ERRATA.

Page 3, line 33 from top. For " superficial " *read* " surficial ".
Page 8, line 10 from top. For " concjeture " *read* " conjecture ".
Page 12, line 12 from bottom. For " media " *read* " mediad ".
Page 23, line 17 from bottom. For " $1\frac{3}{5}$ " *read* " $\frac{3}{5}$ ".

RECORDS

of the

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Vol. XXVIII, Part I

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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus or subgenus; synonyms are printed in italics.]

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Appendix.

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ON THE MORPHOLOGY AND SYSTEMATIC POSITION OF THE CESTODE *GIGANTOLINA MAGNA* (SOUTHWELL).

By Dr. Franz Poche, *Vienna.*

(Plates V, VI.)

In 1915 Southwell (8, pp. 326-328, pl. xxvii, figs. 6, 7) published the description of a very interesting Amphilinid from the body cavity of a teleostean fish, *Diagramma crassispinum*, of the family Pristipomatidae. He named it *Amphilina magna*. Three specimens of the species were collected by Southwell in Ceylon where he found them in as many specimens of their host during his examination of a number of these from the pearl banks. Already in 1912 (7, p. 273, pl. iii, fig. 41) he had published a description of its external characters together with a short note on its most conspicuous internal features (evidently as they were to be seen in unmounted specimens) and a figure of the animal. He did not have time to make a full examination of the parasite then and stated: "I am at present uncertain of its strict zoological position. The worm is to all appearance a huge *Trematode.*" He also refrained from naming the animal at the time. Nevertheless the description then given by him is of value as containing information on the dimensions of living and freshly preserved specimens and on the colour of the latter (in formalin).

On reading Southwell's description (8) and still more on studying the accompanying figures I had serious doubts as to the correctness of his interpretations of two of the organs of the animal, *viz.*, the supposed germarium and the supposed shell-glands. Being engaged at that time on a study of the Amphilinidea, an elucidation of these points was of great interest and importance to me. On my request Dr. Baini Prashad of the Zoological Survey of India, Indian Museum, Calcutta, very kindly sent me material of the cestode in question for examination and later gave me information on an important point of its morphology, *viz.*, the position of its uterine pore (see below p. 3). I offer him my best thanks for his great amiability. He further most obligingly offered to publish the results of my researches on the material in the "Records of the Indian Museum" My heartiest thanks are also due to the renowned arachnologist, Counsellor of the Government, E. Reimoser, to whom I am much indebted for taking the photographs reproduced on plate VI.—Since this was written, Dr. Prashad has placed me under further obligation by having these photographs retaken, the negatives of which had been broken during their transport to India, and by carefully revising the wording of my paper.

According to Dr. Prashad's accompanying letter, the material sent to me consisted of "pieces of one or two (?) specimens in spirit" and "a mounted slide of the posterior end of probably one of the above",

this being "the only material with the exception of one complete type-specimen" A comparison of the mounted fragment (see pl. VI, fig. 4), which is unstained, with Southwell's fig. 7 shows beyond any doubt that it is identical with the original of the latter and is thus one of or a portion of one of the paratypes. As there is also a posterior end among the two pieces in spirit, it further follows that, if the mounted posterior end actually pertains to one of these, they must belong to two different individuals. In the tube containing them there was a label in Southwell's handwriting which reads: " Types. *Amphilina magnum,* Southwell "

Doubt can, however, arise whether they and the mounted fragment represent paratypes or cotypes. Southwell, it is true, uses the term " types " rather loosely, as is obvious from the label quoted above and from his speaking in 1915 of his " types " [of the species in question] on p. 328. As he however (*l.c.*) also definitely says: " The type of *Amphilina magna,* n. sp. is deposited in the Indian Museum ", it would seem that he ultimately designated a single individual as type, and this apparently was the complete specimen (see the above quotation from Dr. Prashad's letter).[1] Granting this, the other specimens are of course paratypes, and as such I shall speak of them in the following pages.

In 1922 (4) when creating the new genus *Gigantolina* (see below p. 25) for *Amphilina magna* I promised to publish elsewhere a fuller and illustrated account of *Gigantolina magna* and also to discuss therein the discrepancies existing between Southwell's description of this species and the definitions given by me of the family and subfamily to which I assigned the animal. Availing myself of Dr. Prashad's kind offer mentioned above, I propose to do this in the following pages.

The two fragments of *Gigantolina magna* in spirit received by me consisted of (i) the posterior part of an individual, as already mentioned above, having in the mounted condition a length of 13 cm. and an average breadth of 1·2 cm., and (ii) a smaller piece measuring 9 cm. in length, 0·37 cm. in thickness and on the average 1·45 cm. in breadth, but not representing either end of the body. I thus had to my regret no anterior end at my disposal, and my remarks on this interesting part of the cestode must, therefore, remain limited to the little that can be gathered from Southwell's fig. 6 and from his description.—The posterior part referred to above I stained with borax-carmine and

[1] Dr. Poche is right about his assumption that Southwell used the term " types " in a rather general sense. He considered all the three specimens as the "types" or the type-series of this species and as such they were entered in the registers of the Indian Museum by the author. At present there are in the Indian Museum collection (i) the complete specimen which is the original of Southwell's fig. 6 on pl. xxvii of vol. XI of the " Records of the Indian Museum " and which Dr. Poche calls the " type " of the species in the present account, (ii) the posterior part of an individual which was reproduced as fig. 7 by Southwell and is refigured as fig. 1 on pl. V and its photograph as fig. 4 on pl. VI in the present paper, and (iii) the posterior part of the third individual figured in the present paper as fig. 2 on pl. V and its photograph as fig. 5 on pl. VI. The fragment of another individual which was also sent to Dr. Poche for examination is probably the anterior part of the third specimen. In it the anterior tip is missing. I have not been able to find the anterior part of the second specimen in the collections of the Indian Museum. The last two specimens are, in accordance with Dr. Poche's suggestion, now designated as the " paratypes " of the species. (*B. Prashad.*)

mounted in Canada balsam. The other fragment I examined in spirit. It is true that in this state almost nothing of the internal organization could be made out, but the mounting of it could not reasonably be expected to shed any more light on the structure of the animal except possibly on the frontal glands, which are doubtlessly present (see below p. 5), and on the configuration of the uterus in the different regions of the body (see pp. 18-21). Any information thereon gained from the fragment would moreover be greatly discounted by the fact that its place in the complete animal is not known for certainty. Further, the very characteristic sculpture on the surface of the animal is greatly obliterated in mounted material (see below p. 4).

Southwell (8) in the explanation of his plate xxvii gives the scale of fig. 6, to which I shall frequently have occasion to refer further, as reduced to $\frac{1}{3}$. This figure has a length of almost 16 cm., so that the real length of the animal would be about 48 cm. In his earlier paper (7, p. 273) however he gives the length of the preserved specimens (and it is evident that the figure in question was taken from a preserved individual) as $9\frac{1}{2}$ inches [=241·3 mm.], and in 1915 (8, p. 327) that of the largest specimen as taken recently as 250 mm. It is, therefore, obvious that the scale attributed by him to the said figure cannot possibly be correct and that the latter is about $\frac{2}{3}$ of the size of the animal.[1]

As in most species of Amphilinidea there is no difference in the arching between the two surfaces of the body. Preserved material may sometimes show a difference; but this is quite accidental. This is clear from the fact that the unmounted fragment mentioned above is quite flat with incurved margins on one surface and distinctly convex on the other in about one half of its length, while in therest of its length the configuration of the two surfaces is exactly the reverse. For the determination of the ventral surface and the correct dorso-ventral orientation of the animal we must, therefore, have recourse to the situation of the uterine pore, which is situated on the *ventral* surface. (The correctness of this assertion with regard to the Amphilinidea and with due reference to the other Cestoidea provided with a superficial uterine pore too I have fully discussed elsewhere (6).) As mentioned already, I had, however, no anterior end of *Gigantolina magna* at my disposal, in which the uterine pore is situated, while from Southwell's fig. 6 it is not clear as to which surface carries the said pore. In his text also he makes no reference to this point. I, therefore, wrote to Dr. Prashad asking him to decide this question by an examination of the type in the Indian Museum. He very kindly informed me that, when the animal is so oriented that its anterior end is directed towards the observer and the second ascending branch of the uterus is situated to his right (as in Southwell's fig. 6), the uterine pore is on the under surface. *This surface is therefore the ventral one.* This result is in full accordance with the conditions found in *Schizochoerus liguloideus* (see Poche, 6) and likewise with the situation of the posterior nerve commissure relative to the terminal part of the male genital duct (see below p. 5 and Poche, 5, p. 589 f.).

[1] I have re-examined the type-specimen in the Indian Museum which was reproduced as Southwell's figure 6 on plate xxvii in 1915. The scale of reduction of this figure as stated by Dr. Poche should be × $\frac{2}{3}$ or reduced by $\frac{1}{3}$ and not × $\frac{1}{3}$, as is given in the explanation of the plate. (*B. Prashad.*)

As regards the general external form of *Gigantolina magna* reference must be made to Southwell's paper (*l. c.*), who had the advantage of being able to examine the cestode in the fresh state and had a complete specimen of it.—The posterior end of both specimens examined by me is distinctly asymmetrical up to a line lying somewhat in front of the accessory receptaculum seminis (see below p. 16), the left margin of the body beginning much further forward to trend medially than the right one (pl. V, figs. 1, 2, pl. VI, figs. 4, 5). A similar asymmetry exists in *Schizochoerus liguloideus* (*vide* Poche, *t. c.*).—The stained specimen shows at its hind extremity, which is otherwise obtuse, in the sagittal plane a small, gently rounded, relatively broad prominence projecting backwards and measuring approximately 0·2 mm. in length and 1·3 mm. in breadth (see pl. V, fig. 2, *p*). As it carries the male genital pore (*vide infra* p. 11) it evidently represents the male genital papilla which I have also recently (5, p. 611-613) described for *Amphilina foliacea*. In the unstained specimen, however, whose hinder end is more fully rounded, no corresponding structure is to be detected (see pl. V, fig. 1), neither in Southwell's fig. 6 which represents another individual. The same is often the case in *Amphilina foliacea*, especially in unsectioned specimens.

The colour of the parasites which was described as milky-white in formalin by Southwell had changed to a dirty yellow grey when I received them in spirit. They were very little transparent and only outlines of some of the main features of their internal organisation could be made out in the unmounted condition. In the unstained mounted fragment the posterior tip of the body for a length of 1·5 mm., *i.e.*, up to the hindermost part of the muscular ring surrounding the vaginal pore (see below p. 15), is throughout its breadth conspicuously darker than the rest of the animal, being as it is of a gold-brown colour (see pl. V, fig. 1). This part is separated by a rather sharp, straight transverse line from the main portion of the animal. In the stained specimen no marking of this type was found.

The surface of *G. magna* is not smooth, but shows a fine, irregularly honeycomb-like sculpture, as is also characteristic of *Amphilina foliacea* and *Nesolecithus janickii*. It is visible even to the naked eye, when it appears to consist of very minute granules. It is best discernible when the specimen is taken out of the spirit and begins to dry superficially, while almost nothing of the said sculpture can be detected even with the microscope so long as the animal is immersed in spirit. Also in mounted specimens it is greatly obliterated in most places except on the margins of the body, which in consequence of it appear finely serrated under the microscope. The individual combs are always very minute and more or less dish- or cup-shaped, but vary considerably among themselves as to shape and size, and are separated from one another by sloping ridges whose breadth diminishes to a narrow crest at their apices. A comb of fair size measured 200 μ in length and 120 μ in width from apex to apex of the adjacent ridges, another one was 240 μ in length and 100 μ in width and a third one 150 $\mu \times 100\,\mu$.—No difference in regard to this sculpture on the dorsal and the ventral surfaces of the tape-worm was noticeable. No transverse wrinkles or furrows exist on the body of the animal, as are found in *Nesolecithus janickii* and *Schizochoerus liguloideus* (see Poche, 6) respectively.

In his short description of this animal Southwell makes no mention of the frontal glands, which are undoubtedly present, as is also the case with all other known Amphilinidea. That the structures in question are really enormous unicellular glands and not, as Woodland (9, pp. 60-64) has maintained, the fibres of a mighty boring muscle, I have fully shown elsewhere (6; see also 5, p. 591 f.). As I had no anterior part of an individual for examination, I can say nothing further about their condition in *Gigantolina magna* except that they certainly do not, as is the case in *Amphilina foliacea*, extend into the posterior part of the body, therein agreeing with those of the Schizochoerinae.

The body musculature consists of very fine fibres. It is composed of a dense outer layer of longitudinal muscles, a much smaller number of diagonal oblique fibres and a dense internal layer of transverse muscles.

Like the other Amphilinidea *Gigantolina* possesses a pair of large lateral nerves which run near the margins of the body and, as far as the testicular bands extend, between these and the vitellaria (pl. V, fig. 2, *n*). I could distinguish them only in the stained specimen and even there not throughout their course. In some places they are best seen by holding the slide against the light.—Where in the hind end of the body the testicular bands curve inwards and secede from the vitellaria (see below p. 6), the nerves run next to the inner margin of these to a point where the vitellaria (or in specimens where these, whose extent is not always exactly the same, have already terminated, the paired vitelloducts) in their turn bend medially and in doing so cross the nerves ventrally. This crossing point lies a little behind the posterior bend of the first ascending branch of the uterus on the right side of the cestode, and in the specimen before me at a slightly more anterior level on the left side. From these points backwards the nerves gradually approach the posterior margin of the body, until at their posterior extremities they are only about 0·5 mm. distant from it; this is less than a third of their distance from the margin throughout the greatest part of the animal. At these points they are approximately equidistant from the sagittal plane and the posterior margin of the body. From here they turn medially and slightly forwards and unite with each other in the middle line dorsally to the terminal portion of the male efferent duct. and form by their union a rather flat transversely placed arc whose convexity is directed towards the anterior end of the tapeworm. From the posterior side of this arc there arises on either side about midway between its beginning and the male efferent duct a short and somewhat thinner nerve. It runs obliquely backwards and laterally at an angle of approximately 45° to the sagittal plane till it almost reaches the hind margin of the body a little medially from the place where, in the specimen under consideration, the male genital papilla referred to above begins (see p. 4). It evidently represents a male genital nerve. The whole arrangement shows a striking similarity to that described and figured by me for *Amphilina foliacea* (5, p. 589 f).

Of the excretory system I could only distinguish some portions in the stained specimen. These suffice, however, to show that it is of the reticular type, as is also characteristic of *Amphilina foliacea* and the

Schizochoerinae, while main longitudinal channels as are found in *Amphilina paragonopora* (Woodland, 9, p. 65) are apparently absent. More especially I have observed two narrow parallel excretory vessels running from the anterior and middle part of the seminal vesicle obliquely forwards and towards the right to the first, backwardly directed portion of the first ascending branch of the uterus (pl. V, fig. 2, *c*). The anterior of these vessels reappears on the right side of the uterus and continues its course towards the right and somewhat backwards till it is again obscured from view by that organ. Both of them give off lateral branches, which anastomose with one another and with the branches of the other vessel. They are mostly too fine to be shown in a drawing of so small a scale as my fig. 2, on pl. V The whole network lies ventral to the vitelloducts, the vagina and the uterus. The anterior vessel is narrowest on the left side and very gradually increases in width towards the right, where it attains a breadth of 36 μ. I was also able to distinguish a dense, irregular network of fine excretory vessels at the posterior extremity of the animal near the dorsal surface, occupying approximately a semicircle whose anterior end lies near the vaginal pore and which extends to the posterior end of the body.—Immediately to the right of the male genital pore, but a little more anteriorly than the latter and some distance below the surface of the body, I have, in the specimen referred to, observed a small, slightly oval vesicle with perfectly smooth, thin walls and with the longer diameter of 45μ (pl. V, fig. 3, *ve*). From its shape and position it may perhaps erpresent an optical section through the excretory vesicle, but I am by no means certain that this is the case.

The male genital organs Southwell (8) described as follows: "The testes lie scattered about through the parenchyma. At a point about 15 mm. from the posterior extremity, the paired vas deferens unite in the middle line, and open by a minute pore 1 mm. from the posterior extremity." Brief as this account is, it is incorrect in more than one respect. In the first place the testes do not lie scattered about through the parenchyma, as is the case in *Amphilina foliacea*, but are strictly limited to two narrow, regularly arranged bands (pl. V, figs. 1, 2, ; pl. VI, figs. 4, 5, *t*). This arrangement is also clearly shown in Southwell's figs. 6 and 7, pl. xxvii. These bands I have (4, p. 281) designated as "Hodenstreifen", and will accordingly speak of them as the testicular bands in the following account. They stretch over the greatest part of the length of the animal and, except in their hindermost part, are situated symmetrically throughout on the sides of the body a little internally to the vitellaria and just outside the two ascending branches of the uterus. At many places they are even partially or in the whole of their breadth covered over dorsally or ventrally by coils of the uterus. Only from the anterior part of the left testicular band the corresponding section of the uterus seems to be slightly further removed (see below p. 20). Anteriorly these bands, according to Southwell's fig. 6, extend to near the anterior end of the animal, reaching here a little further than the uterus, but not so far as the vitellaria (see below p. 12). Posteriorly the testicular bands run internally to the vitellaria, etc., till they almost or quite reach the level of the anterior end of the accessory receptaculum seminis (see below p. 16). Here the

right band suddenly changes its direction, running obliquely backwards and medially at an angleof about 45° to the sagittal plane—and crossing the first ascending branch of the uterus on the ventral side—till it reaches the right margin of the broad part of this receptaculum approximately about the middle of its length. According to Southwell's fig. 7 the point of meeting would be at the hind end of the anterior third of this part of the said receptaculum, which he calls germarium (see p. 11). Having examined the same specimen I find that his drawing is inexact in this respect (*cf.* my fig. 1 on plate V). From here the testicular band, at least in the individuals examined by me (see below p. 8), takes a course which is somewhat more transverse and less backwards. It crosses the broad part of the accessory receptaculum seminis on the ventral side, reaching its left margin in the posterior third of its length, but always more or less anterior to its hind margin. It continues further for a short distance till it meets and unites with the left testicular band at a more or less obtuse angle. This latter band at the level referred to above, though not always at exactly the same level as the right testicular band, also changes its direction, but in a lesser degree and more gradually, running posteriorly and more or less medially till it is joined by the band of the other side at the level of the posterior third of the broad part of the accessory receptaculum seminis and somewhat nearer this receptacle than the vitellarium, but far to the left of the middle line of the animal. From here the united testicular band in the specimens examined by me forms a very obtuse angle with the left and an angle of not much more than 90° with the right testicular band, and runs backwards as a more or less direct continuation of the former. Its trend towards the sagittal plane is always distinctly less marked than that of the immediately preceding part of the left testicular band. It traverses from a quarter to a third of the distance between the point of union of the two testicular bands and the hind end of the cestode and then ceases at a level which may be cephalad or caudad of the posterior margin of the germarium, but which always lies considerably anterior to the ends of the vitellaria. According to Southwell's figures 6 and 7, the testicular bands do not extend so far backwards as described by me; on the contrary the right testicular band in his figures ceases shortly before or just at the point of reaching the right margin of the accessory seminal receptacle (Southwell's germarium) and the left one at a somewhat more posterior level; this is however distinctly anterior to the point of union of the vasa deferentia and also anterior to the anterior extremity of the germarium (Southwell's shell-glands). Naturally, therefore, the two testicular bands are not shown as uniting in these drawings. As a result of my examination of the individual represented in Southwell's fig. 7 I find that his figure is incorrect in the points noted above, which in this specimen are as described by me and shown in my fig. 1 on plate V Southwell's mistake was probably due to the fact that the testes are difficult to see in unstained specimens, especially the more isolated ones towards the ends of the testicular bands. They are best seen when the light is slightly cut off, while I could best distinguish the few lying ventrally to the accessory receptaculum seminis with the naked eye by holding the slide against the light. Also the course of the corresponding parts of the vasa deferentia in Southwell's fig. 7

does not agree with that of the testicular bands as traced by me, in or along which they (see below p. 9) are situated (though I have not been able to actually see the paired vasa deferentia in this unstained specimen). The right vas deferens in this figure trends far too much backwards, so that its point of union with the left one comes to lie almost at the level of the posterior margin of the (real) germarium instead of anteriorly to the foremost point of the latter. Further the left vas deferens as well as the vas deferens commune are shown too far laterally. Thus it seems that the right vas deferens in Southwell's figure has only been drawn by concjeture. Regarding his fig. 6 I cannot positively say that it also is incorrect as to the position of these structures, for I have not been able to examine the specimen from which the figure was made and very considerable individual variation does occur regarding the backward extension of the testicular bands in the Amphilinidea, as was found by me in specimens of *Schizochoerus liguloideus* (6). In view, however, of the unreliability of Southwell's fig. 7 in these respects on the one hand and the striking discrepancy between the condition in the two specimens examined by me and that represented in his fig. 6 on the other, one can reasonably doubt the correctness of the latter drawing as well.—The union of the testicular bands at their posterior ends is a feature of great morphological interest as it constitutes a link between the disposition of the testes as found in *Amphilina foliacea*, where they occupy a single field in the central area of the body, often more or less forked in its anterior part, and that in the other Amphilinidea, where they are restricted to the sides of the animal.

Each testicular band is composed of a very large number of testicles, roughly numbering at least about 2,200. Throughout the main portion of the bands the testicles are for the greatest part arranged in two irregular, in general closely juxtaposed rows, only occasionally however showing a paired disposition in their arrangement. Some of the testes partly overlap each other. Sometimes three, very rarely four testes are situated more or less side by side in a line, while in other places there is only one in the breadth of the band. The successive testicles mostly lie quite close to each other, but here and there short spaces intervene between them. Areas with testes arranged more densely, as described above, alternate quite irregularly with areas in which they are sparser. The average breadth of the testicular bands is about 350—400μ. Shortly before reaching the right margin of the accessory seminal receptacle the right testicular band, and shortly before its union with the band of the left side the latter gradually increases to about 600μ in width in consequence of the large number of more or less juxtaposited testes (see pl. V, figs. 1, 2, *t*). I cannot describe the behaviour of the right testicular band in the stained specimen ventrally of the said receptacle, as the sperm contained in the latter organ is so deeply stained as to make the overlying structures quite invisible. In the unstained individual the above-mentioned broader portion of this band abruptly ceases immediately after reaching the right margin of the receptaculum in question and is followed by a very poorly developed section composed of only a few testicles arranged more or less in a single line and for the greater part separated from each other by a

small or (on the left side of the receptaculum) a rather larger interspace. This condition persists down to the point of union of the two testicular bands. No conclusions can, however, be drawn therefrom as to the configuration of the right testicular band ventrally to the accessory receptaculum seminis in the stained specimen; for in it the band on again becoming visible at the left margin of the receptacle shows the same strong development which it had attained on the right side of this organ and preserves this character to its junction with the left band. Posterior to this junction the development of the now united testicular band shows in both individuals a rapid decline, consisting except at its foremost end of only a single row of testicles partly separated from each other by short but distinct interspaces and continuing so for the rest of its length.—At the anterior ends of the testicular bands the testes, as is apparent from Southwell's fig. 6, are for a short distance also arranged in a single row and for the greater part slightly separated from one another. I all the more consider this as a correct representation of the facts as it is in full harmony with what I have observed in *Schizochoerus liguloideus* (6).

The individual testicles have a more or less circular, oval or even a somewhat irregular contour, while a few of them show an indentation of the margin. Their long axis may be directed longitudinally, transversely or obliquely. Their size also varies to a certain degree in the same individual. In the stained specimen a middle-sized circular testis measured 250μ in diameter; a middle-sized and a rather large oval one 340μ and 400μ respectively, while the big hindermost one was 300$\times$400μ. As is to be expected from their size they are easily seen with the naked eye. In the stained specimen most of the testicles contain several dark-brown balls of a granular appearance which are mostly more or less circular with a diameter of about 40—75μ; more rarely, they are ovoid with a long axis measuring up to 96μ. Besides these there are other similar but lighter coloured balls, which have, probably because of their being in a different stage of development, taken the stain in a lesser degree or not at all and are, therefore, much less conspicuous. From the situation and appearance of these balls and moreover from my observations on *Schizochoerus* (*t. c.*), in which the details were better discernible, I can confidently say that they represent the different generations of the descendants of the germ cells, perhaps held together by a cytophore.

The testicular bands are traversed longitudinally by the vasa deferentia (pl. V, fig. 2, *vd*). These are for the greatest part situated more or less in the middle of the bands; the testes, however, are not all arranged along their sides, but in part also just above or below them. The vasa deferentia are only discernible in certain parts, especially where the individual testicles are separated from one another by interspaces. As in the case of *Schizochoerus* (6) the testes are of course connected with them by short vasa efferentia, which in whole mounts were nowhere visible. The point of union of the vasa deferentia lies, as is evident from the preceding, at the junction of the testicular bands. They therefore by no means unite in the middle line as Southwell says (see above p. 6), but very much to the left of it, as is also quite apparent from his figures. Further, their point of union lies posterior to the posterior turning point of the uterus and laterally to the descending branch

of the latter—characters in which *Gigantolina* differs from the Schizochoerinae. The distance between their point of union and the posterior end of the animal is 10·5 mm. in my unstained specimen.

The part of the male genital duct between the junction of the vasa deferentia and the genital pore is represented in Southwell's figures as an almost straight tube which in its whole length is very gently curved outwards and shows no differentiation whatever. Neither its course nor its structure, however, is so simple in either of the specimens examined by me; and as one of these is the one figured by Southwell as his fig. 7, I am convinced that, making full allowance for the small scale of his drawings, his fig. 6 also is incorrect in this respect. As far as the vas deferens commune (pl. V, figs. 1, 2, *vc*) traverses the united testicular band, its course has already been treated of above (p. 7). From the end of this band the male genital duct continues caudad and somewhat medially in at least essentially the same direction till it reaches the sagittal plane a short distance in front of the hind end of the animal. In the beginning of this section the duct is formed by the continuation of the undifferentiated vas deferens commune, which gradually widens a little and after a rather short distance, increasing considerably in width, differentiates itself as a long, but relatively narrow, and slightly undulated vesicula seminalis (pl. V, figs. 1, 2, *vs*). The latter rapidly attains its greatest breadth and then very gradually narrows again till it reaches the muscular ring described below (p. 15). It is empty in both the specimens before me. The outlines of its anterior portion are not regular, but show complications rather difficult of exact interpretation which vary considerably in the two individuals before me and are, for the sake of clearness, only partly represented in the drawings. They are probably due partly to dorsoventral flexures of the seminal vesicle and partly either to foldings caused by the collapsing of its walls in consequence of its being empty or to evaginations of the organ, an apparently more highly developed type of which I have described for *Schizochoerus liguloideus* (6). At the level of the above-mentioned muscular ring there follows a part which shows no sharp demarcation from the preceding section, but attains a somewhat greater width than the hindermost part of the latter (pl. V, figs. 1, 2, *ap*). It probably represents the propulsory apparatus (see Poche, 6), which is characteristic of the Amphilinidea. If so, it is, however, evidently much less strongly developed, as instead of the powerful mass of muscles which are so conspicuous in the other members of the order, strong circular muscles are to be seen only at its hindermost end. The structure in question reaches to a point just left of the sagittal plane. From here the genital duct, suddenly turning at an obtuse or almost a right angle, runs backwards with slight lateral undulations in the middle line of the animal. With the exception of its foremost part this portion of it is surrounded by a rather thick structure which is doubtlessly composed of the prostate glands, and is therefore the pars prostatica (pl. V, figs. 1, 2, *pp*). The latter in its course gradually narrows, passes ventrally to the posterior nerve commissure and sometimes, trending a little to the right, transgresses the sagittal plane and continues just to its right. The pars prostatica is succeeded by a very short section which has very thick and seemingly strongly

muscular walls and is, therefore, somewhat broader than the terminal part of the former. It may represent a penis-pocket, such as is characteristic of the Schizochoerinae. From it a short, steeply ascending part leads to the male genital pore, which lies exactly in the middle line or, probably in consequence of inequal contraction of the body, just to the right of it. It is situated very near the posterior end of the animal, but distinctly on the dorsal surface (see pl. V, figs. 1, 3, *pm*), and where a genital papilla is visible, halfway between the base and the end of the latter. Only slightly behind the pore the steep declivity of the dorsal surface towards the margin of the animal sets in. In the unstained specimen the distance of the pore from the nearest point of the margin is 405μ and from the posterior tip of the body 500μ, while the latter distance amounts to only 135μ in the stained specimen, whereas it is recorded by Southwell as measuring 1 mm. Relatively considerable differences are thus seen to exist in the species in regard to the exact position of the male genital pore, the difference in size of the various individuals being by no means very great (see above p. 2); probably they are partly due to differences in the state of contraction of the different individuals.

Immediately to the right of the male genital pore but at a deeper level in the body I have observed in the unstained specimen a slender, slightly curved rod of a length of 34μ lying transversally and bent almost at a right angle at its outward end. I am inclined to regard it as a persisting embryonic hook. These hooks, which are ten in number in the embryo, have been recorded by me (6; 5, p. 600ff.) as persisting in full number in *Schizochoerus liguloideus* and *Amphilina foliacea*. That it is longer than those measured by me on the embryos themselves (see below p. 24) presents no serious objection against this interpretation; for in that portion of the uterus the eggs and the embryonic hooks had probably not yet attained their maximum size. Further, certain hooks of some embryos reach a length considerably greater than is usual (6; 5, p. 604). Having, however, been able to discover only one such structure I cannot positively say that it really represents an embryonic hook.

Regarding the interpretation of the different parts of the female genital apparatus I have come to conclusions differing very considerably from those of Southwell. Southwell says (8, p. 327): "The germarium is situated in the middle line 15 mm. from the posterior extremity. It is 7 mm. long and 3·5 mm. broad. Immediately posterior to it are the paired follicular shell-glands. These are each 3 mm. long and together are 3 mm. broad." He further states that our species differs "from *A. liguloidea* in the absence of a vagina, anterior to the germarium" Now what Southwell regards as the germarium is in reality the anterior prolongation of the vagina, *i.e.*, the accessory receptaculum seminis as I have called it (4, p. 280f.; 6), as is proved beyond doubt by its contents (see below p. 17). What he calls the paired follicular shell-glands is the two-winged germarium as is clearly shown by its structure (see p. 12). Further, paired shell-glands for a single germarium would be a unique occurrence among the Platodaria. The real shell-gland lies posterior to the germarium.

The germarium lies approximately in the sagittal plane, sometimes a little more to the right or to the left, at a distance of 6 mm. from the posterior end of the parasite (pl. V, figs. 1, 2, pl. VI, fig. 4, *g*). It is distinctly two-winged in shape, consisting as it does of rather broad right and left wings which are only approximately symmetrical with one another, and a narrow median connecting part. Each wing has more or less the shape of a fan with a very long base and is composed of a number of moderately narrow tubes. The tubes are arranged irregularly radially, and are straight or somewhat curved and rounded and often also somewhat dilated at their peripheral ends. They lie more or less horizontally in two layers one above the other. A few of them bifurcate, each branch being about as broad as the original tube. They are composed of a compact mass of rounded germ-cells, while the median part of the germarium shows a less dense structure. In the stained specimen the wings of the germarium measure 2 mm. and 1·7 mm. in length, whereas the width of the whole organ is 3·3 mm. In the unstained individual the respective dimensions are 3·3 mm., 3·35 mm. and 4·9 mm. This is at variance with Southwell's statement (see above p. 11) according to which the length of each wing (regarded by him as follicular shell-glands) would be as great as the breadth of the whole organ, *viz.*, 3 mm. These measurements are probably taken from the specimen represented in his fig. 6, but according to his own figure the breadth of the germarium in this individual also is noticeably greater than the length of either of its wings. In view of my measurements of the individuals examined by me I regard it as very probable that in this point Southwell's figure is correct while his account is wrong and not *vice versa*.

The moderately developed vitelline glands are situated very near the margins of the body and extend as two narrow stripes over nearly the whole length of the cestode (pl. V, figs. 1, 2, and pl. VI, fig. 5, *v*). Anteriorly, according to Southwell's fig. 6, the left gland extends to a point midway between the anterior end of the testicular bands and that of the animal, while the right gland extends almost to the anterior extremity of the latter. Posteriorly in the specimens examined by me the right vitellarium extends almost or quite to the level of the muscular ring already referred to above (p. 4), while the left one ends a little more anteriorly and always noticeably ahead of the level of the ring. The hindermost parts of the vitellaria, besides coming nearer to the sagittal plane owing to the narrowing of the body towards its posterior extremity, gradually shift away a little from its margins and run more or less media for a somewhat varying distance. Accordingly the ends of the glands in question lie at a greater or lesser distance from the median line, but always considerably lateral to it. The end of the left one lies external to the vesicula seminalis and that of the right one at almost or exactly the same distance from that line. In at least some specimens the extreme ends of the vitellaria pass very obliquely inwards below the lateral nerves (pl. V, fig. 2, *v*). It is, however, very doubtful whether this is always the case (see pl. V, fig. 1 ; in this specimen unfortunately the nerves could not be made out). In the case of individuals in which the vitellaria do not cross below these nerves, it is the paired vitelloducts, to be described further on, which do so. In Southwell's fig. 6 the left

vitellarium, contrary to the condition found in my specimens, extends somewhat further posteriorly than the right one, and in this as well as in his next figure both these glands end at a noticeably more anterior level than in the said specimens. As a result of my examination of the individual represented in Southwell's fig. 7, I am in a position to say that the drawing is inaccurate in this respect and the backward extension of the vitellaria in this specimen is as described above (pl. V, fig. 1). As to his fig. 6 I cannot speak positively in regard to the point in question as individual differences certainly do occur in this respect, but I must confess that I am rather inclined to doubt the accuracy of his figure. The vitelline glands are composed of an enormous number of follicles of various sizes and shapes, which are partly arranged in groups mostly somewhat indistinctly separated from each other. The follicles are crowded almost through the whole length of the glands; but at the posterior and, so far as one can gather from Southwell's fig. 6, at the anterior tips of the latter they are much sparser. As in the other Amphilinidea each vitellarium is traversed longitudinally by a narrow channel—the long vitelloduct. The vitelline follicles are mostly situated on the two sides of these ducts, but often also directly above or below them, and the duct as a result is often not to be distinguished in these places. Only here and there a very short part of the tube is devoid of them. The course of the vitellaria is mostly straight, but in some places they show short undulations. Bifurcations and subsequent reunions of the two branches, which are characteristic for *Nesolecithus janickii*, do not occur in the vitelline glands of this species. The outer margin of the glands is in greater part smooth, but in some places is provided with projections and indentations. These are much more strongly developed and far more numerous on the inner margin. These complications in the course of their margins as well as the undulations of the vitellaria referred to above are, however, by no means so considerable and the latter are also certainly not so numerous as shown in Southwell's fig. 7, as I can substantiate from my examination of the specimen he figured. His fig. 6, while apparently also somewhat inexact, though in the opposite direction, is certainly much nearer to the mark in this respect. The average breadth of the vitellaria shows no appreciable differences throughout the main part of their length in the fragments examined by me and is 450μ, *i. e.*, at least $\frac{1}{10}$ of that of the animal; towards their posterior ends however it decreases very gradually from the level of the anterior end of the accessory receptaculum seminis on the right side and from approximately the level of the posterior end of the broad part of the organ on the left. According to Southwell's fig. 6 the breadth of the vitellaria likewise gradually decreases, but to a much greater degree, at their anterior extremity, beginning from a point a little behind the level of the uterine pore. Besides, it would seem from his figure that throughout approximately the anterior third of their length the vitellaria are somewhat narrower than further backwards, a condition which would be in full accordance with that found by me in *Schizochoerus liguloideus* (6).

From the posterior ends of the vitellaria the paired vitelloducts start as direct continuations of the long vitelloducts (pl. V, figs. 1, 2, *vp*). The right one runs medially and sometimes slightly backwards

to a point lying a little laterally of the muscular ring referred to above. The left one, which commences at a somewhat more anterior level (*vide supra* p. 12), runs medially and somewhat backwards, passing underneath the vesicula seminalis and reappearing on its inner margin at or a little in front of the level of the anterior end of the muscular ring and somewhat lateral to the latter. The duct is at this point on a level with or a little ahead of the last mentioned point in the course of the right vitelloduct. In Southwell's fig. 7 the latter condition is represented, whereas the former was found by me in the specimen (pl. V, fig. 1). At these points the paired vitelloducts turn anteriorly and more or less medially, either suddenly at an obtuse angle or more gradually in the shape of an arc, and continue in this direction till they meet in a right or acute angle in the sagittal plane or slightly to the left of it where they unite to form the unpaired vitelloduct. Their point of union is situated at very different levels. In one specimen it was nearer to the germarium than to the muscular ring mentioned above, while in another it was about three times further from the former than from the latter. It, however, never lies posterior to the level of the hinder end of either of the vitellaria. The paired vitelloducts are broadest at the place of their origin, but soon grow somewhat narrower except for local swellings due to accidental accumulations of vitellocytes.

The unpaired vitelloduct (pl. V, figs. 1 and 2, *vi*) runs forward for a short or a somewhat longer distance, according to the level of the point of union of the paired vitelloducts, with only an occasional slight lateral deviation and sometimes broadening locally due to the cause mentioned above for the paired vitelloducts, till it reaches the complex formed by the shell-gland and the receptaculum seminis (see below). Here it disappears from view in the specimens before me and of course opens into the shell-gland. Its breadth is greater than that of the adjoining parts of the paired vitelloducts. In Southwell's figures 6 and 7 the paired vitelloducts are distinctly shown as not uniting but rather as overlying one another in the median part of the body. In full accordance with it Southwell also says that the *ducts* of the vitelline glands open close to the shell-gland. The union of the ducts as described and figured by me was however clearly to be seen in both the individuals examined by me. This is also the state of things to be expected by analogy with the related forms, while a condition like that represented by Southwell would be an absolutely unique occurrence.

Immediately behind the median portion of the germarium and almost or exactly in the sagittal plane of the animal is a rather small complex which does not lend itself to further optical analysis. From its position relative to the organs surrounding it there can, however, be no doubt that it represents the shell-gland and evidently also the (ordinary) receptaculum seminis (pl. V, figs. 1, 2, *gl*), which, as I have recently shown (6), is similarly often indistinguishable from the former in whole mounts of *Schizochoerus liguloideus*. The whole complex is clearly shown in Southwell's fig. 7 and less distinctly in his fig. 6 but it is neither labelled in the figures nor referred to in his text.

In the unstained specimen one can see rather indistinctly close to the left side of the complex just mentioned what seems to be a narrow duct originating at the hind end of the middle portion of the germarium and extending posteriorly somewhat further than half the length of the said complex (pl. V, fig. 1, *d*). If this is so, the structure in question is certainly the germinal duct and enters the shell-gland.

Backwards from the shell-gland runs the vagina (pl.V, figs. 1, 2, *va*). Southwell's remarks (8, p. 327) about the vagina are as follows :—" The vaginal pore is 2 mm. from the posterior extremity " and " The situation of the male and the vaginal pores also resemble that of *A. liguloidea* and differs from that of *A. foliacea*." The vagina runs approximately in the sagittal plane, sometimes almost in a straight line, sometimes bending sideways for a portion of its length. In its anterior part it lies to the right of and close to the unpaired vitelloduct. According to its further course and that of the latter in the individual specimen it either crosses the unpaired vitelline duct and further backwards the left paired vitelloduct or only the right vitelloduct on the dorsal side. In both cases, however, it crosses the paired vitelloduct near its point of union with its companion. Southwell's figs. 6 and 7 both show the vagina lying entirely to the left of the unpaired vitelloduct. This is, however, not the case in the specimen represented in fig. 7 (see my pl. V, fig. 1), and in view of this and of the exactly opposite condition in the other specimen examined by me (pl. V, fig. 2) I very much doubt whether it is correct for the individual shown in fig. 6. The vagina opens by a single pore situated on the dorsal surface in the sagittal plane near the hind end of the cestode, almost immediately or a short distance in front of the point where the male genital duct reaches the same plane. The distance between the vaginal pore and the posterior extremity of the body is approximately 2 mm. in my unstained specimen. There is thus in this species only one vaginal pore and Southwell is wrong in stating that the situation of the male and the vaginal pores resembles that of *Amphilina liguloidea* (*vide supra*). The character given by me (4, p. 280) for the family Schizochoeridae recognised by me at the time, *viz.*, that the vagina bifurcates in its posterior part and opens by means of two pores, one on the dorsal and the other on the ventral surface, does not, therefore, hold good for *G. magna* which I then included in that family.

The vaginal pore at a distance of about 300μ is surrounded by a broad muscular ring slightly elongated in the transverse direction (pl. V, figs. 1, 2, *a*). The ring consists of a very dense mass of exceedingly fine, circular muscle-fibres which are far more numerous than was found possible to indicate in these small scale drawings. These fibres do not run quite parallel to one another in their whole course, but frequently cross each other obliquely. The ring is sharply limited on its external and on its internal margin. Its dimensions are 1100μ $\times$ 1400μ in the unstained, and 760μ $\times$ 800μ in the stained specimen, while the breadth of the ring itself is 210μ in the former. Southwell makes no mention of this remarkable structure, which is, so far as our present knowledge goes, quite unique amongst the Amphilinidea. It is to be noted, however, that he (figs. 6, 7) represents the vaginal pore as a comparatively large, transversally situated ellipse whose smaller diameter is

far greater than that of the vagina, a condition which does certainly not exist in the specimens. It seems possible, therefore, that the large vaginal pore in his figures wrongly represents the muscular ring in question.

In *G. magna*, as in the Schizochoerinae, there exists besides the ordinary receptaculum seminis a second one extending anteriorly of the former and the shell-gland, which I (4, p. 280 ff.; 6) have termed the accessory receptaculum seminis (pl. V, figs. 1, 2 and pl. VI, fig. 4, *r*). My reasons for regarding the latter as the accessory and the other as the ordinary seminal receptacle and not *vice versa* I have set forth in my second paper cited above to which the reader is referred for details. As in *Schizochoerus liguloideus* the accessory receptaculum seminis of *G. magna* is the direct continuation of the vagina, while the ordinary seminal receptacle evidently is connected with the latter only by a narrow passage not discernible in whole mounts. Southwell's fig. 7, in which the vagina is distinctly represented as opening along its full breadth into an approximately circular structure situated immediately behind his supposed shell-glands, which is neither labelled nor referred to in the text (see p. 14), is therefore incorrect in this respect. The same remark applies to his fig. 6 in which the vagina is shown opening along its full breadth into the cavity of the supposed shell-gland. As to the posterior limit of the accessory receptaculum seminis, I have (6) in *Schizochoerus* drawn it at the place of communication between the ordinary seminal receptacle and the vagina, thus regarding this point as representing the anterior end of the last-mentioned organ. This delimitation is in full accord with the usual termination of the vagina, respectively with the receptaculum seminis and is, in that genus, borne out by the fact that the structure in question does not more anteriorly show any marked differentiation the beginning of which could with any show of reason be considered as the posterior limit of the accessory seminal receptacle. In *G. magna* on the other hand such a differentiation of the structure is certainly present in the very great and more or less sudden enlargement at the anterior end of the germarium (see below); and one would at first be very much inclined to fix the posterior boundary of the accessory receptaculum seminis at this point. This would not, however, be in accordance with the usual place of termination of the vagina, to which the part up to the enlargement referred to above would then have to be reckoned. Further, this delimitation of the organ would not be in harmony with the one adopted with good reasons for the related genus *Schizochoerus*. I, therefore, in *Gigantolina* also consider as the posterior limit of the accessory seminal receptacle the point of communication between the ordinary receptaculum seminis and the vagina, at least till a detailed histological investigation of the structure in question in *Gigantolina* as well as in the Schizochoerinae should show that some other delimitation is more in accordance with the morphological facts. The accessory seminal receptacle begins with a narrow posterior part which is as broad as or only slightly broader than the vagina and runs longitudinally along the median portion of the germarium to a point immediately or almost immediately in front of the latter. Here the organ quite suddenly or, according to Southwell's fig. 6, somewhat

gradually widens very considerably to form a large pouch of the shape of a bag, "a straight-sided ellipse" (see pl. V, figs. 1, 2, *r*) or, as shown in Southwell's fig. 6, a flask. The hindermost extremity of this pouch for a short distance lies between the anterior ends of the wings of the germarium. It is by no means always situated symmetrically in respect to the narrow posterior part of the organ as is represented in Southwell's figure, but may, on the contrary, extend very considerably further on either the right or the left side of the former. The shape of the whole vesicle may likewise show a more or less pronounced asymmetry. In the specimen represented in Southwell's fig. 7 this is, however, much less pronounced than is shown in his figure. My figures (pl. V, fig. 1, pl. VI, fig. 4), which are taken from the same individual, represent the vesicle correctly. The posterior margin of the vessel may in its whole extent form a long straight transverse line, while its anterior end is always rounded and its sides often more or less so. Its outline is in general smooth, but may occasionally show a broad and deep notch near the anterior end of the organ. The relative size of the vesicle varies considerably. It measures 6·3 mm. in length and 3·9 mm. in width in the unstained fragment before me, while the respective dimensions are 2·67 and 2·9 mm. in the stained one. Southwell gives these dimensions as 7 mm. and 3·5 mm., evidently from the specimen shown in his fig. 6. It is situated submedially, lying more to the right side in the two specimens examined by me, while it is shown slightly more to the left side in Southwell's fig. 6. Hence his statement that it is situated in the middle line (see above p. 11) is inexact. Its distance from the hind end of the animal is 7·8 mm. in my unstained specimen, while Southwell gives this distance as 15 mm., obviously for the complete individual represented in his fig. 6. It is densely filled with a yellowish brown mass which stains very deeply and appears nearly homogeneous when seen with a low power of the microscope and only very finely granular under strong magnifications. This mass obviously consists of sperm. The wall of the accessory receptaculum seminis including its narrow posterior part is distinctly thinner than that of the vagina. The distance traversed by the organ in question is always less than $\frac{1}{20}$ of the length of the body, which is a striking though morphologically not a very great difference between *Gigantolina* and the Schizochoerinae, in which subfamily the organ is tube-shaped and extends through at least $\frac{1}{6}$ of the length of the body.

Regarding the uterus of the tapeworm Southwell (8, p. 327) only says: "The uterus is a long convoluted tube having exactly the same form as that figured for *A. foliacea*. It opens by a minute pore which is situated at the base of the small anterior end of the worm. In this respect it agrees with *A. liguloidea*, Diesing, and differs from *A. foliacea* (Rud., 1819)." The uterus certainly possesses the three branches, each of which traverses the greatest part of the length of the animal, as is characteristic of all the Amphilinidea (pl. VI, figs. 4, 5, ua_1, *ud* and ua_2); but otherwise its form differs very considerably from that of *Amphilina foliacea* (*cf.* p. 21). These three branches of the uterus of the Amphilinidea I have (4, pp. 277, 280 ff.; and 6), in accordance with the corresponding terminology used in Trematodes and for facilitating reference, designated as follows: the one arising from

the shell-gland and running forward for nearly its entire length as the *first ascending branch* of the uterus, the one which follows it and runs backwards as the *descending branch* of the uterus, and the last one which turns forwards and runs to the uterine pore as the *second ascending branch* of the uterus. I have further (4, p. 281f. ; 6) called the point where the first ascending branch of the uterus passes into the descending branch the *anterior turning point of the uterus* and the spot where the descending branch passes into the second ascending one the *posterior turning point of the uterus.* The uterus is in consequence of its containing hundreds of thousands of eggs by far the most conspicuous internal organ in this cestode. Its first ascending branch arises from the shell-gland at or near the posterior margin of the latter and runs backward and somewhat to the right for a short distance, lying a little to the right (in Southwell's fig. 6 considerably so) of the sagittal plane, of the vagina, the unpaired vitelloduct and the anterior part of the right paired vitelloduct (pl. V, figs. 1, 2, *ua*↑). After traversing approximately two-thirds of the distance between its point of origin and the hindermost portion of the right paired vitelloduct it turns cephalad in a short curve directed laterally and continues in this direction up to a point which, according to Southwell's fig. 6, lies well within the short rapidly narrowing anterior end of the body. In its short section running backwards and to the right the course of the branch in question is comparatively simple, being in the main more or less straight and only here and there forming one or two short spiral coils. From the beginning of the curve just referred to, however, in the material at my disposal, at least in the fragments of specimens which are mounted on slides and apt for detailed examination, the uterus forms irregular spiral coils which run preponderantly transversely and mostly lie close to one another. In the hindermost portion of the said curve the individual coils are short and the uterus is separated by a relatively large interspace from the posterior part of the right paired vitelloduct and sometimes (see above p. 12) also from the hindermost end of the vitellarium and by at least an equal space from the germarium. Immediately in front of this portion the coils grow larger and extend laterally almost or quite to the lateral nerve, which the outermost margin of one or the other of them occasionally even transgresses dorsally. Medially the coils extend almost or fully to the germarium and the accessory receptaculum seminis. This increase in the size of the individual coils is at first rapid, but approximately from the level of the posterior end of the germarium becomes very gradual and ceases entirely a little anterior to the level of the accessory receptaculum seminis. Where the uterus crosses the testicular band (*vide supra* p. 6) its general outline shows distinct, deep indentations on both the outer and the inner sides due to the divergence or shortening of the respective coils Immediately anterior to this point the first ascending branch of the uterus shifts slightly more towards the sagittal plane and its lateral contour further on lies generally just medially to the testicular band, while in some places it is even separated from the latter by a narrow space. Some coils on the other hand overlap the testicular band and a few of them may extend right to the vitellarium. The breadth that this branch in consequence of the length of the indivi-

dual coils has attained somewhat anteriorly to the level of the accessory seminal receptacle it surpasses nowhere in its further course, while in many places it is only three-fifths and in some only half of it. Broader and narrower sections of varying lengths alternate quite irregularly throughout its extent. Throughout these fluctuations in its breadth its inner outline is much more irregular than its lateral one (see pl. VI, figs. 4, 5, *ua*↑). Its hindermost part, from the beginning of the short curve referred to above to a distance of about 2·5—4·5 cm. from this point, is further distinguished by the coils composing it being closely crowded together. The average width of the uterine tube in its first ascending branch very gradually increases from its place of origin to approximately the level of the anterior part of the germarium. From this latter point onwards it remains fairly constant, although the width of the individual coils varies to some extent. Southwell in his figs. 6 and 7 represents the branch under consideration as consisting from its origin to the end of the above-named curve of a simple arcuate tube without any coils whatever. This is wrong for the specimen from which figure 7 was made (see pl. V, fig. 1), and in view of this and of my similar finding in the other specimen examined, I am inclined to regard it as wrongly represented in Southwell's fig. 6 also. Figure 7 is further inexact in that the lateral contour of this uterine branch as a whole is shown as much more irregular than is actually the case (*cf. supra*, p. 18). As to the anterior part of the first ascending branch of the uterus, which was not present in either of the whole mounts with me, it appears from Southwell's fig. 6 that it is identical in position and character with the portion preceding it, except that in approximately the anterior third of the animal its coils are represented as less closely placed. At its end it turns medially and passes into the next branch. This, the descending branch of the uterus, according to Southwell's fig. 6 lies somewhat to the right of the sagittal plane at first, but after a short distance trends inwards into the middle of the body. Otherwise his figure reveals no difference between the anterior part of this branch and the rest of it. In the mounted fragments examined by me the descending branch of the uterus occupies in general the middle region of the body (pl. V, figs. 1, 2 and pl. VI, figs. 4, 5, *ud*); only here and there for a short distance it is shifted to the left of the sagittal plane by the first or to the right by the second ascending branch of the uterus. For the greater part it runs in irregular zigzags or lateral bends and does not form spiral coils. Where, however, the coils are formed, they are shorter and mostly decidedly wider than those of the first ascending branch. Its course in places where it is devoid of eggs is sometimes difficult to trace. The area of the body occupied by this branch is considerably narrower than that taken up by either of the ascending branches of the uterus. The space between the descending branch and the first ascending branch of the uterus is in general fairly narrow, while that between it and the second ascending branch is still narrower; as a result the exact delimitation between these two branches is not at all clear in some places. On reaching the anterior end of the accessory seminal receptacle the descending branch of the uterus trends more or less to the left and runs backwards next to the margin of the said organ till it almost or quite

reaches the hindmost part of the right testicular band. Here in a sharp, laterally directed curve it passes into the second ascending branch of the uterus. The representation of the descending branch of the uterus in Southwell's figures 6 and 7 differs markedly from the above description. From my examination of the specimen represented in figure 7, I can positively say that the latter is incorrect in this respect. Especially the branch in question is by no means restricted to so narrow an area of the body and in accordance therewith neither separated from the two ascending branches by such broad interspaces as it is represented in that drawing (*cf.* my pl. VI, fig. 4, *ud*). Further, it is in reality considerably wider and its whole configuration is different. Concerning Southwell's fig. 6, I am unable to speak with certainty, as I have had no opportunity of examining the particular specimen and individual differences may possibly occur in this respect. From the study of the specimens before me and the general inexactness of Southwell's respective drawings (*vide supra* pp. 7, 10, 13-16 etc.), I am, however, very doubtful about the accuracy of his figure in this respect.

The second ascending branch of the uterus runs in an anterior direction from its beginning to the uterine pore. This branch in the material examined by me, at least so far as the mounted specimens are concerned, also forms irregular spiral coils which are generally directed transversely and for the greatest part lie close to one another (pl. VI, figs. 4, 5, ua_2). Its lateral outline generally lies just inwards of the testicular band and is in some places even separated from the latter by a narrow space. Some coils, however, overlap the testicular band and a few of them may extend right to the vitellarium. At the hindermost end of this branch the coils are necessarily very short, as the space available for their development here is much restricted, owing to the shifting of the posterior end of the descending branch of the uterus to the left due to the voluminous accessory seminal receptacle on the one side, and to the curving inwards of the testicular band on the other (see above pp.7, 19, pl. V, figs. 1, 2, ua_2). From the very beginning, however, its coils increase rapidly in length, and slightly anterior to the level of the anterior end of the accessory receptaculum seminis they reach their full size. In its further course the breadth of this branch varies considerably, measuring in many places only down to three-fifths and in some only half as much as in others ; broader and narrower sections of varying length follow one another quite irregularly. Throughout these fluctuations in its breadth the inner outline of this branch is far more irregular than its outer one and its average breadth is somewhat greater than that of the first ascending branch of the uterus. The average width of the uterine tube in its second ascending branch is fairly constant throughout its course, although the width of the individual coils varies somewhat, and is more than that of the first ascending branch, being according to the individual greater by $\frac{1}{4}-\frac{1}{2}$ or is even twice as great. As in the case of the first ascending branch Southwell's fig. 7 is incorrect in respect to the second ascending branch in that the lateral outline of this branch is shown as much more irregular than is actually the case. According to Southwell's figure 6 the second ascending branch of the uterus in approximately the anterior third of its

length trends very gradually a little away from the testicular band, without, however, anywhere reaching the sagittal plane, while its course gradually becomes less and less complex, the spiral coils being more and more replaced by simple lateral undulations which are continued right up to the uterine pore. For a short length immediately preceding this pore the width of the branch in question is reduced to about three-fifths of the average width of its main portion. The pore itself, always according to Southwell's figure, lies at exactly the same level as the anterior turning point of the uterus and like it is well within the short rapidly narrowing head end of the body (*cf. supra* p. 18). It, however, lies at a good distance from the anterior extremity of the animal and considerably to the left of the sagittal plane, but nearer to the latter than to the margin of the body. Southwell's statement that it "is situated at the base of the small anterior end of the worm" (see above p. 17) is, therefore, apparently inexact. It is also evident from the above that the uterus of *Gigantolina magna* has by no means exactly the same form as that figured for *A. foliacea*, as was stated by Southwell (see above), but differs markedly from it in several respects. Its descending branch is situated in the medial part of the body and differs considerably in character from the two ascending branches, which in their turn present essentially similar features, and none of its branches forms large transverse coils. In *Amphilina foliacea* the descending branch of the uterus lies well laterally to the sagittal plane next to the first ascending branch, which it resembles very much in shape. The second ascending branch of the uterus is very different, having only a small number of transverse coils, most of which are conspicuous because of their comparatively enormous size.

In both the mounted fragments examined by me the first ascending branch of the uterus is for a distance of about 4 cm. from its origin mostly full and in parts crammed with eggs (see pl. V, figs. 1, 2 and pl. VI, figs. 4, 5, ua_1). In its further course sections of varying lengths more or less densely filled with eggs alternate with others which contain a smaller number of ova, while in some places there are only very few eggs. The descending branch of the uterus throughout the greater part of its length contains a comparatively limited number of eggs. In some places, however, compact masses of them are found collected together as an irregular zigzag rod-like formation with broadened and often prolonged corners (pl. VI, figs. 4, 5, *ud*). The second ascending branch of the uterus is, in the case of the fragments referred to, much less densely filled than the first one, it according to the individual having relatively few and throughout the greater part of its length very few eggs, or showing short sections and single coils which are more or less densely filled with ova alternating with mostly longer portions which contain a much smaller number of ova and in some places even only single ova (pl. VI, figs. 4, 5, ua_2). In view of the possible influence of the season on the production of eggs in the species, a point which is too often neglected by helminthologists, it may be noted that all the three specimens hitherto obtained were collected in February (7, p. 273). Southwell's figs. 6 and 7 represent the uterus as containing a large number of isolated eggs and small groups of such distributed pretty evenly throughout its whole length, with the exception of short areas at the

beginning of the first and at the end of the second ascending branch which are empty. This is, however, not the case in the specimen represented in his fig. 7 (*cf.* my fig. 1, pl. V and fig. 4, pl. VI, which are taken from the same individual). Probably the same is true of the specimen represented in his fig. 6. These inaccuracies in these figures are perhaps due to the small size of the latter.

Of the ova Southwell (8, p. 328) says : "The eggs are large, measuring almost ·1 mm. In shape they resemble half a sphere, the flat surface of which has become concave. No filament was observed." In the mounted specimens almost all the eggs in the posterior 2—4·5 cm. of the first ascending branch of the uterus, provided they are not totally deformed by shrinkage, show the shape ascribed to them by Southwell, their outlines sometimes being oval instead of circular, and also some of those in the further parts of the uterus (pl. VI, figs. 6, 8, 9). They are thus more or less cap-shaped, as I have also observed in the case of the ova of mounted specimens of *Amphilina foliacea* and as has also been recorded for other Cestoidea. This is, however, only due to a certain degree of shrinkage during the mounting, for the numerous eggs from unmounted fragments, which have come under my observation, were all quite spherical without any concavity whatever. I have satisfied myself about their shape by examining the eggs in spirit, under the microscope from all sides (pl. VI, figs. 10, 11, 15, 16). In these eggs also considerable shrinkage immediately sets in when through evaporation of the alcohol they get dry to some extent, and as a result they often become more or less cap-shaped. The egg-shell is thin. It presents no thickening at any place and has no appendages whatever, but possesses a considerable degree of elasticity, flattening under pressure exerted on the coverglass and afterwards regaining its spherical form. Removed from the uterus, the eggs are of a rather pale-drab colour when viewed with the naked eye. Under the microscope their shell appears hyaline, of a pale yellowish hue, approximating the colour of water with a very moderate quantity of white wine mixed with it. The following measurements of intra-uterine eggs refer exclusively to such whose outline had at the most been only slightly affected by shrinkage. Two ova at the very beginning of the first ascending branch of the uterus of the unstained specimen measured 81μ and 83μ respectively, and a dark brown one situated just in the middle of the bend formed by this branch at its posteriormost point 85μ (pl. VI, fig. 7). Such eggs, whose contents are in part or wholly of a dark brown colour, are found among others in limited numbers throughout the three branches of the uterus. They are very rarely cap-shaped, but almost always present an almost circular outline, being evidently more or less spherical. They are eggs whose development has come to a standstill, as is apparent from the fact that their size remains the same throughout the whole uterus. Very often several dark brown vitelline cells can be distinguished in them. They are, therefore, not analogous to the coal-black air-filled ova which are often observed in other cestodes. Besides these brown eggs there are found throughout the uterus others of the normal colour which show the cap-like shape and the size characteristic (in the mounted fragments) of those contained in the beginning of the first ascending branch of the uterus. They thus likewise repre-

sent ova whose development has remained stationary. Their number in comparison with that of the normally developed eggs is small, though they are fairly numerous. A similar phenomenon I have also observed in *Schizochoerus liguloideus* (6). The developing eggs gradually increase very considerably in size during their further way through the uterus, while at the same time their shell grows still thinner. This increase is most marked throughout the posterior 13 cm. of the first ascending branch of the uterus, but apparently continues in a small measure further on as well. From the first 2—4·5 cm. of the first ascending branch of the uterus onward the great majority of the eggs are greatly and irregularly deformed by shrinkage. Ova which I extracted from the foremost point of the first ascending branch of the uterus of the fragment subsequently stained and mounted, *i.e.*, from a place lying a little more than 12 cm. before the germarium, mostly measured 140—150μ in diameter (pl. VI, fig. 10); the smallest one however measured only 78μ, another one 81μ and two others each 87μ; these evidently are eggs whose development had come to a standstill (pl. VI, fig. 11). On the other hand two large ova had a diameter of 165μ each, and the largest one of the set that came under my observation measured 185μ. Those eggs whose development has remained stationary are generally, but not always, completely full (see pl. VI, fig. 11). In others the embryo, which at this place is already formed and has absorbed the yolk, very rarely occupies the whole or the greater part of the egg, but in most cases takes up only a relatively small portion of it (pl. VI, fig. 10, *cf.* also figs. 12, 15 and 16). The embryo is contiguous to the shell and keeps its place throughout all the revolutions that the egg may perform under the microscope, and is often connected with other points of the shell by a small number of fine thread-like plasmatic processes. Its shape is mostly that of an obtuse spindle or an oblong oval; but its appearance naturally differs much according to the position of the ovum. In the majority of cases eggs lying in alcohol so orient themselves that the embryo appears as a narrower or broader belt dividing the egg into two approximately equal parts (pl. VI, fig. 16); the belt, however, does not often extend longitudinally over the whole hemisphere and in breadth is about $\frac{2}{5}$—$1\frac{3}{5}$ of the diameter of the egg. In the comparatively rare cases when the embryo in these developing eggs occupies the greater part or the whole of the egg, the condition is due to the presence of a distinct membranous envelope, which in most places is separated from the body of the embryo by a wide space and evidently represents the enveloping membrane (designated as "yolk envelope" by Beaham (1, p. 71 f. and 111)). As an abnormality I have, among the ova in question, observed one of 180μ in diameter, which was flattened on one side to a plane measuring 155μ in diameter and throughout the whole extent of this plane was connected with a similarly flattened egg which had a diameter of 165μ and thus only slightly projected beyond the plane of union. Both these eggs were otherwise regularly formed and contained embryos which were to all appearance normally developed. Further details of the structure of the embryos were not discernible, and repeated attempts to clear the eggs in glycerine and mount them in glycerine jelly as recommended by Braun (2, p. 101) always resulted in failure, as in spite of all care they shrunk to such an extent as to

render it impossible to distinguish their internal structure. An egg lying in the descending branch of the uterus of the unstained specimen at a distance of 5 cm. before the germarium, whose outline had been only moderately affected by shrinkage, had a diameter of 170μ (pl. VI, fig. 12). The embryo in it showed the ten embryonic hooks (see also pl. VI, fig. 13). The longest of them measured 21μ, another large one 19·5μ and two short ones, which were much the shortest of all, 7μ. From here onwards all the eggs exhibited these hooks except where they were obscured by the folds of the shrunken shell. In another egg lying in the same branch of the uterus of the same specimen 2·5 cm. in front of the germarium and in which likewise all ten embryonic hooks were discernible, the two longest ones had a length of 19μ and the others were approximately 10·5—12μ (pl. VI, fig. 14). As in all Amphilinidea, ten is the normal number of embryonic hooks; often, however, not all of them are visible and sometimes a few of them are perhaps actually missing, as was observed by me in *Schizochoerus* (6). As in the other members of the order the hooklets are by principle arranged in pairs, but this arrangement is often only indistinctly or not at all recognisable in some of them. That the respective hooks belong to individual pairs is indicated by their definite resemblance to each other in regard to shape, size and direction. The hooks are situated near one end of the embryo, the posterior end as is evident from a comparison with the position occupied by them in other cestodes and particularly in the related form *Schizochoerus liguloideus* (*vide* Poche, *t. c.*), in a somewhat irregular and more or less arched transverse row with its convexity directed anteriorly. Most of the hooks are gently curved, the concavity of the curve being generally directed laterally. They appear like more or less slender spines and are thickest at their bases, tapering to an anteriorly and in some of them more or less laterally directed fine point. One or sometimes two pairs of rather fine, long, straight or nearly straight hooklets and, where they occur, the two particularly short ones, referred to above, are not pointed and are equally broad throughout their length. Relative to the long ones the width of these short hooks is much greater. Most of the hooks have a barb or a claw-like prolongation at their base directed upwards or more rarely sideways; often, however, it only appears as a swelling of the base. A sample of eggs extracted from the anteriormost point of the second ascending branch of the uterus of the fragment subsequently stained and mounted, *i.e.*, from a point lying a little more than 12 cm. before the germarium, was composed of only a very limited number of eggs, which is in full accord with the relatively small amount of ova contained in the said branch generally (see above p. 21). The smallest of these eggs measured only 79μ in diameter, another 81μ, two others 140μ and 145μ, while the biggest one observed by me was 150μ. That larger eggs were not contained in the sample or at least were not observed by me is easily explained by the comparative rarity of such large eggs on the one hand and the small number of eggs composing the lot on the other. The ova from this area otherwise exhibited no difference from the sample taken from the corresponding part of the first ascending branch of the uterus (*vide supra* p. 23). Four lots of eggs extracted from both ends of both the first and the second ascending branch of the uterus of the unmounted fragment

(see above p. 2) exhibited no differences among themselves, and will be dealt with collectively. The size of these eggs is within the limits found for those of the last-mentioned sample, the smallest ones measuring 81μ in diameter, other very small ones 84, 90 and 93 , some 135μ and the great majority 144—150μ, while a small number of big ones came up to 180μ. Neither was there any other difference between these and those just referred to, except that the enveloping membrane is often fully developed. In consequence of the opacity of the embryos contained in the eggs lying in alcohol their embryonic hooks were not distinguished in any specimen, although it is evident from the size of the great majority of the eggs and from the uterine areas from which many of them were taken that these must be well developed on the great majority of the embryos in question.—Southwell's statement quoted above (p. 22) that the ova of our species measure almost 0·1 mm. thus in the main only holds good for the eggs in a certain section of the uterus, *viz.*, in the hindermost part of its first ascending branch, where they have a diameter of about 80μ. The smallest egg measured by me was 78μ. Long before having passed through this branch of the uterus, however, the great majority of the normally developing eggs have attained a diameter of 140—150μ and a few even one of 185μ (pl. VI, fig. 16), this being the largest sized egg found by me in *G. magna*. Because of the circumstances mentioned above it was not possible for me to trace the development and structure of the embryos of *Gigantolina magna* in anything like the detail with which I was able to follow in the case of *Schizochoerus liguloideus* (6). From what I have observed of the embryonic development of the former species combined with what is known about that of other forms of the Amphilinidea we may, however, safely assume that in all essential features it is closely similar to that of *Schizochoerus liguloideus*.

In my systematic re-arrangement of the species in 1922 (4), which till then had been assigned to the genus *Amphilina*, I (p. 281) created for *A. magna* the new genus *Gigantolina*, which I placed in the new sub-family Gigantolininae. This latter with the new sub-family Schizochoerinae I placed in my new family Schizochoeridae (4, p. 280). Full definitions of my new family, sub-families and genus, which clearly set forth the reasons for their erection, were given in the paper. Without taking the slightest notice of my statements and without attempting to give any reasons for his conclusions, Woodland (10, p. 462) summarily, and in a most contemptuous manner, rejected the new family and sub-families created by me. As I say elsewhere (6), in view of the discovery of the very interesting species *Amphilina paragonopora* which was described by Woodland (9) after my first paper and which forms a connecting link between the Amphilinidae and the Schizochoeridae, I am myself of opinion that the separation of these two as distinct families is no longer warranted. This was impossible to foresee in 1922 and neither is it the point on which Woodland's censure of my classification rests. Further, it does not impair the validity of the sub-families erected by me, and still less does it afford any justification for the language which Woodland has thought fit to use. The reply due to him

together with a detailed discussion of the facts I am publishing in another place (6), to which those interested in the matter are referred. I may further mention that so competent helminthologists as Fuhrmann and Baer (2a, p. 86) evidently have a very different opinion of my classification of the Amphilinidea (4) than Woodland.

Because of the inclusion of the Schizochoeridae in the family Amphlinidae and the consequent change in the position of the Gigantolininae, which as already stated were originally referred to the former family, a change in the definition of this sub-family as originally given by me becomes necessary. At the same time detailed further study of *G. magna* makes it possible to now render the definition more exact in a few points. I now define the Gigantolininae as Amphilinidae without transverse wrinkles or furrows; with frontal glands not extending into the posterior part of the body; exceedingly numerous testicles arranged in two narrow longitudinal bands lying in the marginal parts of the body laterally to the two ascending branches of the uterus with the exception of the hindermost portion of the right band, which tra erses ventrally to the first ascending branch of the uterus to the left side of the animal and here unites with the left testicular band; paired vasa deferentia extending through the greatest part of the length of the body which do not ramify and unite posterior to the posterior turning point of the uterus and laterally to its descending branch; a short penis; a two-winged germarium branching into numerous tubes; moderately developed vitellaria beginning at the level of the retracted proboscis and ending behind the germarium and reaching a breadth of at least 1/40 of that of the animal; an unpaired vitelloduct running from behind forwards; a large accessory receptaculum seminis extending through less than 1/20 of the length of the body and consisting of a narrow, tube-like posterior and a broad more or less bag-shaped anterior part; an unforked vagina opening on the dorsal surface in the sagittal plane somewhat in front of the posterior extremity; a broad, strong muscular ring encircling the vaginal pore at a short distance; a descending branch of the uterus running approximately medially; a uterine pore situated a considerable distance behind the anterior end of the animal and at the level of the anterior turning point of the uterus, and producing spherical, thin-shelled eggs.

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[Throughout his whole paper Dr. Poche repeatedly accuses Dr. Southwell of inaccuracy and unreliability, especially as regards small details of structure.

Dr. Poche appears to overlook the fact that since Dr. Southwell wrote his account, the specimens have been transferred from formalin to alcohol and have remained in the latter for ten years. Small differences, such as he notes, are in all probability largerly due to shrinkage of the soft tissues, consequent on the treatment of the specimens, and do not justify the wholesale accusation of inaccuracy in which Dr. Poche indulges. *Editor.*]

EXPLANATION OF PLATE V.

FIG. 1.—Posterior extremity of *Gigantolina magna*, mounted unstained; ventral view. Paratype. ×66.

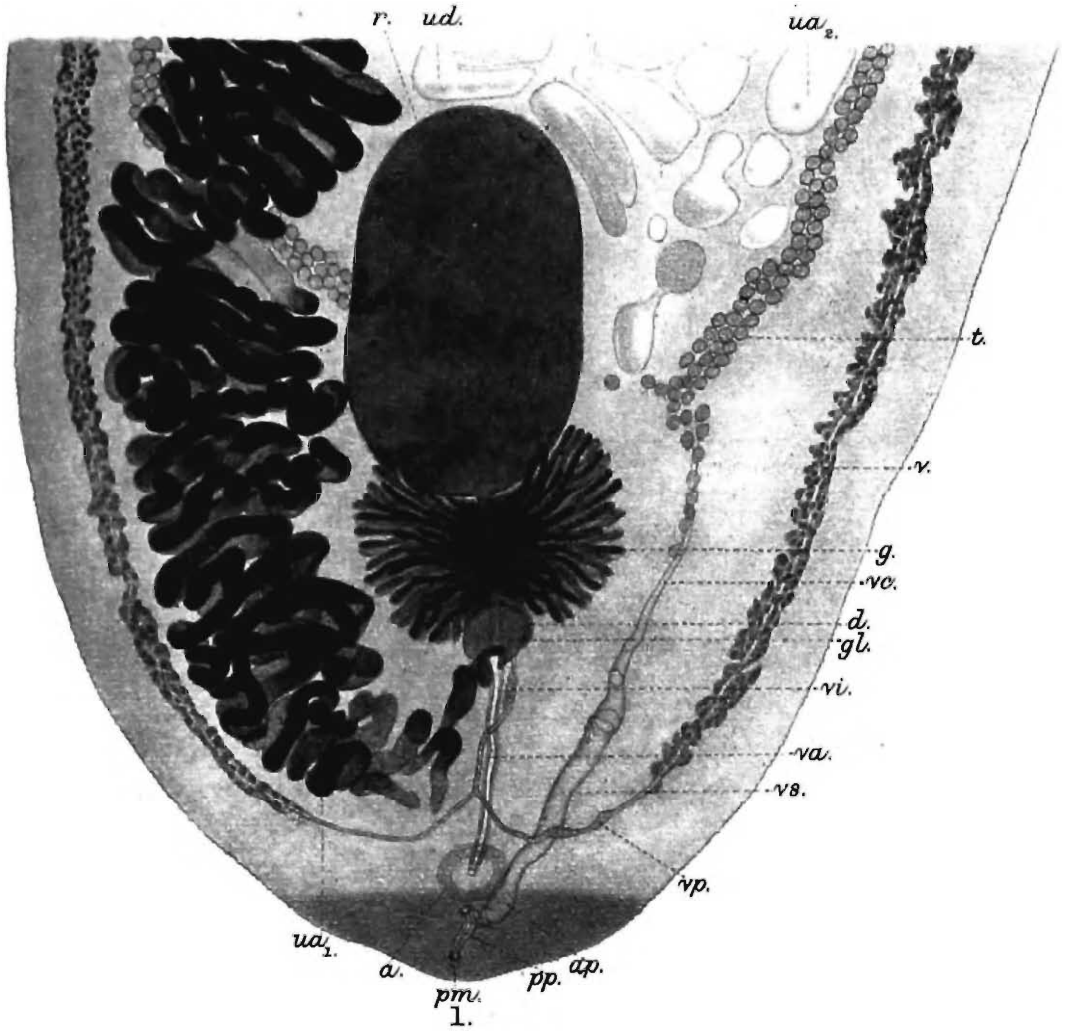
a muscular ring, *ap* propulsory apparatus, *d* germinal duct ?, *g* germarium, *gl* shell-gland (+ receptaculum seminis), *pm* male genital pore, *pp* pars prostatica, *r* accessory receptaculum seminis, *t* testes, ua_1 first ascending branch of the uterus, ua_2 second ascending branch of the uterus, *ud* descending branch of the uterus, *v* vitellarium, *va* vagina, *vc* vas deferens commune, *vi* unpaired vitelloduct, *vp* paired vitelloduct, *vs* vesicula seminalis.

FIG. 2.— Posterior extremity of *Gigantolina magna*, stained with borax-carmine; ventral view. Paratype ×8·6.

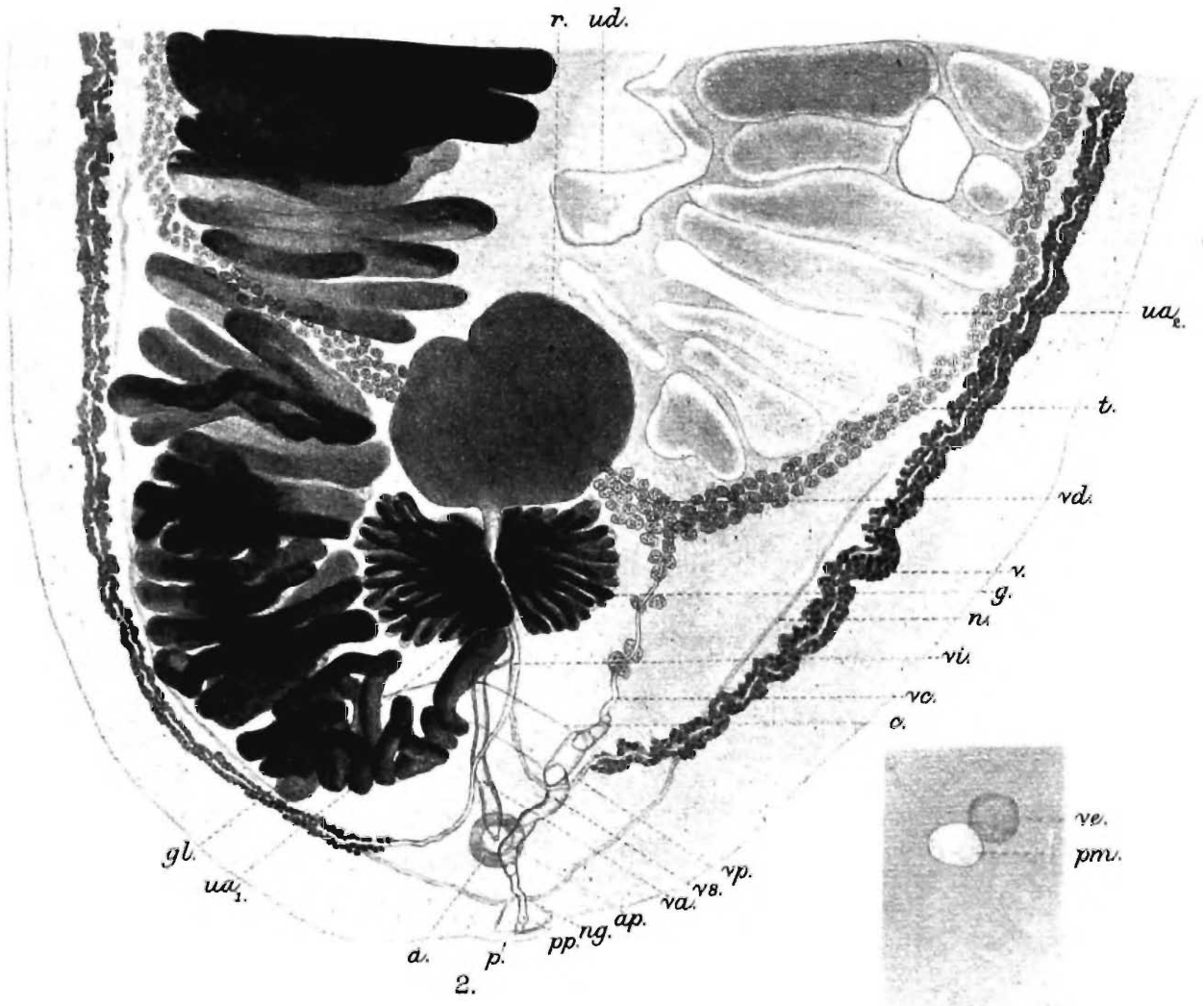
a muscular ring, *ap* propulsory apparatus, *c* excretory channel, *g* germarium, *gl* shell-gland (+ receptaculum seminis), *n* lateral nerve, *ng* male genital nerve, *p* male genital papilla, *pm* male genital pore, *pp* pars prostatica, *r* accessory receptaculum seminis, *t* testes, ua_1 first ascending branch of the uterus, ua_2 second ascending branch of the uterus, *ud* descending branch of the uterus, *v* vitellarium, *va* vagina, *vc* vas deferens commune, *vd* vas deferens, *vi* unpaired vitelloduct, *vp* paired vitelloduct, *vs* vesicula seminalis.

FIG. 3.— Male genital pore of the same specimen; dorsal view. ×125.

pm male genital pore, *ve* excretory vesicle ?



1.



2.

3.

Photogravure. Survey of India Offices, Calcutta, 1926.

EXPLANATION OF PLATE VI.

FIG. 4.— Photograph of the hindermost part of *Gigantolina magna*, mounted unstained; ventral view. Paratype. ×2.

FIG. 5.—Photograph of the posterior part of *Gigantolina magna*, stained with borax-carmine; ventral view. Paratype. ×1½.

FIG. 6.— Two shrunken eggs in the first ascending branch of the uterus of the specimen of *Gigantolina magna* mounted unstained, lying 1·5 mm. behind the shell-gland. × 160.

FIG. 7.— Egg whose development has come to a standstill lying in the middle of the bend formed at its hindmost point by the first ascending branch of the uterus of the same specimen. × 160.

FIG. 8.— Shrunken egg lying at the same place. × 160.

FIG. 9.— Shrunken egg in the first ascending branch of the uterus of the same specimen, 7·6 mm. cephalad of the right wing of the germarium. × 160.

FIG. 10.— Two normal eggs from a point of the first ascending branch of the uterus of *Gigantolina magna* situated a little over 12 cm. cephalad of the germarium; in alcohol. × 160.

FIG. 11.—Two eggs from the same place whose development has come to a standstill; in alcohol. × 160.

FIG. 12.—Egg in the descending branch of the uterus of the specimen of *Gigantolina magna* mounted unstained, lying 5 cm. cephalad of the germarium. Outline of shell slightly affected by shrinkage, reconstructed. × 160.

FIG. 13.—Embryonic hooks of the embryo contained in this egg. × 350.

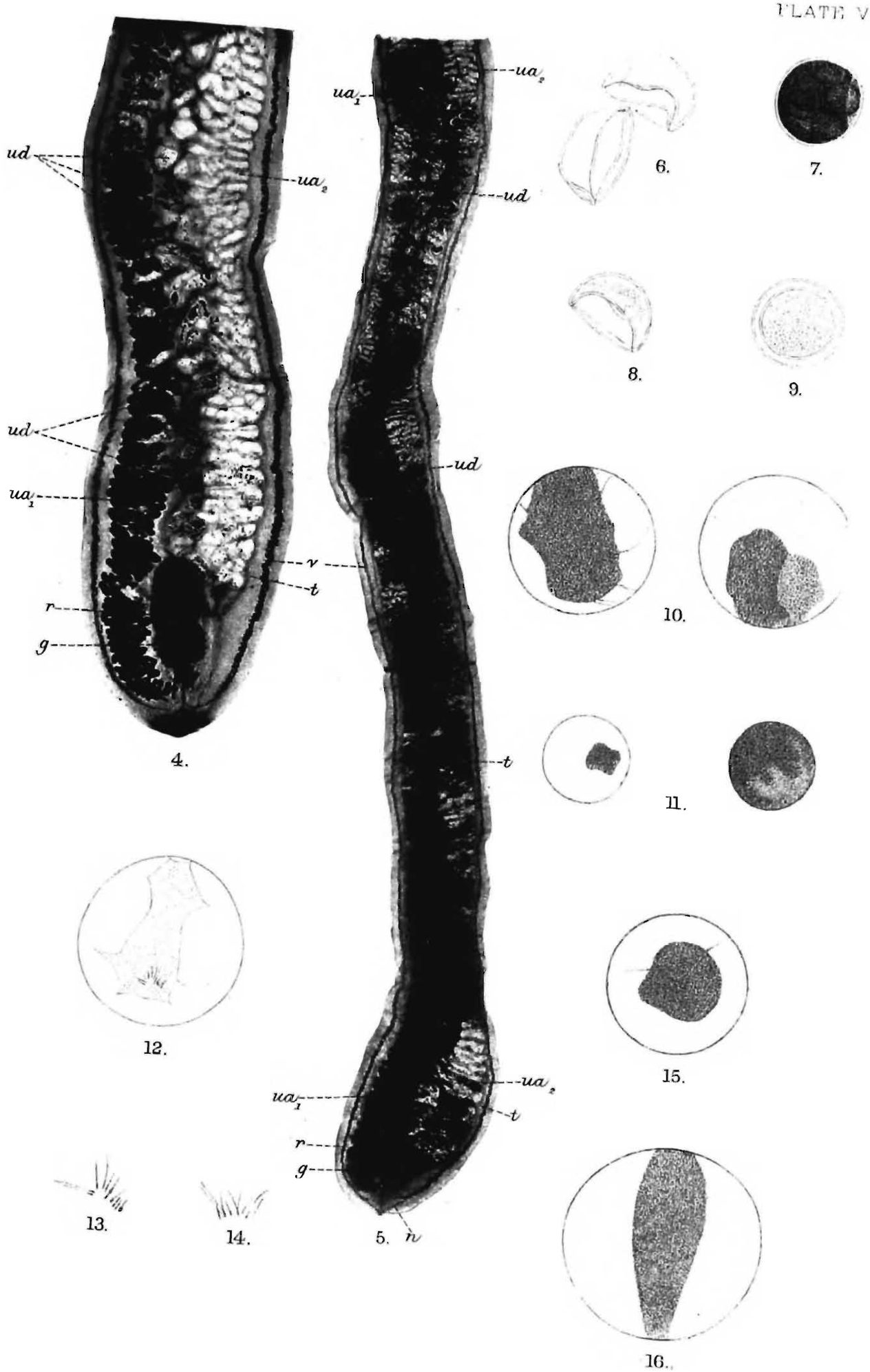
FIG. 14.—Embryonic hooks of embryo contained in an egg lying in the descending branch of the uterus of the same specimen 2·5 cm. cephalad of the germarium. × 350.

FIG. 15.—Normal egg collected from the tube containing the paratypes of *Gigantolina magna*. × 160.

FIG. 16.—Very large egg collected from the same tube. × 160.

g germarium, *n* lateral nerve, *r* accessory receptaculum seminis, *t* testes, ua_1 first ascending branch of the uterus, ua_2 second ascending branch of the uterus, *ud* descending branch of the uterus, *v* vitellarium.

PLATE VI.



Photogravure, Survey of India Offices, Calcutta, 1926.

THE ETHIOPIAN SPECIES OF THE GENUS *MUSCA* LINNAEUS.

By MAJOR W. S. PATTON, *I.M.S. (Retd.), M.B., Ch.B., F.E.S., Lecturer on Medical Entomology and Parasitology, Edinburgh University.*

(Plates I—IV.)

In a recent paper [1] in these *Records* I described, in collaboration with Mr. Senior-White, the Oriental species of the genus *Musca*. In writing that paper special attention was paid to the preparation of the keys to the species, and it is gratifying to learn from my friend Professor Mario Bezzi that he has found the keys a helpful guide to the Oriental species. The short descriptions were accompanied by brush drawings of accurately identified specimens, and here again it is pleasing to know that Professor Bezzi has found them useful.

I may here explain that it is absolutely necessary when describing species of this genus to do so with the specimens always held in the same position. In the paper referred to the abdomens were drawn and described with the head of the specimen directed towards the observer; this position has been found, as the result of very extensive experience, to be the best in which to note the body pattern of these muscids. In this genus this pattern is most important for purposes of identification, and it varies in an extraordinary way according to the position in which the observer examines the specimen. In the position noted above the important stripes, bands and shimmering patches, are seen to the best advantage, whereas if the specimen is examined from the side, or with the head directed away from him the pattern is often quite different.

In the present paper I propose describing shortly the Ethiopian species of the genus at present known to me together with illustrations of their abdomens, and giving keys for the determination of the two sexes. As in the case of the paper on the Oriental species I would like to point out that the present paper is not meant to be a final revision of the species from the Ethiopian Region, but only a preliminary contribution with that end in view. It is meant rather as a practical guide to the identification of the species known at present, and is specially written for medical and veterinary officers to whom a knowledge of these flies is of the first importance. My only regret is that the species are at present so incompletely known.

It is now just twenty years since I noted the peculiar haematophagous habits of a species of the genus *Musca*. This fly, *Musca pattoni* Austen, was observed feeding on the sores on the bellies of calves used for the preparation of cow-pox vaccine at the King Institute, Guindy, Madras; both sexes were seen to feed greedily on blood and serum. Since then I have observed and recorded this habit in a number of other species of this genus. These species of *Musca*, as I have repeatedly pointed out, are wild flies, and are only seen on animals in the open, feeding on blood,

[1] *Rec. Ind. Mus.* XXVI, pp. 553-577, pls. xxix-xxxiii (1924).

serum and discharges from cuts, bites of other flies, wounds, diseased eyes, nostrils, etc. Bearing in mind the nature of the food of these species of *Musca* and remembering that they are intermittent feeders, flitting about from animal to animal, it is easy to understand that they are potential carriers of all kinds of pathogenic organisms. It may yet be proved that some of the large hæmatophagous species of the genus are mechanical carriers of trypanosomes in those parts of Africa where *Glossina* is absent, and other biting flies rare. Although there are several of these hæmatophagous species in Africa, and I have seen one of the commonest (*Musca lusoria* Wiedemann) on animals in South Africa, our knowledge of them is still very incomplete, and I regret to say I have not had the opportunity of examining the larvæ of any of the species, and have no information regarding their breeding habits; some of them I feel sure are viviparous in habit. I hope therefore that medical and veterinary officers practising in Africa, as well as Government entomologists, will collect and send me direct to the Department of Zoology, University of Edinburgh, specimens of these flies, and, if possible, endeavour to ascertain their breeding habits; I need hardly say I will always be glad to help in identifying any specimens. I have now seen most of the types and many of the illustrations accompanying this paper are drawn from them.

Before passing on to the keys and the short descriptions of the species, it is necessary to refer briefly to the genus itself; the following definition covers all the species.

Genus **Musca** Linnaeus.

SYNONYMS *Byomya* R.-D.; *Plaxemya* R.-D.; *Placomya* R.-D.; *? Sphora* R.-D. *Philaematomyia* Aust.; *Pristirhynchomyia* Brun.; *Eumusca* Towns.; *Promusca* Towns.; *Viviparomusca* Towns.; *Ptilolepis* Bezzi; *Awatia* Towns.; *Lissosterna* Bezzi.

EARLY STAGES. Species either oviparous or viviparous. Egg elongated, cylindrical, creamy white with one end broader than the other. Dorsal surface of the chorion raised and thickened to form two parallel rib-like ridges which extend the whole length of egg, and in many of the hæmatophagous species project from the end in the shape of an elongated, spine-like process, often hooked and of a dark colour. Length of egg varies from ·8 to 2·2 mm. in length. Larva smooth (without fleshy processes), probably consisting of thirteen segments; development in three stages with two moults. *Two oral hooks* (mandibular sclerites), *the left always smaller than the right.* Pharyngeal sclerites massive in third stage, and deeply incised, the dorsal and ventral cornua long and stout, the latter with a short hump; there are no anterior rod-like prolongations as in the larva of the Calliphorinæ. Posterior stigmatic plates of third stage larva either D-shaped, or rounded with three sinuous breathing slits, and the button area well within the peritreme. Puparium, either mahogany, or creamy white in colour.

ADULT STAGE. Colour greyish with well marked dark stripes and bands, those on the thorax either two or four in number; a few males metallic and without stripes. Eyes of males either contiguous or well separated, the front then about half the width of an eye; either densely

pilose, very sparsely so that the surface must be examined with a high power to detect the hairs, or bare; the upper and middle facets in some species larger than the lower. In the females eyes well separated, the front commonly equal to the width of an eye; parafrontal or orbital bristles arranged either in one, two, three or more rows but always very variable and most unreliable for classification. Eyes in a few species either densely or sparsely pilose. Third segment of antenna in both sexes elongated, from two to four times as long as broad. Sensoria arranged as follows:—(1) Large grape-like sacculus with a comparatively long duct opening into the socket of third segment on its postero-internal aspect. (2) Large postero-external (lateral) sacculus situated near the distal end of the socket. (3) One or more sacculi on the postero-internal border. Sixth segment of antenna with fixed bristles on both dorsal and ventral borders, 9 to 14 on the former, and 5 to 9 on the latter; the first ventral bristle is attached about opposite the 4th to the 6th dorsal bristle; only a small portion of the apical end of segment is bare. Proboscis retractile and labella well developed; prestomal teeth small and numerous, or large and few in number; in the latter case the proboscis is so adapted that the teeth can be used to scratch the skin of the host and draw blood. Thoracic chætotaxy as follows:—Humeral 3; posthumeral 1; notopleural 2; presutural 1; supra-alar 1; intra-alar 1; post-alar 3; dorsocentral 4 to 6, two to three in front of the suture and four behind it, those in front of suture commonly reduced in size and number; acrostical 1 to 3, variable in size and number; mesopleural 6 to 7; sternopleural bristles either entirely wanting, or, if present, always arranged 1 : 2; pteropleural and hypopleural bristles wanting, hairs often present just above third coxa. Venation characteristic; vein R_{4+5} with a few minute bristles on its dorsal and ventral surfaces near the base, those on the latter surface in many species extending to and beyond the radio-medial cross vein; caudal surface of root of radial vein either with one or more hairs. Vein M_{1+2} bending up either at a sharp or rounded angle, and either joining vein R_{4+5} at the margin, or ending at the margin just behind vein R_{4+5}; cell R_5 either closed, or narrowly open. Squamæ either bare, or with a few long hairs on the dorsal surface near the cephalic margin. Male terminalia very variable and without any characters of generic value.

The above definition covers all the species of the genus *Musca* known to me at present. They form a compact group of closely related flies and I can see no satisfactory reason for splitting the genus into genera and subgenera. I do not intend to go into this question here in any detail but will only refer to two species which have been placed in different genera. Two blood-sucking species, *crassirostris* Stein and *inferior* Stein have been removed from the genus *Musca*, and placed in separate genera, the former has been made the genotype of the genus *Philæmatomyia* Austen, and the latter the genotype of *Ptilolepis* Bezzi. Both these species belong to my third group which contains all the blood-sucking forms; these flies obtain their food by scratching the skin of bovines and equines. I have had the opportunity of studying many specimens of the five known species, and the larvæ of three, and have examined critically all the types except that of *crassirostris*, of the

identity of which, however, there is no doubt whatever; the species are as follows :—

Musca crassirostris Stein. *Musca planiceps* Wiedemann.
,, *inferior* Stein. ,, *senior-whitei* Patton.
Musca fletcheri Patton and Senior-White.

Although it is true that in both *crassirostris* and *inferior* the proboscis is adapted for scratching the skin of animals and drawing blood, it is fundamentally similar to the proboscis of *Musca domestica*; anyone can demonstrate this for himself by making caustic potash preparations of the proboscis of each when it will be noted that the differences are merely those of degree. Both *crassirostris* and *inferior* differ in certain other minor characters from *domestica*. In *Musca inferior*, for instance, there are a few fine scattered hairs on the anterior border of the dorsal surface of the squama, and the two presutural dorso-central bristles are very small, and there are only two strongly developed postsutural dorso-central bristles. The presence of the hairs on the squama is said to suggest relationships with the Calliphorinæ, but I can find no other evidence whatever to support this view. There are some genera of the Calliphorinæ, *Lucilia* for instance, in which the squama is bare, and I fail to see that this character is of any phylogenetic importance. On the contrary both these species have two important structural characters which I believe have a deep significance, and clearly demonstrate that both are very closely related to *Musca domestica*, so closely in fact that I for one do not intend to remove them from this genus. These characters are to be found both in the larva and the adult.

I have had the opportunity of examining the last larval skin of *inferior* kindly sent me by Mr. Senior-White from Ceylon. I note that the cephalo-pharyngeal skeleton is typical of the genus *Musca* (*see* definition). The left oral or mandibular sclerite is smaller than the right, there are no anterior rods on the pharyngeal sclerites which are massive and exactly similar to those of the third stage larva of *domestica*, and the stigmatic slits are sinuous and not straight as in the larvæ of the Calliphorinæ. The front of the male is very wide as in the male of *domestica*, and most important and of phylogenetic significance, the third antennal segment has a large grape-like sensorium which opens on the postero-internal aspect of the socket, and an external sacculus which opens by a large pore on the external surface of the segment near the proximal end of the socket. These sensoria, especially the former, are characteristic of the species of the genus *Musca*, and although I have examined typical examples of all the other genera of the Muscinæ, many species of the metallic and non-metallic Calliphorinæ and also the Sarcophaginæ, I have so far not found one antenna in which there is a sense organ opening into the socket of the third segment; the nearest approach to this arrangement is seen in the antenna of the genus *Lyperosia*. I am strongly of opinion that these characters of the third antennal segment are of great significance; I have dealt with their arrangement in the higher Diptera in another paper in collaboration with Miss McGill.

The larva and the adult of *crassirostris* also exhibit these characters, and therefore I cannot see any reason for placing these two species in

separate genera. I attach no importance to the slight differences in chætotaxy in these two species and *domestica* for the more I study the higher Diptera the more I am convinced that chætotaxy is most unreliable and is not of generic importance. The above remarks will suffice for the present. I intend dealing more fully with this question on another occasion. For the sake of those who have not seen the paper on the Oriental species referred to above, I will again draw attention to the more important characters which I have found of great use in identifying the species of this difficult genus. The following is a list of the Ethiopian species known to me at present.

List of Ethiopian species of the Genus Musca.

1. *Musca domestica* L.
2. ,, *vicina* Macq.
3. ,, *nebulo* Fab.
4. ,, *sorbens* Wied.
5. ,, *vetustissima* Walk.
6. ,, *tempestiva* Fall.
7. ,, *tempestatum* Bezzi.
8. ,, *gymnosomea* Rondani.
9. ,, *fasciata* Stein
10. ,, *vitripennis* Meig.
11. ,, *interrupta* Walk.
12. *Musca lucidula* Loew.
13. ,, *albina* Wied.
14. ,, *pulla* Bezzi.
15. ,, *xanthomelas* Wied.
16. ,, *ventrosa* Wied.
17. ,, *lusoria* Wied.
18. ,, *alpesa* Walk.
19. ,, *natalensis* Villeneuve.
20. ,, *gabonensis* Macq.
21. ,, *dasyops* Stein.
22. ,, *conducens* Walk.
23. *Musca crassirostris* Stein.

External Characters of Use in Determining the Species.

General Colour.—The majority of the species of the genus *Musca* are non-metallic, greyish flies with characteristic stripes, bands and shimmering light spots and patches; these vary according to the position and the light in which the specimen is held, and also whether it is or is not a rubbed specimen. For instance in the case of those species with only two, broad, thoracic notal stripes, if looked at with the head facing the observer the stripes are clearly seen, but if looked at in the reverse direction, and from the side in some lights, the most prominent marking on the thorax is not the dark stripes but the broad grey one between them; this appearance gives an entirely false idea of the notal pattern. Many of the older authors, Wiedemann in particular, described their species in these positions.

In the males of a few species for instance *lucidula*, *vitripennis*, *tempestiva* and *albina* the notum is metallic and there are no definite stripes. In the females of these species, however, the notum though often possessing a metallic sheen has stripes.

Head.—The males of most of the species of this genus are either holoptic or sub-holoptic. The male of only one Ethiopian species, *M. domestica* L., is dichoptic; in this species the front is very nearly half the width of an eye. The eyes in this type of front are referred to as widely separated (Plate I, fig. 3). In some males, *e.g.*, *nebulo*, *vicina* and *sorbens* the front

is much narrower, varying from one-fifth to one-eighth the width of an eye; the eyes in this type are referred to as well separated (Plate I, fig. 4). The majority of the males are holoptic, the front being very narrow, the eyes almost meeting in the middl eline; the eyes in this type are referred to as narrowly separated (Plate I, fig. 5).

The eyes of a few species are hairy or pilose, those of the male *vitripennis*, *interrupta*, and of both sexes of *dasyops* are densely hairy, the hairs being easily detected with the ordinary pocket lens. I have not been able to detect even microscopic hairs on the eyes of any other Ethiopian species known to me at present.

The females are all dichoptic, the front is wide, and its width in relation to that of any eye is of some use in separating the species; it should be remembered, however, that this character is very variable. The so-called parafront, in reality the vertex, bears a number of bristles arranged in one, two, three or more rows. In many of the species in which the bristles appear to be arranged in one row it should be noted that there is a second row commencing at the lower end of the frontal stripe; this arrangement is seen in the type of the genus *domestica*. In the female *conducens*, however, there is a single row of bristles down to the lower end of the frontal stripe. In *lusoria* there are three rows of bristles, and in the female *albina* there are four and sometimes even five. In using these bristles in separating the species it is important to remember that they vary both in number and arrangement in the same species and even on the two sides in the same specimen. The characters of the frontal stripe are not of much use in separating the species, the width varies considerably, and if the fly has been pinned before it has hardened the whole front may collapse, and then the stripe may appear very narrow. In the female *albina* the stripe is normally very narrow and the eyes widely separated.

The characters of the palp are not of much use in separating the species. In the majority the palp is black throughout but in *conducens* and *crassirostris* it is either yellow or yellowish. The shape varies little and is of no value in identification.

The proboscis should always be examined, especially when it is extended. In the non-blood sucking species such as *domestica*, *nebulo*, etc., the theca or mentum is not thickened and enlarged, and does not project backwards to any marked extent to form a bulb (Plate I, fig. 13); this type of theca is common to the majority of the species. In the true biting species the proboscis is specially adapted for scratching the skin and in this way they obtain blood. This type of proboscis is well seen in *Musca crassirostris* in which the mentum is enlarged and strongly chitinized forming a shiny black object on the posterior surface of the proboscis when extended (Plate I, fig. 14). The prestomal teeth are not only reduced in number, but are enormously increased in size, and together with the highly developed interdental armature form a most efficient scratching apparatus. But, as already pointed out in the paper on "The Oriental Species of the Genus Musca" this type of proboscis is only a special adaptation to the adoption of the blood-sucking habit in a fly with mouth parts structurally similar to that of the house fly, *Musca domestica*; though superficially suggestive, especially

when extended, of a piercing organ, such as that of *Stomoxys* and allies, the proboscis of *Musca crassirostris* does not penetrate the skin.

Thorax.—Thoracic chætotaxy, though of some use, especially in conjunction with other characters, in identification, must not be relied on too much as the number and arrangement of the bristles is very variable. The arrangement of the bristles is shown in Plate I, figs. 7 and 10. In *Musca domestica* (fig. 10) there are normally three dorso-central bristles in front of the suture and four behind it, and only one pair of acrostical bristles at the posterior end of the notum. This number and arrangement is common to most of the species and is well seen in such large forms as *lusoria*, *natalensis*, etc. But even in these species it is not uncommon to find the first pre-sutural dorso-central bristle absent or much reduced in size; similarly those behind the suture may be absent or much smaller than normal. In some of the species, *crassirostris* for instance, there is a further reduction, there being only two pre-sutural dorso-central and two behind the suture, the former of which can hardly be called a macrochæta; in some of the Oriental species the reduction of the bristles is even more marked as has been noted in the paper referred to above. *Musca albina* exhibits as far as I know at present the extreme limit of reduction of bristles; in this species there is only one dorso-central bristle behind the suture and both the acrostical and sterno-pleural bristles are absent. This together with other characters has led Professor Bezzi to place this species in the genus *Lissosterna*.

Adomen.—If one examines the dorsal surface of the abdomen in *Musca* only four tergites can be made out. But when the abdomen is removed from the thorax, cleared in potash and mounted flat after cutting the tergites down the middle line, it will be noted that there are six spiracular openings in the male and five in the female. There are two spiracles associated with the apparent first tergite, and it is therefore evident that it represents two tergites fused together; the narrow anterior slip is most probably the true first tergite, the sternite of which is not clearly differentiated from the apparent first sternite. It is most probable that the reduction in the number of segments has taken place at the caudal end of the abdomen; it is not possible, however, yet to come to any definite conclusion on this point. To avoid any confusion therefore in the subsequent descriptions of the species given below the word "apparent" is to be understood before the word tergite and sternite.

The markings on the tergites and sternites are of great value in identification especially when they are taken in conjunction with other reliable characters. As already noted it is most important to examine the specimens in one position, and that I have adopted for this group is with the head directed towards the observer; although there is much variation in the colour of the tergites and sternites each species has its more or less characteristically marked abdomen.

I have not been able to discover any characters in either the male or female terminalia for separating the species. The differences are so small and there is so much variation that it is not worth while using these characters in separating the species.

Venation.—The venation common to most of the species is illustrated in Plate I, fig. 8. It will be noted that cell R_5 (1st posterior) is narrowly open ; in one species, *M. lucidula*, it is closed. There is also some variation in the bend of vein M_{1+2} (4th longitudinal), which may be sounded as in *M. tempestiva*, or more or less angled as in *M. domestica*. The relation of the medio-cubital (posterior) cross vein in relation to the bend of vein M_{1+2} is somewhat variable.

The most valuable characters on the wing are to be found in the number and arrangement of the hairs and small bristles on the veins. The hairs on the caudal border of R (Plate I, fig. 6) are fairly constant for each species, and together with other characters are most useful in separating closely allied species. The small bristles on the ventral side of R_{4+5} may be limited to the base of the vein, or they may extend in a row up to and beyond the radio-medial (anterior) cross vein (fig. 6). The characters have been largely used in separating the species in the keys, and with others they are most useful. If there is any doubt as to whether the bristles extend up to and beyond the cross vein it is best to remove one wing, clear it for a short time in clove oil and then mount it in Canada balsam with the ventral surface uppermost. A row of scars (Plate I, fig. 9) will leave no doubt as to whether the species possesses the bristles or not ; it is seldom that one has to make such a preparation as, if the species has these bristles, one or more are nearly always present even in badly rubbed specimens.

No attempt has been made to give a complete description of the species as this would serve no useful purpose and would defeat the object I have in view. The drawings of the abdomens have been executed by Mrs. Patton, and it should be noted that they are not drawn to any scale but are meant to illustrate the colour markings and nothing else ; many of the drawings illustrate the abdomens of types kindly lent me for study.[1]

Key to the Males of the Ethiopian species of the Genus *Musca*.

1.	Species with metallic thorax and without stripes ...	2
	Species with non-metallic thorax and with dark stripes ...	6
2.	Eyes densely hairy	3
	Eyes bare	4
3.	Abdomen light orange ; first tergite black in middle and along anterior border, orange at sides ; second tergite orange with a broad median black stripe and partial dark caudal band ; third and fourth tergites with large median silvery spots. Two well developed presutural dorso-central bristles. Palæarctic. North Africa ...	*vitripennis.*
	Very similar to above ; dark area on second tergite more extensive along cephalic border ; silvery patches on third and fourth tergites smaller ; front distinctly narrower ; presutural dorso-central bristles absent. South Africa	*interrupta.*
4.	Sternopleural bristles absent. Eyes well separated. First abdominal tergite light orange with a median dark spot or band which may spread on to the next tergite ; second tergite with a similar spot often produced forwards to form an incomplete median stripe ; third tergite	

[1] Some of the drawings were used in the paper on the Oriental species.

with a large median silvery patch, and a similar dark spot; fourth tergite with a large median silvery patch and dark admedian spots. Oriental. North Africa, Egypt and East Africa ... ... *albina.*

Sternopleural bristles present and arranged 1 : 2 ... 5

5. Abdomen light orange; first tergite mainly light orange with a dark green metallic spot at middle and extending to cephalic border; second tergite with a somewhat incomplete dark median stripe; third tergite with a bright green patch in the middle, sides orange; fourth tergite entirely green. Thorax green, presutural area greyish in middle with faintly marked stripes. North Africa, Egypt ... ... *lucidula.*

Abdomen greyish green with dark bands and stripes; first tergite entirely black, remaining tergites as in Plate I, fig. 6. Palæarctic. North Africa ... ... *tempestiva.*

6. Eyes densely hairy. Thorax with two broad black stripes. First abdominal tergite black with bluish admedian spots on posterior border. Oriental (China). Kilama N'ajaro *dasyops*

Eyes bare 7

7. Vien R_{4+5} with a few hairs ventrally but none extending to and beyond the radio-medial cross vein 8

Vein R_{4+5} with a row of bristles on the ventral side extending to and beyond the radio-medial cross vein ... 26

8. Species with two broad thoracic stripes 9

Species with four thoracic stripes 13

9. Small species with abdomen mainly greyish green ... 10

Larger species with abdomen mainly orange 12

10. Presutural dorso-central bristles wanting; scutellum greyish green. Distal dark bands on tergites two and three comparatively narrow. North Africa ... ... *tempestatum.*

Presutural dorso-central bristles present 11

11. Eyes narrowly separated. Thorax bluish grey with two broad black stripes. Abdomen greyish; first tergite dark brown to black; second tergite orange with a broad median black stripe and a black basal band; third and fourth tergites similar but median stripes narrow. Malta. North Africa ... ... *gymnosomea.*

Eyes narrowly separated. Thorax bluish grey with two broad black stripes. Scutellum black. Abdomen with a characteristic bluish sheen. First tergite entirely black except for faint suggestions of light spots at sides; second tergite mainly bluish grey with a broad median stripe, a broad basal band, and faint suggestions of admedian stripes; third tergite similar, but stripe and band narrower; fourth tergite bluish grey with a very narrow median dark stripe. Seychelles. Oriental (widely distributed in Malaya). North and Eastern parts of Ethiopian Region, especially in Abysinnia and Somaliland *fasciata.*

12. Thorax bluish. First abdominal tergite orange, sometimes dark orange to black. Eyes narrowly separated. Oriental and Australasian Regions. Widely distributed in Ethiopian Region ... ... *vetustissima.*

Thorax greyish. First tergite orange, sometimes dark orange with a dark median stripe, sometimes entire tergite black. Eyes well separated. Oriental Region. Widely distributed in Ethiopian Region ... ... *sorbens.*

13. Thorax dark (bluish), the four stripes though present difficult to make out. Abdomen entirely orange and without definite markings. Oriental Region. Widely distributed in Ethiopian Region ... ... *ventrosa.*

Thorax mainly grey or greyish green. Abdomen with characteristic stripes, bands and shimmering patches ... 14

14. Presutural portion of inner thoracic stripes narrower than postsutural part, and much narrower than presutural portion of external stripes 15

All parts of thoracic stripes of about equal width and mostly broad 16

15. Palpi black. Proboscis without enlarged theca, not a blood-sucking species. First abdominal tergite black; second tergite dark orange with a broad median black stripe, and silvery adjacent and marginal patches; third tergite similar but median stripe narrower. Oriental Region. East Africa. ... ... *pulla.*

Palpi light orange. Proboscis with enlarged black theca, a blood-sucking fly. Abdomen greyish green; first tergite black, the posterior border grey; second tergite with a narrow median black stripe, extending along the anterior border (T-shaped). Oriental Region. Widely distributed in Ethiopian Region ... ... *crassirostris.*

16. Eyes narrowly separated 17

Eyes widely separated 18

17. First tergite entirely dark orange to black; second tergite with a broad black median stripe widening out cephalad and caudad, silvery patches at sides of stripe and at margins of tergite well marked. Oriental Region. Egypt *xanthomelas.*

First tergite dark orange; second light orange with yellowish white pollinosity and a broad black median stripe; third tergite similar but with a narrower dark median stripe. Proboscis with enlarged theca and prestomal teeth reduced in number and larger. Oriental Region. Widely distributed in Ethiopian Region ... ... *conducens.*

18. Eyes widely separated; front approximately half width of eye. First abdominal tergite mainly orange with a broad median black stripe and black cephalic margin. North and South Africa and at ports ... ... *domestica.*

Eyes well separated; front from one-fifth to one-eighth width of an eye 19

19. Second abdominal tergite light orange with a broad median black stripe and silvery margins; third tergite orange with a narrower median black stripe, admedian dark stripes, and broader intervening and marginal silvery stripes; fourth tergite orange with silvery lateral stripes. Widely distributed in Ethiopian Region but not such a dominant species as the next and not so widely distributed as in the Oriental Region ... ... *nebulo.*

First and second tergites very similar to those of *nebulo*, but third and fourth with dark brown admedian and much darker greyish intervening stripes. Widely distributed in both Oriental and Ethiopian Regions ... ... *vicina.*

20. Species with four broad black thoracic stripes. Abdominal markings as in figure. Widely distributed in Ethiopian Region ... ... *lusoria.*

Species with two broad black thoracic stripes... ... 21

21. First abdominal tergite mainly orange with a narrow median black stripe and black median cephalic patch; second tergite orange with broader median black stripe, T-shaped at cephalic end, admedian and marginal silvery spots well marked; third tergite with much narrower median stripe and well marked silvery spots; fourth tergite with dark median stripe and silvery patches. Mainly in South Africa ... ... *natalensis.*

First abdominal tergite either entirely or mainly black ... 22

22. Second tergite with a broad median black stripe broadly T-shaped at cephalic end and well marked admedian and marginal silvery spots; third tergite similar, the median stripe narrower, dark band at caudal margin and dark admedian stripes, silvery spots and patches similar to the second segment; fourth segment as in figure. Widely distributed in East, West and Central Africa ... *alpena*

Second tergite mainly dark orange with a suggestion of a narrow median dark stripe and a narrow median cephalic band ; third tergite dark orange ; fourth tergite similar but with some white patches. East, Central and South Africa ... ... *gabonensis.*

Key to the Females of the Ethiopian species of the Genus *Musca.*

1. Thorax and abdomen with metallic sheen, the former with four dark stripes 2

   Thorax without metallic sheen and with either two or four dark stripes 4

2. Thoracic stripes not well marked except in fresh specimens. Abdomen metallic, first tergite light orange ; second and third tergites with dark median stripe. Wing membrane very pale and cell R_5 closed. Egypt ... ... *lucidula.*

   Thoracic stripes better marked. Abdomen not so metallic, first tergite black. Wing membrane not markedly pale and cell R_5 narrowly open 3

3. Two presutural dorso-central bristles present. Abdominal markings as in figure. Palæarctic. North Africa ... *vitripennis.*

   Presutural dorso-central bristles absent. Abdominal markings as in figure. South Africa ... ... *interrupta.*

4. Eyes densely hairy. First abdominal tergite black with admedian bluish white spots on caudal border. China. Kilama N'ajaro ... ... *dasyops.*

   Eyes bare 5

5. Sternopleural bristles absent. Abdominal markings as in figure. Egypt, North and East Africa. Oriental ... *albina.*

   Sternopleural bristles present 6

6. Thorax with two black stripes 7

   Thorax with four black stripes 11

7. Stripes very broad and outer pair not divided in front of suture 8

   Stripes not quite so broad and outer pair divided in front of suture 10

8. Presutural dorso-central bristles wanting. Small species with abdominal markings as in figure. North Africa ... *tempestatum.*

   Small species with presutural dorso-central bristles ... 9

9. Thorax bluish grey with two broad black stripes. Abdomen greyish ; first tergite dark brown to black ; other tergites as in figure, the admedian dark stripes very narrow. Malta. North Africa ... ... *gymnosomea*

   Thorax bluish grey with two broad black stripes. Abdomen with a characteristic bluish (steel) sheen ; first tergite black, sometimes with suggestions of light spots at sides ; second and third tergites bluish grey with markings as in figure, the admedian stripes broad. Seychelles. Oriental Region. North and Eastern parts of Ethiopian Region (Abysinnia and Somaliland) .. .. *fasciata.*

10. Thorax greyish. Abdomen also greyish, first tergite dark brown, other markings as in figure. Oriental Region. Widely distributed in Ethiopian Region ... ... *sorbens.*

    Thorax bluish. Abdomen also bluish, first tergite black, other markings as in figure. Oriental and Australasian Regions. Widely distributed in Ethiopian Region ... *vetustissima.*

11. Vein R_{4+5} without bristles extending beyond base or radio-medial cross vein 12

    Vein R_{4+5} with bristles extending beyond radio-medial cross vein 20

12. Inner thoracic stripes in front of suture narrower than the postsutural part, and considerably narrower than the external stripes 13

All parts of thoracic stripes of about equal width and mostly broad 14

13. Palpi black. Proboscis without enlarged theca, not a blood-sucking species. First abdominal tergite black; other tergite markings as in figure. Oriental Region. East Africa ... ... *pulla.*

Palpi light orange. Proboscis with enlarged strongly chitinized black theca, a blood-sucking fly. Abdomen greyish, first tergite mainly greyish green, the cephalic border black and with or without a narrow median stripe; other tergites marked as in figure. Oriental Region. Widely distributed in Ethiopian Region but mainly in North East *crassirostris.*

14. First tergite either black, or dark orange appearing black 15

First tergite either entirely light orange, or mainly light orange 18

15. First abdominal tergite black; second tergite olive green with a broad black median stripe expanding anteriorly and posteriorly to form black cephalic and caudal bands; third tergite olive green with a very narrow median black band. Small species. Palæarctic. North Africa. *tempestiva.*

First abdominal tergite mainly dark orange. Much larger species 16

16. Parafrontal (orbital) bristles in one row throughout ... 17

Parafrontal bristles in one row up to the lower third of the frontal stripe, then in two rows. Markings of tergites as in figure. Palæartic. At most large ports. South Africa ... ... *domestica.*

17. Second abdominal tergite olive green with a narrow dark median stripe expanding anteriorly to form a partial band; third tergite olive green with a very narrow dark median stripe, and narrow though complete cephalic band. Oriental Region. Widely distributed in Ethiopian Region ... ... *conducens.*

Second tergite orange with a comparatively narrow median dark stripe expanding at the caudal end to form a narrow dark band, silvery margins and admedian spots usually well marked. Oriental Region. Egypt ... ... *xanthomelas.*

18. First abdominal tergite entirely light orange except for a small dark spot at extreme cephalic border; remaining tergites orange without any markings. Thorax dark blue. Oriental Region. Widely distributed in the Ethiopian Region ... ... *ventrosa.*

First abdominal tergite mainly orange 19

19. Abdomen greyish-yellow; first tergite dirty orange with a small dark median cephalic spot; remaining tergites marked as in figure ... ... *vicina.*

Abdomen more silvery. Markings as in figure ... *nebulo.*

20. Large species with four broad black thoracic stripes. Abdominal markings as in figure. Widely distributed in Ethiopian Region ... ... *lusoria.*

Large species with two broad black thoracic stripes ... 21

21. First abdominal tergite black; remaining tergites grey with stripe and bands as in figure. East, West and Central Africa ... ... *alpesa.*

First abdominal tergite mainly orange 22

22. Whole abdomen mostly dark orange; second tergite with a faint median dark stripe, incomplete cephalic and fairly broad caudal black bands. East, Central and South Africa ... ... *gibonensis.*

Abdomen orange with well marked black stripes, bands and silvery patches and spots as in figure ... ... *natalensis.*

Short descriptions of the Ethiopian species.

Although the synonymy of the Ethiopian species is tolerably complete, and the types of the species marked with an asterisk have been examined, I recognize that there is still a good deal of doubt regarding several of the species. Their identity will only be cleared up when I have had an opportunity of studying some fresh material.

I am still very doubtful of the identity of *Musca gymnosomea* Rondani, and have unfortunately not been able to see the types, which Professor Bezzi tells me are in Florence. The drawings of the abdomens of the two sexes are from specimens given me by Professor Bezzi, and believed by him to be this species. It may, however, yet be that *gymnosomea* is identical with *sorbens* when of course Wiedemann's name would replace it, and it would sink into the already extensive synonymy of that species.

Professor Bezzi kindly lent me his type male of *Musca tempestatum*, and the abdomen of the female is drawn from what I believe to be the female of this species ; as far as I can see at present *Musca tempestatum* is a good species.

Although I have seen the types of *Musca albomaculata* Macq. and *M. dorsomaculata* Macq., both of which were described in 1843 from Mauritius, I have not included the former in the keys, nor have I been able to get illustrations of the abdomen of the two sexes. Dr. Villeneuve has pointed out that *albomaculata*, *dorsomaculata* and *rufiventris*, all described by Macquart from Africa, are identical and that *albomaculata* is the correct name for the species. I hope some observer in Mauritius, where *albomaculata* is said to occur, will send me some fresh material ; I would not be surprised to find that *Musca fasciata* Stein described from the Seychelles is this species.

There are several of the species of Macquart, for instance *M. pusilla* and *M. senegalensis*, which I have not been able to recognize from his descriptions. It will, I think, be best to drop these names as no types now exist.

I would again urge upon workers in Africa to send me fresh material so that it may be possible to revise this paper at an early date.

1. **Musca domestica** L.

(Plate II, fig. 1 ; pl. III, fig. 24.)

? *Musca aurifacies* R.-D. ;? *Musca riparia* R.-D.; *Musca stomoxidea* R.-D.; ? *Musca campicola* R.-D.; *?Musca vagatoria.*; *?Musca hottentota* R.-D.; *?Musca vicina* R.-D.; *nec* Macq.; *? Musca rivulans* R.-D.; *Musca corvina* F.; *Musca ludifica* F.; *Musca umbraculata* F.; *? Musca frontalis* Rond.; * *Musca minor* Macq.; * *Musca australis* Macq.;? *Musca lateralis* Macq. ; *Musca chiliensis* Macq.; *?Musca pellucens* Macq.; **Musca pampasiana* Big ;?* *Musca vicaria* Walk. ; **Musca antiquissima* Walk.; * *Musca calleva* Walk.

Male.—Front nearly half width of an eye.

Four thoracic stripes, each as wide as the front and complete, *i.e.*, extending the whole length of the scutum.

Abdomen (Plate II, fig. 1) ; first tergite with cephalic half black and caudal half orange with a broad triangular stripe, base upwards; second tergite orange with a broad black median stripe, the cephalic

end spreading out a little along the margin, edged with indistinct silvery stripes and with marginal yellowish white patches; third tergite with a similar median stripe edged with silvery stripes clove brown admedian stripes and silvery margins; fourth tergite similar but all stripes narrower.

Female.—Front almost equal to the width of an eye. Parafrontals broad below but narrowing towards the vertex.

Four thoracic stripes, about half the width of the frontal stripes, complete, the median pair often narrower than the external.

Abdomen (Plate III, fig. 24); first tergite usually dark orange, often appearing black as shewn in figure, sometimes it is not unlike that of the male; second tergite greyish yellow, often with a bluish sheen in fresh specimens, narrow to broad median black stripe spreading out along cephalic border of tergite, and narrow to broad admedian black stripes; third tergite similar but median and admedian stripes narrower; fourth tergite greyish yellow with faint admedian dark stripes.

I have seen specimens from the larger ports such as Dar-Es-Salaam, Durban, Cape Town, Accra and others; there is no doubt whatever that this species is carried in ships from Europe to these ports, but whether it breeds there I have no information, it probably does.

2. *Musca vicina Macquort (nec. R.-D.)

(Plate II, fig. 2; pl. III, fig. 25.)

**Musca flavinervis* Thoms.; *Musca flavifacies* Big.; **Musca flaviqennis* Big.; *?Musca analis* Macq.; *?Musca divaricata* Awati.

Male.—Front less than one-fifth that of an eye, and less than half that of the front of *domestica*. In most other respects very similar to that species.

Abdomen (Plate II, fig 2); all tergites lighter orange than those of *domestica*.

Female.—Very similar to the female *domestica* but parafrontals not narrowed to the same extent.

Abdomen (Plate III, fig. 25); tergites especially the first much lighter orange than in *domestica*.

This species is widely distributed in the Ethiopian Region, and is the common house fly; inland it entirely replaces *M. domestica*. As I have already pointed out I have not seen it in Great Britain; it first appears in the Palæarctic Region in the Mediterranean. The male can easily be distinguished from the male of *domestica* by the much narrower front, but the female is hard to distinguish from that of *domestica*.

3. **Musca nebulo** F.

(Plate II, fig. 3; pl. III, fig. 26.)

**Musca determinata* Walk. *nec* Patton.; *?Musca multispina* Awati.

Male.—Front varying from one-sixth to one-eighth width of an eye, and about less than a quarter width of front of male *domestica*.

Abdomen (Plate II, fig. 3); first tergite light orange, caphalic border black with black median stripe; second tergite light orange with a

broader median black stripe edged with well marked silvery stripes and silvery marginal spots ; third segment similar, the medial stripe narrower ; fourth tergite with a median dark area never forming a complete stripe.

Female.—Front about half, or a little less the width of an eye.

Adbomen (Plate III, fig. 26) ; first tergite light orange, the middle of the anterior border black, no complete median dark stripe, but always with a dark spot at middle of caudal border of tergite ; second tergite silvery with a median black stripe and dark brown admedian stripes, the marginal area often with a bluish tinge ; third tergite similar but with the median dark stripe narrower ; fourth tergite mainly silvery with some brown pacthes.

This species can as a rule be distinguished from *vicina* by noting that the male has a more orange and silvery abdomen, and by the narrower front ; the female has also a much more silvery abdomen.

Musca nebulo is widely distributed throughout the Ethiopian Region ; it is a common bazaar as well as a house fly.

4. *Musca sorbens* Wied.

(Plate II, fig. 4 ; pl. III, fig. 27.)

**Musca humilis* Wd.; **Musca spectanda* Wd.; **Musca latifrons* Wd.; **Musca mediana* Wd.; **Musca angustifrons* Thoms.; **Musca bivittata* Thoms.; **Musca sordidissima* Wlk.; **Musca eutaniata* Big.; *Musca scapularis* Rond.; **Musca dichotoma* Bezzi ; **Musca primitiva* Wlk.; **Musca biseta* Hough.; *Musca conducens* Patt. *nec* Walk.; *?Musca promisca* Awati.

Male.—Front varies from one-sixth to one-eighth width of an eye.

Two broad thoracic stripes not interrupted at suture.

Abdomen (Plate II, fig. 4) ; first tergite either light or dark brown to black ; second tergite with a dark median stripe spreading out along the cephalic border, T-shaped, to fuse with the dark area of the first tergite, edged with broad silvery stripes, and with silvery marginal spots ; third tergite with a narrower dark median stripe often not reaching the caudal border, edged with silvery stripes and with marginal spots ; fourth tergite with an incomplete narrow dark median stripe, narrow dark brown admedian stripes and marginal silvery patches.

Female.—Front about equal to width of an eye.

Two thoracic stripes divided cephalad of the suture.

Abdomen (Plate III, fig. 27) ; first tergite black ; second tergite with wide black median stripe widening out cephalad, T-shaped, and also caudad, edged with bluish white spots, broad admedian dark brown to black stripes widening out caudad to form a narrow black band, marginal greyish yellow spots ; third tergite similar, the median stripe narrower ; the admedian spots and stripes varying in width according to the angle at which the specimen is held ; fourth tergite with a narrow dark median stripe and dark admedian ones.

Musca sorbens is one of the most widely distributed species of the genus in the Old World. It is common in the Mediterranean area along the North African coast, and boards all steamers going East through the Suez Canal. I have not seen any specimens from the larger islands in the Mediterranean, but have a strong suspicion that *Musca gymnosomea*

Rondani from Malta may be but a small example of this ubiquitous fly. This species is of special interest in that it breeds in cowdung as well as in horse and human excrement, and for this reason it is common to find it on animals far from human dwellings. In the Ethiopian, as in the Oriental Region, it abounds in the bazaars, swarming on food stuffs of all kinds. It is also quite common to see it in large numbers feeding on exudation, from cuts, sores, etc., but more especially about the sore eyes of children. From these habits it will be noted that it is a most important carrier of bacteria especially those which cause opthalmia and allied conditions of the eyes.

Musca sorbens is easily distinguished from the next species by its greyer thorax, and in the male by its wider front. It should be remembered, however, that, as Stein has pointed out, the width of the front varies very considerably in a long series from different localities; and this applies also to the female fly.

5. * **Musca vetustissima** Wlk.

(Plate II, fig. 5; pl. III, fig. 28.)

?Musca pumila Macq.; **Musca niveisquama* Thoms.; *Musca humilis* auctt. *nec* Wied.; *Musca corvina* Frog. *nec* F.; *Musca minor* Patt. *nec* Macq.

Male.—Front about one-twelfth width of an eye.

Thorax with two very broad black stripes, the ground colour bluish grey.

Abdomen (Plate II, fig. 5); first tergite black; second orange with a broad black median stripe, broadly edged with silvery stripes, and with marginal silvery spots which often coalesce with the silvery stripes forming a white band as shown in the figure; third tergite with a narrower median black stripe edged with broad silvery stripes, and with broad silvery marginal spots, caudal border often with a narrow dark brown band; fourth tergite with a median dark area and silvery marginal spots.

Female.—Front about equal to the width of an eye.

Thorax with two broad black stripes divided in front of the suture. Ground colour bluish grey.

Abdomen (Plate III, fig. 28); first tergite black; second with a broad black median stripe, broad black caudal band, narrow black admedian stripes, and remainder of segment bluish grey; third tergite similar but stripes narrower, and either with or without a narrow black caudal band; fourth tergite with median dark area and silvery margins.

Musca vetustissima, commonly mistaken for *M. sorbens*, is widely distributed in the Ethiopian Region, and seems to be present in most places with *sorbens*. It breeds mainly in human excrement.

6. **Musca tempestiva** Fallen.

(Plate II, fig. 6; pl. III, fig. 29.)

Musca cuprea Macq.; *?Musca nana* Meig.

Male.—Front very narrow.

Thorax dark with some metallic sheen.

Abdomen (Plate II, fig. 6) ; first tergite all black ; second tergite grey with a broad median black stripe expanding at both ends to form black bands, the caudad the wider ; third tergite with a very narrow black median stripe often incomplete at the caudal end, and sometimes a narrow cephalic black band ; fourth tergite grey often with a dark patch about the middle.

Female.—Front equal to an eye in width.

Thorax grey with four narrow black stripes, inner pair well marked in front of suture, but behind it tending to merge into the outer pair.

Abdomen (Plate III, fig. 29) very similar to that of the male except that the black bands on the second tergite are usually wider, and there is a narrow median black stripe on segment four.

This small species is found mainly in Egypt and along the North African coast.

7. * **Musca tempestatum** Bezzi.

(Plate II, fig. 7 ; pl. III, fig. 30.)

Male.—Front very narrow.

Thorax grey with two broad black stripes.

Abdomen (Plate II, fig. 7) ; first tergite black ; second tergite grey with a broad black median stripe expanding at both ends to form black bands, that at the cephalic end very incomplete, the caudal complete ; third tergite with a narrow median black stripe expanding at the caudal end to form a narrow black band ; fourth tergite grey with a very narrow median black stripe.

Female.—Front about equal to the width of an eye.

Thorax grey with two broad black stripes.

Abdomen (Plate III, fig. 30) ; first tergite black, the caudal border sometimes greyish ; second tergite with a broad black median stripe expanding at both ends to form narrow bands, two narrow dark admedian stripes, intermediate and marginal silvery spots ; third tergite very similar except that stripes and bands are much narrower ; fourth tergite grey with an indistinct median black stripe.

This species has been described by Professor Bezzi from North Africa ; figure 7 is a drawing of the abdomen of the type male. I am not sure of the identity of the female here described and illustrated.

8. **Musca gymnosomea** Rondani.

(Plate II, fig. 8 ; pl. IV, fig. 31.)

Male.—Front very narrow.

Thorax grey with four broad black stripes.

Abdomen (Plate II, fig. 8) ; first tergite black ; second tergite with a broad black median stripe expanding caudad to form a narrow band, dark admedian stripes and silvery intermediate and marginal spots ; third segment very similar but stripes and bands narrower ; fourth tergite grey with narrower stripes as in figure.

Female.—Front about equal to width of an eye.

Thorax with two broad black stripes.

Abdomen (Plate IV, fig. 31) with markings very similar to those of the male as illustrated in figure.

This species was described originally from Malta but has been recorded by Professor Bezzi and others from the North African littoral. As already pointed out I am very doubtful as to whether *gymnosomea* is a good species and think it possibly may yet prove to be *Musca sorbens*. I hope those who have an opportunity of collecting specimens of *Musca* in Malta will send me their material for identification.

9. ***Musca fasciata** Stein.

(Plate II, fig. 9 ; pl. IV, fig. 32.)

Male.—Front very narrow ; eyes narrowly separated.

Thorax bluish grey with two broad black stripes.

Abdomen (Plate II, fig. 9) ; first tergite black ; second tergite bluish grey with a broad median black stripe, and a broad black basal band, sometimes traces of black admedian stripes, otherwise the grey area forms a broad median band ; third tergite very similar except with narrow cephalic and caudal bands and median stripe ; fourth tergite mainly bluish grey with partial narrow black median and narrow cephalic band.

Female.—Front very wide, about equal to width of an eye, greyish with bluish vertex ; parafrontal bristles in a single row.

Thorax with stripes similar to those of the male, occasionally they are divided cephalad of the suture.

Abdomen (Plate IV, fig. 32) very similarly marked to that of the male except that the admedian stripes are better marked.

This small species was described from the Seychelles but it also occurs on the mainland. I have recently seen specimens from Calcutta in the Indian Museum collection and several specimens named by Stein from the Middle East. It should be added to the Oriental fauna. It may yet prove to be identical with *Musca albomaculata* Macq.

10. **Musca vitripennis** Meigen.

(Plate II, fig. 10 ; pl. IV, fig. 33.)

**Musca osiris* Wd.; *?Musca sugillatrix* R.-D.; *?Musca phasiœformis* Meig.

Male.—Front about one-tenth width of an eye. Eyes densely pubescent.

Thorax dark metallic green without any stripes.

Abdomen (Plate II, fig. 10) ; first tergite orange with a broad dark metallic green area ; second tergite brown with a broad dark green median stripe expanding caudad to form a partial band ; third segment dark orange with a large greyish patch occupying the middle of the tergite, and a small dark median spot near the caudal border ; fourth tergite almost entirely greyish with some matallic sheen and some brown spots at caudal margin.

Female.—Front slightly wider than an eye.

Thorax with four dark stripes ; the inner pair narrow, complete ; outer pair forming a dark spot cephalad of suture, behind it indistinct and tending to merge into the admedian stripes ; ground colour of thorax greyish with some metallic sheen.

Abdomen (Plate IV, fig. 33) ; first tergite dark grey to black with some metallic sheen ; second tergite grey with a broad black median stripe expanding caudad to form a narrow band, tergite with some metallic sheen ; third tergite dark grey with a narrower dark median stripe, dark margins and some metallic sheen ; fourth tergite grey without any definite markings.

This small species can always be recognized by its hairy-eyed male and the characteristic abdominal markings. It is not uncommon in Egypt and in parts of the North African littoral.

11. **Musca interrupta** Walker.

(Plate II, fig. 11 ; pl. IV, fig. 34.)

**Musca lasiopthalma* Thomson.

This species is very closely allied to *vitripennis* and only differs from it in minor details. The presutural dorso-central bristles, which are present in *vitripennis*, are absent in *interrupta ;* the front of the male is distinctly narrower ; and there are some differences in the abdominal markings which can best be noted by comparing figs. 10 and 11, and 33 and 34.

Musca interrupta is common in South Africa.

12. **Musca lucidula** Loew.

(Plate II, fig. 12 ; pl. IV, fig. 35.)

Male.—Front narrow.

Thorax dark metallic without any stripes.

Abdomen (Plate II, fig. 12) ; first tergite with a triangular shaped dark median patch and metallic sheen ; second tergite with a narrow dark median stripe expanding a little cephalad where there is a light patch as in figure ; third tergite with a green metallic area and a silvery patch ; fourth tergite green with a larger light patch.

Female.—Front wide, not quite the width of an eye and narrowing towards the vertex ; a single row of parafrontal bristles.

Thorax light metallic green with four rather indistinct, very narrow, dark stripes, the inner pair are incomplete caudad of the suture.

Abdomen (Plate IV, fig. 35) ; first tergite yellow ; remaining tergites light green and without any distinct markings except dark median stripes on two and three as illustrated in figure.

This interesting metallic species with its pale wings and closed cell R_5 is common in Egypt. Professor Bezzi has recently pointed out how similar the male is to the male of *albina.*

13. * **Musca albina** Wiedemann.

(Plate II, fig. 13 ; pl. IV, fig. 36.)

**Musca speculifera* Bezzi ; *Musca beckeri* Schnabl.

Male.—Eyes well separated.

Thorax dark metallic without any stripes.

Abdomen (Plate II, fig. 13) ; first tergite yellowish with a dark median spot on caudal border of segment spreading on to the front

margin of the second segment ; on the second tergite the spot often forms a sort of incomplete band, this tergite also has a small round spot on its caudal border in the middle ; third tergite with a large silvery patch and a dark spot at the middle of the caudal border ; fourth tergite mainly with a large silvery patch and two admedian dark spots.

Female.—Front very wide, equal to width of an eye ; frontal stripe very narrow ; usually four sometimes five rows of small parafrontal bristles.

Thorax silvery with four narrow dark stripes.

Abdomen (Plate IV, fig. 36) ; first tergite yellow with a dark caudal band which may only be limited to the border ; second tergite silvery with a broad median dark stripe widening out caudad to form a wide dark band, narrow admedian dark stripes ; third tergite silvery with a very narrow median dark stripe and two dark spots at caudal margins ; fourth tergite silvery with two small dark admedian spots.

This species is widely distributed in Egypt and in many parts of East Africa ; I hope observers will be on the look-out for it in other parts.

14. ***Musca pulla** Bezzi.

(Plate II, fig. 14 ; pl. IV, fig. 37.)

**Musca craggi* Patton.

Male.—Front narrow, one-seventh to one-eighth width of an eye.

Thorax with four black stripes, the inner pair always much narrower than the external cephalad of the suture.

Abdomen (Plate II, fig. 14) ; first tergite dark brown to black ; second brown with a broad median black stripe expanded a little cephalad, T-shaped, edged with indistinct silvery spots, and with large yellowish white marginal spots ; third tergite brown with a narrower median black stripe edged with silvery spots, sometimes with a narrow caudal band ; fourth tergite dark brown with light marginal spots.

Female.—Front wide, about equal to the width of an eye.

Thorax with four black stripes as in the male, the inner pair narrower than the outer cephalad of the suture.

Abdomen (Plate IV, fig. 37) ; first tergite dark brown to black ; second tergite brown with a dark median stripe expanding both cephalad and caudad to form narrow dark bands, the latter usually the broader, well marked marginal spots ; third tergite similar but stripes and bands narrower ; fourth tergite with light marginal patches.

This species has been recorded by Professor Bezzi from East Africa ; it can readily be recognized by the narrow presutural inner thoracic stripes. It is an Oriental species.

15. ***Musca xanthomelas** Wiedemann.

(Plate II, fig. 15 ; pl. IV, fig. 38.)

Musca albomaculata auct. *nec* Macq.; *Musca dorsomaculata* auct. *nec* Macq.; *Musca convexifrons* auct. *nec* Thoms.

Male.—Front very narrow, eyes narrowly separated ; area of large facets at middle and inner part of eye usually well marked.

Thorax with four broad black stripes.

Abdomen (Plate II, fig. 15); first tergite dark brown to black; second tergite with a broad dark brown median stripe expanding caudad to form a lighter brown band, admedian brown stripes well marked, intervening and marginal silvery spots; third tergite with a much narrower median stripe edged with silvery stripes, a narrower caudad band; fourth tergite light orange with an incomplete narrow median stripe.

Female.—Front wide, equal to width of an eye.

Thorax similar to that of male.

Abdomen (Plate IV, fig. 38); first tergite brown to dark brown with a broad black median stripe and narrow caudad dark band; second tergite similar but median stripe and caudad band narrower; third tergite very similar, the admedian narrow dark stripes better marked; fourth tergite light orange.

This species is widely distributed in Egypt; it is probable *Musca pusilla* Macquart is the species, but it is impossible to be certain of this.

16. ***Musca ventrosa** Wiedemann.

(Plate III, fig. 16; pl. IV, fig. 39.)

**Musca xanthomela* Walker; **Musca pungoana* Karsch; * *Musca nigrithorax* Stein; *Musca kasauliensis* Awati.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad black stripes on a dark bluish grey ground; in some lights the thorax appears of a uniform shining black colour.

Abdomen (Plate III, fig. 16) orange throughout without any definite bands or stripes; sometimes there is a faint dark median stripe on the second and third tergites as illustrated in the figure.

Female.—Front a little more than half the width of an eye.

Thoracic and abdominal markings similar to those of the male (Plate IV, fig. 39); semi-digested blood in the alimentary tract must not be confused with stripes or bands.

This strikingly coloured species is widely distributed in the Ethiopian Region; it breeds in cow dung.

17. ***Musca lusoria** Wiedemann.

(Plate III, fig. 17; pl. IV, fig. 40.)

Male.—Front narrow.

Thorax with four broad black stripes.

Abdomen (Plate III, fig. 17); first tergite black; second tergite grey with a broad, black, median stripe expanding T-shaped cephalad, and caudad forming a narrow dark band, broad admedian dark stripes; third tergite very similar but stripes and bands very much narrower; fourth tergite greyish white with indefinite very narrow dark stripes as in figure.

Female.—Front about equal to width of an eye.

Thorax with four broad black stripes as in the male.

Abdomen (Plate IV, fig. 40); first tergite dark with two greyish patches as in figure, these may be less marked; second tergite dark grey

with a black median very narrow stripe, triangular shaped, admedian stripes expanding caudad to form a narrow band; third tergite exactly similar; fourth tergite as in illustration.

Musca lusoria is the common, large hæmatophagous species of the genus in the Ethiopian Region; it is widely distributed. I have had the opportunity of examining a number of specimens from Somaliland wrongly determined by Stein as *Musca corvina* (or more correctly known now as *autumnalis*). *Musca autumnalis* never has any small bristles on the ventral side of vein R_{4+5} extending beyond the radio-medial cross vein; *Musca lusoria* always has.

18. *Musca alpesa Walker.

(Plate III, fig. 18; pl. IV, fig. 41.)

Musca spectanda auct. *nec* Wiedemann; **Musca congolensis* Villeneuve.

Male.—Front very narrow.

Thorax with two broad black stripes.

Abdomen (Plate III, fig. 18); first tergite all black; second tergite with a broad black median stripe expanding cephalad, broadly T-shaped and with well marked silvery intervening and marginal spots, the admedian stripes are broad but not very distinct; third tergite very similar, but median stripe narrower, not expanding cephalad but caudad forming a very distinct band, admedian stripes narrow but well marked, silvery spots also well marked; fourth tergite as in figure.

Female.—Front about the width of an eye.

Thorax as in male.

Abdomen (Plate IV, fig. 41); first tergite all black; remaining tergites as in figure.

This large species with two broad black stripes is fairly widely distributed in the Region. Until I examined the type of *Musca spectanda* I was under the impression it was this species; *spectanda*, however, is the widely distributed *sorbens*.

19. *Musca natalensis Villeneuve.

(Plate III, fig. 19; pl. IV, fig. 42.)

Male.—Front narrow.

Thorax with two broad black stripes.

Abdomen (Plate III, fig. 19); first tergite orange, median cephalic border dark, narrow median black stripe; second tergite with a slightly broader median stripe expanding cephalad to form a T-shaped band, well marked silvery adjacent and marginal spots; third tergite very similar, silvery spots much better marked, the median stripe is much narrower and it expands caudad to form a narrow dark band; fourth tergite as in figure.

Female.—Front equal to width of an eye.

Thorax as in male.

Abdomen (Plate IV, fig. 42); first tergite light orange, cephalic border with a black spot, a line-like median stripe ending in a dark elongated spot in middle of caudad border (the dark line joining the two is often

absent); second tergite with a broad median black stripe expanding T-shaped at cephalic border and caudad forming a narrow dark band, narrow admedian stripes and silvery intermediate and marginal spots; third tergite very similar, the median stripe broader; fourth tergite often with a broad median dark stripe.

This species was described from Durban by Villeneuve; the drawing of the abdomen of the male is from his type in the South African Museum. The female was not known to Dr. Villeneuve. I have seen numerous examples from Natal in the collection of the Zoological Museum, Cambridge, which Dr. Scott kindly lent me for study; the illustration of the abdomen of the female is from one of these.

20. ***Musca gabonensis** Macquart.

(Plate III, fig. 20; pl. IV, fig. 43.)

**Musca ethiops* Stein.

Male.—Front narrow.

Thorax with two broad black stripes.

Abdomen (Plate III, fig. 20); first tergite black or nearly so, part of the caudal border orange; second tergite dark orange with an indistinct median dark stripe and an incomplete cephalic band; third and fourth tergites orange with some silvery patches.

Female.—Front almost the width of an eye.

Thorax dark with two broad black stripes.

Abdomen (Plate IV, fig. 43); all tergites mainly orange with narrow bands and stripes as illustrated in figure.

This species is common in East, Central and South Africa. The illustration of the abdomen of the male is from Stein's type of *Musca ethiops*.

21. ***Musca dasyops** Stein.

(Plate III, fig. 21; pl. IV, fig. 44.)

Male.—Front narrow, eyes densely hairy.

Thorax blackish with two broad black stripes.

Abdomen (Plate III, fig. 21); first tergite black, often with greyish admedian spots near caudal border; other tergites as in figure.

Female.—Front wide, eyes densely hairy.

Thorax and abdomen (Plate IV, fig. 44) almost exactly similar to those of male.

This species was described by Stein from Mount Kilama N'ajaro; Villeneuve has also recorded it from East Africa.

22. ***Musca conducens** Wlk.

(Plate III, fig. 22; pl. IV, fig. 45.)

Pristirhynchomiya lineata Brun.; *Musca sorbens* Patton *nec* Wlk.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad stripes, often fused especially cephalad of the suture, the thorax then appears to be two striped.

Abdomen (Plate III, fig. 22) ; first tergite either dark brown or black, if the former the posterior lateral margins are lighter orange ; second tergite yellow with a narrow black median stripe extending along the cephalic border to form a median band ; third tergite similar but median stripe narrower ; fourth tergite as in illustration.

Female.—Front about half width of an eye ; parafrontal bristles in a single row.

Thorax with four black stripes never tending to unite as in the male.

Abdomen (Plate IV, fig. 45) ; first tergite dark orange to black ; second tergite grey with an olive sheen, a narrow median black stripe expanding T-shaped and forming caudad a narrow dark band ; third tergite similar but with a much narrower median dark stripe and caudal band ; fourth tergite as in illustration.

This species is widely distributed in the Region. It is of peculiar interest because, although it has well developed prestomal teeth, it is unable to scratch the unbroken skin sufficiently to draw blood.

23. **Musca crassirostris** Stein.

(Plate III, fig. 23 ; pl. IV, fig. 46.)

Musca modesta Meij.; **Philæmatomyia insignis* Aust.

Male.—Front narrow, eyes well separated.

Thorax with four narrow black stripes.

Abdomen (Plate III, fig. 23) ; first tergite black, the caudal border grey with a greenish tinge ; second tergite greyish green, a narrow median black stripe, extending along the cephalic border T-shaped ; third tergite grey with a narrow black median stripe often not reaching caudal border ; fourth tergite as in illustration.

Female.—Front very wide, almost equal to an eye in width.

Thorax with stripes similar to those of the male.

Abdomen (Plate IV, fig. 46) ; first tergite greyish green, the cephalic border black, a narrow median black stripe or dark area either present or absent, sometimes only showing as an indefinite median black patch on the caudal border ; second tergite grey with a very narrow median black stripe and a black band along the cephalic border ; third tergite grey with a very narrow incomplete median streak-like stripe ; fourth tergite as in illustration.

This species is common in Egypt and in East and Central Africa ; it is a most voracious blood-sucker.

I hope that as soon as some fresh material is available I will be in a position to revise this paper.

EXPLANATION OF PLATE I.

FIG. 1.—Ventral surface of *Musca bakeri*, an Oriental species, showing how the sternites are sometimess all black.

„ 2.—Ventral surface of *Musca hervei*, another Oriental species, showing black sternites (S) and black-edged tergites (T).

„ 3.—The male of *Musca domestica* showing eyes widely separated (dichoptic) in a male of this genus.

„ 4.—Male of *Musca sorbens* showing type of eyes which are well separated.

„ 5.—Male of *Musca ventrosa* showing type of eyes narrowly separated.

„ 6.—Radial vein. The dorsal surface shows the bristles in full, the ventral surface the bristles in dotted lines.

„ 7.—Side of thorax in *Musca* showing location of bristles. Msp.—Mesopleuron. Stp.—Sternopleuron. Hyp.—Hypopleuron. These terms are here retained though they are not strictly accurate.

„ 8.—Venation in *Musca*.

„ 9.—Part of vein R_{4+5} showing a bristle and a bristle scar.

„ 10.—Dorsal surface of thorax of *Musca* showing location of important bristles. Acr.—Acrostichal. Dc.—Dorsocentral.

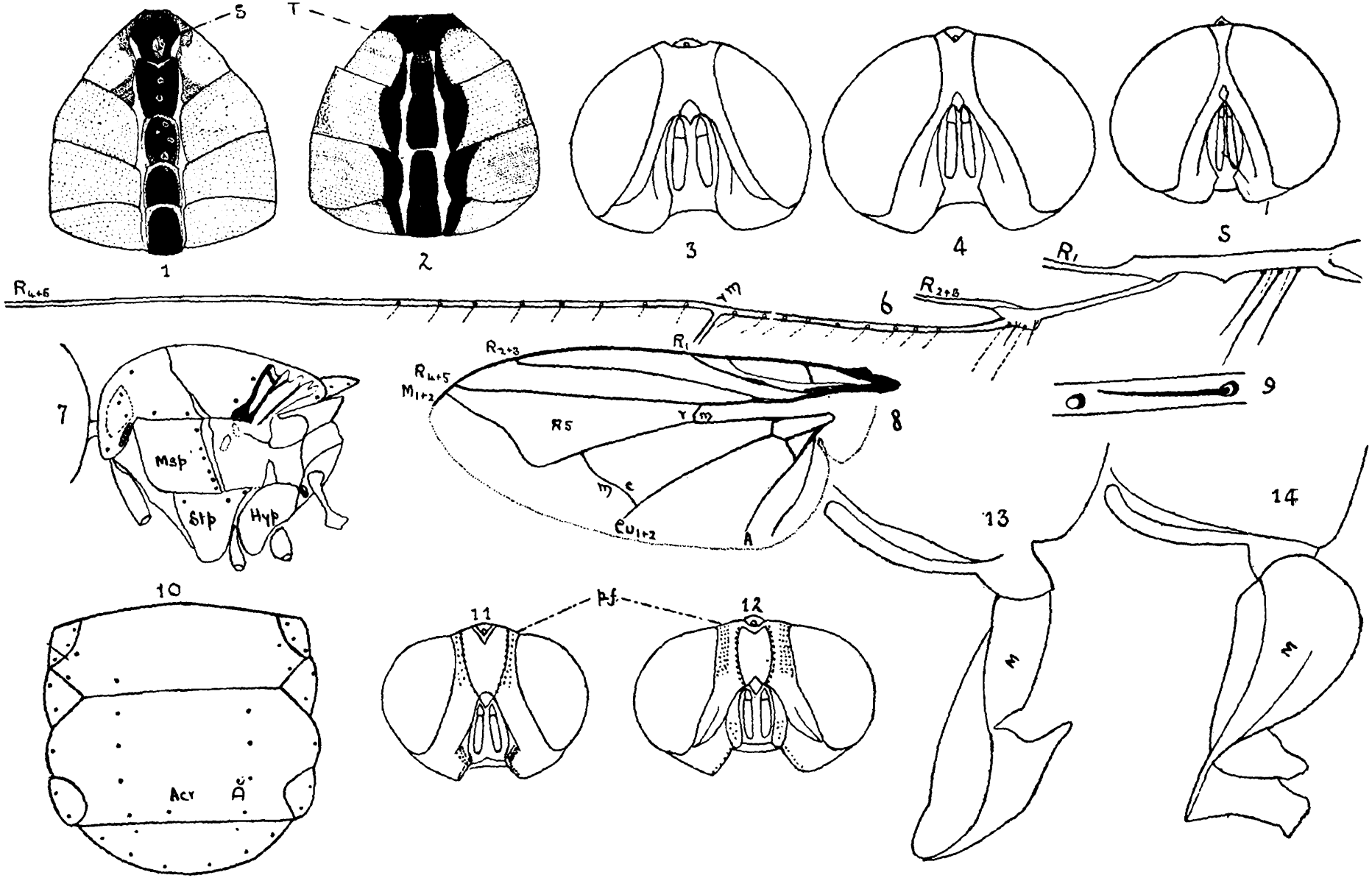
„ 11.—*Musca domestica* female, showing arrangement of parafrontal bristles,—p. f.

„ 12.—*Musca bezzii* female, an Oriental species, showing the arrangement of bristles in a large hæmatophagous species of this genus ; this species is allied to the Ethiopian *Musca lusoria*. p. f.—Parafrontal bristles.

„ 13.—*Musca nebulo* showing normal sized mentum or theca (M).

„ 14.—*Musca crassirostris* showing the enlarged mentum or theca (M).

The above drawings were executed by Mr. Senior-White, and formed Plate XXIX in the paper on the Oriental species, that appeared in the *Records of the Indian Museum*, Vol. XXVI.



R. S.-W. *ad nat. del.*

THE GENUS *Musca*.

PLATE I.

EXPLANATION OF PLATE II.

MALE ABDOMENS.

FIG. 1.—*Musca domestica.*
„ 2.—*Musca vicina.*
„ 3.—*Musca nebulo.*
„ 4.—*Musca sorbens.*
„ 5.—*Musca vetustissima.*
„ 6.—*Musca tempestiva.*
„ 7.—*Musca tempestatum.*
„ 8.—*Musca gymnosomea.*
„ 9.—*Musca fasciata.*
„ 10.—*Musca vitripennis.*
„ 11.—*Musca interrupta.*
„ 12.—*Musca lucidula.*
„ 13.—*Musca albina.*
„ 14.—*Musca pulla.*
„ 15.—*Musca xanthomelas.*

(E. M. P. *ad nat. del*).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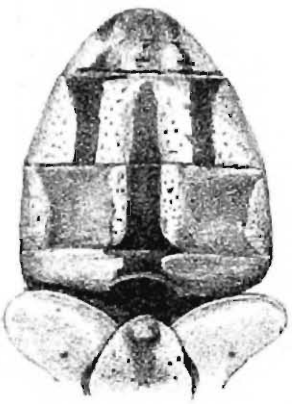
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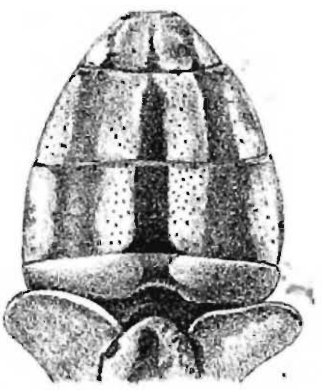
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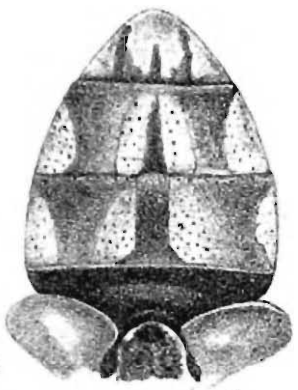
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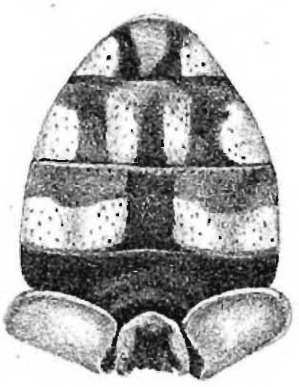
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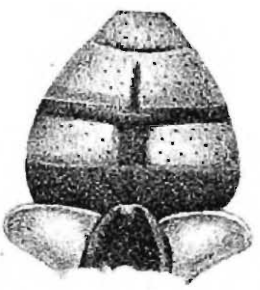
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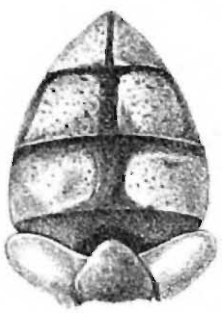
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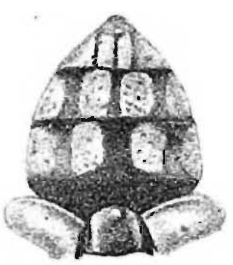
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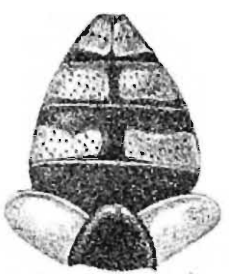
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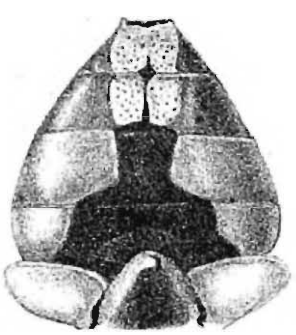
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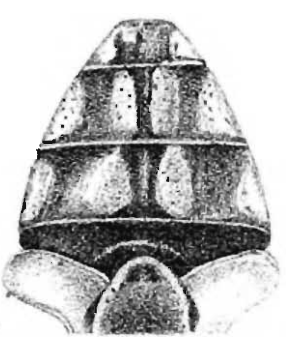
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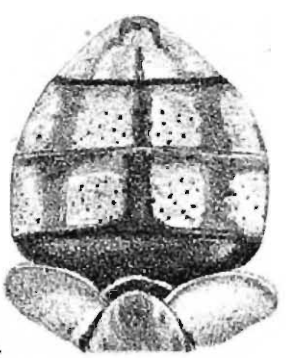
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E.M.P. ad nat. del.

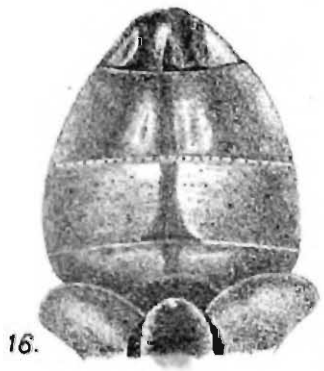
ETHIOPIAN SPECIES OF MUSCA.

EXPLANATION OF PLATE III.

MALE AND FEMALE ABDOMENS.

FIG. 16.—*Musca ventrosa*, male.
„ 17.—*Musca lusoria*, male.
„ 18.—*Musca alpesa*, male.
„ 19.—*Musca natalensis*, male.
„ 20.—*Musca gabonensis*, male.
„ 21.—*Musca dasyops*, male.
„ 22.—*Musca conducens*, male.
„ 23.—*Musca crassirostris*, male.
„ 24.—*Musca domestica*, female.
„ 25.—*Musca vicina*, female.
„ 26.—*Musca nebulo*, female.
„ 27.—*Musca sorbens*, female.
„ 28.—*Musca vetustissima*, female.
„ 29.—*Musca tempestiva*, female.
„ 30.—*Musca tempestatum*, female.

(E. M. P. *ad nat. del*).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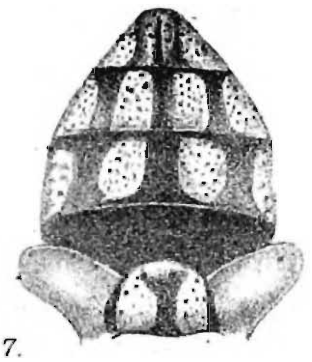
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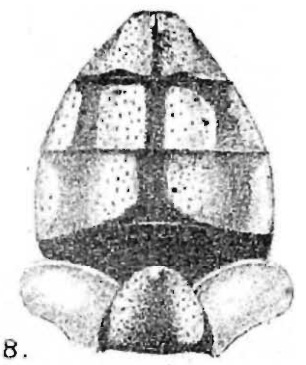
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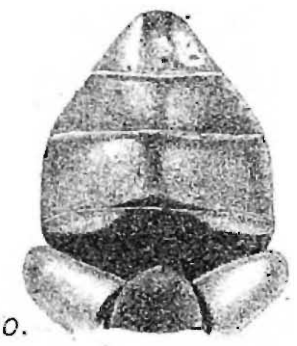
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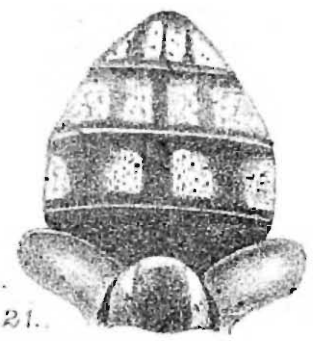
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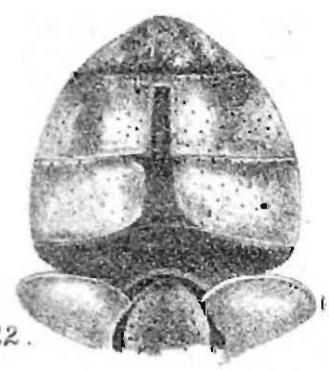
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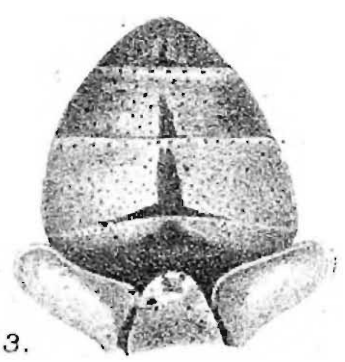
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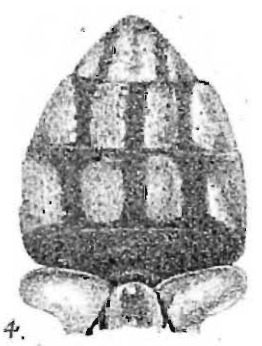
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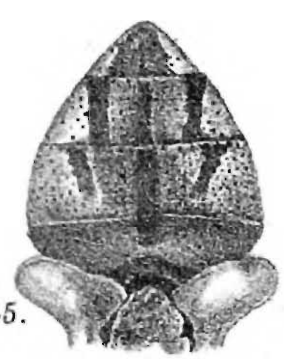
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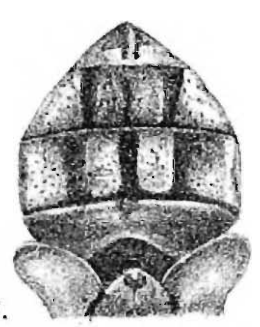
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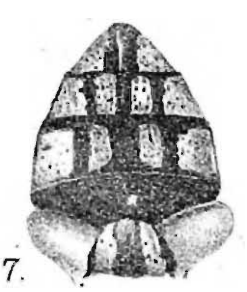
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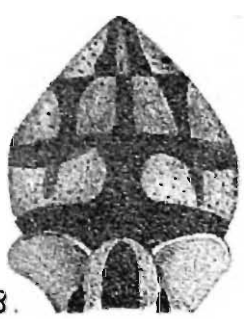
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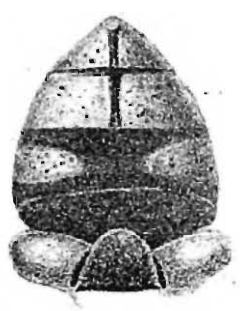
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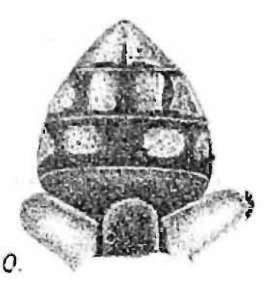
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E.M.P. ad nat del.

ETHIOPIAN SPECIES OF MUSCA.

EXPLANATION OF PLATE IV.

Female Abdomens.

Fig. 31.—*Musca gymnosomea.*
„ 32.—*Musca fasciata.*
„ 33.—*Musca vitripennis.*
„ 34.—*Musca interrupta.*
„ 35.—*Musca lucidula.*
„ 36.—*Musca albina.*
„ 37.—*Musca pulla.*
„ 38.—*Musca xanthomelas.*
„ 39.—*Musca ventrosa.*
„ 40.—*Musca lusoria.*
„ 41.—*Musca alpesa.*
„ 42.—*Musca natalensis.*
„ 43.—*Musca gabonensis.*
„ 44.—*Musca dasyops.*
„ 45.—*Musca conducens.*
„ 46.—*Musca crassirostris.*

(E. M. P. *ad nat. del*).


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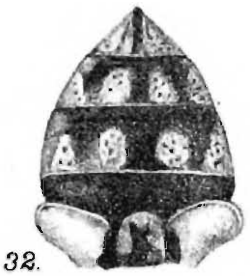
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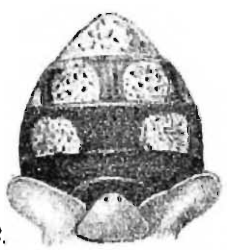
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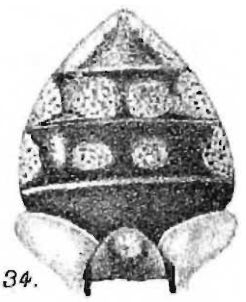
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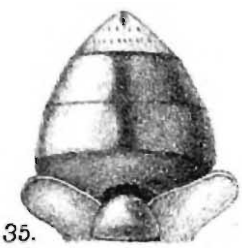
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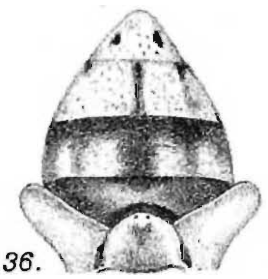
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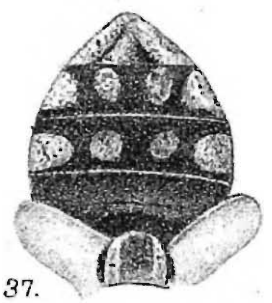
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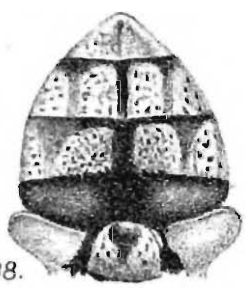
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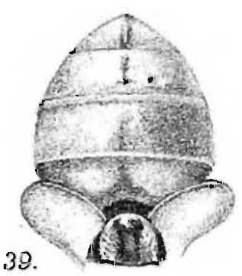
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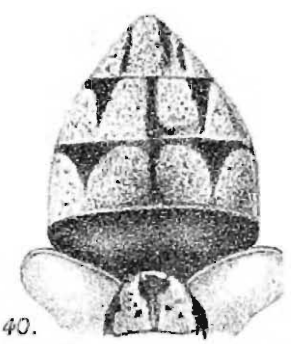
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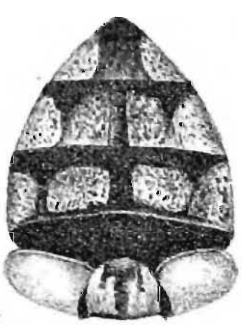
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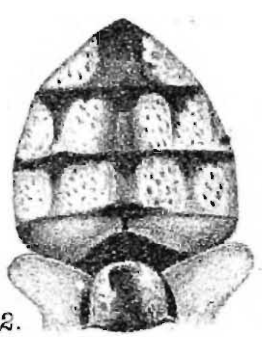
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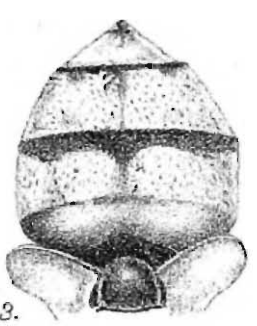
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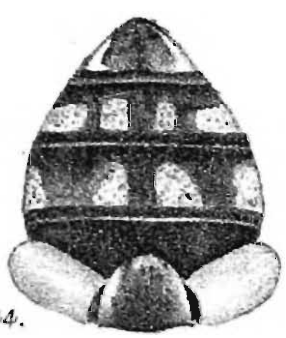
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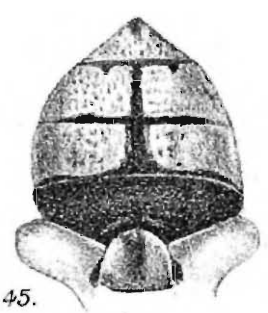
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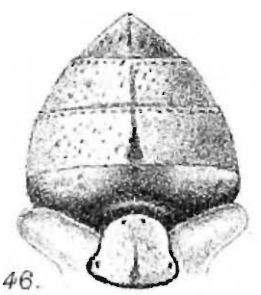
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E.M.P. ad nat. del.

ETHIOPIAN SPECIES OF MUSCA.

TWO NEW SPECIES OF CESTODES FROM INDIAN LIZARDS.

By M. A. Moghe, *M.A., M.Sc., Hislop College, Nagpur, C. P., India.*

(*From the Hookworm Research Laboratory, School of Tropical Medicine, Calcutta.*)

On several occasions I examined the intestines of the common garden lizard, *Calotes versicolor* Daud. and found them to be always infected by a cestode of the genus *Oochoristica*. The intestines of *Varanus bengalensis* Daud. another lizard which I have examined was always infected by *Duthiersia expansa* Perrier (1873), but on one occasion I also got a large number of a Proteocephalid worm associated with *Duthiersia expansa*.

Oochoristica sigmoides, sp. nov.

The species of the genus *Oochoristica* have been recently catalogued by Meggitt (1924) and since then, so far as I am aware, one more species, *O. theileri*, has been described by Fuhrmann (1924) from a lizard. These worms inhabit both mammals and reptiles and those from the latter occur in Lacertilia and Ophidia.

The worm is approximately 28-88 mm. in length with a maximum width of 0·9 mm. (1·4 mm. in the flattened specimen). The width increases as the mature proglottids are reached near the middle of the worm. The head (Fig. 1) is rounded and narrow and not definitely set off from the unsegmented portion of the strobila behind it. There is a slight protuberance which suggests a rudimentary rostellum. It has a width of 0·21 mm. (0·34 mm. in the flattened specimen). The unarmed suckers are oval, their antero-posterior diameter being 114μ and transverse diameter 90μ. The unsegmented region behind the head is 0·17 mm. in length though the beginning of segmentation is very faintly indicated. The most anterior segments are considerably broader than long and do not show any genital organs. The cirrus-sac and vagina are the first to appear. The ovary appears later and lastly the testes. The mature segments (Fig. 2) measure 0·32 mm. in length and 0·9 mm. in width in unflattened specimens. The gravid segments (Fig. 3), which are more or less quadrate, measure 0·87 mm. to 1 mm. in length and 0·9 mm. in width.

There are 15-20 segments in which well developed genital organs can be made out. The ovary disappears somewhat abruptly, being clearly visible up to a certain segment and then, in the following segment, being apparently absent ; the testes, on the other hand, persist through two or three segments more.

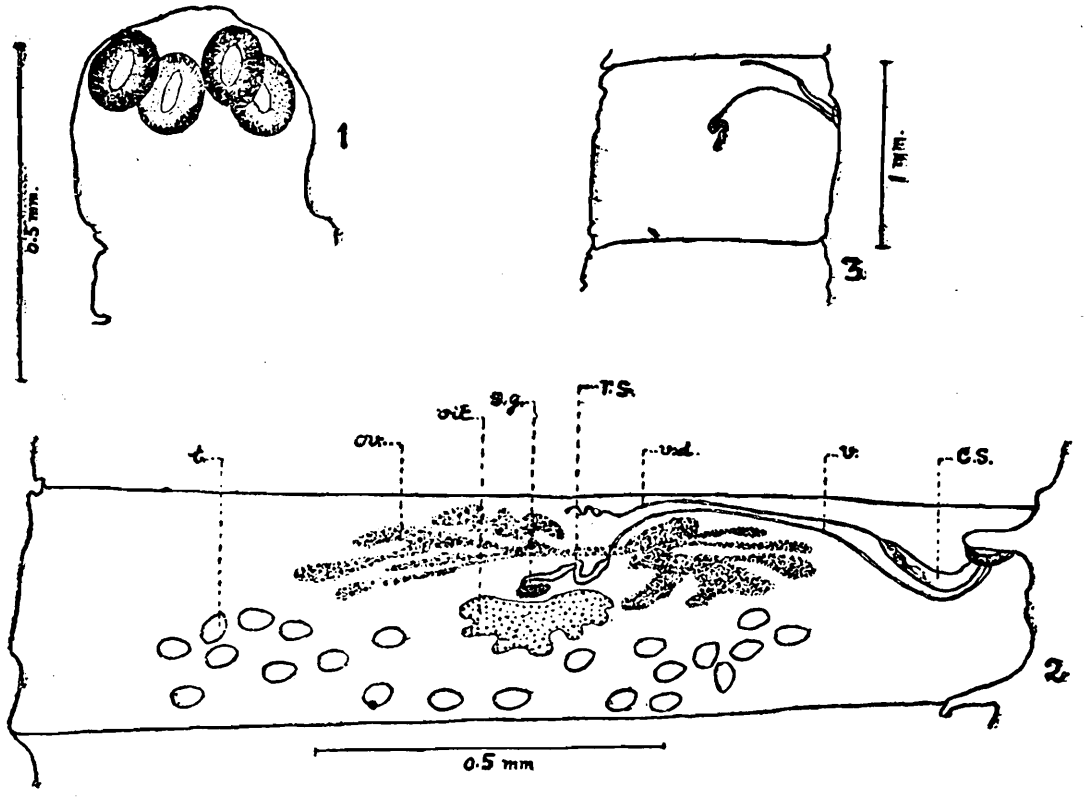
The cuticle is very thick. The musculature is weak and consists of an outermost layer of a few scattered longitudinal fibres, an inner layer of longitudinal bundles and an innermost layer of transverse fibres.

There are four longitudinal excretory vessels in each proglottid, of these the dorsal pair are wide and thin-walled and the ventral pair are

narrow and thick-walled. The latter are situated vertically below the dorsal ones and laterally give off irregular branches. The excretory vessels disappear in the posterior gravid segments.

The genital pores are irregularly alternate and are situated near the anterior corner of the lateral margin of the proglottid. The genital atrium has thick muscular walls and does not extend beyond the longitudinal excretory vessels. The genital ducts pass between the dorsal and ventral excretory vessels and dorsal to the nerve.

The testes (Fig. 2, *t.*), 22-24 in number, are disposed in two main groups one on each side of the corresponding lobe of the ovary. These two groups are connected by a row of 2-4 testes posterior to the vitelline gland. They do not extend in front of or lateral to the ovary



FIGS. 1-3.—*Oochoristica sigmoides*, sp. nov.

(From a flattened specimen.)

1. Scoles × 68. 2. A mature proglottid × 68. 3. A gravid segment. (Eggs are not drawn) × 19.

c. s. cirrus-sac ; *ov.*, ovary ; *r* , receptaculum seminis ; *s. g.*, shell-gland ; *t.*, testes ; *v.*, vagina ; *v. d.*, vas deferens ; *vit.*, vitelline gland.

but extend beyond the aporal excretory vessel. The testes measure 48-52μ × 29-32μ.

The cirrus-sac (Fig. 2, *c. s.*), 154-167μ in length and 20-25μ in width, is a long thin sac containing a coiled portion of the vas deferens near the medial end. It passes beyond the excretory vessels. The vas deferens (*v. d.*), before it reaches the cirrus pouch, is a narrow straight tube as far as the point between the level of the bridge of the ovary, where it is disposed in one or two simple coils. The cirrus-sac opens into the genital atrium.

The ovary (*ov.*) is bilobed, each mass divided into finger-like lobes arising from a transverse stalk. It is situated in the anterior region of

the proglottid and is a large structure extending across more than one-half the width of the segment. The aporal lobe is slightly larger.

The vagina (*v*) is a straight and narrow tube running parallel and posterior to the cirrus-sac and vas deferens. It opens into the genital atrium just posterior to the opening of the cirrus-sac. It turns posteriorly and crosses the bridge of the ovary towards the poral side and then enlarges into a S-shaped narrow receptaculum seminis ; at the other end of the latter structure it runs into the shell-gland (*s. g.*). The receptaculum seminis (*r. s.*) measures 79μ in length and 18μ in width. The large lobed vitelline gland (*vit.*) is slightly aporal.

The development of the uterus and the precise position it occupies could not be made out except that in gravid segments a very large number of parenchymatous capsules are seen, each capsule containing a single egg. These capsules fill nearly the whole of the gravid segment. The eggs are spherical in shape and measure 27μ in diameter, the diameter of the contained embryo being 15μ.

The possession of unarmed suckers, a single set of reproductive organs in each segment, genital pores irregularly alternating, the position of the testes and the eggs becoming enclosed singly in capsules places this worm in the genus *Oochoristica*. Referring to Meggitt's key to the species of this genus (1920) it comes very close to *O. truncata* Krabbe (1879) in the following particulars :—Egg-capsules contain only one egg, vagina opens posteriorly to the cirrus, testes 20-30, posterior to ovary ; eggs present in the centre of the proglottid. It, however, differs from *O. truncata* Krabbe as described by Rudin (1916) in the following particulars :— Posterior segments becoming quadrate, position of the genital openings, longer cirrus-sac, the position of the testes and the smaller size of the eggs. I, therefore, consider it to be a new species. The following is the specific characterization :—

Length 28-88 mm., maximum width 0·9 mm. ; segments broader than long, only a few at the posterior end nearly quadrate ; scolex 0·21 mm. wide (0·34 mm. in flattened specimen), narrow and rounded, suckers oval, 114μ by 90μ ; genital ducts pass between longitudinal excretory vessels and dorsal to the nerve ; testes 22-24, oval, posterior to the ovary, posterior and lateral to the vitelline gland, 48-52μ by 29-32μ, cirrus-sac narrow, 154μ to 167μ long and 20-25μ wide ; ovary bilobed, extending across more than half the width of the segment, aporal lobe slightly larger and vagina straight and narrow posterior to the cirrus ; uterus breaks into egg-capsules, each containing a single egg ; embryo 27 and onchosphere 15μ in diameter.

Habitat.—Intestine of *Calotes versicolor* Daud.

Locality.—Nagpur, C. P., India.

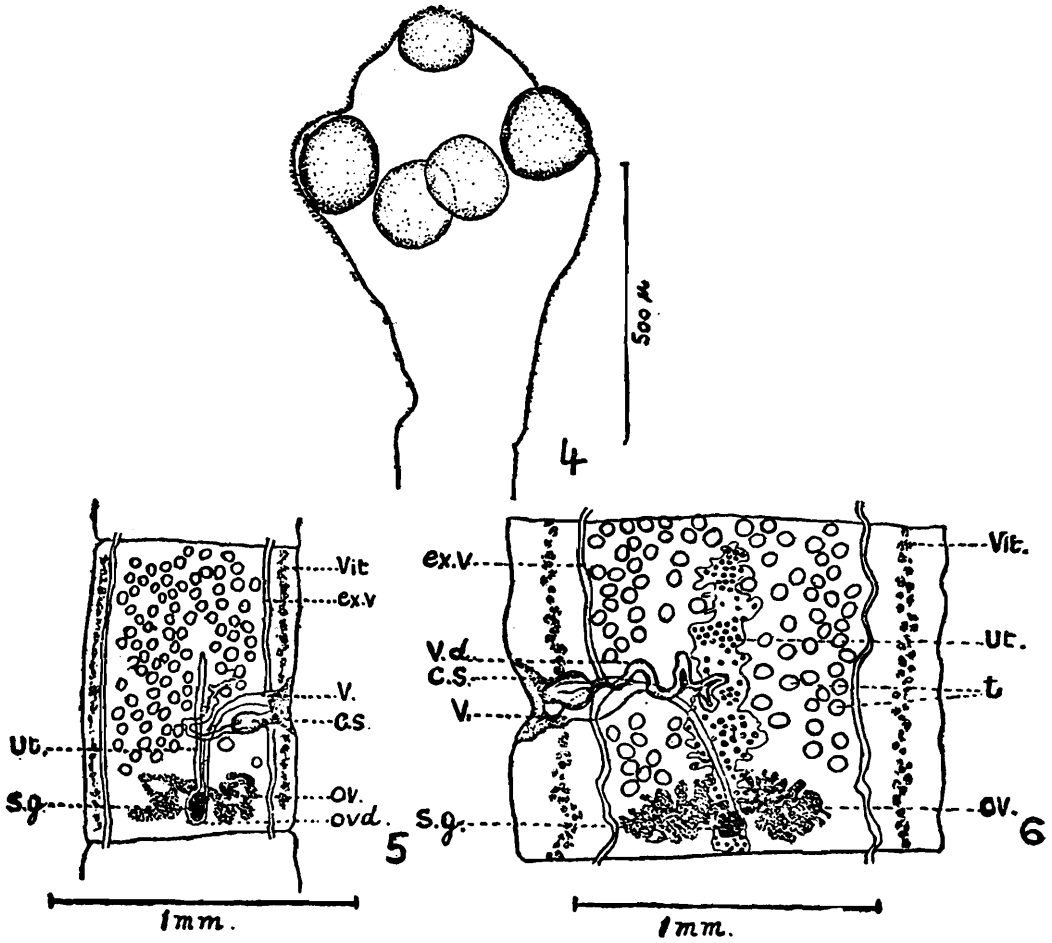
The type slide is deposited in the collection of the Zoological Survey of India.

Proteocephalus woodlandi, sp. nov.

Many pieces of different lengths were found associated with *Duthiersia expansa* Perrier (1873). I obtained only two scolices : one was mounted when fresh in lactophenol but the other was lost during the process of fixing and washing. It is quite possible, as Woodland (1925, p. 374)

suggests, that many pieces remain attached to the intestinal mucosa. The three largest pieces measured 31 mm., 28 mm., and 24 mm. respectively. The total length of the pieces collected was 140 mm.

The scolex is situated on a uniformly wide neck, gradually widening at the level of the suckers and gradually tapering anteriorly. It is 525μ in maximum width, which is at the level of the suckers. It bears four rounded suckers, their diameter being 140μ by 148μ. On the conical apex of the scolex a fifth sucker is borne. The width of the worm behind the scolex is 205μ and increases in posterior proglottids to 1·4 mm. Young mature proglottids (Fig. 5) measure 1 mm. in length and



FIGS. 4-6.—*Proteocephalus woodlandi*, sp. nov.
(From an unflattened specimen.)

4. Scolex × 56. 5. A young mature proglottid × 30. 6. An older mature proglottid × 30.
s., cirrus-sac ; *ex. v.*, excretory vessel ; *ov.*, ovary ; *ovd.*, oviduct ; *s.g.*, shell-gland ; *t.*, testes ; *ut.*, uterus ; *v.*, vagina ; *v.d.*, vas deferens ; *vit.*, vitellaria.

694μ in width. Fully mature proglottids (Fig. 6), *i.e.*, the ones in which the uterus is well developed and nearly fills the whole segment, measure from 0·9 mm. to 1·66 mm. in length and 1·16 mm. to 1·4 mm. in maximum width. The proglottids do not overlap each other.

The cuticle o the scolex and the anterior end of the strobilus is covered with minute spines, which are closely set on the scolex but less dense b hind.

The genital openings are irregularly alternating and are situated posterior to the middle of t e proglottid margin. The opening of the

vagina is sometimes anterior and sometimes posterior to the opening of the cirrus. There is a well developed genital atrium.

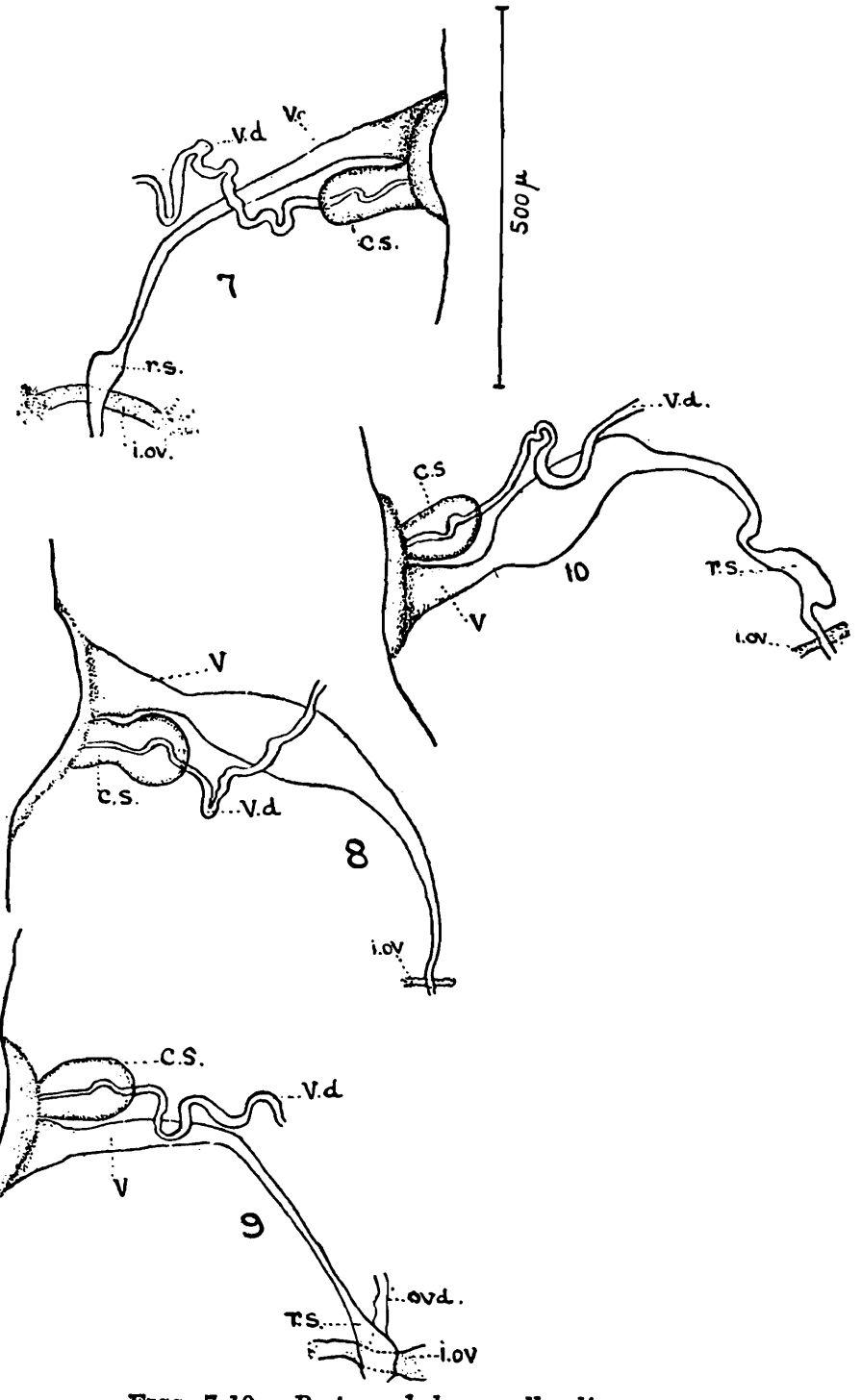
The testes (Fig. 6, *t.*), 90 to 130 in number, occupy in young segments the whole of the space between the longitudinal excretory vessels, but in more mature segments there is a considerable free space in the middle of the proglottid which, however, is not entirely free from testes. In distribution, therefore, the testes, as in *P. beddardi* Woodland (1925, p. 377), exhibit neither a strictly *Proteocephalus* nor a strictly *Ophiotaenia* condition. The testes in none of the older segments that I have examined have a one-field arrangement and yet in young mature segments (Fig. 5) there is a distinct one-field arrangement. There are no testes posterior to the ovary. They are vesicled and oval and measure 44-55μ by 61-68μ. The cirrus-sac (*c. s.*) in well developed segments is 156-176μ long and 115-130μ in maximum width. It is conical, unarmed and muscular, containing a rod-like portion of the vas deferens. It is sometimes anterior and sometimes posterior to the vagina and does not extend beyond the longitudinal excretory vessel. The vas deferens (*v. d.*) is a stout and a very loosely coiled tube dorsal to the excretory vessel. Some of these coils cross the broad vagina.

The ovary (*ov.*) is situated at the posterior extremity of the proglottid and consists of two branching masses connected together by a narrow bridge. It occupies nearly half the width of the proglottid. The poral lobe is slightly larger. The vagina differs considerably in different segments. Generally the vagina in *Acanthotaenia* is divisible into the following four parts:—(i) The initial part reaching from the genital atrium nearly to the middle of the proglottid; it is sometimes broadened out and muscular; (ii) the tube extending back to the interovarian space where its structure changes to (iii) the receptaculum seminis; and (iv) the lower vagina extending from the receptaculum seminis to the oviduct (La Rue, 1914, p. 29).

The initial part of the vagina in *P. woodlandi*, sp. nov. is broadened out and muscular (Figs. 7-10) and the tube, extending back to the interovarian space, commences in some segments with a thin-walled dilatation. This dilatation has the shape of a small spindle, but in some segments it may be very large and possibly corresponds to the "spindleformige Anschwellung" described by Ratz (1900, p. 659) in *I. saccifera*. It measures 250μ in length and 100μ in maximum width. Near the ovarian bridge in some segments but not in all the vagina enlarges into a small curved receptaculum seminis, which narrows posteriorly and passes into the shell-gland to join the oviduct. The oviduct (Fig. 5, *ovd.*) surrounds the shell-gland and continues anteriorly to the ovary into the uterus, which in young mature segments is a small narrow tube lying in the middle of the proglottid but not reaching to its anterior transverse margin. In older mature segments the uterus (Fig. 6, *ut.*) is a broad irregular thin-walled sac with 10-12 outpocketings on each side. As in *P. beddardi* Woodland (1925) the uterus extends to the hind limit of the proglottid, *i.e.*, below the ovary. The vitellaria have the normal Proteocephalid distribution. The eggs in the uterus measure 16 by 20μ.

The possession of cuticular spines on the scolex and the anterior part of the body, the presence of the fifth sucker on the conical apex of the

rostellum and the fact that the vagina opens either anterior or posterior to the cirrus-sac place this worm in the genus *Acanthotaenia* v. Linstow (1903) as subsequently emended by Johnston (1909). La Rue (1911) suggests that to this genus should belong species of *Ichthyotaenia* from



FIGS. 7-10.—*Proteocephalus woodlandi*, sp. nov.

Various positions of the cirrus-sac and the vagina and the shapes of the vagina.

c. s., cirrus-sac ; *i. ov.*, interovarian bridge ; *ovd.*, oviduct ; *r.s.*, receptaculum seminis ; *v.*, vagina ; *v. d.*, vas deferens.

the Varanidae and Johnston (1909) and La Rue (1911 and 1914) included in the genus *Acanthotaenia* species of *Ichthyotaenia* from the Varanidae previously described by Beddard (1913) and Ratz (1900). Later Hall

(1911) and La Rue (1914) maintain that *Ichthyotaenia* Lonnberg (1896) is synonymous with *Proteocephalus* Weinland (1856). Woodland (1924, p. 448) doubts the taxonomic value of characters such as the presence of cuticular spines and maintains that the creation of genera based on such characters is extremely objectionable. In a recent paper, he (Woodland, 1925) has pointed out that the other "non-scolex" characters associated with the spiny scolex in *Acanthotaenia* are also found "singly and probably to a large extent in other Proteocephalids altogether devoid of spiny scolices" (p. 387). He, therefore, considers it necessary that this genus should lapse along with several others of the family Proteocephalidae in the genus *Proteocephalus.* Acting on this I have labelled my worm *Proteocephalus.*

Of the species possessing cuticular spines on the scolex which have been included by Woodland in the genus *Proteocephalus* (1925, p. 379), both *Ichthyotaenia nilotica* Beddard (1913) and *Proteocephalus beddardi* Woodland (1925) have spines on the cirrus and can thus be distinguished from *P. woodlandi*, sp. nov. Besides, in *I. nilotica* the genital pores are slightly in front of the middle point of the proglottid margin, the ovary is solid and the eggs are aggregated in masses. In *P. beddardi* there are only 60-80 testes (90-130 in *P. woodlandi*) and each measures 55×30 microns (44-55×61-68 microns in *P. woodlandi*). *Ichthyotaenia boroi* Ratz (1900), *I. varia* Beddard (1913) and *Acanthotaenia shipleyi* v. Linstow (1903) can also be distinguished from the species described in this paper by the position of the cirrus-sac, which always opens in these species behind the vagina. The reverse is the case in *Ichthyotaenia saccifera* v. Ratz (1900), *I. gracilis* Beddard (1913) and *Acanthotaenia tidswellia* Johnston (1910), in which the vagina always opens behind the cirrus-sac. Of the remaining species, *A. striata* Johnston (1914) is an extremely narrow worm being only 0·12 mm. in maximum width and has the testes disposed in "two rather narrow fields" (Johnston, 1914, p. 108). The description of *A. varia* Nybelin (1917), which is probably specifically distinct from Beddard's *I. varia* (Woodland, 1925, p. 379), is not available to me in India.

I consider *Proteocephalus woodlandi* to be a new species and I have named it in honour of Dr. Woodland, who has recently contributed so much to our knowledge of this family. The following is the specific characterization of *P. woodlandi*, sp. nov. :—

Maximum width 1·4 mm. ; maximum width of scolex 525μ, diameter of suckers 140μ by 148μ; proglottids do not overlap each other ; vitelline follicles scattered and confined to the cortical region ; genital openings posterior to the middle of the proglottid margin, irregularly alternating ; vagina sometimes anterior and sometimes posterior to the cirrus-sac ; 90-130 testes, 44-55μ by 61-68μ ; cirrus-sac conical, 156-176μ by 115 to 130μ ; vagina very variable in shape ; in some segments the distal part at first widened out and muscular and a receptaculum seminis present in some segments ; uterus at first a small thin-walled median tube but later filling nearly the whole medullary space with 10-12 small and irregular outpocketings on each side ; eggs singly scattered in the uterus and its pockets, measuring 16×20 microns.

The type slide is deposited in the collection of the Zoological Survey of India.

In conclusion I desire to express my gratitude to Dr. Asa C. Chandler for giving me very valuable guidance in the compilation of this paper.

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ON THE ADULTS OF *ZOANTHELLA* AND *ZOANTHINA*.

By K. R. MENON, *M.A.*, *Presidency College, Madras.*

In a short note published in the *Records of the Indian Museum* in 1914 and again in a paper read at the second meeting of the Indian Science Congress held at Madras in 1915 the author communicated certain observations on the metamorphosis of *Zoanthella*. He has on subsequent occasions made further observations on this and other forms of Semper's larvæ and can now add to the information already published.

The species of *Zoanthella*, the metamorphosis of which was described in the preliminary note published in the *Records*, can be easily recognised by its small size and slender vermiform shape. The length of the larva is about 2½ to 3 mm. and its breadth as measured on the side about ½ mm. The body is roughly cylindrical, has rounded aboral and truncated oral ends and is slightly bow-shaped, the concavity being ventral. The band of cilia extends from the oral to the aboral end on the concave side. The general colour is yellowish white. The larva often swims rapidly through the water and, when it does so, develops a corkscrew-like twist and progresses by executing a rapid rotatory motion. The young Zoanthid into which the larva is metamorphosed is attached and the attached condition may last some months, the animal growing slowly all the time. As grown in the laboratory, the animal is free from incrustations of any kind, though when sand is supplied the bodywall builds up the characteristic incrustation. The examination of older specimens makes it clear that the animal is a species of *Sphenopus*. The deep siphonoglyph with the thick mesoglœa in its walls, the depressed body, the oral disc slightly elongated in the transverse direction, the dorso-ventral slit-like mouth and the arrangement and disposition of the tentacles are among the more obvious macroscopic characters pointing to this identification. The author was fortunately able, however, to place the identity of the animal beyond the possibility of doubt when in January 1924 he obtained a brood of very early stages from a specimen of *Sphenopus* living in his laboratory. These early stages were reared into the stage of *Zoanthella* obtained in the plankton. The author has preserved several stages and hopes to give an account of the early development of *Sphenopus* before long. The larva of *Sphenopus* is thus a species of *Zoanthella*.

A second species of *Zoanthella* found in Madras is much larger and has an elongated pyriform body with the mouth at the narrow end. The length varies from about 6½ to about 10 mm.; the greatest diameter is near the aboral extremity, being about 2½ mm., the diameter at the oral end being about ½ mm. or a little more. The ciliated band extends from the mouth to about a third or fourth of the body length from the aboral end, and the posterior termination of the band is pointed. The larva has a grey colour, having a light ground colour with an irregular net-work of streaks and patches of dark brown pigment, the pigmentation being dense near the aboral end. The living larva is straight or very slightly curved. In preserved specimens the shape of the living larva is often

retained, but generally the oral portion shows a strong curvature towards the ventral side where it is rolled into a short spiral, the aboral end becomes truncated and the whole surface of the larva becomes strongly puckered. The detailed comparison of the larva with the several species described has not been made but, judged by its external characters, it seems to be identical with *Zoanthella galapagoensis* Heath. The second larva also has been reared in the author's laboratory and advanced specimens with as many as 46 tentacles have been obtained. The specimens are devoid of incrustation but occasionally sand-grains are found embedded in the body-wall. The animal is undoubtedly a species of *Gemmaria*, or, as this genus has latterly been merged by some authors in the genus *Palythoa*, of the latter genus.

One of the Madras species of *Zoanthina* has been reared into a species of *Zoanthus*. The identification of the adult in the present case is quite easy, as the capitular fossa, *i.e.*, the ectodermal groove between the two portions of the sphincter muscle, which is usually seen in contracted specimens of *Zoanthus*, is very clearly visible externally and the double sphincter muscle, which is the diagnostic feature of the genus *Zoanthus*, can be readily made out in longitudinal sections of the animal. The ectoderm of this species of *Zoanthus* is continuous. There is a species of *Zoanthus* common in Madras which in its translucent and delicate body-wall and in other features resembles *Z. pulchellus* described from the West Indies. The specimen reared from the *Zoanthina* appears to be identical with this Madras species, though its specific identity can only be settled when older laboratory-grown specimens are available for comparison.

A second species of *Zoanthina* also occurs in Madras. It differs from the first in having a longer body and by its somewhat tougher build. This larva also has been reared into the parent form which presents very interesting features. The ectoderm of the parent form is discontinuous and contains zooxanthellæ. The condition of the ectoderm in the young larva has not been noted. The oral disc and tentacles of the parent form are always drawn in, and though individuals with as many as 36 tentacles have been reared and a few specimens have been living in the laboratory for over a year they have never been seen with the disc or tentacles expanded. The body of the parent animal is smooth, slightly curved to one side, and has a circular flat, thin or thick base for attachment ; often a few individuals are found stuck together by their base forming clusters. Longitudinal sections show the existence of a well-developed sphincter muscle. The muscle cavities are numerous and in the region of the sphincter occupy the whole of the mesogloea, extending from the ectoderm to the endoderm, and give a vacuolated appearance to the mesoglœa. All these are characteristic features of the genus *Isaurus* with which genus the specimen also agrees in minor histological details. The genus *Zoanthus* has a double sphincter muscle and in contracted specimens there is an ectodermal groove between the muscles. The genus *Isaurus* has a single sphincter muscle. In the specimen in question the muscle is single but is indented by a deep ectodermal groove which occurs in the same position as the capitular fossa of *Zoanthus*. The muscle is neverthe-

less single, the two major portions being connected together by a narrow bridge of muscle which lies below the groove. The only young specimen of naturally-growing *Isaurus* that the author could obtain for comparison was much larger and presumably older than the laboratory-grown specimen, but it also shows a corresponding groove, though the groove is broader and more shallow in this case. It is hoped to investigate this point further in suitably fixed material of *Isaurus*, but appearances seem to indicate that the groove is a natural structure, in the single specimen examined. The description of the adult *Isaurus*, given by various authors does not mention any such groove, and if the groove occurs in the young but disappears in the adult it would be interesting to ascertain the manner of its disappearance. The most striking peculiarity of the fully-grown *Isaurus* is the occurrence of irregular rows of tubercles on the body. Young individuals, however, have a smooth body and are devoid of tubercles. The absence of tubercles in the laboratory-grown specimens which are obviously young does not therefore militate against the identification of the latter as *Isaurus*. The validity of the author's identification can be simply and conclusively tested by rearing the tuberculate forms from the larvæ or by obtaining the larvæ from *Isaurus* ; both these lines of investigation will be taken up as soon as the necessary living material can be obtained. In the meantime the author considers that the form, structure and habit of the laboratory-grown specimen justify its identification as *Isaurus*.

The larvæ of *Zoanthus*, *Isaurus*, *Palythoa* (in which genus *Gemmaria* is included) and *Sphenopus* are thus known. These are the four brachycnemic genera of the Zoanthidæ. *Zoanthus* and *Isaurus* differ from all the other Zoanthidæ in having an unincrusted body-wall, and it is worthy of note that they are both descended from the same type of larval form, *Zoanthina*. With regard to the macrocnemic genera, from Carlgren's description of the young of *Isozoanthus* it appears that the special characteristics of *Zoanthella* and *Zoanthina* are absent. It is not known whether these larvae occur in the other macrocnemic genera, and it will be premature to estimate the value of these larval forms in settling the inter-relationships of the genera of the Zoanthidæ. We may note, however, that two different larval forms give rise to the same, brachycnemic, group of adults.

It is well known that both macrocnemic and brachycnemic types of mesenterial arrangement may occur in the same individual. These facts seem to suggest the possibility that the usual classification of the Zoanthidæ into the Brachycneminæ and Macrocneminæ may not after all be the best expression of phylogenetic relationship. Can it be that the unincrusted forms, *Zoanthus* and *Isaurus*, are fundamentally distinct from the incrusted genera? While the question seems to be perfectly legitimate in the light of known facts, it would be impossible to answer it without further knowledge of the development of the group.

The results of rearing zoanthid larvæ and of keeping zoanthid colonies alive in the laboratory are not without some bearing on zoanthidean technique. The greatest difficulty in the study of the group is presented

by the incrustation of the body-wall. Specimens collected from coral seas are described as containing calcareous deposits ; these can be easily removed by ordinary acids. All the specimens which the author has procured from various localities in South India are incrusted with ordinary sand and the only method which he has so far found useful in dealing with them is the application of hydrofluoric acid. The most satisfactory way, however, of getting specimens without sandy inclusions is to rear them from their larvæ in clean sea-water. *Sphenopus*, a very thickly incrusted genus, and *Gemmaria*, also an incrusted form, can be obtained in this way. In colonies of *Gemmaria* kept growing in the laboratory in clean sea-water the fresh individuals which develop have thin and transparent body-walls and are not so heavily incrusted as the older individuals. What seems to take place is this. The crust of the part of the cœnenchyme or body-wall of a zooid from which a new bud sprouts is distributed in the growing bud. Apparently there is no transport of foreign material from one part of the colony to another and as the developing bud does not obtain sand or other particles from outside, it grows into a thin-walled form without the usual incrustation. This habit suggests the possibility of obtaining individuals practically free from foreign matter by keeping the colonies alive for long periods, though the practical value of the method has yet to be established. The method of rearing soft-walled adults from larvæ is no doubt tedious but is well worth the trouble and the time.

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