

[From the PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON,
1915.]

[Published June 1915.]

On Two New Species of *Polyplax* (Anoplura) from
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(Natural History) †.

(Text-figures 1-16.)

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Introduction.

The following descriptive paper on two species of *Polyplax* is based on a large supply of spirit material collected on *Acomys cahirinus* Geoff. (Family Muridæ), at Assiût, in Egypt, and forwarded by the Department of Public Health in Egypt to the Lister Institute of Preventive Medicine, by whom they were subsequently presented to the British Museum through Mr. A. W. Bacot and Dr. G. F. Petrie. Both these species, which are new, were fortunately collected in large numbers in all stages of development, and it has been possible to present an account of the larvæ and also of several features of interest in the internal anatomy of the imagines; unfortunately, the specimens were so badly preserved as to make a study of the soft parts out of the question.

It is to be hoped that in future collectors will bear in mind the extreme value to systematists of a long series of specimens of the same species, particularly in the case of ectoparasites like the Anoplura and Mallophaga, where so little is yet known of the morphology, metamorphosis, and variation.

Polyplax oxyrrhynchus was the more numerous species, there being 918 adults besides numerous immature forms, as compared with only 360 *P. brachyrrhynchus*, of which 75 were immature. Both these species, which are quite distinct, were collected on the same host.

Associated in the tubes with these, and, according to the label, collected on the same host, were several fleas, one or two Psocids, many mites, and a Muscid fly.

The Hon. N. C. Rothschild has kindly identified the flea for me as *Xenopsylla cheopis* Roths., and my colleague, Mr. A. S. Hirst, refers the mite to *Dermanyssus aegypticus* Hirst.

The fly and the Psocids are probably only accidental inclusions.

* Communicated by the Secretary.

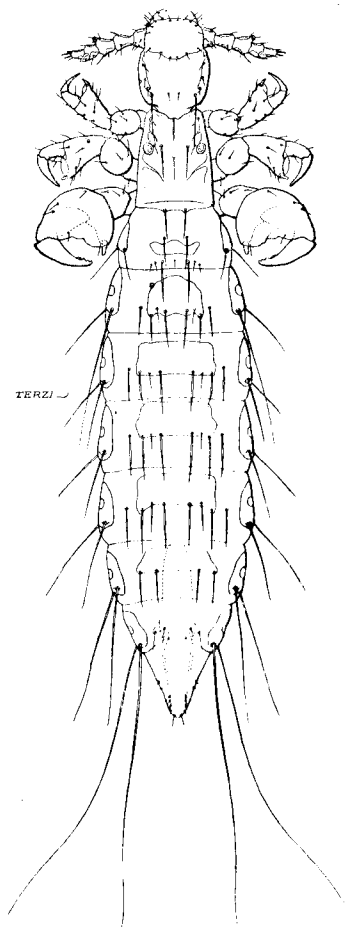
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POLYPLAX BRACHYRRHYNCHUS, sp. n. (Text-figs. 1-3.)

Proportion of the sexes. ♂♂ 57, ♀♀ 228, 75 immature.
Percentage of males = 20.

External Form. MALE. (Text-fig. 1.)—*Head*: The preantennal area is quite short, broad, a little rounded. Postantennal area parallel-sided, a little broader than the preantennal area and

Text-figure 1.

*Polyplax brachyrrhynchus.* Male. × 69.

broader also than the thorax. A small bay behind the antenna. Before entering the thorax, temples show a pronounced posterolateral angle. *Antennae* stout and relatively long. Second

segment longest, third with distal preaxial angle produced a little and carrying a sensorium. Another larger sensorium between segments 4 and 5. The *mouth* opens on the ventral surface.

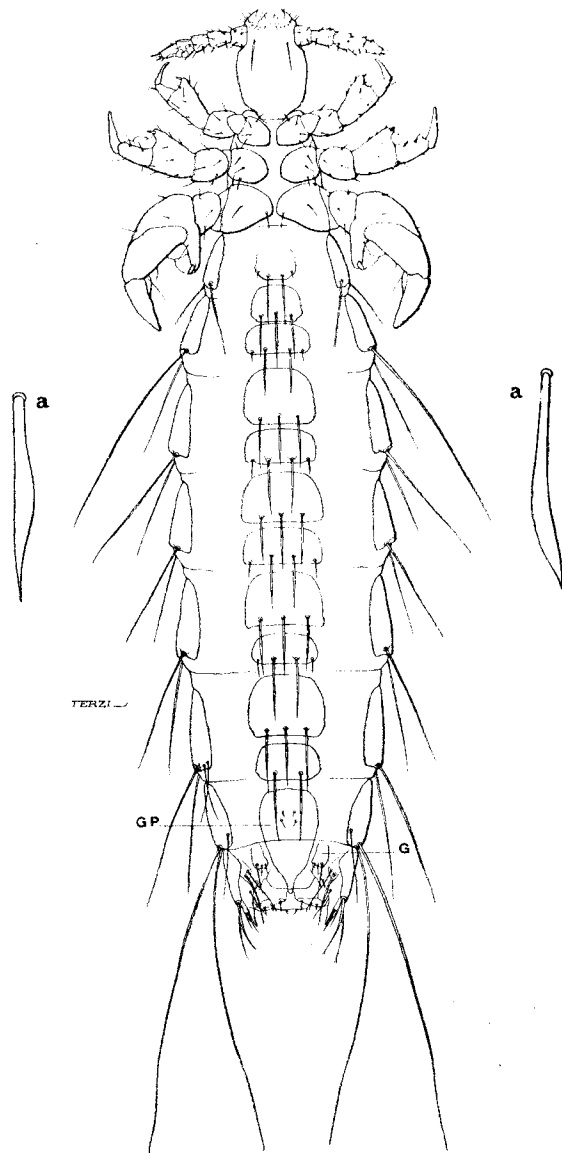
Thorax of an unusual shape. Narrower than the head and very elongate. Lateral margins almost parallel-sided. Mesothoracic spiracles on the extreme margin. *Legs*: First pair very small. Third pair relatively immense.

Abdomen: Last segment ends in a cone. Lateral margins parallel-sided. Pleurites are elongate plates with the spiracle in the centre, lower margin straight, lateral margins indefinite, converging anteriorly. Each segment with a single broad tergite and sternite. Genital plate is long and covers the three terminal segments, which are, therefore, without separate sternites.

External Form. FEMALE. (Text-fig. 2.)—*Antennae* with third segment normal. *Abdomen*: There are two tergites and two sternites on each of segments 4 to 7. On segment 2 only a single tergite and sternite each. On segment 3 there are two sternites and one tergite. On segments 8 and 9 only a single tergite. The genital plate on sternum of segment 8 is illustrated in text-fig. 2, which also shows the two small plates on each side of the plate—the representatives of the gonopods. End of the abdomen broad, truncate.

Chaetotaxy. MALE.—Head: On the dorsal surface, preantennal area, a transverse row of four or five minute hairs. On the anterior margin four larger hairs, widely spaced. Behind the antennae a transverse row of six minute hairs, the two middle ones the smallest. A single stout, elongate bristle at each posterior lateral angle of the head. In front of this, inside the lateral margin, a minute hair, and in front of this again, and well spaced, three more minute hairs, one behind the other. On the ventral surface just in front of the antennae there is a transverse row of about a dozen small hairs in a semicircle. Behind this, near the base of each antenna, a single strong bristle. *Thorax*: A large hair on the inside of each mesothoracic spiracle and a small one just in front. Along posterior margin of metanotum two hairs. *Abdomen*: Each pleurite with two hairs on lower margin. These are both small on segments 2, 4, 5, and 6. One of the two (the dorsal one) is longer than the other in segment 3, while on segments 7 and 8 they are both very long. On tergite 1 there are two flattened spines, spear-shaped, with sharp tips. On tergite 2 there are two more spines of the same character, and near the base of each of these two minute hairs. On each of tergites 3 to 6 is a row of flattened spines and hairs mixed and arranged along an irregular transverse line (see text-fig. 1). On tergite 7 are only four spines, of which the outer one on each side is broadest and most lanceolate. On tergite 8 are four minute hairs, the two inside ones being the smallest. At the extreme conical tip of the terminal segment two small hairs in large alveoli. On all sternites except no. 3, which has three, and the last, which is bare, are two lanceolate spines.

Text-figure 2.

*Polyplax brachyrrhynchus*. Female. Ventral surface. $\times 67.4$.

GP. Genital plate. G. Gonopod. a. Two spines from a sternite, enlarged.

[4]

Chatotaxy. FEMALE.—*Abdomen*: Pleurites each with two hairs of much about the same length in each segment. The outline of the tergites at the base of the abdomen is ill defined, and it is therefore difficult to be certain of the exact segmental distribution of the chatotaxy. It is easier and safer to say that at the base of the abdomen, upper surface, up to segment 2 inclusive, there are two parallel longitudinal rows of well-spaced spines, three in each row. The anterior spine of each row is probably metanotal (*vide* Chatotaxy, Thorax). On the outer side of each of the two posterior spines is a minute hair. Tergite 3 with a single row of six flattened lanceolate spines. Tergite 4 with two rows (five in the first row, six in the second). Tergites 5 and 6 with two rows each (six in each row). In tergite 7 there are five in the first row, four in the second. Tergite 8 has only one row of four. Sternite 2 with two spiny hairs; sternite 3 with two rows (three in the first, two in the second), similarly in sternites 4 to 7. The two spines in row 2 are the strongest; on each side of these, except in segment 7, a small minute hair. Sternite 8, which is the genital plate, is bare except for four minute hairs with large alveoli. A group of short spiny hairs and one larger spine on each side of the genital opening. Three small hairs on each gonopod.

Male Copulatory Apparatus. (Text-fig. 3).—This is long and narrow, occupying the three terminal segments of the abdomen. The *basal plate*, narrow and elongate, broadens elegantly in its posterior half. It lies in segments 7 and 8. The lateral margins are strongly chitinised and rod-like. The *paramera* lying in segment 9 are bowed outwards at the base but nearly meet each other at the tip. Beyond the point of its articulation with the basal plate, the base of each parameron projects as a process into the intraparameral space. These two processes approach each other but do not meet. Midway the paramera broaden and meet each other beneath the mesosome* so as to join a cavity in which the latter is contained. The *penis* is a narrow rod with a forked base. The basal forked part may, however, be a separate piece, as there is a distinct transverse line of division between it and the rod of the penis. The *mesosome* consists of two pieces, a posterior and an anterior.

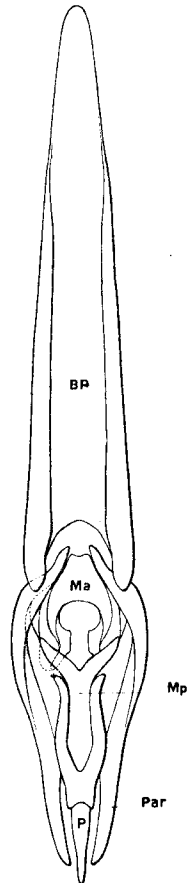
Mouth-parts.—For a description of the infra-buccal plate, see Ann. Mag. Nat. Hist. ser. 8, vol. xv. Feb. 1915.

Notes on the Tracheal System.—The description is taken from an immature specimen in Stage III. There is a pair of spiracles on each of segments 3 to 8 and a pair of larger ones on the mesothorax. The tracheal tubes are very fine and difficult to see through the integument. There are the usual two cardinal trunks, one on each side, joined by a commissure in the last abdominal segment. There is another commissure in segment 4. A lateral diverticulum runs out to each spiracle, and each

* For the explanation of the use of these terms, see Waterston (1), p. 279.

diverticulum gives off a posterior root. On the sixth there is also an anterior root. In segment 2, where there are no spiracles, a diverticulum nevertheless exists and runs out on each side as a small twig.

Text-figure 3.



Polyplax brachyrrhynchus. Male copulatory apparatus. $\times 433$.

BP. Basal plate. Par. Parameron. P. Penis. Ma. Mesosome (anterior piece).
Mp. Mesosome (posterior piece).

The course of the tracheals in head and thorax was too uncertain to justify description.

Measurements of Polyplax brachyrrhynchus (in millimetres).

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Head .....	.20	.13	.21	.17
Thorax .....	.20	.11	.20	.18
Abdomen .....	.98	.29	1.37	.41 (across segment 6)
Total	1.38		1.78	
	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Legs: 1st pair ...	.15	.04	.15	.05
2nd „ ...	.20	.06	.22	.07
3rd „ ... (with closed claw)	.20	.09	.21	.10 (with closed claw)

Length of antenna ♂ .16 ♀ .16

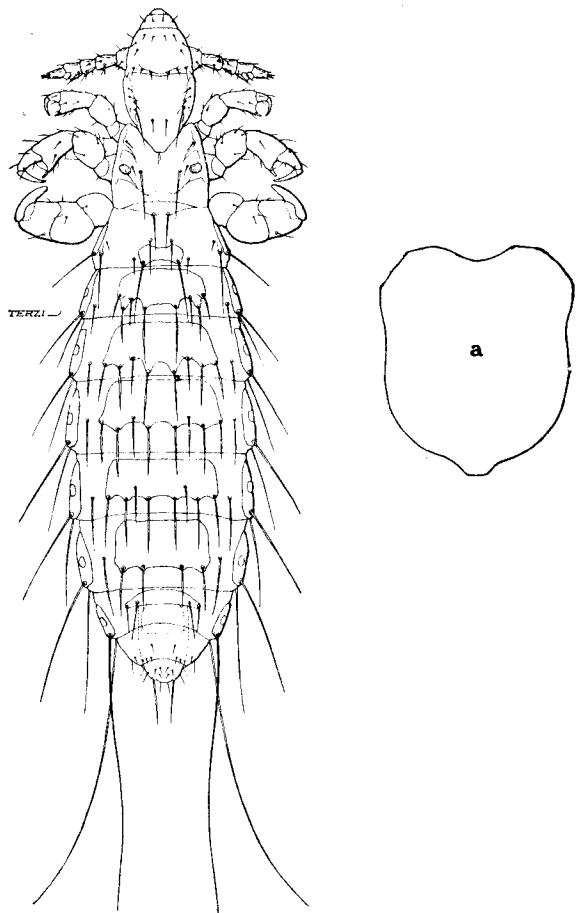
POLYPLAX OXYRRHYNCHUS, sp. n. (Text-figs. 4-6, 8, 9, 11-13.)

Proportion of the Sexes. ♂♂ 243, ♀♀ 675, besides numerous immature forms. Percentage of males = 26.

External Form. MALE. (Text-fig. 4.)—*Head* elongate; pre-antennal area long, conical; postantennal bay small; temple-margins converge a little towards the thorax. On the ventral surface is a raised diamond-shaped area with its long axis longitudinal and running from the mouth to the thorax. *Antenna*: First segment broad, squat, second longest. A large sensorium at the postaxial distal angle of segment 4, extending across the joint into segment 5. *Thorax* small, shorter than the head, with convex lateral margins. Sternal plate as in figure 4a. *Legs*: First pair slender, third pair very powerful. Coxæ of first pair close to each other, those of the second pair separated by a space, those of the third pair large and contiguous at their inner angles. *Abdomen* very long (for measurements see p. 260). On segment 2 a small tergite, broader than long, with possibly a second one weakly chitinised and ill-defined. On each of segments 3, 4,

5, 6, and 7 there is a single tergite, broad and deep. The chitin, on the dorsal surface of segments 8 and 9, is thin and transparent. The sternites on segments 2 to 7 are of the same form and disposition as the tergites, excepting that on each of segments 2 and 3 there are two sternites, the first in segment 3

Text-figure 4.

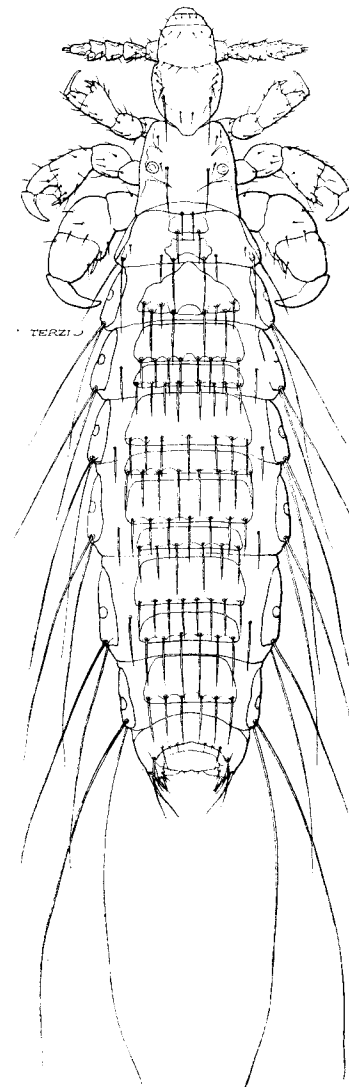


Polyplax oxyrrhynchus. Male. $\times 675$. a. Sternal plate.

being of a triangular shape. The sternum of segment 8 is occupied by the genital plate, which, on each side behind, is produced into a narrow band of chitin connecting the plate with the thickened margin of the terminal segment. The pleurites of

segment 2 are small and delicate, the rest strongly developed, without processes, longer than broad, lower margin straight.

Text-figure 5.



Polyplax oxyrrhynchus. Female. $\times 565$.

External Form. FEMALE. (Text-fig. 5.)—*Abdomen* elongate,
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truncate at the terminal end. On segment 2 there is one tergite and indications of a second in front of it. On segment 3 there is a single tergite, broad at the base, narrowing rapidly in front. On segments 4 to 7 there are two tergites, each being broad and long but broader than long, the first the longer of the two. Only one tergite on each of segments 8 and 9. The sternites show the same disposition and arrangement as the tergites, excepting that in segment 2 there are no vestiges of a second sternite; in segment 3 two sternites, as opposed to the single tergite, while the sternum of segment 8 is occupied by the genital plate, which in its anterior part is rectangular and in its posterior part triangular, the apex pointing backwards. The apex is minutely pectinate. A dentate fringe runs on each side from this apex towards the lateral margins of the abdomen. The pleurites differ from those in the male. In segment 2 they are small and thinly chitinised. In segments 3, 4, and 5 the lower angle on the ventral surface is produced into a short process.

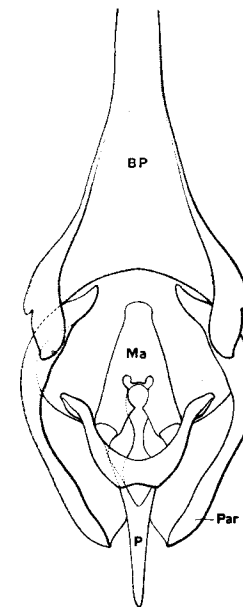
Chaetotaxy. MALE.—Head: On preantennal area, dorsal surface, several minute hairs. At the rostrum two minute hairs. Just in front of the antennæ, dorsal surface, a transverse row of hairs. Behind the antennæ, situated along a well-marked transverse groove, another row of small hairs. Along the temples a longitudinal row of four hairs, the most posterior being large and spiny. At about the level of these two posterior bristles, but situated nearer the middle line of the dorsal surface, two small hairs. On the ventral surface two small hairs on each side of the mouth-parts in front of the antennæ. A bristle at the base of each antenna, lower surface. *Thorax:* A long bristle and a minute hair on the inside of each spiracle. *Abdomen:* On the lower margin of each pleurite two hairs; these, as usual, are very long on segments 7 and 8. On the dorsal surface segment 1* has two hairs. On segment 2 there are two rows of spine-like hairs, two in the first row and four in the second; in the latter row the two middle hairs are much the largest and equal in size the two in row 1. Along the lower margin of tergite 3 are eight hairs, the two middle ones the largest, the remaining six flanking each side in two groups of three. Tergites 4, 5, and 6 each have a row of eight flat spines, the two middle ones the largest. There is also a smaller spine on each side in the space between the pleurites and tergites. On tergite 7 is one row of only four spines; another smaller spine on each side in the space between tergites and pleurites. On tergite 8 there are only four spines, the middle ones occupying a position one on each side of the basal plate. At the extreme end of the abdomen are two small stiff hairs. On the under surface there are five hairs in the first row and six in the second on the sternite of segment 2; in segment 3 five in the first, and in the second six, with another one on each side. The sternites of segments 4, 5, and 6 each carry a row of six hairs, with another one on each side. On sternite of no. 7

* As is ordinarily the case in the Order, segment 1 is small and almost obsolete.

only four, with one on each side, and on no. 8 only 2, one on each side of the basal plate.

Chaetotaxy. FEMALE.—Abdomen: On tergum of segment 1 are two hairs; in segment 2 there are two hairs on tergite 1 and four on tergite 2. Of the latter the two middle ones are the largest. On the single tergite of segment 3 is an irregular row of eight spines. In segment 4 each of the tergites has a row of eight powerful spines, with another hair on each side between the pleurites and tergites. On segment 5 tergite 1 has seven spines, tergite 2 has eight, with one on each side. On both tergites of segment 6 there are seven spines, with one on each side. On segment 7 tergite 1 has eight and tergite 2 has six spines, with one on each side. On the tergite of segment 8 there are six spines. Ventrally segment 2 has six hairs. On segment 3 sternite 1 has five and sternite 2 has six, with one on each side.

Text-figure 6.



Polyplax oxyrrhynchus. Male copulatory apparatus. $\times 500$.

BP. Basal plate. Par. Parameron. P. Penis. Ma. Mesosome (anterior piece). The piece labelled MP. in text-figure 3 is apparently unrepresented or very small.

On segments 4, 5, 6, and 7 there are five hairs on sternite 1 and six on sternite 2, with one on each side. On the genital plate is a row of four minute hairs in large alveoli. On each side of the terminal segment is a group of hairs and one large spine.

Male Copulatory Apparatus. (Text-fig. 6.)—This is of the

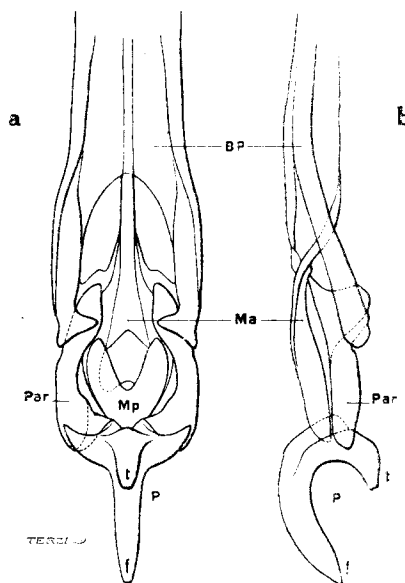
same type as that described for *P. brachyrrhynchus*. It differs, however, in details.

The *basal plate* is small. Anteriorly it is very narrow, being little more than a rod or band. Lower down, towards the paramera, it broadens rapidly, and its two lower lateral angles are produced so that the whole plate somewhat resembles an inverted catapult as used by schoolboys.

The *paramera* articulate with the produced angles of the basal plate. Beyond the point of articulation the base of the parameron projects into the intraparameral space. Towards the extremity each parameron broadens out and meets the other distally beneath the mesosome, for which they form a basin-shaped cavity.

The *penis* is a curved, pointed, narrow rod with a forked base. As in *P. brachyrrhynchus*, the forked basal part may be a separate piece. The limbs of the fork enclose the lower part of the rest of the mesosome, as shown in the figure.

Text-figure 7.



Polyplax spinulosa. Male copulatory apparatus:—*a*. Dorsal view. *b*. Side view. $\times 350$.

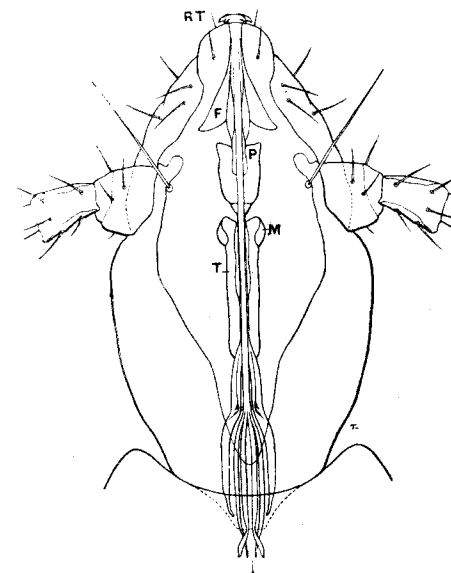
BP. Basal plate. *Par*. Parameron. *P*. Penis (*f*, finger, and *t*, thumb).
Ma. Mesosome (anterior part). *Mp*. Mesosome (posterior part).

Comparison with the Male Copulatory Apparatus of Polyplax spinulosa (Burmeister). (Text-fig. 7.)—The remarkable copulatory apparatus of this common species of *Polyplax* from Rats has hitherto remained unnoticed save for a summary description by Piaget (2, p. 636), which is difficult to follow and is accompanied by an inaccurate figure (pl. lii. fig. 2*a*).

The *basal plate* is longer than broad, with the lateral margins gracefully biconcave.

There are no separate *paramera*. Probably the deep band-like pieces (*Par*) represent modified paramera. At their anterior extremity there is a joint between them and the lower angles of the basal plate. At their posterior extremity they curve inwards and become fused with a remarkable penis consisting of two limbs like a finger and thumb—the longer “finger” (*f*) being ventral and the “thumb” (*t*) being dorsal. There is another chitinous piece (*Ma*) which consists of two limbs that arise from a single small median splint lying in the middle between the two lateral bars of the basal plate, dorsal to the basal plate and about half-way down its length. Each limb runs downwards and outwards so as to underlie the parts named paramera for as far as the penis. The strange form of the latter is probably correlated with some modification of the genitalia of the female.

Text-figure 8.



Polyplax oxyrrhynchus. Mouth-parts. $\times 252$.

RT. Rostral teeth. *F*. Fultura. *P*. Pharynx. *M*. Mandible. *T*. Tendon.

In regard to the male copulatory apparatus *P. brachyrrhynchus* and *P. oxyrrhynchus* are much nearer to one another than they are to *P. spinulosa*.

An attempt at homologising these parts with those in the two new species is made in the legend to the figure.

Mouth-parts. (Text-fig. 8.)—The figure shows the shape of the chitinised fore-part of the alimentary canal, *i. e.* pharynx

(*larynx* of Enderlein) and *fultura* (5). No attempt is here made to describe the mouth-trophi, but attention is drawn to two structures lying together just behind the pharynx and above the needle-like trophi, strongly suggesting mandibles. In the figure they are labelled mandibles, and the chitinous band which runs backward from each is indicated as a tendon. Mandibles, of course, in blood-sucking Anoplura cannot be functional, but their presence as vestiges is to be expected if the Anoplura are in truth descended from the mandibulate Mallophaga. Enderlein (4) regards as mandibles certain pieces in the head of *Hæmatopinus suis*. Mjöberg (3) figures and describes mandibles in *Arctophthirus tricheci* Boh. The latter are extremely suggestive in form, and much resemble the mandibles here figured.

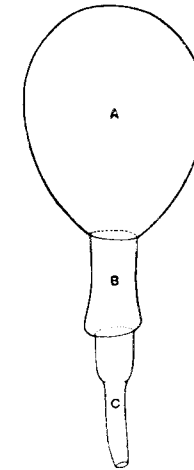
Spermatheca. (Text-fig. 9).—Mjöberg (3, p. 254) finds a spermatheca present in *Linognathus angulatus* Piag. and in *Acanthopinus scurinus* Mjög., in both of which it consists of the same form, *i. e.*, "Aus einem fast kreisrunden Gebilde das beiden Übergang in den sehr schmalen Ausführungsgang mit einer gerundeten Chitinscheibe versehen ist, von deren Mitte der Ausführungsgang seinem Ursprung nimmt." Landois (6, p. 14) described the spermatheca of *Phthirus inguinalis* and remarked (7, p. 32) upon its absence in *Pediculus vestimenti*. Patton & Cragg (5, p. 560) single this out as a fact of some interest in view of the length of copulation in the louse and the large size of the seminal vesicles in the male. Landois explains the difference in *Phthirus* and *P. vestimenti* in this matter by reference to the habits of the two insects—*Phthirus* is sedentary and therefore rarely meets with its kind; the *Pediculus* is active, and coitus is, therefore, frequent.

Whatever be the explanation, the absence of the spermatheca in *P. vestimenti* is a confirmed fact, and it becomes a matter for further research to enquire from what other genera in both Anoplura and Mallophaga this receptacle may be absent. It probably occurs in a great many Mallophaga in which its chitinous "Scheibe" can frequently be seen at the end of the abdomen through the integument of specimens passed through caustic potash. Mjöberg figures it from *Nirmus lineolatus* N., and reports it as probably present in many Ischnocera. In the Amblycera he sought for it in vain. It may, however, exist unchitinised in these forms, though the club-shaped organ found in *Menopon titan* by Grosse, who regarded it as a spermatheca, is reported by Snodgrass (8) to be non-existent.

In the two species of *Polyplax* here described, a spermatheca is present, and its chitinous parts can be detected in specimens passed through potash. Text-fig. 9 shows the part in *P. oxyrrhynchus*. In general form it resembles the figure of the spermatheca of *Phthirus inguinalis*. Nothing comparable to the "Chitinscheibe" or disc of Mjöberg was observed; in some specimens, passed through caustic potash, the chitinous part of the duct B (the funnel) was telescoped backwards into the

sac; it then presented the appearance of a dice-box in a glass bowl. The specimens were in too poor a state of preservation for histological examination, but both the sac and the upper part of the duct appear to be chitinised, while the lower part, which could not be traced, is of peculiarly elastic nature and capable of being pulled out a long distance.

Text-figure 9.

*Polyplax oxyrrhynchus*. Spermatheca.

A. Sac. B. "Funnel." C. Duct.

In the Siphonaptera the shape and size of the chitinous parts of the spermatheca vary a good deal, and are sometimes used for taxonomic purposes. It is improbable that they will serve this end in Anoplura and Mallophaga.

Notes on the Tracheal System.—The following description is taken from a preparation of an immature form in Stage III. :—

There is a pair of abdominal spiracles on each of segments 3 to 8 of the abdomen and a pair larger in size on the mesothorax. Text-fig. 5 (p. 253) shows the arrangement of the main branches in the abdomen. There is a posterior commissure in the abdomen and on each lateral diverticulum a posterior root. Anterior roots are absent except in segment 4, where one runs forwards and inwards as far as the first diverticulum. It will be remembered that a commissure is present in this segment in *P. brachyrrhynchus*.

There is, I believe, no longitudinal commissure in the thorax as in *Phthirus inguinalis* (6) and *Hæmatopinus tawotragi* (9). The two lateral trunks are continued, one on either side, through the head as far as the antennæ, where each splits into smaller branches. Small twigs are given off to the mouth-parts and

antennæ, and across the base of the head there appears to be a commissure, although it is impossible to be sure that this does not consist of two separate branches. I find similarly an apparent commissure between the two lateral trunks, in exactly the same position, in the head of *Polyplax spinulosa*. *Polyplax spinulosa* further resembles *P. oxyrrhynchus* in the presence of a large anterior root on each lateral diverticulum in segment 4, which runs forward through the next segment.

Measurements of Polyplax oxyrrhynchus (in millimetres).

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Head	·25	·14 (behind antennæ)	·25	·15
Thorax	·16	·15	·18	·16
Abdomen	·92	·34 (across segment 6)	1·35	·46 (across segment 6)
Total	1·33		1·78	
	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Legs: 1st pair ...	·14	·03	·16	·04
2nd „ ...	·23	·06	·21	·08
3rd „ ...	·20	·08	·20	·10
Length of antenna	♂. ·15		♀. ·15	

METAMORPHOSIS.—Very little mention of the post-embryonic changes of either Anoplura or Mallophaga is to be found in the rapidly growing literature of these two groups. In Warburton's (10) Report to the Local Government Board an account, in some detail, is given of the life-cycle of *Pediculus vestimenti*, while Dr. A. C. Oudemans (11) has described the nymphal stages of three species of Mallophaga—*Liotheum flavescens*, *Philoaterus celebrachys*, and *P. macrocephalus*. Patton and Cragg (5) figure the three larval stages of *Pediculus vestimenti*; while in the standard work 'Les Pédiculines' (p. 6) Piaget (2) makes a few

remarks about metamorphosis, amounting to little more than a profession of ignorance. (See, however, note in square brackets on p. 272.)

It seems very probable that, in the future, a careful study and description of the immature stages of both Anoplura and Mallophaga will prove largely the vehicle in which to arrive at a sound classification of these two orders.

Several points of interest have emerged from a study of the immature stages of *Polyplax brachyrrhynchus* and *P. oxyrrhynchus*.

In *Pediculus vestimenti* Warburton describes three stages:—

- Stage I. on hatching.
 „ II. after the first moult.
 „ III. after the second moult.

Oudemans in *Philoaterus macrocephalus* and *Liotheum flavescens* describes three stages.

In *Polyplax oxyrrhynchus* the immature forms are readily sorted out into three stages. In *P. brachyrrhynchus* only one stage was present. Little evidence can be given as to the number of moults. One would suggest two as in *Pediculus*, but from a study of a very instructive slide in which the larva in

Text-figure 10.



Polyplax sp. Egg. $\times 633$. MA. Micropyle apparatus.

Stage I. of *P. oxyrrhynchus* is about to moult, and the new instar can be seen through the old skin, it seems evident that a larva changes its skin at least once with very little or no change in form or chaetotaxy. On the other hand, in the last ecdysis the change from Stage III. to the imago is quite abrupt, as was

proved by specimens in Stage III. about to moult with the imago beneath visible through the old skin. A comparison for example between text-figs. 14 and 1 shows the extent of the change.

In *P. brachyrrhynchus*, *P. oxyrrhynchus*, as well as in *P. spinulosa*, the chaetotaxy of the head and thorax in the larval stages is almost identical with that of the adult. This probably holds for all the Anoplura. On the abdomen the larval chaetotaxy differs from stage to stage, and it is a matter of particular interest to trace the sequence in which the hairs develop. Thus in the abdomen of *P. oxyrrhynchus* and *P. spinulosa* there is a tendency for the hairs to appear first at the end of the abdomen, and to develop subsequently in later stages further forward. For example, in Stage I., there are no hairs on the pleurae except in the last segment, while the only hairs on the ventral surface appear first on the last segment.

The sexes of the larvæ are indistinguishable—at all events in external form. In the last stage the male copulatory apparatus is in some specimens visible in the imago beneath.

Text-fig. 10 is a representation of the egg, found in some numbers in the tube with both species; I am unable to say to which it belongs.

POLYPLAX OXYRRHYNCHUS.

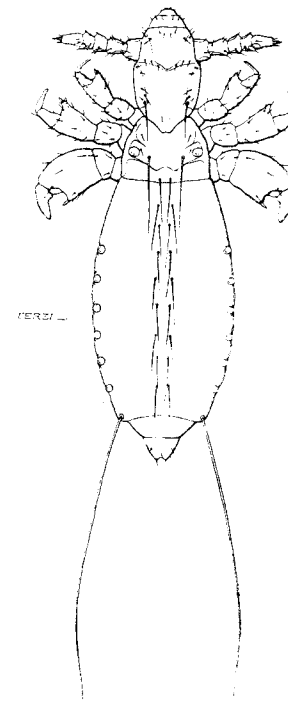
Stage I. (Text-fig. 11.)—The head is short and broad, and there are no sclerites on the abdomen. The sexes are indistinguishable, the abdomen in all specimens ending in a cone. The insect is very soft and delicate, and requires to be dehydrated very slowly in carefully graduated alcohols before clearing, if complete and instantaneous shrivelling is to be avoided. In parts, however, the cuticle is harder and more perfectly developed, *e. g.*, the mouth-parts (to enable the young larva to pierce and

STAGE I.—Measurements (millimetre scale).

	Length.		Breadth.	
	Specimen... (1)	(2)	(1)	(2)
Head .....	.17	.20	.11	.14
Thorax .....	.10 (about)	.13	.16 (at the base)	.15
Abdomen .....	.56	.59	(Seg. 4) .30	.33
Total .....	.83	.92		
Antenna .....	.10 to	.12	.20 (Seg. 4) to	.25

suck), the legs and thorax (to enable it to cling to the host). The chaetotaxy of the abdomen is as follows:—There are in the median area two hairs in the dorsum of each segment. On the sternum of the last segment there are also two hairs, medially placed. Rest of the ventral surface bare. Pleurae without hairs, except on the last segment, where there is on each side a single long, curved hair, usually in a curl. The spiracles are large.

Text-figure 11.

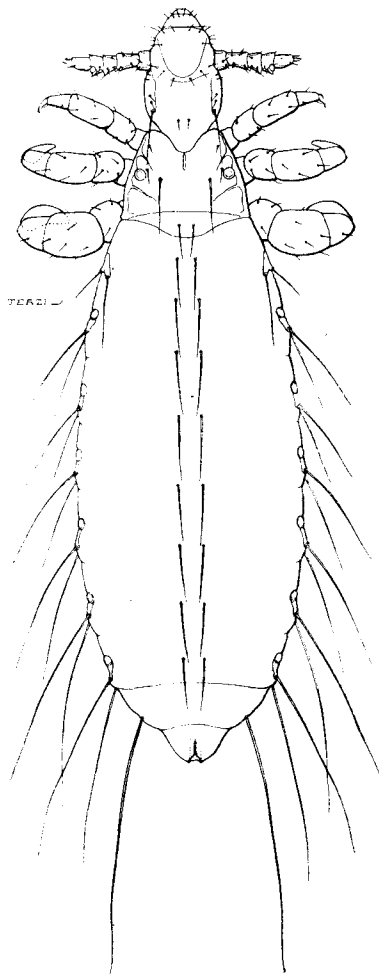


Polyplax oxyrrhynchus. Larva, Stage I. × 65.

Stage II. (Text-fig. 13.)—In external form this stage resembles Stage I. It differs, however, in size (see measurements below) and in the development of minute pleurites on the abdomen. The head, too, is more produced in front of the antennæ, and its front margin is very rounded. The delicacy of structure is much less marked; the abdominal cuticle is thicker and covered with a great number of triangular denticles with sharp apices. On the abdomen the chaetotaxy is more developed. Medially there are two hairs on both tergum and sternum of

each segment. On each pleurite are two hairs; those on segments 7 and 8 are very long. On the terminal segment, which is without pleurites or spiracles, there is on each side a single elongate bristle.

Text-figure 12.



Polyplax oxyrrhynchus. Larva, Stage III. $\times 74.5$.

The pleurites are small quadrilateral plates, attached along their anterior margin to the lower margin of the spiracle.

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STAGE II.—*Measurements (millimetre scale).*

	Length.		Breadth.	
	Specimen... (1)	(2)	(1)	(2)
Head23	.19	.15	.14
Thorax .....	.17	.13	.18	.17
Abdomen	1.05	.88	(Segment 5) .47	.37
Total ...	1.45	1.20		
Antenna .....	.14	.13	(Segment 4) .03	.03

Stage III. (Text-fig. 12.)—Except in the shape of the head, which is here longer and narrower in front of the antennae, it has been difficult to discover any difference between Stage III. and Stage II.

STAGE III.—*Measurements (millimetre scale).*

	Length.	Breadth.
Head .....	.21	.12
Thorax .....	.18	.18
Abdomen .....	.95	(Segment 4) .38
Total ...	1.34	
Antenna .....	.16	(Segment 4) .03

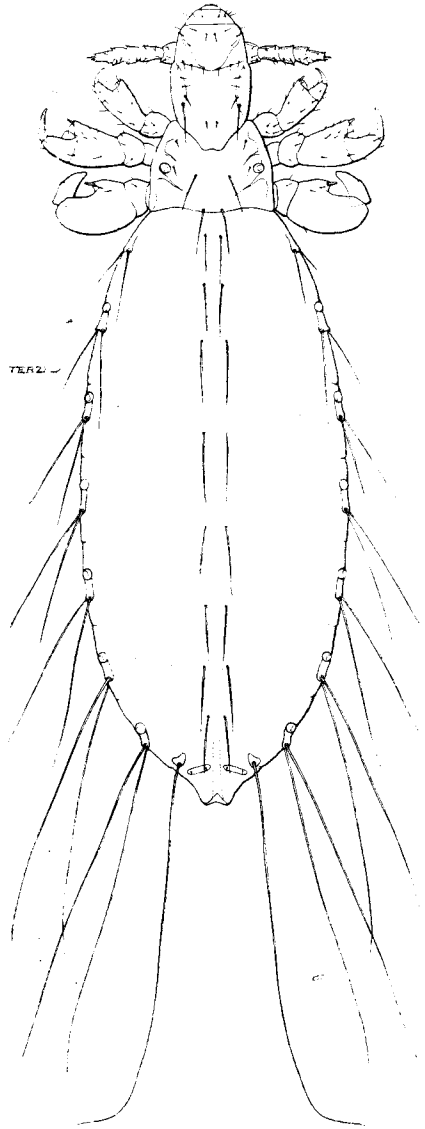
POLYPLAX BRACHYRRHYNCHUS.

In this species only one stage was represented—Stage III. (text-fig. 14). The figure gives an accurate representation of the external form of the insect at this stage. It will be observed that on the abdomen are neither tergites nor sternites, while the pleurites also are either absent or very faint and indefinite.

The abdominal chaetotaxy presents features of special interest. There are a couple of hairs in the middle area of each tergum and sternum, except the tergum of segment 8, which is bare. The pleurae are bare, with the following exceptions:—Segment 3,

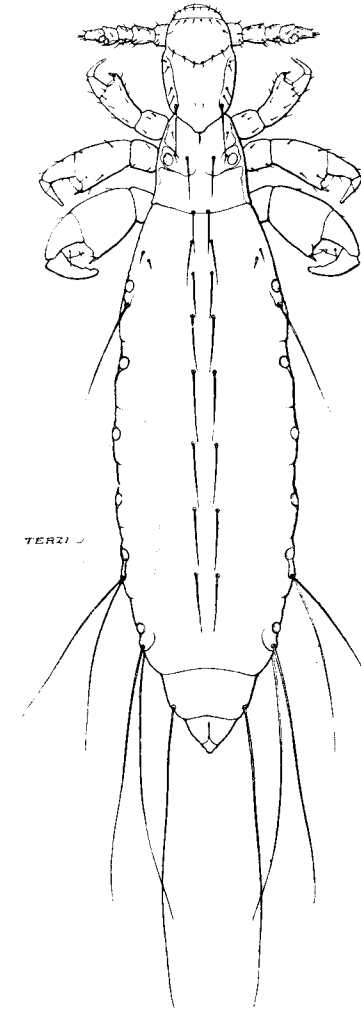
[21]

Text-figure 13.

*Polyplax oxorrhynchus*. Larva, Stage II. $\times 73.1$.

with one long bristle on each side; segments 7 and 8, each of which possesses two long bristles on each pleura; and segment 9, which possesses one long bristle on each side. The bearings of these facts are discussed on page 271.

Text-figure 14.

*Polyplax brachyrrhynchus*. Larva, Stage III. $\times 77.3$.

STAGE III.—Measurements (millimetre scale).

	Length.	Breadth.
Head	·19	·13
Thorax	·19	·15
Abdomen	·90	(Segment 4) ·29
Total...	1·28	
Antenna	·15	(Segment 4) ·63

The Metamorphosis of Polyplax spinulosa (Burm.) for Comparison.

From a large amount of material from this common parasite of the Rats *Mus norvegicus* and *M. rattus*, presented to the British Museum, along with other species, by the Lister Institute, it has been a simple, if laborious, matter to sort out all the immature forms, which fell into three stages as in *P. oxyrrhynchus*.

Larva, Stage I. (Text-fig. 15.)—This is a tiny, delicate insect, with a rounded head, the postero-lateral angles being very slightly developed. On the dorsal surface of the head there is a suture between the two epicranial plates, which in front bifurcate and so divides the two epicranial plates from the single plate—frons—which roofs in the anterior part of the head. Sclerites on the abdomen absent.

Chaetotaxy of head and thorax as in the imago. On the abdomen two bristles in each tergum. Sterna bare except the last, which, as in *P. oxyrrhynchus*, has two bristles. Pleurae bare, except that in the pleural region on each side of the last segment are two very elongate hairs—one dorsal and one ventral. Spiracles relatively large.

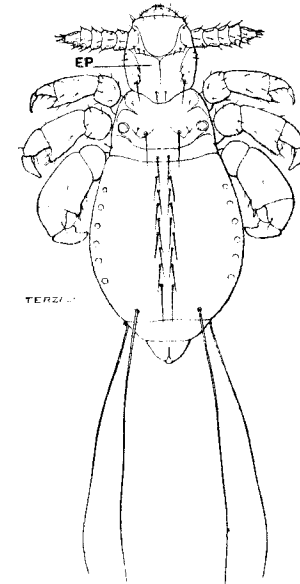
STAGE I.—Measurements (millimetre scale).

	Breadth.	Length.
Head	·101	·102
Thorax	·112	·105
Abdomen	·203	·211
Total...		·418
Antenna	·003	·001

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Larva, Stage II.—Postero-lateral angles of the head more pronounced. Minute pleurites developed on the abdomen.

Text-figure 15.

*Polyplax spinulosa.* Larva, Stage I. × 112.

EP. Epicranium.

Chaetotaxy of the abdomen:—Two minute hairs on the pleurites of the first seven segments. On segments 8 and 9 the pleurites bear two long bristles each. On terga and sterna of all segments two longish hairs on the middle area.

STAGE II.—Measurements (millimetre scale).

	Breadth.	Length.
Head	·12	·14
Thorax	·19	·14
Abdomen	·37 (Segment 4)	·55
Total...		·83
Antenna	(Seg. 4) ·024	·12

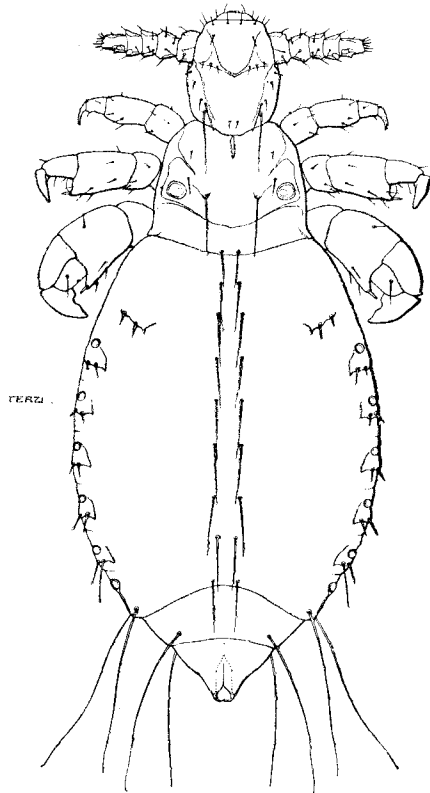
PROC. ZOOLOG. SOC.—1915, No. XIX.

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Larva, Stage III. (Text-fig. 16.)—Head more angular, pleurites on the abdomen larger and more strongly chitinised. Chaetotaxy as in Stage II., except that in the pleurites of segment 7 one hair is long and one short.

Text-figure 16.

*Polyplax spinulosa.* Larva, Stage III. $\times 102.2$.

Reference to a figure or description of the imago makes clear that the final stage of the development differs from Stage III. in the possession of well-chitinised tergites and sternites on the abdomen carrying strong bristles in rows. The pleurites are also better developed than in the larvæ, and on those of segment 7 both hairs are elongate as in segment 8, while the two very elongate hairs on each of the pleuræ of the last segment in the larval stages are apparently replaced in the female imago by a group of short hairs on each side and in the male by one long hair.

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STAGE III.—Measurements (millimetre scale).

	Breadth.	Length.
Head13	.15
Thorax20	.14
Abdomen .....	.40 (Segment 4)	.61
	Total...	.90
Antenna	(Seg 4) .03	.14

Summary.

An examination of the immature forms in these three species of *Polyplax* reveals that the metamorphosis in all three consists probably of at least three distinct stages, although there may be more than two moults. The differences between Stages II. and III. are slight. In the first stage the louse is very soft and delicate for the most part, although even thus early the mouth-parts, thorax, and legs are well chitinised. On the abdomen segmentation is absent except at the end, and sclerites are absent in all three stages, although in *P. oxyrrhynchus* and *P. spinulosa* minute pleurites appear in Stage II., and in Stage III. of *P. brachyrrhynchus* also there are present weak pleurites of indefinite outline. The spiracles are large. In the last stage the head and thorax closely resemble the adult.

In all three stages the chaetotaxy of the head and thorax is almost identical with that of the imago.

The abdominal chaetotaxy and the abdomen itself, however, undergo a very considerable metamorphosis at the last ecdysis into the imago.

The metamorphosis of all three shows that there is a tendency for the hairs to develop from behind forwards, inasmuch as the terminal pleuræ develop hairs while the rest are still bare, and in *P. oxyrrhynchus* and *P. spinulosa* the sterna are at first also bare except in the last segment.

Two hairs on each tergum and sternum is invariably the number if hairs are present at all.

Some of these early stages may represent stages in the phylogeny of the group, and in this connection it is suggestive to recall that the Anopluran genus *Linognathus* is characterized by the large size of its spiracles and the absence of abdominal plates, just as *Polyplax* is characterized by the small size of the spiracles and the presence of the plates, so that in future it may be convenient to speak of the larva of *Polyplax* as the "*Linognathus* larva."

The larva of *P. brachyrrhynchus* described above recalls in particular such species as *Linognathus breviceps* Piaget, *L. gazella* Mjöberg, *L. limnotragi* Cummings, *L. africanus* Kell. & P., and

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L. cavie-capensis (Pallas), in which there is on each pleura of the 3rd abdominal segment an elongate bristle and on the pleuræ of the 7th and 8th two long bristles.

The chætotaxy of *L. cavie-capensis* (see figs. 2 & 3, Bulletin of Entomological Research, iv. May 1913, pp. 38 & 39) bears a close resemblance to that of the *Polyplax* larvæ. Some later work further reveals the fact that a somewhat similar plan of abdominal chætotaxy exists also in the larvæ of at least two species of *Linognathus* in which the imaginal chætotaxy is more complex. This general plan of chætotaxy, therefore, is perhaps a primitive one in the Anoplura, and *Linognathus* is perhaps a more primitive genus than *Polyplax*, and perhaps the most primitive of all the Anopluran genera, an hypothesis which, however, cannot be supported by reference to the systematic position of the host-species, *Linognathus* occurring with *Hæmatopinus* on Ungulates such as the Antelope, *Capra* and *Ovis*, and also on the Dog.

It would be interesting to know whether *Linognathoid* types of a more primitive character than any Anoplura hitherto known remain to be discovered on the primitive Insectivora and other ancient mammalian groups. Hitherto, Anoplura have not been found on Monotremes and Marsupials. It should be remembered that *L. cavie-capensis* is a parasite of the Cape Hyrax—a member of a very isolated group.

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[NOTE.—I find I have overlooked the following paper by H. Fahrenholz: "Beiträge zur Kenntnis der Anopluren," Hannover Jahresber. zool. Ver. 2-4 (1910-12), 1912. The author describes the larvæ of *Pediculus capitis* and of one or two species of *Polyplax*, including *P. spinulosa*. He is mistaken in supposing there are hairs on all the sterna of what we are agreed in calling Stage I. of *P. spinulosa*. See also:—"Neue Läuse," Hannover Jahresber. zool. Ver. (1909), 1910, and the figures of various larval Mallophaga scattered through Kellogg's papers.]