles that of the inner lobe of the maxilla of *Arixenia*, *Forficula*, and other mandibulate insects, that the food of *Arixenia*, or at least the way of feeding, is different from that of the earwigs. The mandibles of *Hemimerus* and the earwigs have, as far as they are known, the ordinary triangular shape with the inner margin incurved, as widely found in the mandibulate insects. There may be earwigs which approach *Arixenia* in the structure of the mandibles. Unfortunately these organs cannot be well seen without being dissected out,

* Hansen, in *Tidskr. Ent.* xv. p. 67 (1894).

and for that reason we have not been able to compare them with the collection of earwigs in the British Museum.

The mandibles of *Arixenia* appear to me to be much more suitable for brushing food into the mouth than for cutting it up. The length of the bristles placed on the inner edge near the apical teeth speaks against the mandible being used for cutting up hard substances, with the exception perhaps of small pieces not so large as the three teeth together. The hook-like shape of the bristles also indicates that the mandible is largely used as a kind of brush.

The *maxilla*, which is represented in fig. 2 of Pl. XVII. from the underside, agrees on the whole with that of the earwigs and *Hemimerus*. As in the allied insects, it lies in a deep sinus, bounded laterally by the lateral portion of the caputal capsule, and mesally by the mentum. The lateral edge of this sinus or groove is much less sharply cariniform than in the earwigs. The proximal portion of the maxilla, in live specimens of earwigs, is capable of a strong forward movement, and can slide but little sideways. The latter movement is reserved for the distal parts of the maxillae, which open and shut like the mandibles. In consequence of this opening and shutting and the simultaneous forward movement of the maxilla the food is hauled into the mouth, which latter at that moment is widened on account of the underlip flapping downwards and its apical lobes moving sideways. The sutures on the proximal parts of the maxilla are very distinct in *Arixenia*, and we were surprised to find that the part which corresponds to the cardo of other insects consists of two sclerites (Pl. XVII. fig. 2, a 1, a 2). The cardo is generally stated to be one single sclerite in all insects. A comparison of *Forficula* and *Hemimerus*, however, convinced us that also in these insects there is a suture extending, as in *Arixenia*, from about the centre of the outer margin inward and forward. We can hardly assume that this suture is of secondary origin, but believe the non-divided cardo of insects to be the result of the fusion of two sclerites in consequence of stronger chitinisation. The cardo acting as a lever to the maxilla requires to be rigid, especially in insects in which the maxillae are pushed far forward when feeding, or have to execute abrupt movements. In the earwigs the mouth-parts are relatively soft, and it would therefore be intelligible that here a suture was preserved which had disappeared in more strongly chitinised insects.

The central portion of the maxilla, the so-called stipes, consists of three sclerites (Pl. XVII. fig. 2, b 1, b 2, b 3). The inner and the median sclerites (b 1 and b 2) are hollowed out on the upperside for the reception of the muscles. The two apical lobes c 1 (= lacinia) and c 2 (= galea) resemble those of the earwigs. The inner lobe is armed at the apex with two teeth which stand one beside the other, the longer one being dorsal and the smaller one ventral. Both teeth are claw-like, their apical surface being convex and the proximal surface concave. The inner margin of the lacinia gradually widens proximally, so that the molar surface thus formed represents a narrow triangle, the point of which lies at the apex of the lacinia. The two sides of this surface bear each a single row of stiff bristles. This row becomes more irregular proximally, where additional bristles appear on the lateral surfaces near the edge, and some also in between the two rows. The stiff bristles are slightly bent twice, reminding one of the letter S. The lacinia of *Hemimerus* has four apical teeth instead of two as in *Arixenia* and *Forficula*, and the edges of the inner margin are very thin and cariniform, the molar surface being deeply hollowed out.

The number of bristles, moreover, is much smaller in *Hemimerus* than in *Arixenia*. The common earwig, too, has but a small number of bristles at the molar margin of the lacinia, and the latter is much slenderer than in *Arixenia*, but bears two apical teeth as in that insect.

The outer lobe of the maxilla, the galea, is almost identical in *Forficula*, *Hemimerus*, and *Arixenia*. It is gently curved inwards, and its transverse section is circular. The apex is pale, without bristles and but slightly chitinised, serving doubtless a sensory purpose.

The maxillary palp consists of five segments, as in the allied insects. The two proximal segments are very short, and the third is a little longer and stouter than the fourth. The fifth bears at the apex short and stumpy bristles which differ from the ordinary bristles with which the palp is clothed. There is, moreover, a minute accessory segment at the tip of the fifth, as is the case in the labial palp also. This accessory segment, which gives the palpi their very characteristic appearance, is found in the earwigs as well as *Hemimerus*, whereas the Locusts, Blattids, Mantids, etc., have quite different palpi.

The gap in which the maxilla is inserted nearly extends to the hind edge of the head, being separated from the occipital foramen only by the narrow submentum, which is joined rigidly at each side to the lateral part of the caputal capsule (Pl. XVII. fig. 1). The submentum (*sm*, Pl. XVII. fig. 7) is the posterior sclerite of the second pair of maxillae or the labium. The suture which separates it from the main part of the labium is quite distinct. The second sclerite is the mentum. It is broader than long and strongly rounded at the sides, and its anterior margin is incurved at each side, so that the angles, which are strongly rounded, project a little. The surface is nearly flat, being slightly impressed from the sinus of the anterior margin backwards and somewhat convex at the sides. Neither the mentum nor the submentum shows a distinct trace of a mesal suture. The two apical segments of the labium are divided in the middle line, and therefore can not only execute a downward movement, but can also move horizontally, especially the two apical lobes, which open and shut like the maxillae. The third segment, or the palporium (= palpiger), which bears the palpi, is separated by sutures from the mentum as well as the two apical lobes, which form the ligula (*li*, Pl. XVII. fig. 7). The apex of the ligula is white and without bristles, and recalls the pale apex of the galea of the maxilla. The inner edges of the two lobes of the ligula bear some rigid bristles. The labial palp (*lp*, Pl. XVII. fig. 7) is composed of three segments as in the allied insects, bearing like the maxillary palp a minute apical accessory segment.

On the upperside of the apical lobes of the labium there lies the hypopharynx (or endolabium). It consists of a broader central flap and two narrow lateral flaps ; the latter are strongly chitinised at their outer edges and partly cover the central flap in a dorsal view (Pl. XVII. fig. 9). The chitinised edges of the lateral flaps extend backwards for a short distance and send out a side-branch towards the maxillae. The hypopharynx is remarkably similar to that of *Hemimerus*, whereas it differs somewhat in shape from that of *Forficula*.

Thorax.

The prothorax is the longest of the three thoracic rings. The pronotum is broader than it is long, and its lateral and posterior edges almost form an evenly curved semicircle, reminding one of certain Forficulids. The disc is feebly convex

anteriorly, the upper surface being somewhat depressed at the sides and behind. The anterior margin is sinuate at each side, and the central portion depressed so as to fit into the concave occipital part of the head. There is no sharp edge either on the occiput or at the base of the pronotum, nor are head and pronotum closely applied to one another. In *Hemimerus*, on the other hand, the hind edge of the head projects backwards, overlapping to a slight extent the pronotum. This overlapping, which is not often observed among insects, is best known of some Hemiptera parasitic on bats and of the fleas. In the beaver parasite, *Platypsyllus castoris*, the head and pronotum fit well together, and there is, moreover, a comb of spines extending from the edge of the head on to the thorax, bridging over the gap which might be formed when the head is bent down. The overlapping we find in these parasites, which live in the fur of mammals, renders the surface of the head and pronotum more uniform and hence more suitable for gliding through the fur, and is certainly a secondary development which has taken place independently in these not nearly related insects.

In certain lights there appears a thin pale line along the centre of the pro- and mesonotum, which is also found in *Hemimerus*.

The mesonotum is similarly rounded as the pronotum, but still more strongly at the sides. The metanotum, however, though its sides are also strongly rounded, resembles in outline more the abdominal segments, inasmuch as its hindmargin is slightly incurved instead of rounded. The metanotum, moreover, is a little broader than the pro- and mesonotum. The three nota project much less sideways than in *Hemimerus*, and do not even quite conceal in a dorsal view the pleural sclerites and trochanters (Pl. XVI. fig. 1).

As the head is longer above than below, the membrane connecting it with the thorax is more extended beneath than above (Pl. XVII. figs. 1 and 8). Ventrally this membrane expands between the submentum (*sm*) and a small sclerite which lies in front of the sternum of the prothorax and undoubtedly belongs to the thorax and not to the head. Hansen considered this transverse sclerite in *Hemimerus* to be the sternum of the labium, *i.e.* a part of the head, and drew it as lying close to the submentum and well separated from the prosternum. Our specimens of *Hemimerus*, however, prove that the sclerite in question has the same position in that insect as in *Forficula* and *Arixenia*. Verhoeff,* with customary acumen, recognised it from Hansen's figures as being part of the thorax, and identified it as the sternal plate of the "microsternum." † The sclerite, I think, is homologous with what I termed "mesoclidium" in the mesosternite of insects, the sclerites extending from this central plate upwards corresponding to the peri- and parasterna.‡ The mesoclidium is not developed in the mesosternite of *Arixenia*, but is quite distinct in the mesosternite of some other Orthoptera—for instance, *Acridium*.

The prosternum is nearly as long as it is broad, and overlaps the mesosternum, which latter projects over the metasternum. The sternal parts of the thorax are much less densely hairy than the nota (the hairs are not indicated in our figs. 1 and 8 of Pl. XVII.). The meso- and metasterna are much broader than long. The metasternum is the widest of the sterna, and bears on each side a small groove, from which extends inward a narrow, rod-like, pointed endoskeleton. The coxal cavities are large and lateral, and are situated at the hind edge of the

* In *Zool. Anzeig.* xxv. p. 204 (1902).

† For the morphology of the thorax of insects, see Börner, in *Zool. Anzeig.* p. 290 (1903).

‡ In *Verh. V. Intern. Zool. Congress, Berlin*, p. 820 (1902).

sternites, being porteriorly closed only by a narrow strip of membrane, which, in a lateral view (Pl. XVII. fig. 8), appears widest in the prothorax. The pleural sclerites are but feebly chitinised. Their position is best seen in a lateral view (Pl. XVII. fig. 8). The so-called meral suture, which separates the anterior or sternal part of the sternite from the posterior or meral part, is plainly visible in all three sternites. The episternum (*epst*) is larger than the epimerum (*epm*). The latter projects backwards over the membranous posterior marginal part of the sternite. In the meso- and metathorax the epimerum is narrowed posteriorly, forming a conical process, which is visible also in a dorsal view (Pl. XVI. fig. 1). Between the episternum, sternum, and coxa there lies a triangular sclerite (*ti*), which was regarded by Hansen in *Hemimerus* with some doubt as the trochantine. We believe this identification to be correct. In front of the trochantine there is another small sclerite in the pro- and mesosternite which, we think, is the lateral sclerite, the peristernum (*per*), of Verhoeff's microthorax. It is somewhat globose and wrinkled in the prothorax of *Arixènia*. Above this plate there is in the prothorax a narrow sclerite extending upwards in front of the pronotum. This is the parasternum.*

The legs are long and of a characteristic structure. At rest they appear to be held in the position in which they are represented in fig. 1 of Pl. XVI., lying in our four specimens almost in a plane with the body, the tibiae being directed forwards, scorpion-fashion. Many earwigs hold the legs in a similar position. The mid- and hindlegs of *Arixenia*, when moved upwards and the tibiae backwards, remain in this position, so that it is probable that *Arixenia* walks like an ordinary earwig with the mid- and hindlegs directed back- and sidewards. Except for a slight difference in length the three pairs are identical. The coxae (*co*) are larger than in *Hemimerus* and *Forficula*, and are ventrally much longer than dorsally. They bear ventrally before the apical edge a transverse, pale, membranaceous groove. The trochanter (*tr*) is considerably narrower behind than in front. The femora are slightly compressed. They are hollowed out beneath at the apex for a short distance for the reception of the tibiae, which can be laid close along the femora. The tibiae are as long as the femora, but much thinner and nearly cylindrical, slightly narrowing towards the base, which is gently curved. The apex of the tibia is dorsally cut off obliquely and somewhat impressed so as to allow the tarsus to be laid back on the tibia. The tarsus is characteristic. It most nearly resembles of all earwigs that of *Tagalina* and *Apachyus*. The first segment is quite short and curved upwards, its under-surface (*a*, Pl. XVII. fig. 6) being clothed with ordinary small bristles, which are absent from two elongate areas. The second segment (*b*) is still smaller than the first. It is shorter dorsally than ventrally, as is also the case in the first segment, and the apical surface therefore is slanting, the second and third segments having the appearance of being inserted on the dorsal side of the preceding segment, as in the earwigs. The tips of the first and second segments are pale, soft, and without bristles. The third segment (*c*) is quite long, subcylindrical, and slightly curved. Its ventral surface is less hairy than that of the first and second segments. The apical edge is marginate, *i.e.* there runs a groove along the edge, except on the ventral side, so that the edge itself is slightly elevate. Ventrally the edge projects as a small rounded lobe. The claws (*un*) are slender, and there is the vestige of a pad between them.

* Jordan, *l.c.*

Abdomen.

The imbrication of the abdominal segments is exactly the same as in the earwigs. The intersegmental membranes, which are quite concealed from view in non-dissected specimens, bear laterally numerous short hairs, the hairy area being especially large on the underside. The first tergite forms part of the thorax and resembles the thoracic tergites in being rounded at the sides. There are eleven tergites altogether in the small as well as the large specimens, counting the pygidium (or telson) as a separate segment (Pl. XVI. figs. 2, 3; Pl. XVII. fig. 8). The ninth and tenth tergites are the shortest. The tenth has a hump in the centre clothed with longer bristles. The pygidium is rounded, its upperside being convex.

The first abdominal segment has no sternite. The eighth sternite (= sternite of the eighth segment) is the largest, and moreover differs from the others in being evenly rounded posteriorly from side to side (Pl. XVI. fig. 2). The ninth sternite is smaller than all the preceding ones. It is narrowed at the apex, which is truncate-emarginate, the sides being rounded proximally and incurved distally, While in *Hemimerus* and *Forficula* the tenth sternite is represented by two chitinised plates placed at the base of the cerci (*xtg*, Pl. XVIII. fig. 7), respectively callipers, in *Arixenia* the two plates are quite membranaceous.

The callipers of the earwigs are represented in *Arixenia* by a pair of cerci, which are hairy, like the body, and almost circular in a transverse section. They are non-segmented, and therefore agree with the cerci of *Hemimerus*, and not with the segmented cerci of certain immature earwigs : *Diplotaxys*, *Karschiella*, etc. The cerci are longer, slenderer, and less curved in our small specimens of *Arixenia* than in the larger specimens. In the individual figured the left cercus is a little longer than the right one. This, we think, is accidental. Unfortunately the left cercus is broken in our second large specimen. In the smaller specimens the right cercus is as long as the left one.

We may presume that in adult *Arixenia* similar sexual differences will be found as in the earwigs and *Hemimerus*. It was the close agreement in the abdomina of the small and large *Arixenia* which first aroused our suspicion that all our specimens might be immature.

Respiratory System.

The position of the spiracles is exactly the same as in *Hemimerus* and the earwigs. The stigma situated on the prothorax (*sti*, Pl. XVII. fig. 8) is much larger than the others. On the meso- and metathorax the spiracles are placed behind the epimerum, being concealed underneath the lobe of the latter. The seven abdominal stigmata are situated in front of the upper anterior angle of the sternites of segments 2 to 8. The tracheae agree on the whole with those of the common earwig.

Nervous System.

Here, again, *Arixenia* does not present any essential characters which would remove it from among the Dermaptera. The main chain consists of eleven ganglia, namely, the supra- and infra-oesophageal ganglia, three thoracic and six abdominal ones. The infra-oesophageal ganglion escaped Dufour's notice in the earwigs,*

* *Ann. Sci. Nat.* xiii. p. 361 (1828).

which was doubtless due to the strong development of a very remarkable chitinous plate, the tentorium of Kleuker,* which conceals the ganglion from view. The tentorium of *Forficula* is a horizontal plate (brown like the exoskeleton) which lies beneath the oesophagus, and extends from near the occipital foramen almost to the centre of the head. The plate is slightly concave on the upperside, and nearly evenly incurved anteriorly. The anterior and posterior angles are each produced into a slender process. The two anterior processes are curved and join the capsule of the head in front of the antennae, while the posterior processes end at the hind wall of the head, all four being so firmly attached to the head that it requires some force to break them off. Between these two pairs of processes there is another process on each side, branching off from the anterior process and extending obliquely upwards, being but loosely connected with the upper wall of the head in the neighbourhood of the eye. The tentorium of *Arixenia* (*te*, Pl. XVII. fig. 10, ventral side; Pl. XVIII. fig. 1, dorsal side) is similar to that of *Forficula*, except that its anterior half is much broader. The second process being subvertical is drawn shortened in our figures. *Hemimerus* also has a tentorium of the same type (*te*, Pl. XVIII. fig. 2). This endoskeleton divides the capsule of the head into an upper chamber containing the oesophagus and the brain serving the higher faculties, and a smaller lower chamber which contains the sub-oesophageal ganglion working the mouth-parts. The commissures connecting the infra- with the supra-oesophageal ganglion are in front of the tentorium.

Alimentary Canal.

Considering that the nervous and respiratory systems and, in the main, also the external anatomy agree so well with what is observed in *Forficula*, we were rather surprised to find that the gut deviates markedly from the type known in the earwigs. In fact, the alimentary canal of *Hemimerus* resembles that of *Forficula* much more than does the gut of *Arixenia*. The digestive system of insects is often remarkably different in forms not very distantly related. A difference in the kind of food on which the species of insect subsists appears to be generally accompanied by some distinct difference in the shape or structure of the digestive organs, and this may account for the peculiarities observed in *Arixenia*.

The oesophagus of *Arixenia* (*oe*, Pl. XVIII. fig. 1) consists of two divisions. The anterior division, extending from the mouth to the occipital foramen, is very muscular in itself, and numerous muscles are attached to its lateral and upper surfaces. The upper wall unites with the underside of the upper lip, the muscles of the latter extending backwards above the oesophagus. On opening the oesophagus from above, and at the same time pressing the under lip from beneath, the lower wall of the oesophagus can be seen ending in the hypopharynx (or endolabium), which is described above (p. 313). Where the oesophagus leaves the head it is constricted, and from this point backwards its wall is thin and very expansible. This wide portion, which extends into the abdomen, where it ends abruptly, is the "crop." Upon the oesophagus follows the short proventriculus or gizzard (*pr*), which has internally six folds lined with a chitinous membrane armed with minute teeth, which stand rather far apart. The folds project into the stomach as conical processes, which are about three times as long as they are broad at their bases. The teeth on these processes are minute, transverse, and slightly curved ridges, the teeth placed on the apical portions of the processes being produced into

* *Dissert. Göttingen* (1883).

a point (Pl. XVI. fig. 4). The principal function of the proventricle appears to me to serve as a kind of sieve by which the food, which may have become lumped together in the crop, is divided up into smaller particles. The proventricle cannot cut up any hard substances. In one of the specimens of *Arixenia* a piece of chitin covered with long hairs was lying in the hind part of the proventricle. It was unbroken, although its diameter nearly equalled the transverse diameter of the proventriculus.

The stomach (*sto*, Pl. XVIII. fig. 1) is not quite so wide as the crop. It is asymmetrical at the base, bulging out towards the right side, forming a kind of sack. The stomach of *Forficula* was represented by Dufour* to be quite straight, without any convolutions, and this statement is still being copied in text-books. In all the specimens of *Forficula auricularia*, however, the apex of the stomach forms one convolution together with the anterior portion of the small intestine, as is the case also in *Hemimerus* (Pl. XVIII. fig. 2). As the crop of the oesophagus of *Arixenia* takes up so much room—its enormous capacity seems to indicate that *Arixenia* takes a large quantity of food at a time and stores it, so to speak, in the capacious oesophagus—the stomach is completely coiled up so as to acquire but little space. It forms nearly two convolutions, and a third is formed by the basal portion of the small intestine. The coil is arranged like the convolutions of a shell, the anterior half of the stomach forming the largest convolution, which is ventral and gradually ascends dorsad. The centre of the coil is the most dorsal point of the spiral. At this point the small intestine descends vertically, and then curves backward, as indicated by the dotted lines in our figure. The small intestine ends in a large rectum, whose six internal projections are long and narrow.

The Malpighian tubules (*Mp*, Pl. XVIII. fig. 1) are very narrow. They form a densely coiled up mass which lies on the top of the stomach and a similar mass placed beneath the stomach. When the stomach is uncoiled the tubules are found to be arranged in four bundles of about twenty tubules altogether. The tubules of each bunch open in a very short common duct. The largest bunch is inserted dorsally on the posterior (or left) side of the apex of the stomach, and consists of ten tubules. A second bundle of five tubules is found subventrally on the right side. There are further three tubules placed on a short tube subdorsally on the right side, and two similarly connected tubules subventrally on the left side. The numbers vary very slightly in our specimens. The places where the dorsal bundles are inserted are marked black in our figure. Many of the tubules branch off in twos and threes from a short common tube, as in the earwigs.†

I have not found any salivary glands.

Systematic Position.

The agreement with the earwigs is too close to admit any doubt that *Arixenia* is a kind of wingless Dermapteron. If the characters, however, which distinguish *Hemimerus* from the true earwigs are considered of sufficient weight for placing *Hemimerus* in a separate suborder of Dermaptera, we must erect a third suborder for the reception of *Arixenia*. But I abstain from giving a name to the suborder, as there is still some uncertainty what name the whole order of earwigs should bear. I have referred to them as Dermaptera, which name is the most commonly

* *l.c.*

† I find 16 tubes in *Forficula auricularia*, arranged in 4 bundles (5, 3, 4, 4). The statements by Dufour and Schindler that there are about 30 or 40 tubules are certainly erroneous.

in use ; but some authors object to the name (originally employed for almost all the Orthoptera), apparently with good reason.

Arixenia is to a certain extent a connecting-link between the earwigs and *Hemimerus*, not in a phylogenetic sense, but anatomically and morphologically. The eyes, which are quite absent in *Hemimerus*, are much smaller in *Arixenia* than in the earwigs. The cerci, moreover, agree with those of *Hemimerus* in being hairy, non-segmented, and not modified into callipers, and at the same time resemble in our larger specimens of *Arixenia* a little the earwig-callipers, inasmuch as the cerci are somewhat curved towards each other. The sensory pits of the antenna are found both in *Hemimerus* and *Arixenia*, and the hypopharynx is almost the same in the two insects. On the other hand, the inner lobe of the maxilla bears in *Arixenia* two apical teeth as in *Forficula*, not four as in *Hemimerus*. The head is, as in the earwigs, not closely applied to the pronotum. The legs are long and slender, and have a tarsus which recalls *Tagalina* and *Apachyus* among the earwigs by the proportional length of its segments. The mandible of *Arixenia*, however, has in its setose inner edge a character which separates the insect very markedly from the earwigs (as far as their mandibles are known) and *Hemimerus* ; and the alimentary canal, which in *Hemimerus* is almost the same as in *Forficula auricularia*, is very different in *Arixenia*.

The similarities between *Hemimerus* and *Arixenia* do not indicate any close relationship, we think. The discussion of that question, however, is better left until the adult *Arixenia* and the reproductive system of that insect are known. If we may speculate on the derivation of *Arixenia*, we should say that the insect is a development from some form of earwig like *Tagalina*, the approximate agreement in the relative lengths of the tarsal segments at least suggesting a connection between the genera. The loss of wings in *Arixenia*, the reduction of the eyes, and the peculiar structure of the mandibles are explained by the parasitic life. The hairy cerci, which are found again only in *Hemimerus*, are ancestral organs, and at first sight appear to speak against *Arixenia* being a derivation from earwigs with callipers. However, as cerci, though segmented ones, are known to exist in the larvae of several genera of earwigs (*Diplatys*, *Karschiella*, *Bormansia*), it is quite sound to assume that *Arixenia* developed from a species of earwig which had segmented cerci in its larval stages and callipers in the adult stage, and that, in consequence of the assumption of parasitic habits, the ancestral *Arixenia* retained the larval cerci through all stages in a shape intermediate between the long segmented cerci and the smooth callipers.

I append a short diagnosis of the family and genus which we have to create for the new species :

Arixeniidae fam. nov.

Facies as in apterous earwigs. Head cordiform, not closely applied to the prothorax. Eye present, but reduced (eighty odd facets). Mandible toothed at apex, its inner edge rounded and densely clothed with rigid bristles. Inner lobe of maxilla with two apical teeth. Hypopharynx trilobate. Antennal segments with two patches of sensory pits from the third onwards. First and second tarsal segments short, third long. Cerci non-segmented, hairy. Crop of oesophagus large and long; gut with three convolutions. Malpighian tubules arranged in two small and two large bunches. Eleven ganglia in the main chain. Ten spiracles. (Reproductive system not known.)

Arixenia gen. nov.

Wingless, hairy. Head broader than long, the clypeus longer than the frons. Upperlip four times as broad as long, its anterior edge very slightly bent downwards in the centre. The space between the two rows of bristles at the molar edge of the inner lobe of the maxilla very narrow. Mentum broader than long, strongly rounded at the sides. Antenna three-fourths the length of the body, segment 1 extending to middle of pronotum, 2 very short. Pronotum nearly semicircular, much broader than long, as long as the meso- and metanotum together. Mesonotum strongly rounded at the sides and behind. Legs long, all of nearly equal length and the same in structure; femora about as long as the tibiae, equalling the thorax in length; first tarsal segment but little longer than the second, both without a very dense covering of hairs on the underside, third segment almost three times the length of the first and second together.

Type: *Arixenia esau* spec. nov.

The nymotypical specimen of the species which served as original for fig. 1 of Pl. XVI. has been presented to the British Museum.

EXPLANATION OF PLATES XVI., XVII., & XVIII.

Plate XVI.

Fig. 1. *Arixenia esau*, enlarged × 9.

„ 2. Seventh to eleventh abdominal segments of the same, ventral view.
A = anus.
ci = cerci.

„ 3. Sixth to eleventh abdominal segments, side-view.
A = anus.

„ 4. Intima of proventriculus of *Arixenia*.

„ 5. The same of *Hemimerus*.

Plate XVII.

Fig. 1. Head, thorax, and proximal segments of abdomen of *Arixenia*.
mi = microsternum.
epst = episternum.
ti = trochantine.
tr = trochanter.
co = coxa.

„ 2. Left maxilla of *Arixenia*, ventral view.
a 1, *a* 2 = the two sclerites of the cardo.
b 1, *b* 2, *b* 3 = the three parts of the stipes; *b* 3 = palpiger.
c 1 = lacinia (inner lobe of the maxilla).
c 2 = galea (outer lobe of the maxilla).

„ 3. Right mandible of *Arixenia*, dorsal view.

„ 4. Left mandible, ventral view.

„ 5 Eighth segment of the antenna, showing the patch of sensory pits present on each side of segments 3 to 13.

„ 6. Hindtarsus, ventral view.
a, *b*, *c* = first, second, and third segments.
un = claw.
tb = tibia.

Fig. 7. Labium of *Arixenia*.
sm = submentum.
m = mentum.
pg = palpiger.
lp = labial palp.
li = ligula.

„ 8. Head, thorax, and segments 1 to 3 of abdomen of *Arixenia*, lateral view.
ant = antenna.
o = eye.
mi = microsternum.
st = sternum.
per = peristernum.
epst = episternum.
epm = epimerum.
ti = trochantine.
sti = stigma.
at 1, *at* 2, *at* 3 = first, second, and third tergites of abdomen.
as 2, *as* 3 = sternites of first and second abdominal segments.

„ 9. Hypopharynx of *Arixenia*, dorsal view.

„ 10. Head of *Arixenia*, the mandibles, maxillae, and labium, as well as a part of the wall of the head-capsule removed, ventral view.
lr = labrum.
hp = hypopharynx.
te = tentorium.
oe = oesophagus (lying dorsally of the tentorium, in our figure therefore beneath the tentorium).
cy = condylus for the mandible.

Plate XVIII.

„ 1. Alimentary canal of *Arixenia*, dorsal view.
lr = labrum.
te = tentorium, lying beneath the oesophagus.
o = facetted eye.
oe = oesophagus.
pr = proventriculus.
sto = stomach, with two bundles of Malpighian tubules on the dorsal side of the inner coil and two bundles on the ventral side.
Mp = Malpighian tubules.
in = small intestine.
r = rectum.
sa = sack-like enlargement of base of stomach.

„ 2. Alimentary canal and ovaries of *Hemimerus*, dorsal view.
te = tentorium.
oe = oesophagus.
pr = proventriculus.
sto = stomach, with the Malpighian tubes.
in = small intestine.
r = rectum.
ov = ovaries.
ovd = oviduct.

Fig. 3. Posterior part of head of *Hemimerus*, dorsal view.
nch = nuchal plate, forming the dorsal wall of the foramen occipitale.

„ 4. External portion of the ductus ejaculatorius of *Hemimerus* ♂, ventral view.
tm = bundle of transverse muscles.
va = chitinous armature (valvae).
pe = penis, with two orifices.

„ 5. Reproductive system of ♂ of *Hemimerus*, dorsal view (only the right testicle drawn).
ts = testicle.
vd = vas deferens.
vs = vesicula seminalis.
re = reservoir.
dei = ductus ejaculatorius.
lev = chitinous lever for the chitinous genital armature.
tm = bundle of transverse muscles.
lm = bundle of longitudinal muscles.
va = chitinous armature of the penis (valvae).
ct = dorsal plate of penis.
pe = penis.

„ 6. Last abdominal segments of ♀ of *Hemimerus*, ventral view.
ci = cerci.
VII. *tg* and VII. *st* = seventh segment of abdomen.

„ 7. The same, with the seventh sternite removed.

VIII. *st* = eighth sternite.	VIII. *tg* = eighth tergite.
IX. *st* = ninth „	IX. *tg* = ninth „
X. *st* = tenth „	X. *tg* = tenth „
	XI. *tg* = eleventh „ (pygidium).

ci = cerci.

„ 8. Reproductive system of ♀ of *Hemimerus*, ventral view (only the right ovary drawn).
Eight tubes, each containing one embryo.
h = head of embryo.
nch = nutriment chamber.
ovd = oviduct.

„ 9. Head and anterior part of pronotum of embryo of *Hemimerus*, dorsal view.
h = head.
prt = pronotum.
nch = nuchal organ, corresponding to *nch* of Figs. 3, 8, and 10.

„ 10. The same from the side.
The labium is not visible in a side-view.
mx = maxilla.
md = mandible.
ant = antenna.
h = head.
nch = nuchal organ.
prt = pronotum.