ON A NEW PISIONID FROM THE SANDY BEACH, MADRAS.

By R. Gopala Aiyar and K. H. Alikunhi.

(From the University Zoological Research Laboratory, Madras.)

(Plates I & II.)

Contents.

Historical.

While engaged in a study of the fauna of the sandy beach of Madras we came across a very interesting polychaete, allied to *Pisione*, but markedly different from it in several respects.

Pisione was first discovered by Kroyer on the Chillian Coast and in 1857 Grube described it and created a new genus and species *Pisione oerstedi*. He placed it in the Phyllodocidae and regarded it as a transitional form between the Phyllodocidae and Glyceridae. Later Levinsen (1886) created a new family Pisionidae for its reception. Then Ehlers (1901) gave a full description of the species *P. oersteli* and also added a second species *P. contracta*. In 1914 Southern described another genus and species *Praegeria remota* which he collected from Clew Bay during the Clare Island Survey. In 1924 Augener described a third species of *Pisione* viz., *P. germanica* from the Black Sea.

Material and Methods.

The worms live in the upper layers of the intertidal sandy zone. Though small, they are easily detected by their active movements. Numbers of them can be collected by shaking the sand with water in a glass trough, allowing the sand to settle when the worms could be seen swimming in the water and then quickly pipetting them out into a tube before they burrow again into the sand. When removed from the sand and placed in a dish of water they swim with peculiar jerking

movements and then curl themselves and settle down at the bottom of the dish.

The sexes are separate, and the mature males and females can be distinguished from each other under the microscope by their reproductive organs seen through the body wall. But an experienced eye can distinguish the sexes by mere sight. The males are usually smaller than the females. The worms breed freely in their natural habitat and we were able to obtain some of the developmental stages. Fully mature male and female specimens could be obtained throughout the year.

The description given below is based on living worms, whole mounts and serial sections. The worms were fixed in Bouin's Fluid. Iron haematoxylin, Mann's Methyl-blue Eosin, Carmine and Picro-nigrosin were used for staining the sections.

EXTERNAL CHARACTERS.

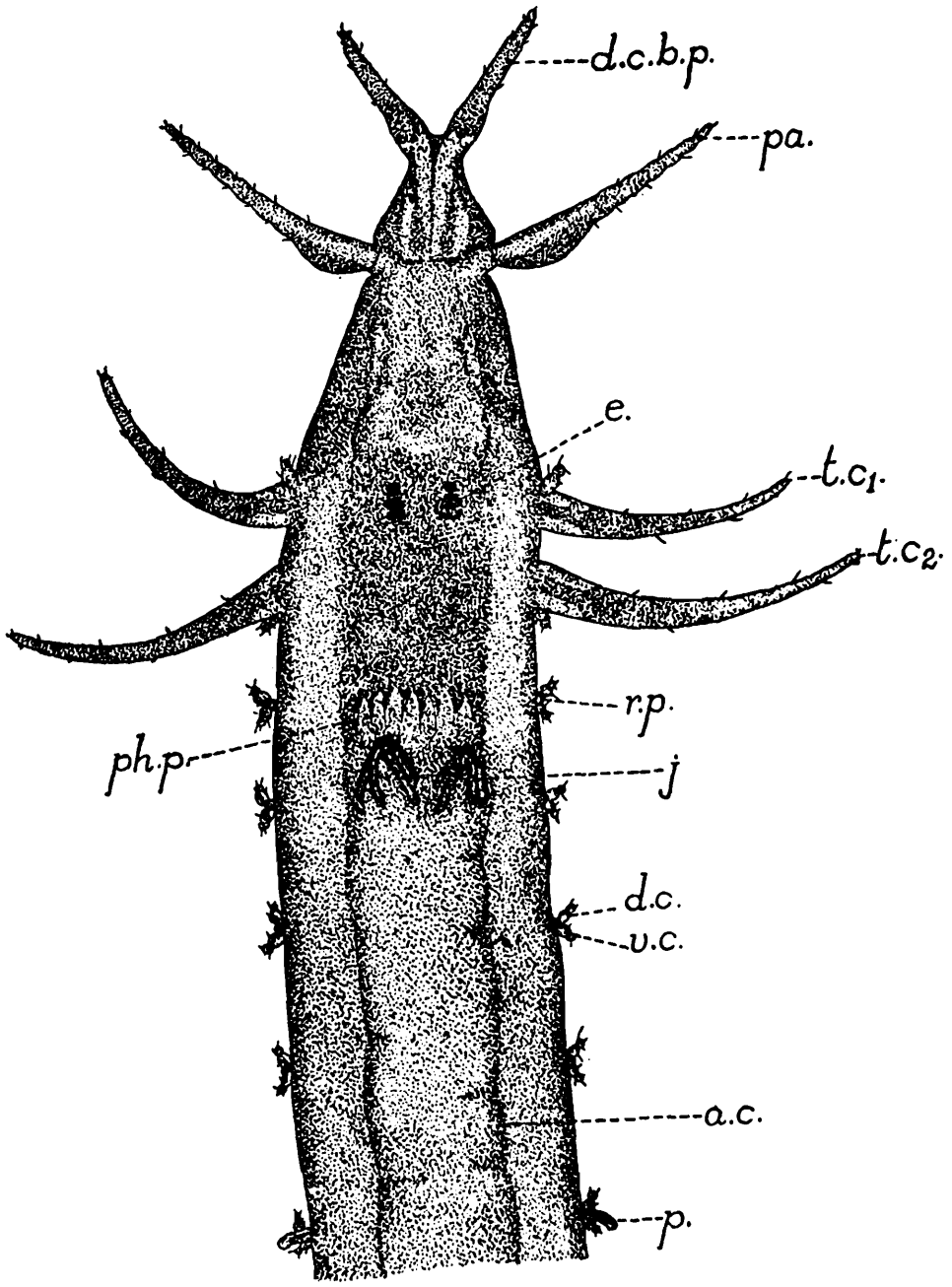
A fully grown male worm measures about 14 to 18 mm. in the living condition. The body is cylindrical, the tail tapering and there are as many as 50 to 60 distinct body segments.

Head.—The prostomium is highly reduced. The appendages of the head are all well developed (Pl. I, fig. 1 and text-fig. 1) and following Southern's description of *P. remota*, an allied form, the bases of the buccal parapodia are fused in front of the head. In addition, the bases of the dorsal cirri of the buccal parapodia have also fused to a great extent, the fusion being marked by well defined dorsal and ventral grooves. The ventral cirri of the buccal parapodia, mentioned as occurring as small flask shaped structures at the bases of the dorsal cirri of the same parapodium in *Praegeria*, are conspicuous by their absence. The buccal parapodia are devoid of any setae. Immediately behind these dorsal cirri is a pair of well defined palps. Their bases are enclosed by conspicuous sheaths of tissue from which they appear to arise. These palps as well as the modified dorsal cirri have a jointed appearance and are provided with stiff processes, the palpocils. The basal core of each of the dorsal cirrus of the buccal parapodia is supported by rigid tissue which at first gives the appearance of setae, but application of caustic potash and subsequent examination under the microscope do not reveal any. In this respect the present form differs markedly from *Praegeria*.

Below the palps there follows an elongated region wherein the fused brain is situated. About half way down the brain are placed the two pairs of eyes. They are irregularly placed. The anterior pair is smaller and diverge slightly while the posterior pair, of almost twice the size of the anterior pair of eyes converge slightly. Behind the posterior pair are two spots of dark brown pigment.

The ventral cirri of the first segment are elongate and function as tentacular cirri but unlike the case in *Pisione* and *Praegeria*, the segment is non-setigerous. As in *Pisione* the dorsal cirri of the second segment are modified into tentacular cirri, but here again this segment is non-setigerous whereas the corresponding segment in *Pisione* and *Praegeria* is setigerous. This second pair of tentacular cirri is the largest of the cephalic appendages. The dorsal cirri of the first segment and the ventral cirri of the second segment are present as slightly inconspicuous globular structures.

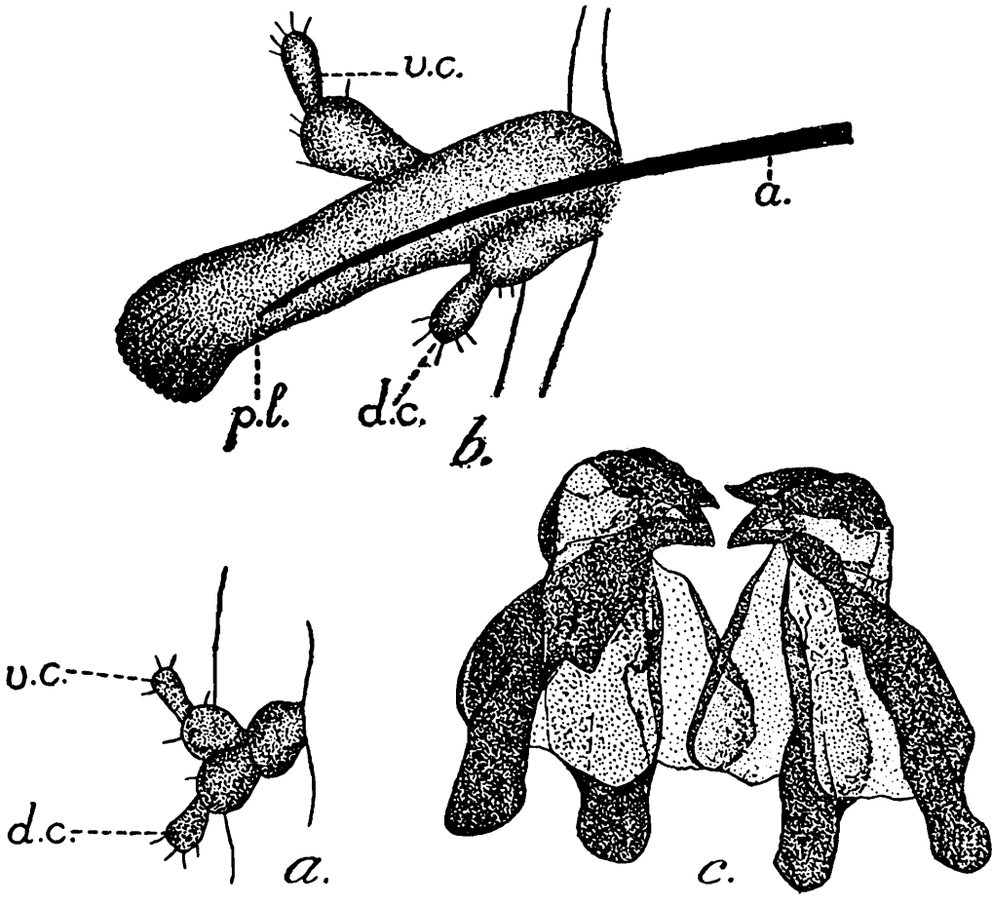
The parapodia of the third to the sixth segments are peculiar and are represented only by very minute globular structures provided



TEXT-FIG. 1.—Anterior end of *Pisionella indica*, gen. *et* sp. nov.: ×80.

with palpocils at their tips (text-fig. 2*a*). Curiously enough these parapodia, are not provided with any kind of setigerous support. What has happened in these segments—judging from the development of the larvae —is that the main setigerous lobe of the parapodia has mysteriously disappeared and the minute globular structures, in the place of the parapodia are really the dorsal and ventral cirri of the corresponding segment. The condition in the first two segments carrying the tentacular cirri is also the same except that the dorsal or ventral cirri, as the case may be, are modified. The parapodia from the 7th segment backwards are setigerous and they begin to increase in dimension until they attain fair proportions in the middle segments.

A parapodium from one of the middle segments may be considered as typical (text-fig. 2*b*). Such a parapodium is uni-ramous like the rest



TEXT-FIG. 2.—*Pisionella indica*, gen. et sp. nov.
a. A reduced parapodium of the 6th segment: ×375;
b. Parapodium of the 10th segment: ×375;
c. The jaws of the worm: ×375.

and is provided with a distinct dorsal and ventral cirrus. Each cirrus is two jointed and has a definite globose cirrophore with a terminal papilla provided with a few palpocils at the end. The ventral cirrus springs from the middle of the main parapodial lobe while the dorsal cirrus takes its origin almost from the body wall just at the base of the parapodium. Each parapodium is supported by only a single bristle. There are no setae of any other kind. In the male, in the segments in which the sperm-sacs are developed, the parapodia are greatly modified. The proximal half of the parapodium together with the ventral cirri gets hypertrophied and carried along the eversible portion of the sperm-sacs (text-fig. 5). The dorsal cirrus remains unmodified. In the female the parapodia, at the bases of which the receptacula seminis open, have not undergone any modification.

There is a pair of long anal cirri of about the same length as the tentacular cirri (Pl. I, fig. 2).

Adult females are slightly bigger and stouter than adult males with a corresponding number of segments. Some exceptionally large females measuring about 25 mm. in length are also not uncommon. In the anterior region there is practically nothing to distinguish the sexes externally. The palps and cirri of the head are similar in both the sexes. So also are the four pairs of tiny anterior parapodia. The anal cirri also are alike in the male and the female.

Genital Papillae (Suckers).—When the worms are fully mature they become provided with a series of median genital papillae or suckers on the ventral side (Pl. I, fig. 3). Their arrangement is different in the two sexes. In the male they are arranged in two series, an anterior and a posterior. The first series consists usually of 5 to 7 papillae occurring from the 10th to 16th segment. The second series is developed in the posterior half of the body. In a specimen having 50 body segments the anterior series occupied segments 10 to 16, while the posterior series occurred on segments 24 to 39. In a number of specimens this posterior series of papillae was found to occur on segments 26 to 38.

In the female the anterior series of papillae is absent. The posterior series consisting usually of 10 to 12 in number is found in the second half of the body. These papillae in the female are usually developed only on alternating segments, whereas in the male the papillae follow each other without any break in the series (text-figs. 5, 6). Also they are smaller and less strongly built than in the male.

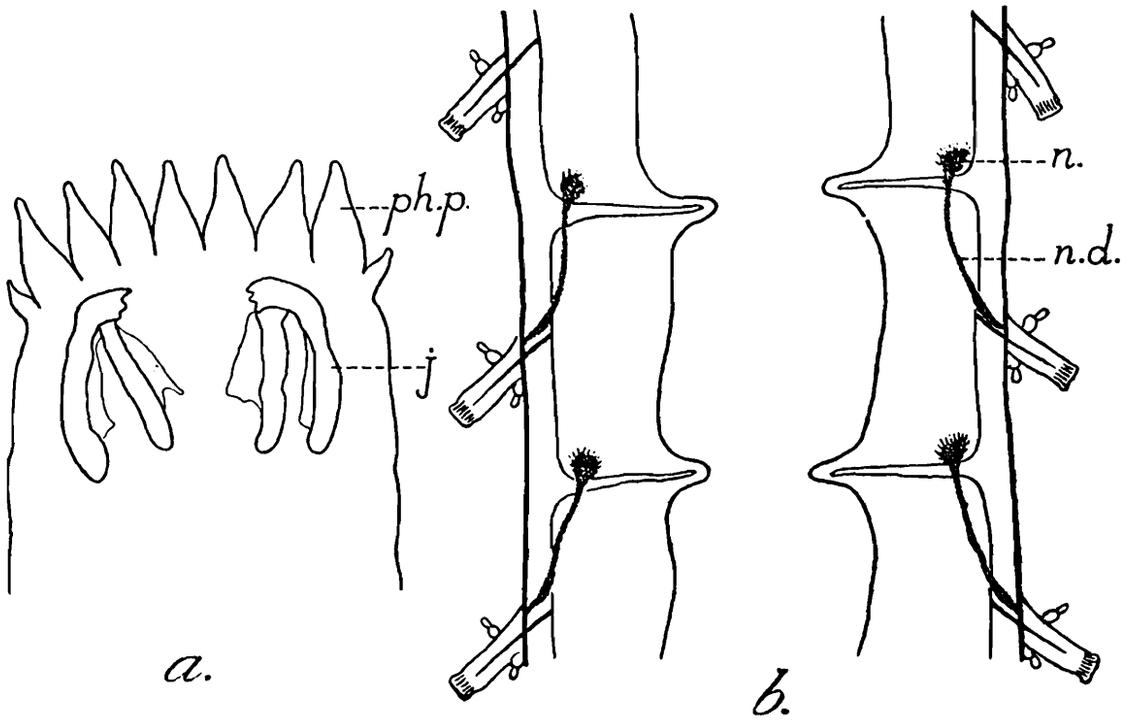
When protruded they remind one of the false feet of lepidopterous larvae. As has been mentioned they are developed only when the worms become mature. Their structure can be made out by a reference to text-figures 5 and 6 and Plate I, fig. 4. From the centre of each sucker there arises a stout muscular papilla the tip of which is divided into 3 or 4 smaller processes. The circular rim of the sucker or cup is chitinised and shows minute teeth-like serrations and this portion has got a bright amber colour. To the bottom of the cup internally is attached a group of muscles spreading fan-wise and getting attached to parts of the dorsal body wall. By the help of this stout band of muscles the papilla is capable of being retracted. Eversion is probably effected by the contraction of the body wall resulting in the body fluid exerting a pressure on the papilla and forcing it out. In this condition the latter takes the form of a finger like process.

BODY-WALL.

Externally there is a thin cuticle. The epidermis consists of a single layer of flattened cells with darkly staining nuclei. There is a rich development of glands. The glands are of two kinds. The first kind consists of minute unicellular structures with their outer ends drawn out into short narrow tubes opening to the outside. The second consists of larger and more specialised glands. They are developed in the thickness of the body wall and are metamerically arranged on either side in between two successive parapodia. In the living worm they appear as definite groups of coiled refractile tubes. In sections they are poorly stained and nuclear elements could not be made out. In some of the very anterior segments they are not so conspicuously developed. These glands are probably of a mucous secreting function. Below the epidermal layer is placed an extremely thin layer of circular muscles and below this is the highly developed layer of longitudinal muscles arranged in five definite bands; two dorso-lateral, two ventro-lateral and one ventro-median. The oblique muscles are also well developed. Below the longitudinal layer is the coelomic epithelium.

ALIMENTARY CANAL.

The mouth is median, ventral in position, elongated in shape and is situated between the palps and the first pair of tentacular cirri. It leads into a highly muscular protrusible pharynx (Pl. I, fig. 5). In the retracted condition the pharynx extends to the 8th segment. The pharyngeal armature consists of two pairs of highly chitinised amber coloured jaws (text-fig. 2*c*) with blunt teeth. The pharynx is provided with a crown of 14 conical papillae of almost uniform size (text-fig. 3*a*). The two lateral papillae on each side carry in addition a small papilla on their outer margins. The bases of all these papillae are extremely rich in glandular tubules. The pharyngeal wall consists of an external covering of visceral epithelium below which is situated the highly developed longitudinally arranged muscles. The internal lining is formed of an epithelial layer made up of flattened cells.



TEXT-FIG. 3.—*Pisionella indica*, gen. *et* sp. nov.
a. Pharyngeal papillae and the jaws : ×166⅔ ;
b. Diagram to show the arrangement of nephridia in the non-genital segments : ×166⅔.

The pharynx is followed by a thin walled chamber—the stomach—occupying the next four segments. This is followed by the intestine which gets wider in the middle segments but undergoes deep constriction at the level of the septa. Behind, the gut gets narrower and finally ends in the anus situated ventrally in the last segment. In the segments in which the gonads are developed the alimentary canal is in the form of a narrow tubular structure on account of internal pressure from the gonads. The wall of the intestine is thin and is formed of only a single layer of digestive epithelium consisting of large cells with big, deeply staining basal nuclei.

NERVOUS SYSTEM.

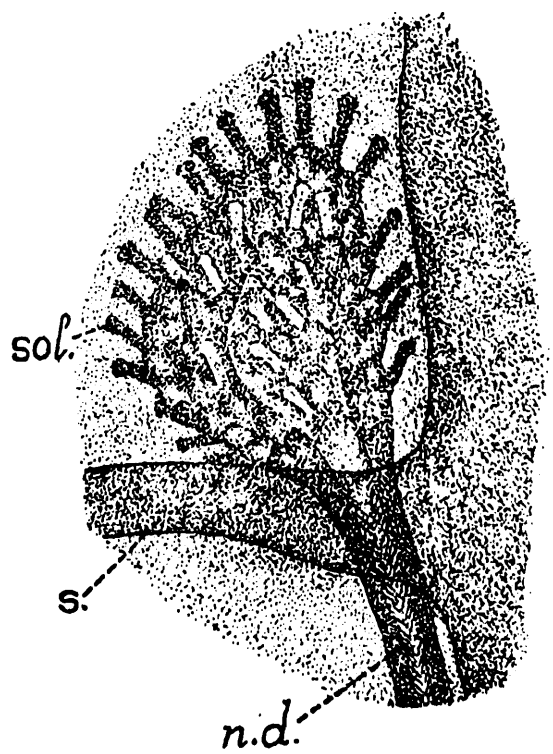
As has been previously mentioned the brain is situated dorsally in the region between the palps and the first pair of tentacular cirri. It is in

the form of two more or less elongated lobes which are fused together in the middle. The eyes, situated at the level of the first pair of tentacular cirri, are placed on two elongated conical posterior extensions of the brain.

The brain is covered over by a strong membrane which consists of cells having very deeply staining nuclei. These nuclei are very large with very little cytoplasmic covering. From the anterior portion of the brain are given off two stout nerves to the palps. The circum-oesophageal commissures run down to the ventral side, fuse together in the mid-ventral line and then proceed as the nerve cord. Well defined ganglionic swellings are not present. The nerve cord is of almost uniform thickness throughout but in the level of the septa there is slight reduction in the thickness. Hence, segmentally, there is a gentle enlargement which may be taken as the ganglionic swelling for each segment. Sections reveal that in certain regions there is a space between the two halves, in other places the covering membrane runs between the two halves and in still other places the two halves are completely fused.

NEPHRIDIA AND GENITAL FUNNELS.

Nephridia.—On examining with a microscope a living specimen of the worm gently compressed under a coverglass, paired nephridia can be seen in every segment after the first three or four, as bunches of cells projecting into the body cavity from the corner between the body wall and the septum. (Pl. I, fig. 6 and text-fig. 3*b*.) Each nephridium consists of a globular cluster of cells. There is a cavity inside. From the outer side of each one of these cells springs a slender process which ends in a minute swelling. These swellings together with the connected processes

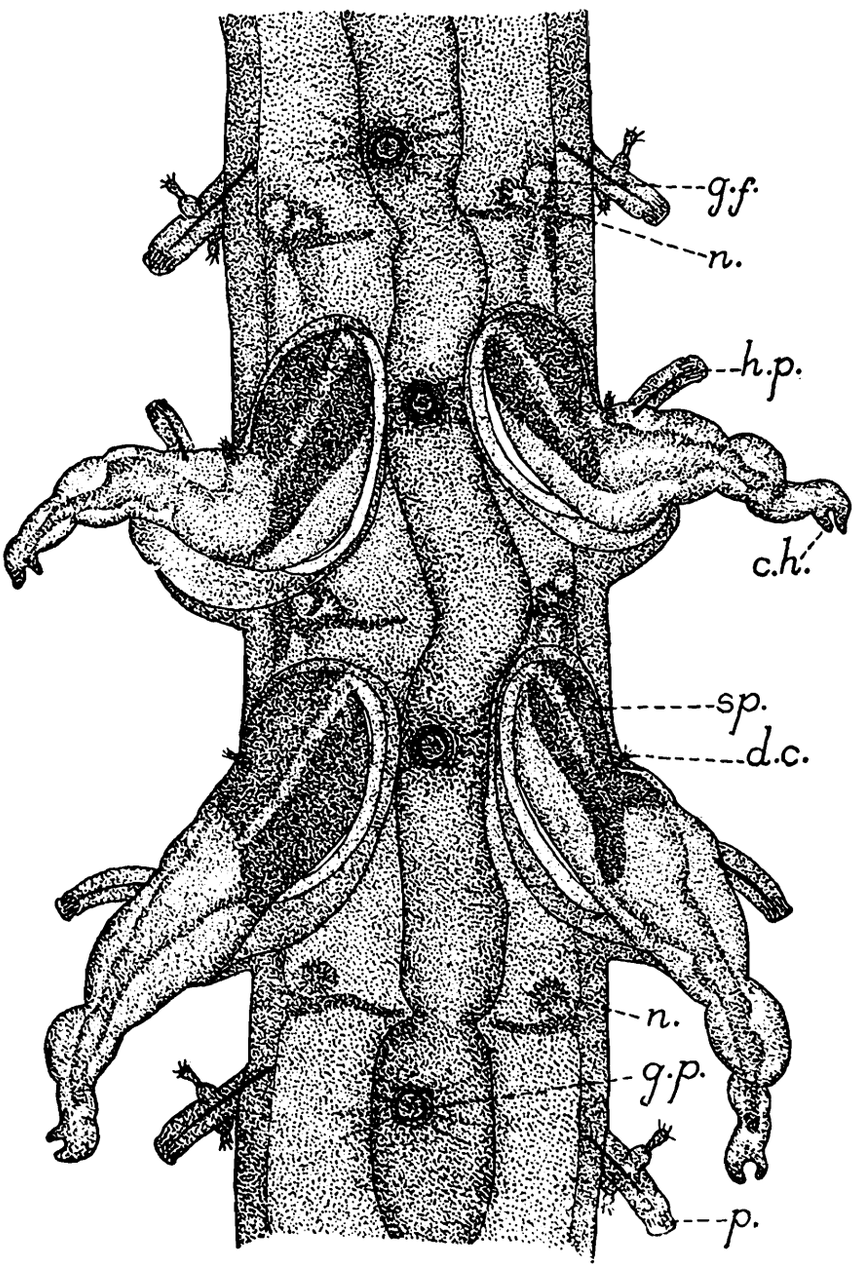


TEXT-FIG. 4.—Nephridium of *Pisionella indica*, gen. *et* sp. nov.; ×1125.

constitute the solenocytes of the nephridium. Each nephridium is provided with a number of these solenocytes (text-fig. 4) projecting into

the coelomic cavity and thus making the nephridial swelling conspicuous. Each solenocyte is a short narrow tube of even diameter throughout. The minute swelling at the tip constitutes the cell body of the solenocyte. A long flagellum works rapidly down each tube of solenocyte and passes into the lumen of the nephridial swelling and may even pass into the commencement of the nephridial canal.

Certain irregular vacuoles and globules—probably of excretory nature—are found in the cells of the walls of the nephridial swelling. Each nephridium opens ventrally to the exterior just in front of the base of the parapodium. This external opening leads into a slightly dilated chamber which is continued into the narrow, straight, ciliated nephridial duct extending forwards and finally emerging beyond the septum in front as the dilated closed swelling. The nephridial duct



Text-fig. 5.—The middle segments of a mature male of *Pisionella indica*, showing the sperm-sacs and copulatory hooks (Slightly diagrammatic) : ×80.

is inter-cellular (text-fig. 4) and in the ordinary segments it is not coiled anywhere.

Genital Funnels.—Besides the nephridia, well developed genital funnels are developed in the adult worms—male and female—in the segments in which the gondas are formed (text-figs. 5, 6). To take a specific example in a female with 55 segments, 4 pairs of ovaries and 4 pairs of receptacula seminis, only 4 pairs of genital funnels were developed. They were situated in segments 27, 31, 35 and 40 *i.e.*, in those segments which just precede the segments in which each pair of receptacula seminis is situated. In the case of the males also the occurrence of these funnels is restricted to the reproductive region. In a male worm, for instance, with 50 segments there are 14 pairs of testes and two pairs of sperm-sacs. The latter occurred in segments 29 and 30. There were two pairs of genital funnels and they occurred in segments 28 and 29.

This highly localised distribution of the genital funnels, receptacula seminis and sperm-sacs is necessitated by the fact that the reproductive elements have to pass through the receptacula seminis or sperm-sacs as the case may be. As will be explained presently the nephridial canal in these segments after the union with the genital funnel invariably opens into the receptaculum seminis or sperm-sacs according as the worm is female or male. Hence the reproductive products are gathered by the genital funnel and are taken to the receptaculam seminis in the female and to the sperm-sacs in the male and from there sent to the outside.

Genital funnels are fully developed only when the worms become sexually mature and they are associated with the nephridia. In a specimen which was sexually immature *i.e.*, without any trace of the genital papillae as well as the reproductive elements, genital funnels were not developed. In another specimen—a developing female—in which the first rudiments of the reproductive elements were visible, the nephridia in the segment following each developing group of ovaries were found to be enlarged. On careful examination it was found that the coelomic epithelium at the very corner between the body wall and the septum had undergone active cell proliferation, with the result, a thick mass of cells towards the body wall side of the nephridium had formed. This is the first rudiment of the genital funnel. As the genital elements mature, the cells of the funnel subdivide and the genital funnel rudiment enlarges. In another specimen which was slightly more developed these rudiments of the genital funnels had become cup like with a few cilia but still with no communication with the nephridia. In a fully mature female specimen the cup has become enlarged and thin walled. The rim of the funnel is specially differentiated and becomes thickened and strongly ciliated. It is about three times the size of the nephridium associated with it (Pl. II, fig. 1). The funnel has now acquired an opening into the nephridial canal just above the septum and below the nephridial swelling. The nephridial canal after piercing the septum slightly enlarges and, as has been already mentioned, opens into the anterior half of the receptaculum seminis. The development of the genital funnel in the male is similar but it does not get so highly enlarged as in the females probably because of the much smaller size of the sperms.

In the fully differentiated condition the wall of the genital funnel is found to be formed of columnar epithelial cells with larger but less

deeply staining nuclei than those of the nephridial canal. In transverse sections passing just above the point of union of the genital funnel with the nephridium the difference between the genital funnel and the nephridium could be made out clearly owing to the differential staining property of the nuclei of the two organs.

REPRODUCTIVE ORGANS.

Male.—The sexes are separate. In the male the reproductive organs are in the form of paired testes which could be seen shining through the body wall. They are usually developed in the second half of the body, the anterior half as well as some of the posterior segments being probably sterile. In a specimen with 50 segments 14 pairs of testes were found extending from the 24th to the 39th segment *i.e.*, in the segments in which the posterior series of genital papillae were developed.

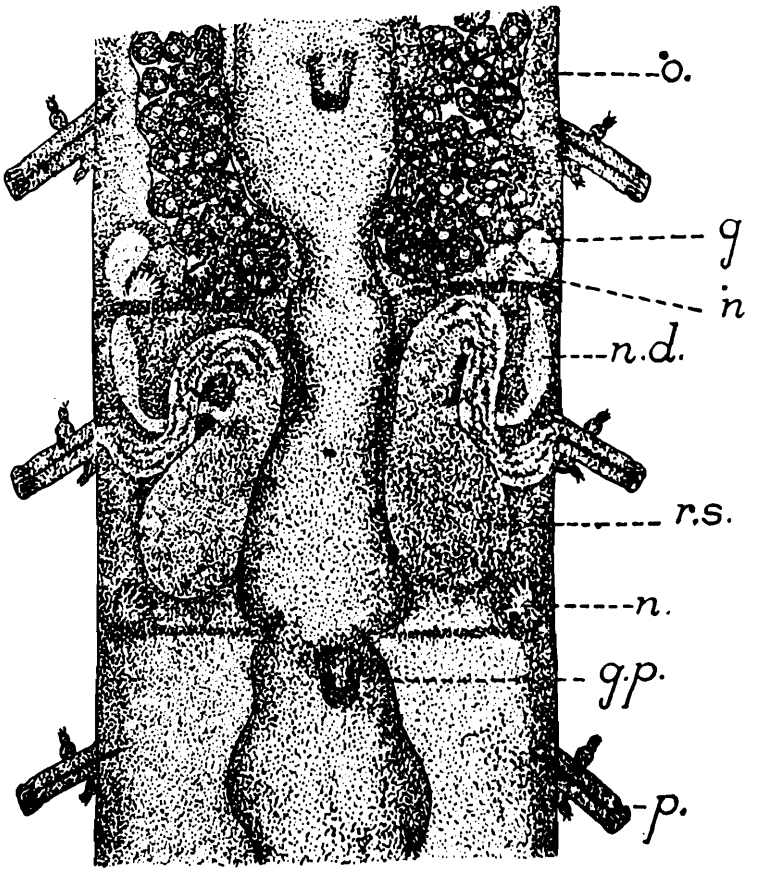
It is curious to note that the sperms are non-motile. Mature sperms are liberated into the coelomic cavity and can easily pass to the adjoining segments through the interspaces in the septa at the point of their attachment with the alimentary canal. In segments 29 and 30 there are two pairs of highly conspicuous sacs which are the sperm-sacs (text-fig. 5). The testes themselves are absent in these two segments. Often 3 or rarely 4 pairs of sperm-sacs are developed but instead of being found in two consecutive segments, are situated in such a manner that there are one or more intervening ordinary segments in between succeeding pairs. For instance in a specimen with 54 segments and three pairs of sperm-sacs the first pair was found in segment 30, the second pair in segment 36 and the third pair in segment 41. Exceptionally, however, only one pair of these spermatophoral sacs is developed, but these, then, may extend into two or three neighbouring segments.

The sperm-sacs are club-shaped sacs, the posterior portion being drawn out and eversible (Pl. II, fig. 2). Its outer end is slightly chitinised and definitely modified for sperm transference into a grooved spatula-like structure. The terminal part also acts as a copulatory hook. The tip of the copulatory hook is peculiar and has three definite processes two of which are conical and pointed while the third is a curved hook like one which in its turn is retractile partially. Transverse sections through the anterior half of the sperm-sacs show these sacs to be formed of a layer of elongated cells with rounded basal nuclei (Pl. II, fig. 3). The cells are all packed with highly refringent granules which are uniformly distributed. So numerous are these granules that the sperm-sacs become very conspicuous in the living worm. These special cells are confined to the anterior two-third of the sac while the distal portion merely functions as a passage or conducting part in which these cells have disappeared. This distal portion of the sperm-sac, devoid of the cells with refringent granules, develops a strong outer sheath of muscles. The cells lining the interior are minute and flattened. The external muscle layer which probably brings about the extrusion of the sperms has a very peculiar deceptive appearance in the living worm, and is seen as a clear and transparent space around the sperm-sac but the muscle striations can be made out by careful focussing. When

fixed and cut, transverse sections through this region reveal no such space around the sperm-sacs but a well defined sheath of muscles.

The internal lumen of the sac is narrow and is powerfully ciliated throughout. Mature sperms could be seen tossed about in the lumen by the action of the cilia. They are brought into it by means of the nephridial duct. The actual course of the nephridial duct in the segment carrying the sperm-sacs and the opening of the sac to the outside can be clearly made out on examining a male worm which is not fully mature. After the union of the genital funnel with the nephridial canal, the nephridial tube pierces the septum and enlarges into a thin walled chamber which again narrows and running inwards below the distal portion of the sperm-sac, takes an upward bend and runs forwards between the sperm-sacs and the alimentary canal and finally opens into the sperm-sac which in its turn is continued to the exterior by the narrow ciliated duct which opens just behind the tip of the copulatory hook.

The structure of the sperm is peculiar (Pl. II, fig. 4). As has been mentioned the sperms are non-motile; and in comparison with the size of the worm, they are large. Each sperm has got a central thick and deeply staining portion the extreme ends of which on either side are drawn out into a long flagellum. The sperms are thus a typical (bi-flagellate) and this kind of sperm is of rare occurrence amongst polychaetes.



TEXT-FIG. 6.—Genital segments of a mature female of *Pisionella indica*, gen. et sp. nov. showing a pair of ovarian groups and a pair of receptacula seminis: ×90.

Female.—In the female the reproductive organs are in the form of a few paired ovarian bags confined to the middle segments of the body (Pl. II, fig. 5 and text-fig. 6). As in the male the sexual elements are

absent in the anterior one-third part of the body and in several segments at the posterior end. This localisation of the sexual elements is known to occur in other polychaetes also like the Eunicids but the distribution of these elements in paired groups is peculiar. The eggs are greenish in colour and by this character the mature female can be easily distinguished from the mature male with the naked eye.

Usually two to five pairs of ovarian groups are developed. Exceptionally worms with six pairs have also been seen. In a specimen with 55 segments four pairs of ovarian groups were found developed. The first pair occupied segments 24 to 27. In the 28th segment there was a pair of receptacula seminis. In segments 29 to 31 was situated the second pair of ovarian groups. Segment 32 was occupied by another pair of receptacula seminis. The next three segments were occupied by the third group of ovaries which also was immediately followed in the next segment by a pair of receptacula seminis. Segments 38 to 40 were occupied by the 4th pair of ovaries while the 41st segment contained the 4th pair of receptacula seminales. In some worms it has been noticed that there is an interval of two or three segments between the last and the penultimate pair of ovarian groups.

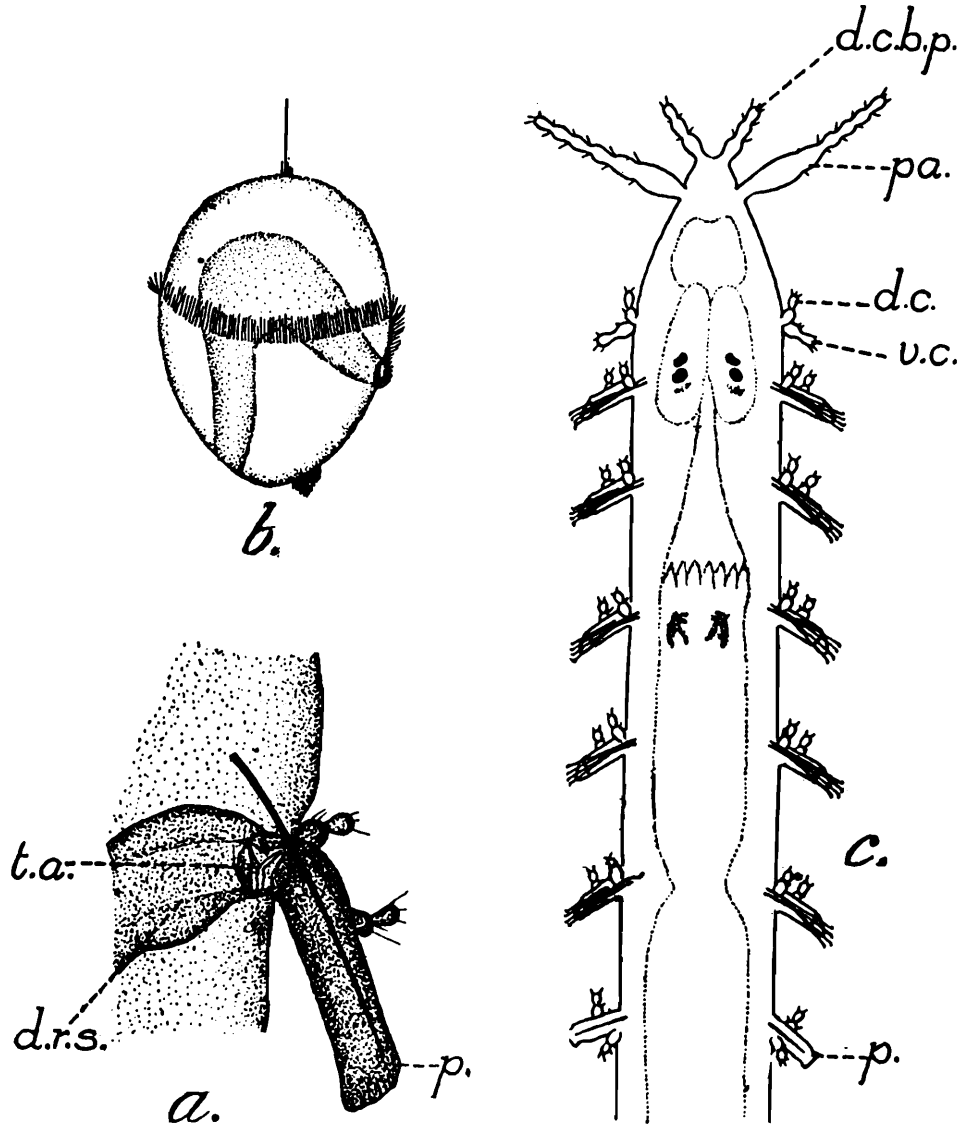
There are as many pairs of receptacula seminis as there are pairs of ovarian groups and the state of development of the receptacula seminis corresponds to the state of maturity of the ovaries. The receptacula seminis are globose or club-shaped sacs containing spermatozoa. Unlike the sperm-sacs already described, these are very thin walled and are lined externally by a layer of highly flattened epithelial cells and a thin layer of muscle fibres lined internally by a layer of cubical cells. At the proximal end of the sac the cells are very small while their size increases gradually until in the terminal portion they become large and highly protoplasmic. This terminal portion is drawn out into a muscular duct which opens to the exterior by means of a triradiate aperture (Pl. II, fig. 6 and text-fig. 7*a*) surrounded by a fleshy area at the base of the parapodium. The interior of the receptaculum seminis, unlike the lumen of the sperm-sac is not ciliated.

The mature eggs are heavily yolked and as they grow the ovarian bags rupture liberating them into the coelom. From here they are attracted towards the genital funnel due to the ciliary action of the latter and then are carried down the genital funnel into the nephridial duct which in its turn takes them to the receptaculum seminis. Here they are fertilised by the sperms received during copulation.

Breeding Habits.—As has been mentioned the worms breed throughout the year and numbers of fully mature specimens of either sex could be easily obtained.

The presence of well developed sperm-sacs and copulatory organs in the males and the presence of seminal receptacles containing spermatozoa inside, in the females, naturally suggest the occurrence of some sort of copulation between the two. Fortunately we were able to notice the actual process by keeping a number of male and female worms together in finger bowls containing clear sea water. Union usually takes place between fully mature worms only. During the process, unlike the case in the earthworms, the head of each worm is directed to

the same side. The suckers are everted in both the copulating individuals. The sperm-sacs of the male project out and the copulatory



TEXT-FIG. 7.—*Pisionella indica*, gen. *et* sp. nov.

a. External opening of the receptaculum seminis : ×187½ ;

b. Trochophore : ×600 ;

c. Anterior end of the worm with 13 segments (1st stage) : ×90. (Note the nature of the anterior parapodia).

hooks of a pair are firmly applied to the openings of a pair of receptacula seminis of the female. Sperm transference is thus effected. The sperms thus received from the male are stored up in the receptacula seminis and used for fertilising the eggs as already described.

It is clear that during an act of copulation only one pair of receptacula seminis is furnished with sperms and only a single pair of sperm-sacs is used in transferring the sperms as the second pair of sperm-sacs situated in the next segment cannot reach the openings of the next pair of receptacula seminales situated five or six segments below or above as the case may be. Female worms with only one or two pairs of receptacula seminis with sperms and the others empty are often met with. It is therefore probable that the eggs arriving at the receptacula seminis devoid of sperms remain there till a supply of sperms is received Now the presence of three or even four pairs of sperm-sacs in some

male worms with an intervening space of 4 or 5 segments between successive pairs, as has been already described, suggests the possibility of simultaneous sperm transference from three or four pairs of sperm-sacs to a corresponding number of receptacula seminis.

DEVELOPMENTAL STAGES.

Trochophore.—The fertilised eggs are perfectly spherical in outline and measure ·03 mm. in diameter. Segmentation is very rapid and the gastrula stage is reached in 5 to 6 hours after fertilization. Now they come to the surface and begin to swim actively. In about 14 to 18 hours the trochophores are formed (text-fig. 7*b*). They are very minute, a 46 hours old trochophore measuring only ·04 mm. along the long axis and ·03 mm. across the prototroch. The pre-trochal region is greenish in colour. The apical tuft consists of usually one or two very long cilia of about thrice the length of the cilia of the prototochal circlet. At the base of these long cilia there are two or three small cilia also. The mouth is comparatively large and is placed just behind the prototroch. Short vibratile cilia surround the mouth opening. In the interval between the mouth and the prototroch there is a row of cilia. There is a short band of cilia near the posterior end on the ventral side which probably represents the remnant of the neural band.

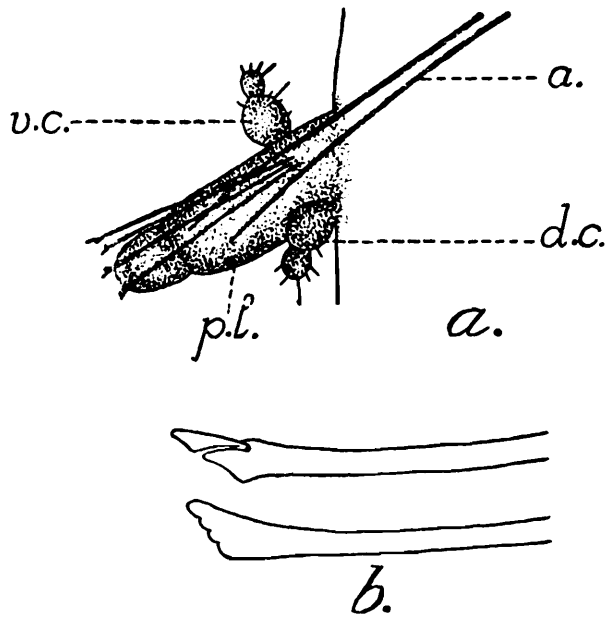
During the second day the posterior end gets suddenly elongated into a narrow conical projection beset with a few cilia. These cilia are continued into a row to a certain distance and ends behind the anal opening. The trochophores are often noticed to attach themselves to the bottom of the glass by this elongated projection and then execute quick rotatory movements. Situated at some distance above the anal opening, on what will become the dorsal side, is a group of four or five cilia which are slightly longer than the cilia of the prototroch.

The trochophores were kept in the laboratory up to the fourth day after which they failed to develop. The description that follows is that of the larvae picked out from sand and found occurring side by side with the adult worms.

Larval Stages.—Stage I. (Text-fig. 7*c*). This is the earliest stage obtained. The larva measures about 2 mm. in length and including the prostomial there are 13 segments. Two pairs of eyes have developed. The anterior pair is somewhat crescent like while the posterior is larger and rounded. Partly surrounding the posterior pair there are two dark brown pigment spots. The dorsal cirri of the buccal parapodia are fused in the middle as in the adult. The palps are well developed and have attained the adult condition except in size. These appendages are faintly constricted giving a jointed appearance and are provided with palpocils. The ventral cirri of the buccal parapodia are absent as in the adult. The ventral cirri of the parapodia of the first segment are slightly elongated while the dorsal cirri remain globose and two jointed as in the adult. The main lobe of this parapodium is absent and as such there are no setae present.

The parapodia from the 2nd to the 6th segments are well developed and conspicuous (text-fig. 8*a*). Each parapodium has a definite two jointed globose dorsal and ventral cirrus. The main parapodial lobe

is uniramous and is provided with a terminal bluntly conical fillet. Two acicula are present in the main lobe of the parapodium. The setigerous



TEXT-FIG. 8.—*Pisionella indica*, gen. *et* sp. nov.
a. Parapodium of the 4th segment of young worm with 13 segments: ×375;
b. Setae from the 4th segment: ×1500.

support of this lobe consists of 4 setae of which three are compound and one simple. This simple seta has a slightly bivelled tip (text-fig. 8*b*) and is often protruded along with the compound setae. Each compound seta has got a terminal joint provided with a small blade devoid of any teeth.

The parapodia from the 7th segment backwards differ from the preceding ones. These are also provided with dorsal and ventral cirri with palpocils as in the anterior ones. The main lobe is uniramous but is devoid of the terminal fillet. The setigerous support consists of only one simple capillary seta representing the aciculum. The rest of the simple setae as well as the compound setae of the anterior parapodia are absent.

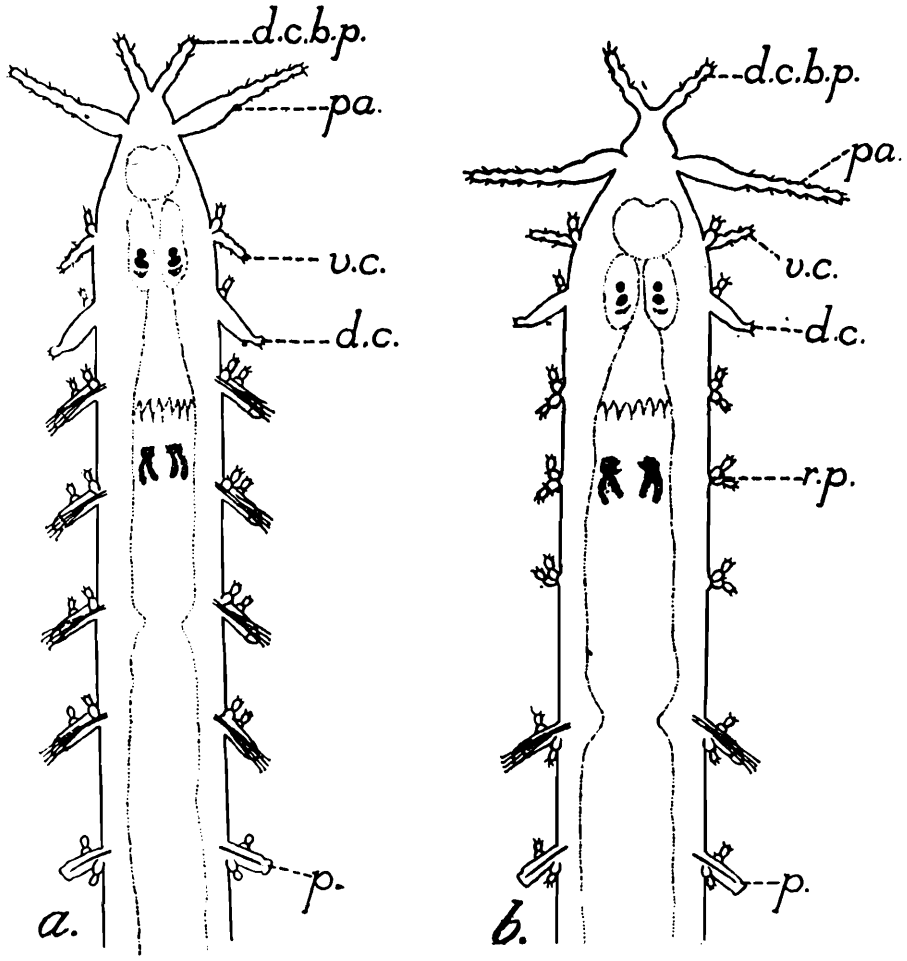
On the anal segment just above the posterior extremity there is a layer of brown pigment. A pair of long anal cirri is present.

The mouth is median and ventral. There is a protrusible pharynx. Two pairs of jaws are developed and have all the adult characters except size. Pharynx is provided with a crown of papillae as in the adult. The alimentary canal is slightly constricted. Specialised groups of glandular tubules are developed on either side of the body wall in between the successive parapodia. The minute tubular glands that are found on the general body surface in the adult worms are not yet developed.

Stage II. (Text-fig. 9*a*)—Obtained from sand along with the adult worms, measures about 3 to 4 mm. in length and including the prostomial there are 19 distinct segments. Besides the general growth in length this stage differs from the previous one in the following respects.

The palps have lengthened. The ventral cirri of the first segment are more elongated. The main setigerous lobe of the

parapodia of the second segment has disappeared and hence the segment, like the first, is non-setigerous. The dorsal cirri of this parapodium are slightly elongate. The parapodia from the 3rd to the 6th segments remain the same as in the previous stage.



TEXT-FIG. 9.—*Pisionella indica*, gen. *et* sp. nov.

a. Anterior end of young worm with 19 segments (2nd stage): ×80;

b. Anterior end of worm with 23 segments (3rd stage) ×80. (Note the changes in the anterior parapodia.)

The eyes are situated slightly more apart. The pigmentation of the anal segment is more diffuse. The constrictions of the alimentary canal are more pronounced and the jaws have become more chitinised. Paired nephridial swellings with a few solenocytes could be seen as flattened saucers pressed against the anterior face of the posterior septum of each segment.

Stage III. (Text-fig. 9*b*)—Also obtained from the sand along with the adult worms. Measures about 4·5 to 5 mm. and there are as many as 23 segments. The main points of difference from the previous stage are the following :—

The parapodia from the third to the fifth segments have become highly reduced and inconspicuous. The main setigerous lobes of these parapodia have disappeared and hence the segments are non-setigerous. The dorsal and ventral cirri of these parapodia persist as minute globular structures as in the normal parapodia. In the sixth segment the parapodia correspond with those of the previous stage and are provided with setae.

The pigmentation of the anal segment is hardly visible now. The alimentary canal has all the adult characters. The jaws have developed the amber colour characteristic of the adult. The nephridial clusters have grown larger.

In the next stage the setigerous parapodia of the sixth segment also disappear and then the worm has become an adult with the tentacular cirri well developed, the first four pairs of parapodia inconspicuous and non-setigerous and the rest of the parapodia having only simple setae.

Thus in the earlier stages there is an apparent uniformity in the presence of well developed parapodia even though the first 5 pairs differ from the rest. This uniformity is completely lost by the disappearance of the setigerous lobes of these 5 pairs of parapodia. The worms are not yet sexually mature and the sexes are now quite indistinguishable. Genital papillae are completely absent at this stage.

SUMMARY AND CONCLUSION.

From the account given above it will be seen that there are a number of characters peculiar to this form. There is no doubt, however, that it is a Pisionid and that it is more closely related to the genus *Pisione* than to *Praegeria*. It differs from *Pisione* and *Praegeria* in the non-setigerous nature of the first two segments carrying the tentacular cirri, in the non-setigerous inconspicuous parapodia of the next four segments, in the entire absence of compound setae from the parapodia, and in the absence of curved hook-like genital papillae on any of the parapodia. It differs again from *Praegeria* in the presence of two pairs of tentacular cirri carried on non-setigerous segments and in the absence of the buccal spines, besides in some minor points in the reproductive organs. The accompanying table will make the position clear.

Tabular Statement of the Generic Characters.

Praegeria.	*Pisione.*	*Pisionella.*
1. Segments 50 to 60.	Segments numerous.	Segments 50 to 70.
2. First segment setigerous.	First segment setigerous.	First segment non-setigerous.
3. Ventral cirrus of the first parapodium elongate.	Ventral cirrus of the first parapodium elongate.	Ventral cirrus of the first parapodium elongate.
4. Second segment setigerous.	Second segment setigerous.	Second segment non-setigerous.
5. Dorsal cirrus of the second parapodium globular.	Dorsal cirrus of the second parapodium elongate.	Dorsal cirrus of the second parapodium elongate.

Tabular Statement of the Generic Characters—contd.

Praegeria.	*Pisione.*	*Pisionella.*
6. Other parapodia similar and setigerous with simple as well as compound setae.	Other parapodia similar and setigerous with simple as well as compound setae.	Parapodia of 3rd to the 6th segments inconspicuous and non-setigerous. Rest of the parapodia similar with a single slender aciculum only and with no other setae of any kind.
7. Genital papillae absent.	Genital papillae present on the posterior parapodia as hook like structures.	Genital papillae present in the anterior as well as posterior segments in the form of suckers arranged along the mid-ventral line.
8. A pair of buccal spines present.	....	Buccal spines absent.
9. Sperms typical but non-motile.	....	Sperms a typical and non-motile.

The differences mentioned above seem to us so vital that we believe there is clear justification in creating a new genus for the reception of this form. We propose the name *Pisionella* for the new genus and in doing so we wish to indicate the relationship between *Pisione* and this new genus.

Pisionella, gen. nov.

Pisionidae with, much reduced head, the buccal and the six succeeding segments non-setigerous, ventral cirrus of the first segment and the dorsal cirrus of the second segment elongate and functioning as tentacular cirri, the parapodia of the next four segments minute and inconspicuous, only one seta in the form of an aciculum in each parapodium, genital papillae in the form of suckers in the mid-ventral line of the body in the anterior and posterior segments and compound setae in the anterior parapodia in the young condition which are lost in the adult.

Pisionella indica, gen. *et* sp. nov.

Characters of the species are the same as those of the genus.

Locality.—Madras Beach India.[1]

Holotype.—(No. W3436-1) in Zoological Survey of India, (*Ind. Mus.*) Calcutta.

Affinities.—The affinities of the family Pisionidae have been considered by early authors in the light of the external features only. Grube describing *Pisione oerstedi* has placed it in the Phyllodocidae and regarded it as a transitional form between the Phyllodocidae and the Glyceridae. Later Ehlers and Southern have discussed the affinities of the family

[1] Since writing this paper Mr. K. Chidambaram of the West Hill Biological Station has sent us a few specimens of the same species from the sandy beach, Calicut.

and have pointed out its relationship with Aphroditidae, Sigalionidae, Nephthydae, Hesionidae and Syllidae. The structure of the nephridia which has been studied for the first time in the family, lends support to the view held by Grube that it is related to Phyllodocidae and Glyceridae. In the genus *Pisionella* each nephridium in the non-genital segments consists, as already shown, of tufts of solenocytes with a conducting tube to the exterior. Ciliated organs are developed in the genital segments and later become associated with the nephridia. A similar condition of the nephridia and the genital funnels has been observed by one of us in *Praegeria remota* and in a new species of *Praegeria* both occurring in the Madras beach, a detailed account of which will form the subject matter of another paper. The condition of the nephridia and the genital funnels is very similar to that met with in the Phyllodocidae and the Glyceridae as described by Goodrich (1898, 1900) and thus confirms the view held by Grube in regard to the relationship of the Pisionidae.

ACKNOWLEDGMENT.

Our thanks are due to Mr. R. Velappan Nair for making several of the illustrations.

EXPLANATION OF LETTERING IN TEXT-FIGURES.

a., aciculum ; *a. c.*, alimentary canal ; *c. h.*, copulatory hook ; *d. c.*, dorsal cirrus ; *d. c. b. p.*, dorsal cirrus of the buccal parapodium ; *d. r. s.*, duct of the receptaculum seminis ; *e.*, eye ; *g. f.*, genital funnel ; *g. p.*, genital papilla ; *h. p.*, hypertrophied parapodium ; *j.*, jaw ; *n.*, nephridium ; *n. d.*, nephridial duct ; *o.*, ova ; *p.*, parapodium ; *pa.*, palp ; *p. l.*, parapodial lobe ; *ph. p.*, pharyngeal papillae ; *r. p.*, reduced parapodium ; *r. s.*, receptaculum seminis ; *s.*, septum ; *sol.*, solenocyte ; *sp.*, spermasac ; *t. a.*, triradiate aperture ; *t.* c_1., first tentacular cirrus (ventral cirrus) ; *t.* c_2., second tentacular cirrus (dorsal cirrus) ; *v. c.*, ventral cirrus.

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