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VII.—DESCRIPTION OF AN OLIGOCHÆTE WORM ALLIED TO CHÆTOGASTER.

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The worm described below was found in water taken from a tank in the pleasure-gardens at Shalimar, near Lahore, in the early part of February, 1907. It lives well in water kept in small vessels with a little green alga in the laboratory, and appears to propagate itself asexually with freedom. Specimens have been under observation at various times during the last month.

External characters.—In length the animal measures from 1 to 2 mm.; the variations are considerable, and depend principally on the stage which the asexual reproductive process has reached (*v. inf.*). There is a short blunt prostomium, followed by a region slightly swollen in an ovoid manner and corresponding to the pharynx; the rest of the body is of uniform diameter, showing a wrinkling corresponding to the degree of contraction of the animal, but no regular annulation. The anterior end of the body is studded with a few fine hairs; and similar hairs also occur posteriorly in the neighbourhood of the anus. The whole animal is very transparent.

Segmentation.—As just said, there is no external annulation; the segmentation is, however, indicated externally to some extent by the bundles of setæ. The first setæ are placed ventro-laterally on the slightly swollen anterior region, and may be taken to belong to the second body-segment; the next bundles are placed some distance further back, this achætous interval being in length equal to about three of the immediately following segments. The bundles then succeed each other regularly, being placed, however, closer together at the posterior end of the animal.

Internally the segmentation is defined by the septa, of which the first occurs at the posterior end of the pharynx, behind the level of the first bundle of setæ, and may be taken to be the posterior limit of the second segment: the next septum occurs at the posterior end of the œsophagus, similarly delimiting the third segment; in the region of the crop there are three septa, the first of these about the junction of the anterior and middle, the second about the junction of the middle and posterior thirds, and the last near the hinder end of the crop. The second bundle of setæ occurs at the level of the posterior part of the crop, in the sixth body-segment according to the limits established by the septa. Segmentation is also evident internally in connection with the ganglia of the ventral nerve-cord and with the nephridia (*v. inf.*).

Setæ.—There are two bundles of setæ in each segment in which they occur, and there are about six setæ in each bundle; five and seven are also met with. They are ventro-lateral in position; the portion which projects externally is approximately equal in length to the portion within the body; and the whole length of a seta is equal to about two-thirds the diameter of the body when the latter is in the condition of moderate extension. Each seta has the form of an elongated \int , the end is unequally forked, and there is a small nodulus (*v.* plate v, fig. 2).

When the animal is at rest, most of the setæ project at about a right angle; those of the most anterior bundles, however, lie flat against the surface of the body, their free ends forwards. The somewhat hooked free ends of the setæ may point either forwards or backwards (I do not refer to the direction of the seta as a whole); in the setæ of a single bundle, the hooks of some may point forwards, of others backwards; and a bundle of setæ, the hooks of which are pointing forwards, may be seen shortly afterward with hooks pointing backwards; some of the muscular fibres attached to the setæ have, therefore, the power of rotating the setæ about their longitudinal axes. A common arrangement is for the hooks to point backwards in the anterior, forwards in the posterior segments. Backward-pointing hooks are presumably of use in forward progression, forward-pointing hooks in backward progression. The first bundles, however, appear always to have their hooks pointing backwards.

The distribution of setal bundles in the anterior part of the body is apparently subject to slight variation; on one occasion a few small setæ were noted in the third body-segment; in another case those of the sixth segment were fewer and smaller than normal.

Asexual reproduction.—The smallest number of segments observed was eight (*v.* plate v, fig. 3 *a*); the body, that is, came to an end at the end of what I have called the "stomach," and comprised only four pairs of setal bundles; there was, in addition a commencing constriction visible, which if completed would separate off the posterior two segments. This specimen may have been pathological; the body-cavity contained numerous clear, oval or irregular corpuscles, apparently non-nucleated, which were seen in no other specimens; it was in this animal also that the setæ of the sixth segment were fewer and smaller than usual.

All the other animals examined were divided by a well-marked constriction into two parts, an anterior, of at least eight body-segments, and a posterior, of varying length; these two principal divisions of the worm were usually again divided by slighter constrictions. Thus the anterior portion might consist of eight body-segments, the posterior of four setigerous segments (plate v, fig. 3 *b*); or the anterior of eight body-segments, the posterior of six setigerous segments (*c*); or the anterior of eleven body-segments, the posterior of seven setigerous (*d*); or the posterior portion might comprise eight setigerous segments, and be again divided into two

parts each bearing four pairs of bundles, the four posterior segments of the anterior part of the body being also separated by a distinct constriction from those in front (*e*); finally, in a specimen where a deep constriction divided off an anterior portion of eleven body-segments from a posterior of eight chætigerous segments, the new prostomium, mouth, buccal cavity and cerebral ganglion of the posterior half could be distinctly seen (*v.* plate v, fig. 4). The regions of the alimentary canal which I have called "crop," and "stomach" are, however, differentiated in the posterior half of the dividing worm at an earlier stage than this. It may be noted here that the seat of the constrictions, secondary as well as primary, is always marked in addition by a conspicuous extension laterally of the nervous matter of the ventral chain; these lateral extensions spread so far as almost to meet dorsally, and this takes place on the anterior as well as on the posterior side of the actual site of constriction (*v.* plate v, fig. 5).

Figure 6 represents the site of constriction in one of the specimens examined. The anterior setal bundles of the posterior worm are seen to be developing; they thus arise as new formations, and from the first point forwards, not perpendicularly outwards. If the groups of setæ already existing posterior to these (originally the first pair behind the constriction) persist as the setæ of the sixth segment of the second worm, then each act of fission involves the intercalation of five newly-formed body-segments behind the site of constriction. The same figure shows also a group of developing setæ immediately in front of the constriction; new segments are therefore formed on both sides of the site of constriction.

Alimentary system.—The mouth is ventral, and leads into a buccal cavity of small extent. This is succeeded by the pharynx, a thick-walled tube, which extends backwards as far as the septum between the second and third segments, and is attached to the body-wall by numerous fine, short, sometimes Y-shaped muscular fibres. The œsophagus occupies the third segment, it is narrower behind than in front, and is usually short, about half as long as the pharynx; in the specimen mentioned previously as being perhaps pathological, it was of a length about equal to that of the pharynx. The crop, which follows, is a dilated portion of the canal, occupying a little more than three segments, the fourth, fifth and sixth, its posterior end being in the seventh segment; its walls are clear, and one cell in thickness; the degree of its distension varies; it may be ballooned so as to occupy the whole of the body-cavity in its own segments.

A well-marked and constant constriction separates the crop from a second dilated region of the alimentary tract, which is distinguished by being slightly pigmented, of a light yellowish-brown colour, and by containing a large number of refractile globules like minute drops of oil in its walls. It is situated in the seventh and eighth segments. The intestine occupies the remainder of the body; its diameter is less than that of the stomach but varies somewhat; the anus is terminal.

The *body-cavity* is extensive, and (with the exception already noted) was not seen to contain corpuscles. The septa are delicate partitions showing swellings indicative of nuclei (*v. fig. 7*).

Circulatory system (*fig. 8*).—The dorsal vessel extends from the hinder end of the body to the prostomium, and is pulsatile along its whole length except for a very short distance in front, anterior, that is, to the level of the refractile particle of the cerebral ganglion (*v. inf.*) close to which it runs; the contractions proceed from behind forwards. There are two lateral vessels, of calibre approximately equal to that of the dorsal vessel, which encircle the œsophagus, uniting ventrally with the ventral vessel; they are also contractile, the contractions progressing from above downwards. The ventral vessel cannot be traced quite as far forward as the dorsal; it is of about the same calibre, and is nowhere pulsatile. There appears to be a fine plexus of capillaries on the external surface of the crop and stomach (*v. fig. 9*). The blood is colourless and contains no corpuscles.

The *Nephridia* are much-coiled fine tubes, which, however, become thicker, with more granular walls, near their external opening; this is situated a short distance in front of the bundle of setæ of the same segment. The canal is somewhat dilated just before it opens to the exterior. I could not distinguish the beginning of the tube; no ciliary action was visible in any part of it; nor did the nephridia appear to be connected with the septum in front of them. Nephridia are constantly found in the seventh and eighth segments at the sides of the stomach; for the rest, their distribution varies (*v. fig. 10 a and b*). They are not found in any of the segments that have recently formed.

Nervous system.—The cerebral ganglion is situated far forwards, just behind the prostomium, occupying a space corresponding to the buccal cavity and anterior part of the pharynx. It is not distinctly bifid, but rather irregularly lobulated in shape (*v. fig. 7*). One particular portion, spherical in shape, slightly more refractile than the rest, and situated at the level of the junction of buccal cavity and pharynx, stands out in all specimens; posteriorly there is closely opposed to it a bright, somewhat granular mass, semilunar in shape as seen sideways (*v. fig. 7*). I am unacquainted with a similar structure in other forms, and have no suggestions to make as to its function, unless it be a degenerate otocyst.

The circumbuccal commissures are situated at the level where the buccal cavity passes into the pharynx. The subpharyngeal ganglionic mass is irregularly lobulated, broad from side to side, narrowing posteriorly to become the ventral nerve-cord. Some small lobes frequently appear entirely detached from the main nerve-mass. The ganglia of the ventral cord are placed at the level of the setæ in each segment; in the achætous interval (3-5 segm.) there are irregular swellings on the cord, which do not appear to have the definiteness of the ganglia in the following segments. The ventral cord is of considerable thickness and is always very easily seen; it is not united with the epidermis. Its double origin is perhaps indicated

by its bifid anterior end and the median row of buttonhole-like perforations in its anterior portion which are shown in fig. 11.

The upward growths of nervous matter within the body-wall at the site of the constrictions have already been mentioned. The cerebral ganglion can be distinguished in the posterior portion some time before this is ready to separate.

Under an oil-immersion lens the nodulations on the ventral cord, which aggregated together form the ganglia, are seen to consist of spherical hyaline cells with nuclei, placed mostly in the dorsal sides of the cord.

Sense organs are represented by the tactile hairs, and possibly by the refractile particle in the cerebral ganglion.

No *sexual organs* have so far been observed.

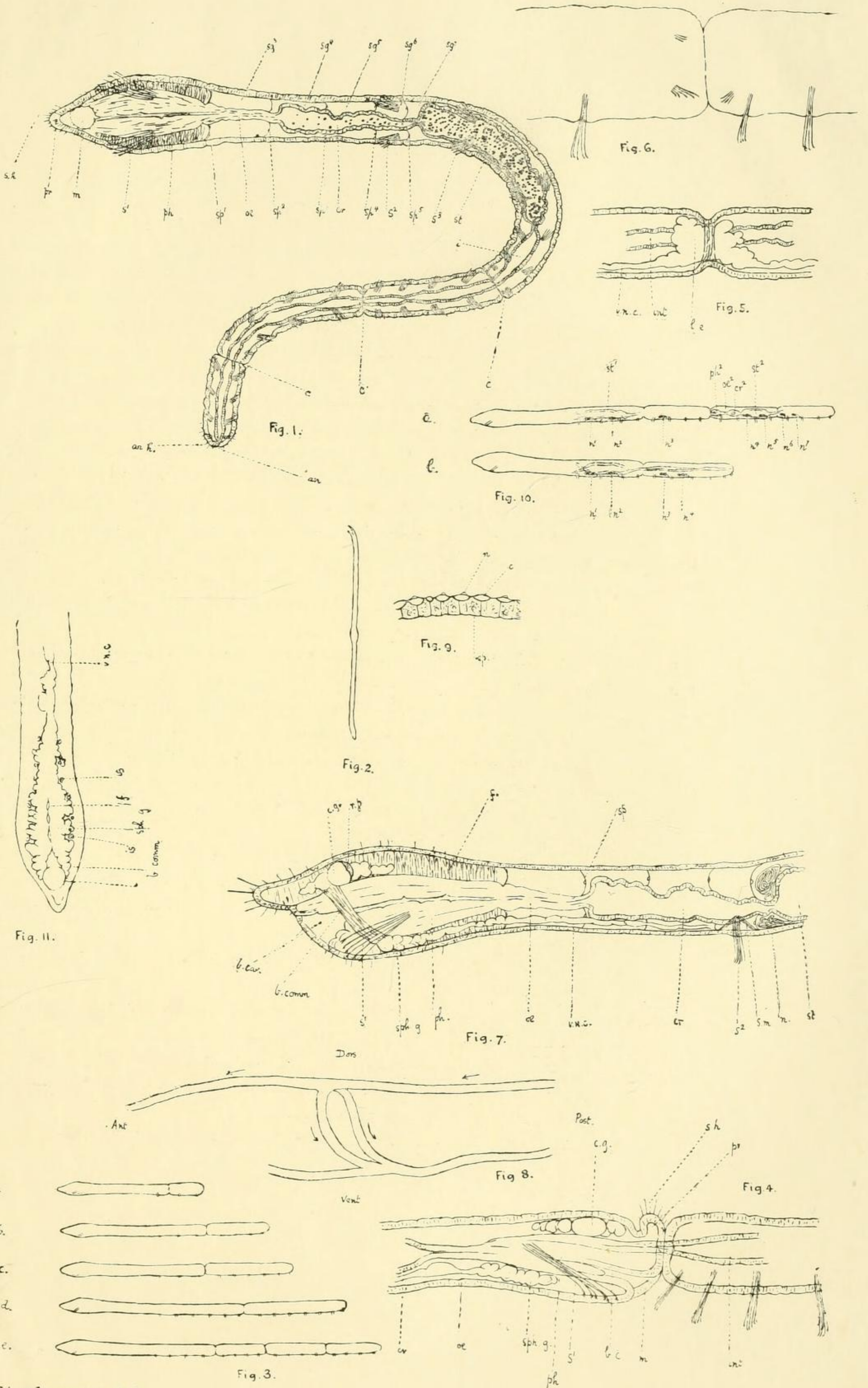
The mode of examination adopted throughout has been the observation of the living animal under the microscope; its transparency renders this easy. A stained specimen revealed comparatively little of the structure of the animal.

The predominance of asexual reproduction, together with the presence of a nervous system unconnected with the epidermis, places this form at once among the Naididæ. The total absence of hair-setæ, of dorsal setæ altogether, and of ventral setæ also in the third, fourth and fifth segments, would seem further to assign it to the genus *Chætogaster*. The definition of this genus, however, includes a reference to the third segment, which is much elongated in all forms hitherto recognised as belonging to the genus; while in the form now described the third segment is commensurate with the œsophagus, and of no greater length than the two succeeding segments. In *Chætogaster*, also, the longitudinal commissures of the ventral cord are separate from each other in the anterior part of the body; this can hardly be said of the form now described (*v.* fig. 11). The definitions of genera include no reference to the alimentary canal, and I cannot say whether or not the differentiation of the parts of the tract which I have called "crop" and "stomach" occurs in the various species of *Chætogaster*.

If, in consideration of the similarity in other respects of this form to the species of *Chætogaster*, it should be thought advisable to widen the definition of the genus so as to include it, I would suggest *punjabensis* as a suitable specific name; since, besides the characters mentioned above, it differs in its length, or transparency or extent of the œsophagus, or the characters of the circum-œsophageal vascular ring, or the number of setæ in each bundle, or in more than one of these points, from the several species described by Michaelsen (*Oligochæta*, 1900) as belonging to the genus.

EXPLANATION OF PLATE V.

- FIG. 1.—General view of the animal from ventral surface.
an. Anus. *an. h.* Anal hairs. *c.* Constriction. *cr.* Crop.
i. Intestine. *m.* Mouth. *æ.* Œsophagus. *ph.* Pharynx.
pr. Prostomium. *s¹, s², s³.* First, second and third
bundles of setæ. *sg³⁻⁷.* Third to seventh body-seg-
ments. *s. h.* Sensory hairs on anterior part of body.
sp¹⁻⁵. Septa in the anterior part of body. *st.* Stomach.
- FIG. 2.—A seta.
- FIG. 3.—*a-e.* Diagrams illustrating asexual reproduction.
- FIG. 4.—Site of division.
b.c. Buccal cavity. *c.g.* Cerebral ganglion. *int.* Intes-
tine of anterior animal. *sph. g.* Subpharyngeal ganglion.
Other letters as before; all except *int.* have reference to
the posterior animal.
- FIG. 5.—Lateral view of the site of constriction, showing lateral
extension of nerve-cord in this situation.
int. Intestine. *l.e.* Lateral extension of nerve-cord.
v.n.c. Ventral nerve-cord.
- FIG. 6.—Growth of seta bundles near the site of a constriction.
- FIG. 7.—Lateral view of anterior part of body.
b. cav. Buccal cavity. *b. comm.* Buccal commissure.
f. Fibres attaching pharynx to body-wall. *n.* First
nephridium. *r. p.* Refractile particle in the cerebral
ganglion. *s. m.* Setal muscle fibres. *sp.* Septum, show-
ing a projection due to a nucleus in its substance.
Other letters as before.
- FIG. 8.—Diagram illustrating chief blood-vessels. The arrows
show the direction of the contractions.
- FIG. 9.—Part of wall of crop, showing capillary blood-spaces
outside the crop epithelium.
c. Capillary blood-space. *n.* Nucleus. *ep.* Epithelium
of crop.
- FIG. 10.—Diagram illustrating distribution of nephridia: parts of
the alimentary canal are outlined.
n¹⁻⁷. The nephridia. *st¹.* Stomach of anterior animal.
ph², æ², cr², st². Pharynx, œsophagus, crop, and sto-
mach of posterior animal.
- FIG. 11.—Anterior part of nerve-cord, seen from the ventral surface.
is. Islands of nerve-tissue isolated from the rest. *pf.*
Perforations along the median line of the subpharyngeal
ganglion. Other letters as before.



J. Stephenson del.

CHÆTOGASTER (?) PUNJABENSIS, sp. nov.