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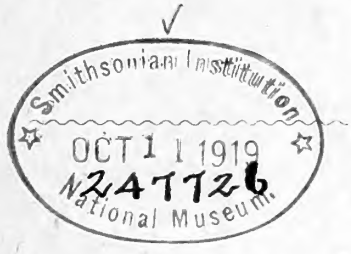

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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus; synonyms are printed in italics.]

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MEMOIRS OF THE INDIAN MUSEUM

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REPORT UPON THE TUNICATA IN THE COLLECTION OF THE INDIAN MUSEUM.

By ASAJIRO OKA, *Ph.D., Tokyo.*

(Plates I—V.)

The collection of Tunicata may, for the sake of convenience, be divided into three groups: (1) simple Ascidians, (2) compound Ascidians, and (3) pelagic Tunicata including the Ascidiae Salpaeformes, the Thaliacea, and the Larvacea. The present report contains a detailed account of the first and third groups; the compound Ascidians, of which there are only a few specimens, will be worked up along with those from other sources and will be described and figured afterwards in a separate paper.

The collection generally was in a fairly good state of preservation, but some of the specimens, especially the pelagic forms, were rather in a poor condition, making in a few cases the identification extremely difficult. Among the simple Ascidians I found two specimens of which the test alone was preserved, so that it was impossible to determine with certainty to what form they belonged.

The group of simple Ascidians consists of seventeen species arranged in nine genera. Ten of the species seem to be new to science, and for one of these it was found necessary to form a new genus. The other group—the pelagic Tunicata—contains only one species of *Pyrosoma* and five species of *Salpa*, all of which are well known cosmopolitan forms, and a specimen of a very large Appendicularian, apparently belonging to the genus *Megalocercus*. The number of species recorded in this paper is, accordingly, twenty-four in all.

This collection, though a small one, is especially interesting on account of its containing five well-preserved specimens of an extremely aberrant simple Ascidian, very probably belonging to the genus *Hexacrobylus*, Sluiter. As is well known, this genus was formed by Sluiter for a curious deep-sea Ascidian dredged during the Siboga Expedition, which in external appearance was so unlike ordinary Ascidians that neither Weber nor Sluiter was able to guess its true nature until they cut open the only specimen. The description published in the Reports of the Siboga Expedition, based upon the examination of the unique specimen, could naturally not be quite satisfactory, and yet it has remained the only record of the genus. Under such circumstances the five specimens contained in the collection, though representing a different species, were extraordinarily valuable, and I paid special attention

to the internal anatomy of the animal. One specimen was carefully dissected and two others, removed from the test, were stained with borax carmine and cut into sections. Pl. III, fig. 2, is a reconstruction from such sections and represents, satisfactorily I hope, the relations of the internal organs of this very curious Ascidian.

The new genus *Monobotryllus* is interesting inasmuch as it represents a connecting link between the two families, the Styelidae and the Polystyelidae. Although itself a simple Ascidian, it is most closely allied, not to any of the simple forms, but to some members of holosomatous compound Ascidians. In the shape and position of the branchial sac and alimentary canal it very much resembles the genus *Botryllus* or *Botrylloides*, while in the arrangement of the gonads, which are hermaphrodite polycarps, it is so exactly like the genus *Michaelsenia* among the Polystyelidae that nobody would hesitate placing it in that genus, were the individuals found imbedded in a common test. This furnishes another instance showing that the division of the Ascidians into simple and compound forms is simply a matter of convenience.

The occurrence of a representative of the genus *Megalocercus* in the Indian Seas is of much interest zoo-geographically. This genus has hitherto been known only from three specimens procured from a considerable depth (600 and 900 meters) near Ischia and Capri in the Mediterranean.

Two specimens of simple Ascidians, belonging to widely different species, *Polycarpa annandalei*, n. sp., and *Ascidia willeyi*, n. sp., harboured each in the branchial sac a pair of macrurous crustaceans, which, judging from their size, must have entered the body of the host as larvae and grown up there to maturity. Although a number of crustaceans may frequently be found in the branchial sac or atrial cavity of Ascidians they are almost always amphipods or copepods; commensal macrurans living in pairs, as those found in the interior of the siliceous sponge *Euplectella*, have, so far as I am aware, never been recorded from Ascidians.

Before proceeding to the description of the species I wish to express my cordial thanks to Dr. N. Annandale, Superintendent of the Indian Museum, Calcutta, for having given me the opportunity of studying a material including so many interesting forms.

ASCIDIAE SIMPLICES.

Fam. MOLGULIDAE.

This family is represented in the collection by three species. Two of these belong to the genus *Molgula* (*Caesira*) and, though both of them are new to science, do not exhibit any striking characters. The third is a very remarkable form apparently belonging to the genus *Hexacrobylus*, Sluiter, which has hitherto been considered as the type of a separate order, the Aspiraculata, on account of the total absence of stigmata in the branchial sac. After a careful study of the internal anatomy, however, I came to the conclusion that it is more natural and convenient to place it, notwithstanding its most aberrent characters, in the family Molgulidae. A preliminary note on this animal giving the reasons for regarding it as a highly modified

Molgulid was published in "*Zoologischer Anzeiger*", Vol. XLIII, No. 1, in November 1913.[1]

Molgula simulans, n. sp.

(Pl. II, figs. 1 and 2.)

External Appearance.—The body is ovate, broad and rounded at the anterior end and somewhat tapering towards the posterior, the long axis being directed antero-posteriorly. It is compressed laterally, evidently in consequence of preservation. The apertures are sessile, not conspicuous; they are situated at the dorsal and ventral edges of the anterior end, the distance between them being about one-fifth of the longitudinal circumference of the body. The animal is not attached.

The surface of the body is regular and even, and is pretty smooth. There are, however, a large number of small papilla-like processes, corresponding no doubt to the delicate hairs of other Molgulids, scattered all over the surface. These are usually short and almost conical, but in some places they are longer and may even be branched. On account of the adhering mud particles they appear as minute opaque dots on the surface of the otherwise transparent test. Here and there foraminiferan shells and broken sponge spicules are found attached to the external surface of the body. The colour of the animal preserved in alcohol is a light transparent grey.

The dimensions of the three specimens are as follows:—

Specimen.	Entire animal.	Internal body.
No. 1	10 mm. × 7 mm.	4 mm. × 5 mm.
No. 2	8 mm. × 5 mm.	3 mm. × 3·5mm.
No. 3	7·5 mm. × 5 mm.	3 mm. × 3 mm.

The *Test* is thin, soft, gelatinous, and quite transparent. Between the papilla-like processes, which are mostly opaque, the outer surface of the test is entirely naked, allowing the mantle and the viscera to be seen distinctly from the outside. There are no blood vessels traversing the substance of the test.

Owing to the contraction of the mantle the internal body taken out of the test is considerably smaller than the entire animal (see the dimensions given above). There is a large space between the test and the mantle all over, the latter being separated from the test except round the apertures; in the posterior half of the body this space is especially large so that here the test is hollow inside. The internal body is, consequently, broader than it is long, *i.e.* its greater diameter lies dorso-ventrally. It is oval or almost spherical with the short siphons projecting from the dorsal and ventral edges of the broad anterior end (Pl. II, fig. 1). The branchial siphon is pointed anteriorly and somewhat ventrally, and is distinctly six-lobed; the atrial is directed anteriorly and is four-lobed. The lobes are triangular and pointed.

The *Mantle* is thin, almost membranous, and transparent. The musculature is only feebly developed, the bands being fine and distant, with the interstices filled up

[1] Dr. R. Hartmeyer, of Berlin, who is at present engaged in drawing up a complete list of the Ascidians for "Das Tierreich", has told me in a letter that he will in that work relinquish the Order Aspiraculata and place the genus *Hexacrobylus* in the family Molgulidae.

with gelatinous connective tissue. The muscular bands either radiate from the bases of the branchial and atrial siphons, or run parallel with their lower edges, so that they generally cross one another at right angles and form a more or less regular network with large rectangular meshes. Posteriorly the work is more irregular. The siphons are short, but the sphincters are tolerably well developed.

The *Tentacles* are much branched and not numerous. There are about seven large ones and, alternating with these, about the same number of much smaller ones. In the interspaces between these branched tentacles a number of minute, unbranched, almost papilla-like, rudimentary tentacles are found, arranged in a row. The mode of branching of the larger tentacles is rather irregular and the terminal twigs end bluntly, as is usual in other Molgulids (Pl. II, fig. 2).

The *Branchial Sac* is tolerably well developed and has seven distinct folds upon each side; those next the endostyle are rather slighter than the others. These folds, however, do not include the stigmatic part of the branchial sac, but are formed entirely of a number of internal longitudinal bars united by short transverse vessels, and thus form an open network with rectangular meshes. Usually eight to ten internal longitudinal bars form a fold, while there is none in the space between two folds. Narrow horizontal membranes are seen running transversely from fold to fold at the same levels as the transverse vessels. The stigmata form large flat infundibula arranged regularly in longitudinal and transverse rows, each infundibulum being composed of a single spiral with six to eight turns. The longitudinal rows of infundibula coincide in position with the folds in the interior of the branchial sac, but as the infundibula are extremely shallow, they hardly project into the folds. The boundary lines between the transverse rows of infundibula correspond in position with the transverse vessels on the folds. The arrangement of the infundibula is therefore much the same as that found in the genus *Eugyra*. The peripharyngeal ridge is conspicuous by being strongly undulated.

The *Dorsal Tubercle* is very simple, the opening being a short straight slit with slightly raised lips, situated longitudinally in the centre of a rather small perituberecular area.

The *Dorsal Lamina* is a plain broad membrane with no ribs and no teeth.

The *Alimentary Canal* forms a long narrow loop upon the left side. The oesophageal aperture is situated rather backward in the branchial sac, near the dorsal edge of the body. The oesophagus is short, narrow, and cylindrical, and opens into the wider end of the small pyriform stomach. There are no hepatic folds, and the posterior end of the stomach is not sharply bounded from the intestine. The intestine runs posteriorly and ventrally for some distance, then turns round abruptly, and returns closely pressed against the anterior wall of its first part, so that no open loop is formed, and finally runs anteriorly along the dorsal edge of the branchial sac past the oesophageal aperture and opens just opposite the lower edge of the atrial siphon. The anal opening is entire and smooth. The greater part of the alimentary canal is firmly attached to the inner surface of the mantle and is clearly visible from the external surface.

The Gonads are paired; that on the left side is placed anteriorly to the intestinal loop, close to the place of bending of the latter, while the other one is situated in the centre of the right side; both are attached to the inner surface of the mantle. They are roundish oval in shape, with the peripheral part divided into a number of small lobes. The ducts of the genital glands, as well as the renal organ, could not be satisfactorily made out.

Locality.—Station 277, 5° 48′ 15″ N., 80° 56′ E.; depth 859-880 fathoms; bottom green mud and sand; January 10th, 1901. Three specimens.

This interesting little species looks externally very much like *Eugyra*. The large infundibula arranged regularly in longitudinal and transverse rows and showing clearly through the transparent test strongly reminds one of those of *Eugyra*, so that at first glance one is greatly tempted to refer the animal to that genus. On cutting it open, however, it becomes at once clear that we have here, not *Eugyra*, but a member of the genus *Molgula*, which is characterized by the branchial sac being disposed in well marked folds. There are, indeed, some species of *Molgula* already known, such as *M. eugyroides*, Traustedt (16) from the West Indies and the two species, *M. sordida* and *M. crinita*, Sluiter (13) from the Malay Archipelago, which have the branchial sac with large infundibula arranged regularly like that of *Eugyra*, but the present species is quite distinct from all of them. It differs from *M. eugyroides*, whose "gjellesaekken minder i en paafaldend Grad om Eugyra-Slaegtens", in having seven folds instead of six upon each side of the branchial sac, and also in having eight to ten internal longitudinal bars on each fold instead of three or four. The other two species, which have both seven folds on each side, can readily be distinguished from the present species by the unusual number of the lobes at the branchial and atrial apertures, *M. sordida* having seven lobes at the branchial and none at the atrial, while *M. crinita* has both apertures four-lobed.

Of the three specimens one was tolerably well preserved, though somewhat contracted; and the above description refers mainly to this specimen. The remaining two had the whole internal body so strongly contracted that it was impossible to study the internal anatomy satisfactorily.

Molgula birmanica, n. sp.

(Pl. I, figs. 1—2; pl. II, figs. 3—7.)

External Appearance.—The body is roughly speaking egg-shaped, with the longer axis directed dorso-ventrally. The anterior surface is usually sunk in, so as to form a shallow elliptical depression, at the bottom of which the short siphons are placed (Pl. I, fig. 1). The posterior end is broad and rounded. The dorsal and ventral edges are both strongly convex, but the ventral is more so than the dorsal, the former corresponding with the pointed end of the egg. The animal is not attached, lying at the bottom either singly or gathered into groups of several individuals.

The apertures are borne on short siphons, and are not distant. The siphons form knob-like prominences and are distinctly visible even when they are fully

retracted. The number of lobes at the apertures, which is as usual six for the branchial and four for the atrial, is always discernible, though very faintly, from the outside.

The surface is entirely covered with a layer of fine sand attached to the hair-like processes of the test. The sandy coating is partly continued on the siphons, thus rendering them incapable of being completely retracted. The colour of the sand is dark greenish grey.

Size: length of the body (dorso-ventral) 28 mm., breadth of the body (antero-posterior) 21 mm., distance between the apertures 7 mm.

The *Test* is thin (less than 0·2 mm. in thickness), membranous but rather tough, and is quite transparent. It bears fine, branched, hair-like processes all over the outer surface, to which sand is attached in such quantity as to form a solid coating of uniform thickness (about 0·5 mm). On sections it is clearly seen that the sand grains are also attached to the outer surface of the test itself, but are never imbedded in the substance of the test. The length of the hair-like processes does not exceed 1 mm.

The internal body taken out of the test has nearly the same form as the entire animal (Pl. II, figs. 3 and 4), the test being in close contact with the mantle all over. The test can, however, be separated with ease except at the tips of the siphons where it is firmly attached to the mantle. The siphons, though short, are prominent, and the lobes at the branchial and atrial apertures are very distinctly seen. Most of the internal organs, particularly the gonads, the intestine, and the endostyle show through the mantle. The internal body is of a pale brownish-grey colour with a slight tinge of greenish-yellow.

The *Mantle* is thin, membranous, and for the most part transparent. The musculature is not strong; in the anterior part of the body stout longitudinal bands radiating from the bases of the siphons are conspicuous, but in the posterior half there are scarcely any muscle bands visible to the naked eye. Examined under a low power, however, we find minute spindle-shaped muscle bands, so characteristic of the Molgulidae, scattered over the whole extent of the mantle. They are very minute and run in all directions, not forming a continuous layer. In the anterior part of the body they lie mostly in a transverse direction so as to cut the conspicuous longitudinal bands at right angles. Ring muscle fibres are well developed on the siphons, especially at their base, and form powerful sphincters.

The *Tentacles* are compound, and much branched; there are about seven large and seven small ones placed alternately. The larger tentacles show ramifications repeated to the fifth order. The stem is pyramidal and curved so as to have the convex side looking posteriorly. The fine terminal twigs end rather bluntly, with the epithelial lining somewhat thicker at the tip than elsewhere.

The *Branchial Sac* is moderately strong, with seven distinct but narrow folds on each side. There are usually three or four internal longitudinal bars upon each fold, and none in the space between two folds. The transverse vessels are very irregular; they originate at the base of the folds and soon divide and anastomose to form a network in the meshes of which the infundibula are placed. Narrow, delicate mem-

branes springing from the branches of the transverse vessels run in all directions over the space between the folds. The stigmata are very irregular in shape, being short and almost straight or even oval in some places, while in others they are long and wavy or curved in spirals. These spirals are quite irregular both in size and in position, the larger ones form conical infundibula, but the smaller ones are perfectly flat (Pl. II, fig. 6). The endostyle is long, but rather narrow.

The *Dorsal Tubercle* is elliptical or kidney-shaped with the greatest length antero-posterior; both horns are coiled inwards and form simple spirals of nearly equal size; the aperture is at the left side. It occupies the centre of a flat triangular peritubercular area (Pl. II, fig. 7).

The *Dorsal Lamina* is narrow and very thick; it looks like a stout internal longitudinal bar, and there are no ribs and no marginal teeth.

The *Alimentary Canal* forms a long curved closed loop on the left side. The oesophageal aperture is on the dorsal side of the branchial sac at the posterior extremity of the dorsal lamina, and the oesophagus curves posteriorly to open into the oblong stomach situated at the dorsal edge of the posterior end. The wall of the stomach is thick, and its outer surface is rough from the presence of a number of small rounded projections.

The *Gonads* are present on both sides of the body. The gland on the left side lies dorsally to the place of abrupt bending of the intestine, while the opposite gland occupies the centre of the right side. They are irregular in shape, being composed of minute follicles, and there is no apparent distinction between the ovarial and testicular portions of the gland. A common genital duct is seen springing from the middle of the inner side and running for a short distance towards the base of the atrial siphon.

The *Excretory Organ* is a long, slightly curved, sausage-shaped sac, situated posteriorly to the genital gland of the right side. A small number of irregularly shaped brownish concretions are found floating in the sac.

Locality.—Byickhwaaw Bay, Lower Burma, "Investigator", 1911. About a dozen specimens.

This species is very closely allied to *M. martensi*, Traustedt, a species collected by the "Gazelle" in Mermaid Strait in North-West Australia. In the external appearance, the shape of the body, and the configuration of the intestinal loop, the two species are almost identical, and, besides, they are both from the Indian Ocean. There are, however, certain differences in the internal anatomy which necessitate the specific separation of these two forms. In *M. birmanica* the dorsal tubercle is elongated antero-posteriorly with both horns coiled inwards, whereas in *M. martensi* it is broad and S-shaped with one of the horns bent outwards and the other inwards—"Fomreorganet stort, bredere end langt, S-formigt, det tilhöire liggende Horn udad—det tilventre liggende indad krummet." Then, the latter species has usually six internal longitudinal bars on one side of the fold, the stigmata are mostly straight, and the anus has "3 store Lappen in Randen", all of which characters do not apply to our species. They are also different in size, *M. martensi* being much the larger of the two.

Hexacrobylus indicus, Oka.

(Pl. I, fig. 3; pl. II, figs. 8-13; pl. III, figs. 1 and 2.)

Hexacrobylus indicus, Oka, A., Zur Kenntnis der zwei aberranten Ascidiengattungen, *Dicopia*, Sluiter und *Hexacrobylus*, Sluiter. *Zool. Anz.* Bd XLIII, No. 1, 1913.

External Appearance.—The body is ovate in shape, and is slightly compressed laterally (Pl. I, fig. 3, and pl. II, fig. 8). The anterior or upper end is broad and rounded, the posterior or lower is somewhat narrower and slightly pointed. The dorsal and ventral edges are equally convex. The branchial aperture is situated a little above the middle of the ventral edge, and is very large and conspicuous. The atrial aperture is placed in the middle of the anterior surface, *i.e.* at the summit of the body, looking anteriorly; it is very small and insignificant. The animal is not attached, having its lower end simply imbedded in sand or mud of the bottom.

The configuration of the branchial aperture is very peculiar. It is a wide transverse slit, more or less gaping in all the specimens, and guarded by what seems at first glance to be thick projecting warty lips. In reality the opening is surrounded by six pinnately branched processes arranged in such a manner that two of them stand on the anterior border and the remaining four on the posterior border of the aperture. They are not all of one size, those on the anterior border being the largest, while the median ones on the posterior border are slightly smaller than the lateral ones (Pl. II, fig. 9). In consquence of preservation in alcohol they are all strongly contracted and bent inwards, and the stem exhibits a series of transverse furrows corresponding to the intervals between the lateral branches, of which there are five to seven on each side. These branches are again ramified (Pl. II, figs. 10 and 11). Judging from the development of muscular fibres in their interior it is highly probable that these processes could be expanded during life, like the tentacles of Alcyonarians, to serve as an organ for collecting food.

The external surface is covered all over with delicate woolly hairs. These generally are rather short, but at the lower end of the body, which seems to have been buried in mud or sand, they are much longer. Sand grains and foraminiferan shells are seen here and there adhering to these hairs. The colour of the animal is a light brownish-grey, owing to fine mud particles on the outer surface. Held against the light, the body is found to be semi-transparent. The six tentacle-like processes of the branchial aperture are almost destitute of hairs and are much darker.

The dimensions of the five specimens are as follows:—

Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).	Thickness.
No. 1	34 mm.	23 mm.	20 mm.
No. 2	28 mm.	20 mm.	15 mm.
No. 3	25 mm.	18 mm.	14 mm.
No. 4	20 mm.	15 mm.	10 mm.
No. 5	19 mm.	15 mm.	12 mm.

The *Test* is composed of two layers, an outer and an inner. The outer layer, which is formed mainly of the basal parts of the delicate hair-like processes, is very

thin all over and can be peeled off as a fine, moderately tough membrane. The hairs are outgrowths of this layer and are seen to spring densely from the surface in an oblique direction. Each hair is nearly of the same thickness throughout and is never branched ; the surface is rugged and is covered with fine mud particles. The inner layer or the test proper is soft, cartilaginous, almost colourless and transparent. Its thickness varies considerably in different parts, so that the internal body, taken out of the test, has quite a different shape compared with the entire animal (Pl. II, fig. 12). It is thickest in the region lying between the branchial and atrial apertures where it is nearly 5 mm. thick, while at the opposite end of the body it is less than 0·5 mm. thick. The inner surface is even and smooth, and is of the same colour as the substance of the test proper. A thin continuation of the test extends for some distance inwards from the branchial aperture.

The internal body has a very peculiar shape. It consists of a globular trunk from the anterior end of which two large siphons are projecting. One of these, the atrial, exhibits no striking character, being simply a long, conical, slightly curved tube directed anteriorly and ending in a small four-lobed aperture, but the other, the branchial, is modified in a most extraordinary manner, and its shape is quite unique among the whole group of the Ascidiacea. Roughly speaking, it may be compared with a very short but wide tube bent in a curve, with one end compressed so as to represent a bilabiate mouth, and the wall on the convex side puffed out in the form of a hemispherical dome. The branchial aperture is directed ventrally, the rounded dome-like surface looks anteriorly, and the whole structure is placed at the ventral edge of the anterior end of the trunk. The branchial siphon is nearly as large as the trunk itself, and as there is a slight constriction looking like a neck between the trunk and the siphon, one is reminded of a bird's head with a disproportionally wide mouth. Strangely enough, there is nothing in the external appearance of the animal suggestive of this peculiar configuration of the internal body.

The *Mantle* is very thin and transparent in the trunk region, and scarcely any muscle bands are visible in this part of the body. On the siphons, on the contrary, both the connective tissue and the muscular bands constituting the mantle are well developed. There are strong muscle bands forming the rim of the branchial aperture, and a number of concentric annular bands are seen running parallel with the former. The longitudinal muscle bands are also numerous; they all start at the margin of the aperture, and run on the inner side of the transverse bands, cutting them at right angles so as to form a regular network with rectangular meshes. On the anterior surface of the body the longitudinal bands disappear gradually, being lost in the connective tissue, but on the ventral side they all terminate rather abruptly in a line marking the posterior boundary of the branchial siphon. Each of the tentacle-like lobes surrounding the branchial aperture is provided with a bundle of strong muscle fibres which fill up the axial portion of the stem. On reaching the base of the process just inside the rim of the branchial aperture, these fibres diverge and are either mixed up with the longitudinal and transverse bands of the branchial siphon proper or are gradually lost in the connective tissue (Pl. III, fig. 1).

The musculature of the atrial siphon is simple and regular, being composed of longitudinal and transverse bands cutting one another at right angles so as to form a very regular network.

The *Tentacles* are entirely absent. There is not even a trace of these organs, whose much branched and dendritic form is so characteristic of the family Molgulidae.

The *Branchial Sac* is in a totally reduced condition. There is, it is true, a more or less widened part of the alimentary canal in front of the narrow oesophagus, but this region exhibits nothing characteristic of a Tunicate pharynx. The walls are not perforated, and there are no stigmata, no endostyle, and no dorsal lamina, if we do not count as such a slight longitudinal ridge immediately below the opening of the dorsal tubercle. Besides, there is no demarcation between this part and the oesophagus proper. The inner surface is perfectly smooth, and the lining epithelium seems not to be ciliated. A network of fine blood spaces traversing the wall probably subserves the respiratory function. The boundary between the internal wall of the branchial siphon and the pharyngeal portion of the oesophagus is very distinct, since the former is lined with a thin layer of test, whereas the latter has of course the epithelium naked.

The *Dorsal Tubercle* is situated on the dorsal wall of the pharyngeal region just below its anterior boundary. It is a simple round pit with scarcely raised lips, connected by a short canal with the subneural gland lying immediately underneath the nerve ganglion. The latter is oval-shaped and is placed at the anterior end of the trunk between the bases of the branchial and atrial siphons. It gives off six nerve trunks, one to each of the tentacle-like lobes of the branchial aperture.

The *Alimentary Canal* consists, as usual, of oesophagus, stomach, and intestine, and forms a loop twisted somewhat in the shape of the figure 8. The oesophagus, which is fairly long but rather narrow, is directed posteriorly and dorsally and opens into the anterior end of the stomach. The stomach is of an elongated oval form, and lies obliquely in the hindermost region of the trunk with its hind end looking ventrally and a little towards the left. The wall of the stomach is smooth both inside and outside. The intestine, immediately after leaving the stomach, turns dorsally and, running along the inner surface of the mantle of the left side, reaches the dorsal edge of the body and then turns anteriorly to open into the cloacal cavity at the base of the atrial siphon. The anus is somewhat bilabiate with entire margins. A rounded pouch-like liver is present, attached to the hind part of the stomach. It is a large organ, hollow inside, crenated externally, and placed in the centre of the trunk, occupying the space between the stomach and the renal organ.

The *Gonads* are symmetrically developed on both sides of the body. The ovaries and the testes are separate, and each gland is provided with its own duct. The testes, of which there is one on each side, are attached to the inner surface of the mantle about half way between the anterior and posterior end of the trunk, and rather nearer the ventral than the dorsal edge. Each testis is roughly oval in outline, and is composed of a large number of branched seminiferous tubules. The vas deferens is extremely short and opens directly into the lateral region of the peribranchial cavity.

The ovaries, of which we find likewise one on each side, are elongated tubular organs placed for the greater part horizontally in the same level with the testes and in direct contact with the dorsal part of these organs. Each ovary is bent almost at a right angle near its distal end, so that the terminal portion assumes a vertical position. This part is pointed anteriorly and is directly continuous with the oviduct. The latter is short and wide and opens with a large gaping aperture into the cloacal cavity at the base of the atrial siphon. The axial portion of the ovary is taken up by a spacious canal directly continuous with the oviduct, while the ova are found imbedded in, or bulging out of, the thickness of the wall.

The *Excretory Organ* is globular in shape, and is situated just inside the mantle on the ventral median line of the trunk. It is a large, completely closed, sac-like organ with thin transparent membranous walls, in which a comparatively large dark brown spherical concretion is seen floating.

Locality.—South of Ceylon, at Station 278; 6° 52′ N., 81° 11′ E.; depth 1912 fathoms, bottom green mud and sand, January 11, 1901. Five specimens.

The genus *Hexacrobylus*, undoubtedly the most extraordinary member of the Order Ascidiacea, has hitherto been known to science in only one species, namely, *H. psammatodes*, Sluiter (13, 14). A single specimen of this form was collected during the Siboga-Expedition at Station 211 (5° 40′ 7″ S., 140° 45′ 5″ E.) from a depth of 1158 meters, and a detailed account of its external appearance and its internal anatomy, so far as could be ascertained from the unique specimen, was given by Sluiter in 1905 in the Report of that Expedition. As the present species differs markedly from this form in some essential points of structure, it will be interesting to go over the more important organs and examine the differences and resemblances which they exhibit in these two forms.

In regard to the external form, the difference between the two species appears to be considerable. In *H. psammatodes* the body is provided at the anterior end with a distinct collar, sharply bounded from the trunk proper and a little narrower than the latter. The trunk proper is cylindrical in shape and bears a small tail-like atrial siphon at the posterior end. Thus, in this species, the branchial and atrial apertures lie at the anterior and posterior extremities of the body, whereas in the new species here described the branchial aperture is on the ventral edge and the atrial on the anterior surface, so that the two apertures are separated only by a fraction of the longitudinal circumference of the body. However, this difference might be more apparent than real, since the condition met with in *H. psammatodes* would also be produced in *H. indicus* if the atrial aperture were shifted dorsally until it came to lie opposite the branchial, and the denominations of parts were changed accordingly. The condition of the external surface and the colour of the animal seem to be essentially the same in both forms.

In *H. psammatodes* the test is very thin, especially on the ventral side, but on the tentacle-like lobes of the branchial aperture it is thicker and brittle on account of foreign bodies imbedded in its substance. In *H. indicus*, on the contrary, the test is rather thick all over, and is elastic and never brittle. The delicate hair-like

processes of the test are in *H. psammatodes* least numerous on the ventral side, while in our species these processes are best developed at the posterior end, evidently corresponding to the ventral side of the Malayan species.

The musculature of the mantle exhibits, roughly speaking, the same type of arrangement in both species. There are but few muscle bands on the trunk proper, while on the siphons they are pretty well developed. The strongest muscle bands are found in both species along the margin of the branchial aperture and inside the tentacle-like lobes surrounding it.

The tentacles show a very striking difference in the two species. In *H. psammatodes* there are more than a hundred tentacles having the form of short finger-like filaments. As stated above, our species has no tentacles at all.

The branchial sac, which is the most characteristic feature of the genus, exhibits a wonderful conformity in the two species. In both forms it is narrow, and its walls are perfectly intact, there being no stigmata perforating them. Between the pharyngeal portion of the alimentary canal and the oesophagus there is no visible constriction, so that these two regions cannot be sharply defined.

The course of the alimentary canal is very different in the two species. In *H. psammatodes* it is very short and wide, and runs almost in a straight line to the anus at the hind end of the trunk, there being no stomach and no intestinal loop, a condition not found in any other known Ascidian. The liver, which is a conspicuous organ in our species, was not observed in *H. psammatodes*.

The gonads show partly a close agreement and partly a remarkable discrepancy in the two species. Both have the testes and ovaries developed one on each side, and the gonoducts are all separate. The testis is roughly oval in outline, while the ovary is elongated and bent in knee-like fashion. But in *H. psammatodes* each genital gland is provided with a large bladder-like sac with thin membranous walls, and differs in this respect markedly from the gonads of all other Ascidians. In the present species nothing comparable to these sacs could be observed.

The excretory organ is not mentioned in Sluiter' s description of his species. In *H. indicus*, on the other hand, there is a large globular renal sac containing brown concretions, exactly like that of a typical *Molgula*.

As seen from the above comparison, the two species, while agreeing in many important points of structure, still exhibit so great a difference that it would seem almost necessary to regard them as the types of two different genera. When we consider, however, that they agree in a most striking manner just in those points which separate them so widely from all other Ascidians, and further that only a single specimen of *H. psammatodes* could be examined, which of course made the investigation of the internal anatomy somewhat difficult, it is thought best, at least for the present, to unite the two forms under one generic title and amend the diagnosis of the genus *Hexacrobylus* accordingly. Under these considerations I have decided to name our species *Hexacrobylus indicus*.

The only other simple Ascidian hitherto known which shows any close affinity to the genus *Hexacrobylus* is the curious deep-sea form *Oligotrema psammites*, collec-

ted by Dr. Willey off Lifu, New Britain, and described by Prof. Bourne in the "Quarterly Journal of Microscopical Science" in 1903 (1). In external appearance this species looks very much like an Alcyonarian zooid having six pinnately branched tentacles surrounding the mouth-opening at the anterior end of the body. In regard to internal anatomy it agrees with *Hexacrobylus indicus* far better than *H. psammatodes*. The intestine forms a loop, with distinct oesophagus, stomach, and intestine, and there is a globular renal sac lying on the ventral side of the stomach. The chief point of difference, which renders the generic separation of the two forms necessary, is found in the structure of the branchial sac. This organ is likewise much reduced in *Oligotrema*, being nothing more than the widened anterior portion of the alimentary canal, but its walls are perforated by a number of rudimentary stigmata.

Fam. CYNTHIIDAE.

This family is represented in the collection by four species: *Cynthia lanka*, Herdman; *C. sluiteri*, n. sp.; *Rhabdocynthia ceylonica*, Herdman; and *Microcosmus manaarensis*, Herdman. Three of these were collected for the first time by Herdman on the coast of Ceylon, and were described in his "Report on the Pearl Oyster Fisheries", 1906 (7). The remaining one, which is new to science, shows a close affinity to *C. spinosa*, Sluiter (15), from the Gulf of Tadjourah on the eastern coast of Africa. It is curious to find that out of the four species two are entirely covered by a thick coating of sand, which is rather exceptional in this family.

Cynthia lanka, Herdman.

(Pl. I, fig. 4.)

Cynthia lanka, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf Manaar. On the Tunicata*, 1906.

Localities.—(1) Palk Strait, 12 fathoms. One specimen. (2) Mergui. One specimen. (3) Laccadive Sea, at Station 246, 11° 14′ 30″ N., 74° 57′ 15″ E.; depth 68-148 fathoms; bottom sand and stones; October 15th, 1897. Two specimens.

In one of the specimens the ridge joining the apertures on the anterior end is well marked, and the configuration of the apertures is exactly like those shown in Herdman's figures. In the remaining three the ridge is only very faintly represented and the apertures are simply cross-shaped as in the majority of *Cynthia*. The sandy coating of the test is in one specimen, from Palk Strait, rather thick (about 3 mm.), while in the others it is "not thick", as given in the original description of the species. The branchial and atrial siphons are of nearly the same length, and the minute spines lining the branchial siphon are yellowish-green with beautiful metallic lustre. The zigzag arrangement of the oviduct connecting the gonads is very conspicuous except in the specimen from Mergui, which also differs somewhat in the course of the intestinal loop reaching higher up than in the other specimens. Otherwise the internal anatomy agrees pretty well with the accounts given by Herdman. The dimensions of the four specimens are 30 mm. × 26 mm., 24 mm. × 18 mm., 23 mm. × 17 mm., and 20 mm. × 15 mm. respectively.

Cynthia sluiteri, n. sp.

(Pl. I, fig. 5; pl. III, figs. 3 and 4.)

External Appearance.—The body is roundish ovoid in shape, and is not compressed laterally. The branchial aperture is at the anterior end, and the atrial about one-third down the dorsal edge; they are both cross slit, and are borne each on a very short, truncated, conical projection. The animal is attached by the ventral edge and near the ventral half of the left side.

The surface in the exposed part of the test is regular and even, but very rough from the presence of small pointed scales all over. On the lips of the apertures these suddenly increase in size and form large branched spines. The latter, however, are not numerous, being arranged in a single irregular row round the aperture. The attached surface of the test is provided with numerous short but branched root-like processes to which a few shell fragments and sand grains are seen attached. Along the boundary line between the free and attached parts of the surface, the test is slightly raised, so as to form a very low ridge running in a circle.

The scales covering the greater part of the test are roundish in outline, slightly elevated, and are each provided with a small pointed spine at or near the anterior border (Pl. III, fig. 4). The base of this spine is surrounded at some distance by a number of much smaller prickles arranged in a circle. The larger spines found on the lips of the aperture consist each of a straight stem, tapering towards the tip, from which a number of lateral prickles spring at three or four different levels (Pl. III, fig. 3). Some of these spines are 1·5 mm. long and are surrounded at the base by a circle of curved pointed prickles. There are, besides, smaller spines which look like intermediate stages between the larger spines and the ordinary scales shown in the figure.

The colour of the body is a dull greyish-yellow. The tips of the spines and prickles are dark brown. The body measures 25 mm. in length and 19 mm. in diameter at the broadest part.

The *Test* is leathery, not thick (0·5 mm); the inner surface is of nearly the same colour as the outside.

The *Mantle* is not very thick, but muscular. The musculature consists of two layers, an outer layer of fine transverse fibres and an inner layer of much stronger longitudinal bands. On the siphons the external fine transverse fibres are wanting; but there is a deeper layer of annular muscle bands which form powerful sphincters at their bases.

The *Tentacles* are compound, but not bushy, the branches being rather distant and short; they are about twenty in number, five of them being much larger than the rest. They are of several sizes and there is no regularity in their arrangement.

The *Branchial Sac* has nine broad folds upon each side. There are about thirteen to fifteen internal longitudinal bars on the fold, and only three to four in the interspace. Every fourth transverse vessel is much wider than the intermediate ones, which are all of one size. The meshes are elongated transversely and contain each six or seven stigmata.

The *Dorsal Tubercle* is roundish in outline; the funnel is horseshoe-shaped with the horns turned spirally inwards.

The *Dorsal Lamina* is represented by a series of slender languets.

The *Alimentary Canal* forms a wide loop as is usual in the genus *Cynthia*. The anus has its margin entire.

The *Gonads* are hermaphrodite glands developed one upon each side of the body. Each gland has the shape of a curved cylinder with smooth surface, and opens into the peribranchial cavity at the base of the atrial siphon. The openings of the glands are separate, but lie very close to each other.

Locality.—Muscat, 5 fathoms. One specimen.

This species is closely allied to *C. spinosa*, Sluiter (15), from the Gulf of Tadjourah, East Africa, which is also covered all over with peculiarly shaped spiny scales. These scales, however, though apparently belonging to the same type, are different in shape in the two species. In *C. spinosa* they are characterized by bearing along the margin five to seven curved spines, 0·25 mm. long, with their points turned towards the central spine, which is erect, straight, and 0·5 mm. long. As will be seen at once by comparing our figures (Pl. II, fig. 8*c*. Sluiter, *l.c.*, and Pl. III, fig. 4 of this paper) the difference in the shape of these scales is fairly striking. The larger spines surrounding the aperture, on the other hand, are quite similar in both species.

In internal structure the two species agree tolerably well, but slight differences are found in the number of tentacles, the number of internal longitudinal bars on the fold and the arrangement of transverse vessels, and in the form of the gonads. Thus, in *C. spinosa* the tentacles are only sixteen in number instead of twenty, and they are all of the same size. The number of the internal longitudinal bars on a fold is ten in *C. spinosa*, but thirteen to fifteen in *C. sluiteri*. Again, in *C. spinosa* the transverse vessels are placed large and small alternately, whereas in *C. sluiteri* every fourth transverse vessel is distinctly wider than the intermediate ones. The hermaphrodite glands of *C. spinosa* are lobed, and not entire as those of *C. sluiteri*. In other respects the two species agree almost perfectly.

Rhabdocynthia ceylonica, Herdman.

(Pl. I, figs. 8-11.)

Rhabdocynthia ceylonica, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf of Manaar. On the Tunicata*, 1906.

Localities.—(1) Station 152; 11½ miles S. 83° W. of Colombo Lt., depth 26½ fathoms; bottom sand, shell and coral; December 12th, 1893. One specimen. (2) Andamans. One specimen. (3) West coast of Andamans. Four specimens. (4) Coast of Cheduba, 20-30 fathoms; August 29th, 1877 (coll. *Armstrong*). One specimen. (5) Nicobars (coll. *Armstrong*). One specimen. (6) East of the Terribles, 15 fathoms. Two specimens.

This species appears to be rather common in the northern part of the Indian

Ocean, as the collection contains specimens from no less than six different localities. They vary somewhat externally, but in internal structure they agree pretty well with Herdman's original description and figures of this species. The largest specimen, from the Andamans, measures 38 mm. × 21 mm. × 16 mm., and is considerably larger than those from the Gulf of Manaar. The next largest, also from the Andamans, is 26 mm. long and 21 mm. wide. The remaining specimens are all less than 20 mm. in length.

Four of the specimens, from the west coast of the Andamans, have the siphons very prominent and the body covered with clear pale yellow sand and small shell fragments, and thus look very like the type specimens figured by Herdman (*l.c.* Pl. III, figs. 1, 2, 3, and 4). In another specimen, the largest one, the anterior surface of the body is sunk in, undoubtedly in consequence of preservation, and the siphons, which are less prominent than in others, are placed at the bottom of this concavity. Besides, this specimen is characterized by the well-developed condition of the dorsal tubercle which recalls that of *Rh. pallida*. The rest of the specimens, except two mentioned below, have the siphons more or less contracted, but conspicuous on account of their nakedness.

The two specimens referred to above are those from East of the Terribles. They differ somewhat both externally and in internal structure, and might as well be regarded as a distinct variety. The body is nearly globular, and the siphons are very short with the apertures scarcely discernible, being thinly covered with sand all over. The test is soft, leathery, and transparent. Internally they agree in most respects with the typical form, but differ somewhat markedly in the structure of the branchial sac. There are seven folds on each side as usual; the internal longitudinal bars are, however, much broader and look like so many longitudinal membranes, projecting into the lumen of the branchial sac. I counted four to six such membranes on a fold and about two in the interspace. The meshes are broader than long and contain six or seven stigmata each.

Microcosmus manaarensis, Herdman.

(Pl. I, figs. 6 and 7.)

Microcosmus manaarensis, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf of Manaar. On the Tunicata*, 1906.

Locality.—Madras coast, 20 fathoms. Twelve specimens.

I have referred these specimens to this species notwithstanding certain differences in the structure of the branchial sac, because they agree quite well in all other respects with the original description. They are nearly spherical and form a rough mass of sand, foraminifera, and shell fragments, stiff but brittle, with two short siphons projecting, and having the posterior end thickly covered and prolonged into root-like sandy wisps. The apertures are distant and looking away from each other, they are both cross slit. The crust of sand covering the test is 3 to 7 mm. thick, and some of the branched root-like processes are more than 20 mm. in length.

The tentacles are much branched, there are six to eight large and six to eight smaller placed alternately, with some very small intermediate ones. The dorsal tubercle is small, cordate in outline, with the opening anterior and both horns turned in. The dorsal lamina is a plain membrane.

The branchial sac has six folds on each side, but there are on each fold about twelve internal longitudinal bars instead of five, and only one in the interspace instead of three. In this respect the specimens are sharply distinguished from the type of the species, but otherwise they agree quite well, so that it seems inadvisable to separate them specifically on the strength of this single character. Possibly the species may have a very wide range of individual or local variation in the arrangement of the internal longitudinal bars. The arrangement of the transverse vessels is also somewhat different; in the type specimens there are seven narrower transverse vessels between each pair of very much wider, while in our specimens they are of three different sizes placed alternately after the scheme 1, 3, 2, 3, 1... The meshes in the interspace between the folds are elongated and contain about nine stigmata each. Most of the meshes are crossed by a narrow horizontal membrane.

As Herdman has already pointed out, this species is very closely allied to *Microcosmus gleba*, Traustedt, from the Pacific. The differences are, in fact, rather slight, being confined to some details of the branchial sac, and it seems doubtful whether the two forms should be regarded as specifically distinct or not. I have preferred, however, to leave the question to those investigators who have the opportunity of comparing the original specimens of both forms. It is, by the way, also questionable if the Island of Banca where *Microcosmus gleba* was found should be included in "Stille Hav", as given in Traustedt's paper and quoted by Herdman.

Fam. STYELIDAE.

This family is represented in the collection by three species of *Polycarpa*, one of which is new to science, and a minute solitary form for which it was found necessary to form a new genus. The latter is especially interesting, as it exhibits a combination of characters which is intermediate between the Styelidae from among the simple Ascidians on one hand and the Polystyelidae from among the compound Ascidians on the other.

Polycarpa cryptocarpa, Sluiter.

(Pl. I, fig. 13.)

Polycarpa cryptocarpa, Sluiter, Über einige einfache Ascidien von der Insel Billiton. *Natuurk. Tijdschr. Ned. Ind.* D. XLV, 1885.

Localities.—(1) Madras coast, 20 fathoms. Five specimens. (2) Off C Negrais, Burma, at Station 384; 16° 0′ N., 93° 37′ E.; depth 40 fathoms; bottom coral; February 22nd, 1909. One specimen.

The specimens agree quite well with the original description by Sluiter except in certain details of internal structure. The tentacles are not all of one size as in the type specimens, but are of three different sizes placed alternately after the

schema 1, 3, 2, 3, 1. . . There are about seventeen tentacles of the first order. The dorsal tubercle is of the usual form and not broken up in a number of small openings as in Sluiter's specimens. The branchial sac is dark brown and has four large folds on each side, but there are ten to twelve internal longitudinal bars upon a fold and four or five in the interspace, while in the original description the number of longitudinal bars in the interspace is given as about eight. The transverse vessels are of two sizes, there being three smaller ones between each pair of the larger. These are, however, all points of minor importance subject to individual variation and do not affect in any degree the identification of this exceedingly well characterized species.

The specimens from the Madras coast are about 50 mm. long and 35 mm. broad, and much compressed laterally; at the posterior end the test is provided with a number of branched root-like processes for attachment. The specimen from Station 384 is somewhat smaller and is of a lighter brown colour.

Polycarpa glebosa, Sluiter.

Styela glebosa, Sluiter, Die Tunicaten der Siboga-Expedition. IAbt. Die Sozialen und Holosomen Ascidien. *Siboga-Exped.* Bd. LVIa, 1904.

Locality.—Andamans. One specimen.

It is with much hesitation that I refer this specimen to Sluiter's species from Pulu Sebangkatan, Borneo Bank. As will be seen below, there are many points in internal structure in which it does not quite agree with the description of *Styela glebosa*, but as the points in which they agree appear to outweigh the differences I have thought it better to regard, at least temporarily, the two forms as identical, rather than to increase the number of species of this already bulky genus on the strength of a single doubtful specimen.

The body is erect, oval in shape, 27 mm. in length and 18 mm. in breadth, and is not compressed laterally. The branchial aperture is at the anterior end, and the atrial is about one-third of the way down the dorsal edge; they are both cross slit, inconspicuous, there being no prominent siphons. The surface is irregularly creased all over, and is of a pale greyish yellow colour, with reddish brown patches on both sides of the dorsal half. There are some branched root-like processes of the test, especially along the ventral edge and on the ventral half of the left side, to which foraminiferan shells and fragments of algae are found adhering.

The test is not thick, but tough and leathery; it is white on the inside and in section. The mantle is rather thick, soft and gelatinous, with the musculature only feebly developed. The siphons are very slight even in the mantle.

The tentacles are simple, filiform; there are eight larger and eight smaller, placed alternately, with some quite small intermediate ones here and there.

The branchial sac has four very narrow folds on each side; the most dorsally situated pair is very slight. The fold has about ten internal longitudinal bars and there are two to three in each interspace. The transverse vessels are of three sizes

arranged thus: 1, 3, 2, 3, 1. . . The meshes are broader than long and contain each about seven stigmata.

The dorsal tubercle is broadly crescentic in shape, placed transversely with the concavity turned forwards.

The dorsal lamina is a narrow plain membrane.

The alimentary canal forms a short close loop with a distinct stomach. The intestine is rather wide, and the wall of the stomach is ridged longitudinally. The anus has a finely toothed margin.

The gonads consist of about a dozen roundish polycarps on each side, all embedded in the thickness of the wall.

The most important point of difference between the present specimen and the description of *Styela glebosa* by Sluiter is in the shape of the dorsal tubercle which is a transverse slit with irregularly indented lips in the type specimens. Another point of difference is that in our specimen the "ziemlich regelmässig verbreitete runde Pünktchen" on the outside of the mantle are not found. There are also differences in the number of tentacles and of the internal longitudinal bars on the folds of the branchial sac, but they are not considerable.

Polycarpa annandalei, n. sp.

(Pl. I, fig. 12; pl. III, figs. 5-9.)

External Appearance.—The body is somewhat quadrate in shape, with the apertures on two equal projections at the dorsal and ventral edges of the anterior end, giving the latter a cleft appearance (Pl. I, fig. 12). The siphons are bent towards the ventral and dorsal sides respectively. The surface is corrugated and encrusted with sand grains and shell fragments all over, and is of a yellowish-brown colour on account of the sand. It is 33 mm. long, 23 mm. broad, and 19 mm. thick, and the apertures are 38 mm. distant from each other. The apertures are both cross slit.

The *Test* is thin, hard, and stiff, and is whitish with pearly lustre on the inside. In section it is seen that the sand grains are embedded in, as well as attached to, the test. Some of the sand grains even project inwards forming little prominences on the inner surface of the test.

The *Mantle* is exceedingly thin and colourless, and contains an irregular network of fine muscle fibres.

The *Tentacles* are of three sizes; there are about twelve large, twelve smaller, and a number of still smaller ones arranged regularly, though not throughout, after the scheme 1, 3, 2, 3, 1. . . They are finger-like in shape, with the tips rather blunt (Pl. III, fig. 5).

The *Branchial Sac* has four narrow folds upon each side. There are seven to fourteen internal longitudinal bars on a fold and five to nine in the interspace. The transverse vessels are of two sizes, for the most part placed large and small alternately, but in some places every fourth vessel is larger than the intermediate ones. The meshes are nearly square and contain three to four stigmata each (Pl. III,

fig. 6). In one of the specimens the number of internal longitudinal bars on the folds and in the interspaces is as follows:—

End. 8 (7), 6 (9), 5 (14), 7 (9), 9 D.L.

The *Dorsal Tubercle* is a cordate horse-shoe, with the opening anterior and the horns bent inwards at the tip (Pl. III, fig. 8).

The *Dorsal Lamina* is very narrow but rather thick, somewhat resembling a stout longitudinal bar.

The *Alimentary Canal* forms a simple small open loop on the left side of the branchial sac. The stomach is distinct, oblong in shape, and longitudinally folded; the intestine is both thin and short for an animal of this size (Pl. III, fig. 7). The margin of the anal opening is entire.

The *Gonads* are present in the form of numerous elongated polycarps attached to the outer surface of the branchial sac. There are about twenty placed along the fourth fold on each side, and about fourteen forming a row just below the anterior margin of the branchial sac. Each polycarp consists of a central ovarial portion surrounded by a peripheral layer of fine testicular follicles (Pl. III, fig. 9).

Locality.—Madras coast, 20 fathoms. Two specimens.

The specimens show externally so striking a resemblance to *Polycarpa manaarensis*, Herdman, from the Gulf of Manaar, Ceylon, that at the first glance I had almost no doubt as to their identity. On cutting them open, however, many points of difference in internal structure were found, which necessitated the formation of a new species for the present form. Thus, the mantle, which is very thin and colourless in our species, is thick, opaque, and ruddy brown in *P. manaarensis*. The dorsal tubercle is a widely open horse-shoe with the horns not turned in in that species, whereas it is almost closed in our specimens. The shape of the stomach also is not the same in the two species. But perhaps the most important point of difference in the internal anatomy is the situation of the polycarps, which in Herdman's species are rounded and embedded in the thick mantle.

A pair of a macrurous Crustacean was found living as commensals in the branchial sac of one of the specimens.

Monobotryllus violaceus, n. g. and n. sp.

(Pl. III, figs. 10 and 11; pl. IV, figs. 1-3).

External Appearance.—The body of this curious little species is ovoid in outline, much depressed, and attached by the whole of the under surface. Along the periphery the test is drawn out to form a thin layer with irregularly indented margins. The upper surface is convex and bears the branchial and atrial apertures on the longer diameter, placed rather distant from each other. The apertures are both simple round holes, not lobed, with somewhat raised lips. The surface is entirely naked and smooth and is of a pale greenish-violet colour with a little silky lustre. The size of the largest specimen is about 4 mm. in length and 2·5 mm. in breadth.

The *Test* is thin, but tough and leathery; on the under surface it is exceedingly

thin and colourless. In the marginal zone it is traversed by numerous blood vessels with terminal knobs like those of *Botryllus*.

The *Mantle* is very thin all over, with no specially developed musculature. It is quite transparent, allowing all internal viscera to show through distinctly.

The *Tentacles* are simple, filiform, with pointed tips. They are twenty in number, and of two sizes, placed large and small alternately.

The *Branchial Sac* is well developed and occupies a large portion of the internal cavity. It is not folded, but bears a number (fifteen or more) of internal longitudinal bars on both sides. The stigmata are broad and short, sometimes oval in shape, and are arranged more or less regularly in transverse rows on both sides of the endostyle; in other places their arrangement is quite irregular. The transverse vessels, where they are present, are only slightly larger than the interstigmatic vessels, and are all of one size. The endostyle is long but narrow.

The *Dorsal Tubercle* is elongated longitudinally and placed between the posterior arms of the peripharyngeal ridge; its opening is a short simple longitudinal slit. The nerve ganglion is seen lying immediately behind the dorsal tubercle.

The *Dorsal Lamina* is a very narrow plain membrane.

The *Alimentary Canal* is very much like that of *Botryllus*. It forms a simple loop consisting of oesophagus, stomach, and intestine, and is placed under the posterior portion of the branchial sac, mostly on the left side of the median line. The oesophagus is very short and bent ventrally to open into the stomach. The stomach is oval-shaped with its walls folded longitudinally. It is provided with a small curved blind sac. The intestine is bent in the shape of the letter S, and has its posterior half surrounded by a ramifying gland whose duct opens into the blind sac of the stomach. The margin of the anal opening is entire.

The *Gonads* consist of a number of small polycarps projecting from the walls of the peribranchial cavity. They are arranged in two rows, one on each side of the endostyle. Each polycarp is rounded in shape and is made up of two parts, the ovarial lying nearer the endostyle and the testicular occupying the outer half.

Locality.—Puri, Orissa. "Golden Crown". About fifty large and small specimens attached to a fragment of oyster-shell.

This species is especially interesting as it exhibits a close resemblance to certain compound Ascidians, such as the Botryllidae and the Polystyelidae. The shape of the body, the structure of the branchial sac and the alimentary canal, and the condition of the reproductive organs are all so strikingly similar to the corresponding parts in members of the above named families that the only thing wanting for placing it in one of these families is the common investing mass. At first I considered the possibility of the reproduction by budding and carefully examined some of the specimens, but was unable to find any trace of the occurrence of this mode of propagation. Besides, compound Ascidians are, so far as I know, never solitary, and even in a minute colony containing a single full grown ascidiozooid there are always one or two large and some smaller buds imbedded in the common test. That the test is traversed by blood vessels with enlarged terminal bulbs like those of

Botryllus is not in itself suggestive of the occurrence of budding, since exactly the same condition is also met with in certain species of simple Ascidians, *e.g. Ascidia lurida*, Möll., *Ascidiella expanse*, Kiaer, *Ascidiella minuta*, Kiaer, etc. which certainly do not propagate by gemmation.

As this species cannot be included in any of the known genera of the Ascidiae Simplices, it was found necessary to form a new genus for its reception. This genus, which I propose to name *Monobotryllus* in reference to its great resemblance to *Botryllus*, may be diagnosed as follows:—

Monobotryllus, nov. gen.

Test leathery, both apertures not lobed.

Tentacles simple, filiform.

Branchial sac without folds, with numerous internal longitudinal bars.

Alimentary canal lying alongside the branchial sac; stomach longitudinally folded, with a small blind sac.

Reproductive organs consisting of a number of hermaphrodite polycarps arranged in two rows, one on each side of the endostyle; each polycarp made up of an ovarial and testicular part joined together to form a rounded mass.

As to the systematic position of this genus it is quite obvious that its nearest allies are those forms among the Polystyelidae which have no folds in the branchial sac, *e.g. Goodsiria* and *Chorizocormus*; but as it is a solitary form I have thought it more convenient to place it in the family Styelidae alongside the genus *Polycarpa*. In the structure and arrangement of the polycarps it comes very near Michaelsen's *Monandrocarpa*, which is known only from a solitary individual but which the author is inclined to regard as the young stage of a colony. The presence of a small curved blind sac attached to the posterior end of the stomach seems to point to a close affinity to the Polystyelidae, whose members are invariably provided with such an appendage, while on the other hand the simple unlobed condition of the branchial and atrial apertures would rather suggest a near relationship to the Botryllidae.

Fam. ASCIDIIDAE.

This family is represented in the collection by five species, which, with the exception of a single doubtful form, are all new to science. They all belong to the genus *Ascidia*. The doubtful form could not be identified with certainty, as the internal body had been removed from the test, the latter alone being preserved.

Ascidia canaliculata, Heller (?).

(Pl. IV, fig. 4).

Ascidia canaliculata, Heller, Beiträge zur näheren Kenntnis der Tunicaten. *Sitzungsber. Akad. Wiss. Wien.* Bd. LXXVII, 1878.

Locality.—The Andamans. One specimen (the test only).

It is from the external appearance alone that I refer this specimen with much doubt to Heller's *Ascidia canaliculata*, originally described from the Cape of Good

Hope. So far as the shape and condition of the test is concerned, especially in the presence of longitudinal grooves on the outer surface of the siphons, it agrees pretty well; but the number of lobes at the branchial and atrial apertures is different, being in our specimen seven and five instead of the usual eight and six respectively. As there is only one specimen in the collection it is impossible to decide whether this is an abnormal condition or a constant specific character. In the latter case it should of course be considered as a distinct species and be given a new specific name.

The body is ovate in shape, with anterior end narrower and pointed and the posterior broader and rounded; it is somewhat compressed laterally, and is attached by the whole of the left side. The apertures are borne on large prominent siphons, the sides of which are channelled by well marked straight grooves running down longitudinally from between the lobes. The branchial siphon is anterior, terminal, and is directed anteriorly; it is not curved and the aperture has seven lobes. The atrial is situated about one-third the way down the dorsal edge, it is nearly as large as the branchial, and is directed anteriorly and somewhat dorsally; the aperture is only five-lobed. The surface is a little roughish, otherwise it is smooth and regular, and is quite naked. The colour is a light yellowish-grey. The test is cartilaginous and semi-transparent; it is not thick, the thickness varying from 0·5 mm. on the left side to nearly 1 mm. on the siphons. Size of the body: 43 mm. long and 22 mm. broad.

Sluiter (11) described two specimens of this species from the island Billiton; strangely enough they had both only seven longitudinal grooves on the branchial siphon, the same as our specimen, and not eight as in the type described by Heller. The atrial siphon, however, seems to have had the usual number of lobes and grooves, as Sluiter makes no mention of abnormalities about them.

What makes me more inclined to believe that the test described above belongs to this species, is the presence in another bottle, also containing Ascidians from the Andamans, of a specimen of *Ascidia*, devoid of test, which agrees tolerably well with the description given by Sluiter. It is rather small, being only 25 mm. long and 7 mm. broad at the widest part, so that it is of course questionable whether it belonged to the same individual as the test. I insert here a brief account of this specimen in order to show how far it agrees with the internal body of *A. canaliculata* as described by Sluiter. As Heller gave no detailed account of the internal organs it is impossible to compare our specimen with the original type of the species.

The mantle is thin and delicate on the left side; on the right it has well developed muscle bands running perpendicularly to the margin and ending abruptly at a short distance from it so as to form a sort of boundary zone surrounding the remaining part of the mantle. The siphons are strongly muscular.

The tentacles are simple, filiform, and numerous; they are not all of one size and are arranged irregularly.

The branchial sac is rather delicate, and slightly plicated longitudinally. The internal longitudinal bars are numerous but very thin, and bear at the points of crossing

with the transverse vessels short curved papillae with rounded tips. Intermediate papillae do not occur. The meshes are longer than broad, and contain about four stigmata each. Owing to the contracted state of the specimen the form of the dorsal tubercle could not be ascertained.

The alimentary canal forms a double loop with only a little space in the first loop. The stomach is globular, with irregularly raised walls, and is sharply bounded from the intestine. The intestine is rather thick throughout, except the rectum which is very short and narrowed. The gonads are not well developed; they lie in the first intestinal loop and seem, partly at least, to extend over the outer surface of the intestine.

The locality is East Island, Andamans (coll. *Dr. A. R. Anderson*), 1898.

In the same bottle with this there is a specimen of a simple Ascidian entirely covered with shell fragments. As nothing but the test is preserved it is impossible to determine to what genus and species it belongs, but judging from the shape and condition of the test I am inclined to believe that it is *Styela lapidosa*, Herdman, first described from Ceylon.

Ascidia irregularis, n. sp.

(Pl. IV, figs. 5-10.)

External Appearance.—The body is roughly oval in outline and a little flattened laterally. It is attached by the entire left side. Encircling the area of attachment the test sends out a thin layer extending over the substratum in the form of an irregular skirt. The siphons are both prominent and tube-like; the branchial is situated at a little distance from the anterior end, and is pointed anteriorly and to the right; its aperture is surrounded by seven lobes, two of which are much smaller than the rest. The atrial siphon is placed about half way from the anterior to the posterior end, and is pointed posteriorly and to the right; its aperture is only five-lobed. The surface is naked and shows small pointed protuberances all over, which causes a very rugged appearance (Pl. IV, fig. 5). The colour is a hyaline pale yellow. In size the animal is 29 mm. long, 20 mm. broad, and 8 mm. thick.

The *Test* is thin, cartilaginous, transparent, and of a pale yellow colour. On the left side, by which the animal is attached, it is very thin and shows the internal viscera most clearly.

The *Mantle* is very delicate on the left side, where no muscle fibres are visible. On the right side the musculature is pretty well developed and forms a continuous layer of obliquely running fibres (Pl. IV, figs. 6 and 7).

The *Tentacles* are simple, filiform, with tapering ends; they are about sixteen in number and are all of one size.

The *Branchial Sac* is delicate, and is not plicated longitudinally. The transverse vessels are all of one size. The internal longitudinal bars are moderately strong and bear at the angles of the meshes, as well as in the middle of each segment, short conical papillae with bluntly pointed ends (Pl. IV, fig. 10). The papillae are all of the same form, but those at the angles of the meshes are somewhat larger than the

intermediate ones. The meshes are much longer antero-posteriorly than transversely and contain each three long narrow stigmata.

The *Dorsal Tubercle* is cordate in shape, and is placed antero-posteriorly, with the opening at the anterior end, slightly to the left of the median line. The horns are both turned inwards (Pl. IV, fig. 9).

The *Dorsal Lamina* is a simple membrane with no ribs and no teeth. It is rather broad.

The *Alimentary Canal* forms a double loop on the left side of the branchial sac (Pl. IV, fig. 8). It consists of a very short oesophagus and a large intestine bent in the form of the letter S, of which the first loop is almost closed. There is no distinct stomach. The anus is bilabiate.

The *Gonads* are inconspicuous. No compact ovaries are present, but a large number of eggs, some very small and some larger, are found imbedded in the mantle on its inner surface over the intestinal loop. The largest eggs measure about 0·3 mm. in diameter.

Locality.—Laccadive Sea, at Station 245, 12° 40′ 28″ N., 74° 2′ 45″ E.; depth 449-465 fathoms, bottom green mud; October 14th, 1898.

This species belongs to that group of *Ascidia* which is characterized by the presence of asperities on the outer surface of the test, but differs from all of them hitherto known in one or other of the distinctive characters, either in the number of tentacles, or the condition of the dorsal lamina, or the number and arrangement of the internal longitudinal bars in the branchial sac. At first I took it to be *A. donnani*, Herdman, recorded from the Gulf of Manaar, Ceylon; but the latter has fifty to sixty tentacles, a strongly ribbed dorsal lamina, and about half a dozen stigmata in each mesh of the branchial sac, and can by no means be identified with our species in spite of their resemblance in the external form.

Ascidia hyalina, n. sp.

(Pl. I, fig. 14; pl. IV, figs. 11 and 12; pl. V, fig. 1.)

External Appearance.—The body is irregularly ovate in outline, and is much flattened laterally (Pl. IV, fig. 11). The apertures are both sessile, inconspicuous; they are both in the anterior part of the body and are not far distant from each other. The surface is naked and smooth. The colour is a pale transparent grey. The animal appears to have been attached by the left side to branches of a bryozoan colony. The size of the body is 20 mm. in length and 14 mm. in breadth.

The *Test* is thin, soft, and gelatinous; it is almost colourless and quite transparent.

The *Mantle* is delicate and transparent, with the musculature very feebly developed. In some places, especially near the atrial aperture, blood vessels with minute branches are very distinctly visible.

The *Tentacles* are simple, filiform, and not numerous.

The *Branchial Sac* is rather delicate. The transverse vessels are of three different sizes, three of the smallest ones occurring between those of the larger sizes

which alternate more or less regularly. The meshes are almost square and contain each five or six stigmata (Pl. V, fig. 1). Short, rounded knob-like papillae are found at the angles of the meshes. There are no intermediate papillae.

The *Dorsal Tubercle* is horseshoe-shaped, simple, with both horns bent near the tip to the right (Pl. IV, fig. 12).

The *Dorsal Lamina* is a simple narrow membrane, with no ribs and no teeth.

The *Alimentary Canal* forms a simple loop on the left side of the branchial sac in the posterior half of the body (Pl. IV, fig. 11). It consists of a short narrow oesophagus, an oval stomach, and a rather wide intestine bent in the form of the letter S. The stomach is smooth-walled, and the anal opening is smooth-edged.

The *Gonads* form an elongated hermaphrodite gland placed inside the intestinal loop. From it a duct is seen to proceed along the first part of the intestine and the stomach, and then along the terminal portion of the intestine to open a little below the anus.

Locality.—E.N.E. of Preparis Id., Bay of Bengal, at Station 61, 14° 54′ 30″ N., 93° 51′ E.; depth 41 fathoms; bottom sand, shell, and coral; November 30th, 1889. One specimen.

This species resembles in external appearance some of those Ascidiae already known which have thin transparent tests, but differs from all of them in the details of internal structure. It appears to be most closely allied to *Ascidia aperta*, Sluiter (13), obtained during the Siboga-Expedition, but the form and condition of the genital glands as well as the course of the genital duct are quite different. The form of the intestinal loop, too, is very unlike in the two species.

Ascidia willeyi, n. sp.

(Pl. V, figs. 2-5.)

External Appearance.—The body is longish oval in shape, and is somewhat flattened obliquely (Pl. V, fig. 2). It is attached by the greater part of the left side and partly by the posterior end, and the edge of the base is in places expanded into a thin spreading margin. The apertures are both on the upper (right) side; the branchial is anterior and subterminal; the atrial is about half way down and at some distance from the dorsal edge. They are almost sessile, and the lobes, of which there are eight at the branchial and six at the atrial as usual, are very distinct.

The surface is even, smooth, and naked. The colour is a pale horny tint. The size of the body: 35 mm. in length and 20 mm. in breadth.

The *Test* is cartilaginous and transparent; it is very thin on the left side, but is much thicker on the right. Fine blood vessels are seen everywhere traversing the test.

The *Mantle* is thin and transparent. The musculature is only feebly developed, consisting on the right side of an irregular network of delicate fibres running in all directions, while on the left side there are scarcely any muscle fibres so that the internal viscera are very clearly visible (Pl. V, fig. 3). Even around the apertures the musculature is very weak.

The *Tentacles* are simple and filiform, and about sixty in number. They are of various sizes, some very long, and are arranged apparently without any regularity.

The *Branchial Sac* extends to the base of the mantle and is not longitudinally plicated. The transverse vessels are all narrow. The internal longitudinal bars are very numerous and bear pointed conical papillae at the angles of the meshes. There are no intermediate papillae. The meshes are elongated antero-posteriorly and each contain two stigmata (Pl. V, fig. 4). Parastigmatic vessels are not present.

The *Dorsal Tubercle* is horseshoe-shaped, broader than long, with the aperture directed forwards.

The *Dorsal Lamina* is a rather broad membrane, showing ribs which are continued beyond the margin of the lamina as long tentacle-like filaments (Pl. V, fig. 5).

The *Alimentary Canal* forms a close loop on the left side of the posterior half of the body. The stomach is ovate, smooth-walled, and is not sharply bounded from the intestine. The anal aperture is not toothed.

The *Gonads* are placed in the narrow space between the first and second loop of the intestine, as well as over its branchial surface. The testicular follicles are seen to be connected by delicate ducts with the vas deferens. The oviduct is distended by a large number of spherical ova and is quite conspicuous; it runs along the terminal portion of the intestine.

Locality.—Off Cape Negrais, Burma, at Station 387, 15° 25′ N., 93° 45′ E.; depth 40-49 fathoms; bottom sand and coral; November 16th, 1909.

This specimen presents in external appearance much resemblance to *Ascidia depressiuscula*, Heller, with which it also shows certain affinities in internal structure. The shape and colour of the body, the mode of attachment and the condition of the test are much the same; and in the number of tentacles, the shape and size of the alimentary canal, and the position of the gonads our specimen agrees pretty well with the description of that species given by Herdman in his report on the Tunicata of the Gulf of Manaar. But the number of stigmata in each mesh of the branchial sac is in *A. depressiuscula* five or six instead of two, and the dorsal lamina is a plain membrane with slight ribs and small marginal denticulations, differing in a marked degree from what is found in our specimen.

Ascidia andamanensis, n. sp.

(Pl. V, figs. 6-9.)

External Appearance.—The body is longish oval, much depressed laterally, and is attached by the whole of the left side (Pl. V, fig. 6). The branchial aperture is anterior, terminal, and appears to be sessile; the atrial, on the other hand, is placed on a prominent cylindrical siphon springing from the dorsal edge about half way from the anterior to the posterior end. The apertures are eight-lobed and six-lobed respectively, as usual. The surface is quite naked and smooth except for a few slight longitudinal creases and is of a pale yellowish-grey colour. The size of the body is about 32 mm. in length and 16 mm. across the wider posterior part of the body; the length of the atrial siphon is 6 mm.

The *Test* is rather thick. It is cartilaginous and semi-transparent, allowing the internal body to be seen more or less clearly from outside.

The *Mantle* is very thin and transparent, with the musculature only very feebly developed (Pl. V, fig. 7). Even on the siphons the muscular bands are not strong.

The *Tentacles* are simple, filiform, and more than thirty in number. They are not all of one size and are not arranged with any regularity.

The *Branchial Sac* is well developed and has very numerous internal longitudinal bars. The transverse vessels are nearly all of the same size. The meshes are much longer antero-posteriorly than transversely and contain mostly only two stigmata each (Pl. V, fig. 9). Very short wart-like papillae are found at the angles of the meshes. No intermediate papillae are present.

The *Dorsal Tubercle* is horseshoe-shaped, simple, with both horns turned inwards. It is placed in the posterior corner of a triangular peritubercular area just in front of the origin of the dorsal lamina.

The *Dorsal Lamina* is a simple broad membrane. It has no teeth and no ribs, and has the free margin undulated sideways (Pl. V, fig. 8).

The *Alimentary Canal* forms a double loop on the left side of the branchial sac in the posterior third of the body. There is no sharp boundary between the stomach and the intestine and the anal aperture is smooth-edged.

The *Gonads* form an oval mass of testicular and ovarial follicles filling up the space between the first and second loop of the intestine. The oviduct and the vas deferens are separate, both running parallel with the rectum.

Locality.—Andamans. One specimen.

This species differs more or less distinctly from all the other known species of *Ascidia* which have about two stigmata in each mesh of the branchial sac. It differs from *A. diplozoon*, Sluiter, *A. longisiphoniata*, Kiaer, and *A. longistriata*, Hartmeyer, in having the dorsal lamina plain, and from *A. tricuspis*, Sluiter, in having the branchial papillae rounded and not provided with lateral processes. In the structure of the branchial sac this species agrees pretty well with *A. reptans*, Heller, from which, however, it differs markedly in several important characters. Perhaps its nearest ally is *A. nodosa* described by Sluiter from the Bay of Batavia, but in this species the tentacles are all of one size, the dorsal lamina is narrow, and the mantle is muscular.

Fam. CLAVELINIDAE.

This interesting family, characterized by the possession of the faculty of reproduction by budding, is represented in the collection by the following single species.

Podoclavella fecunda, Sluiter (?).

(Pl. V, figs. 10-12.)

Podoclavella fecunda, Sluiter, Die Tunicaten der Siboga-Expedition. IAbt. Die Sozialen und Holosomen Ascidien. *Siboga-Exped.* Bd. LVIa, 1904.

Locality.—Coral Islands, Andamans. Five specimens.

It is with much doubt that I refer these specimens to the above named species,

first recorded from Banda. They are much contracted, and it was difficult to make out their internal structure. The external appearance, however, and the greater part of what could be examined internally agree pretty well with the description given by Sluiter. The slight differences which occur here and there may be regarded as coming within the limits of individual variation. I insert here a brief account of one of the specimens which was least contracted.

The body is cylindrical in shape, about 15 mm. long and 5 mm. across, with the posterior end tapering into a short stalk. The branchial aperture is anterior and terminal, the atrial is placed a little backwards on the dorsal median line; the two are borne on short conical projections, and are not lobed. The surface is of a grey colour, and is wrinkled transversely in consequence of preservation. The test is thin, soft, and transparent. The branchial sac is regularly built but rather small; there are broad horizontal membranes running along the transverse vessels and the stigmata are long and narrow. Internal longitudinal bars are entirely absent. The dorsal tubercle and dorsal lamina are just like the figures given by Sluiter. The intestine forms a distinct abdomen; the stomach is large, oval and smooth-walled. The gonads are situated in the intestinal loop and are visible on both sides, and the duct is seen running parallel with the terminal portion of the intestine. Four tadpoles were found in the atrial cavity.

PELAGIC FORMS.

Of the three different groups comprised in the Pelagic Tunicata each is represented by a single family in the collection,—the Ascidiae Salpaeformes by the family Pyrosomatidae, the Thaliacea by the family Salpidae, and the Larvacea by the family Appendiculariidae.

Fam. PYROSOMATIDAE.

The collection contains numerous specimens of *Pyrosoma*, but they are mostly in such a bad state of preservation that it is almost impossible to determine to what species they belong. It is even difficult to count how many colonies there are, as the specimens are nearly all very incomplete fragments, some being not more than one-tenth of a colony. The only species which I could identify with some degree of certainty is the following.

Pyrosoma spinosum, Herdman.

Pyrosoma spinosum, Herdman, Report on the Tunicata, Part III. *Report of the Scientific Results of the Voyage of H.M.S. "Challenger,"* Vol. XXVII, 1888.

Localities. (1) Laccadive Sea, at Station 275, 8° 27′ N., 75° 35′ E.; depth of net 731-771 fathoms; bottom green mud. One colony, 80 mm. long and 15 mm. across. (2) 20° 17′ 30″ N., 88° 50′ E. Two imperfect colonies. (3) No locality given, 1300 fathoms. Two imperfect colonies.

Specimens of *Pyrosoma* from the following localities could not be identified on account of their bad state of preservation:—

(1) Andaman Sea, at Station 235, 14° 13′ N., 93° 40′ E.; depth of net 370-419 fathoms; bottom grey mud; April 8th, 1898. Two broken colonies and four fragments. (2) Andaman Sea, at Station 236, 13° 59′ N., 93° E.; depth of net 172-303 fathoms; April 11th, 1898. One fragment. (3) Laccadive Sea, at Station 371, 12° 18′ 46″ N., 74° 5′ 29″ E.; depth of net 450-580 fathoms; bottom green mud, sand, and globigerina ooze; December 3rd, 1906. Ten larger and many smaller fragments. (4) Bay of Bengal, 1300 fathoms. Four larger and four smaller fragments. (5) Andamans. One small fragment.

Fam. SALPIDAE.

This family is represented in the collection by five species of the genus *Salpa*, all well known to science.

Salpa costata-tilesii, Quoy et Gaimard (Cuvier).

Thetys vagina, Tilesius, *Jahrb. Naturg.* Vol. I, 1802.
Salpa tilesii, Cuvier, *Ann. du Mus.* tome IV, 1804.
Salpa costata, Quoy et Gaimard, *Freycinet, Voyage,* 1824.

Localities.—(1) Station 152, 11½ miles S. 83° W. of Colombo Lt.; depth of net 26½ fathoms; bottom sand, shells, coral; December 12th, 1893. One specimen. (2) Bay of Bengal, at Station 162, 13° 51′ 12″ N., 80° 28′ 12″ E.; depth of net 145-250 fathoms; January 30th, 1894. One specimen. (3) Arabian Sea, at Station 358, 15° 55′ 30″ N., 52° 38′ 30″ E.; depth of net 585 fathoms; bottom green mud and sand; December 18th, 1905. Four specimens.

The specimen from Station 152 is imperfect, nothing but the test being preserved.

Salpa hexagona, Quoy et Gaimard.

Salpa hexagona, Quoy et Gaimard, *Freycinet, Voyage,* 1824.

Localities.—(1) Bay of Bengal, at Station 166, 13° 34′ 55″ N., 80° 32′ 12″ E.; depth of net 133 fathoms; bottom brown mud; February 8th, 1894. Two specimens. (2) Bay of Bengal, at Station 323, 16° 25′ N., 93° 43′ 30″ E.; depth of net 463 fathoms; bottom green mud; December 21st, 1903. One specimen. (3) Off Port Blair, 244 fathoms. One specimen. (4) 57 miles SE by E of Ross Island, Andamans, 165 fathoms. Three specimens. (5) Andaman Sea. Three specimens.

Salpa cordiformis-zonaria, Quoy et Gaimard (Pallas).

Holothurium zonarium, Pallas, *Spicil. Zool.,* fasc. X, 1774.
Salpa cordiformis, Quoy et Gaimard, *Ann. des Sci. nat.* tome X, 1827.

Localities.—(1) Arabian Sea, at Station 135, 15° 29′ N., 72° 41 E.; depth of net 559 fathoms; bottom green mud; May 4th, 1892. One specimen. (2) Lat. 5° 56′ N., Long. 91° 05′ E.; 1590 fathoms. Two specimens. (3) Off Port Blair, 244 fathoms. One specimen. (4) Bay of Bengal, 20° 18′ N., 90° 50′ E., 65 fathoms. Nine specimens. (5) Andaman Sea. One specimen.

Salpa cylindrica, Cuvier.

Salpa cylindrica, Cuvier, *Ann. du Mus.* tome IV, 1804.

Locality.—Andaman Sea. Numerous specimens.

Salpa scutigera-confoederata, Cuvier (Forskål).

Salpa confoederata, Forskål, *Descrip Anim.*, 1775.
Salpa scutigera, Cuvier, *Ann. du Mus.* tome IV, 1804.

Localities.—(1) Laccadive Sea, at Station 319, 12° 2′ N., 73° 46′ E.; depth of net 1154 fathoms; bottom green mud, globigerina ooze; November 7th, 1903. (2) Gulf of Oman, at Station 342, 24° 46′ 15″ N., 57° 15′ E.; depth of net 745 fathoms; bottom soft green mud; October 19th, 1904. Four specimens. (3) Off Cinque Id., Andamans, surface. One specimen. (4) Andaman Sea. Two specimens.

Fam. APPENDICULARIIDAE.

Of this family the collection contains only a single specimen, but this specimen is highly interesting on account of its being unusually large and having voluminous spiracular passages which occupy nearly the middle third of the trunk. Very probably it belongs to the rare genus *Megalocercus*, Chun.

Megalocercus sp.

This very interesting specimen is unfortunately in a somewhat shrivelled condition, so that it was impossible to make out the internal structure satisfactorily. So far, however, as could be ascertained without injuring the unique specimen, it presents no character, except its slightly smaller size, particularly contradictory to the description of *Megalocercus abyssorum* given by Chun (2). Whether it belongs to that species or not, it is of course difficult to say, but it appears to me very probable that it belongs to the same genus.

The body including the tail is about 15·5 mm. long. The trunk alone is nearly 5 mm. long and 3 mm. across at the widest part; it is elongated oval in shape, with the greatest width at the middle of the length and gradually narrowing towards both extremities. The anterior end is truncated and is occupied by the transversely elongated oral aperture, while the posterior end is rounded and a little compressed laterally. The anterior two-thirds are taken up mainly by the large pharynx and are comparatively transparent, but the posterior third is filled up with the gonads and is quite opaque. The endostyle is rather long and narrow, and runs along the ventral median line of the pharyngeal cavity; it is somewhat widened at the anterior end where it joins the peripharyngeal band. The peripharyngeal band runs transversely in its ventral half parallel to the margin of the oral aperture, but in its dorsal half its course is more oblique, enclosing a triangular space on the roof of the pharyngeal cavity. The spiracula are very large; they form two large cavities symmetrically placed one on each side of the median line in the middle third of the trunk. It is these cavities that make this region the widest part of the trunk. The spiracular openings are about 1 mm. in diameter, and seem to have been circular in

life. The spiracular cavities are mostly lined with ordinary flat cells, the ciliated epithelium being present only at certain places inside the external openings. The tail is 13 mm. long and 3 mm. wide; the median muscular portion measures 2 mm. in breadth and is thus wider than half the breadth of the tail. The colour of the specimen preserved in alcohol is dirty greyish-yellow.

There is in the same bottle a detached tail of another individual; it is about 10 mm. long and 3 mm. across. It is somewhat darker in colour, being a little brownish, but otherwise differs in no respect from the tail of the uninjured specimen described above.

The genus *Megalocercus* contained hitherto only a single species, *M. abyssorum*, known from three specimens collected by Chun near Capri and Ischia from a depth of six to nine hundred meters. They are 18, 22, and 30 mm. in length respectively.

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(15)——Tuniciers recueillis en 1904 par M. Ch. Gravier dans le Golfe de Tadjourah (Somalie française). *Mém. Soc. zool. France*, Vol. XVIII. 1905.

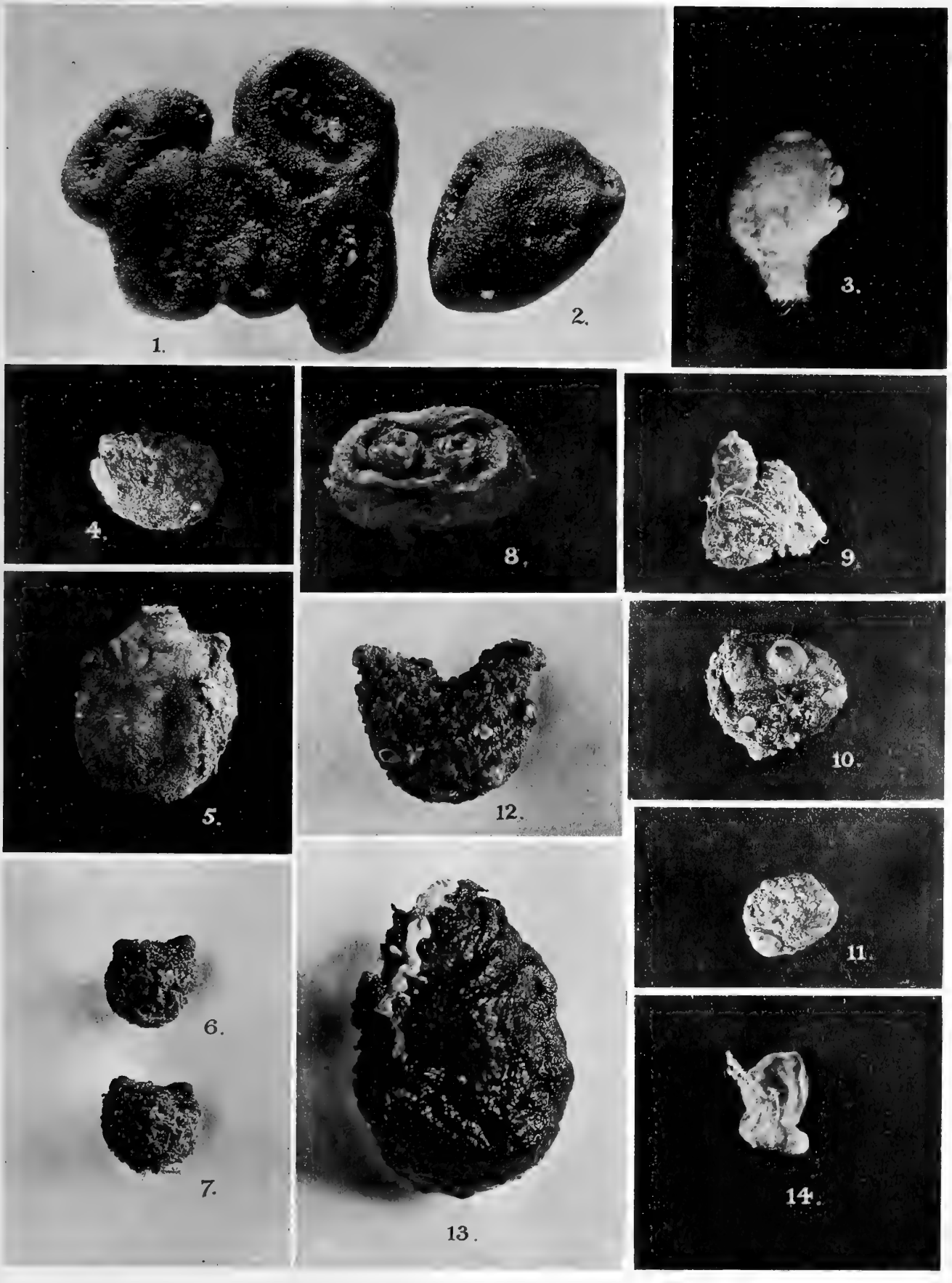
(16) Traustedt, M. P. A. Vestindiske Ascidiae Simplices. Molgulidae og Cynthiidae. *Vid. Meddel. fra den naturh. Foren.*, 1882.

(17)——Ascidiae Simplices fra det Stille Hav. *Vid. Meddel. fra den naturh. Foren.*, 1885.

(18) Van Name, W. G. The Ascidians of the Bermuda Islands. *Trans. Connect. Acad.*, Vol. XI. 1902.

EXPLANATION OF PLATE I.

FIGS. 1 and 2. *Molgula birmanica*, n. sp. About natural size.
FIG. 3.—*Hexacrobylus indicus*, Oka, from right side. About natural size.
,, 4.—*Cynthia lanka*, Herdman. Nat. size.
,, 5.—*Cynthia sluiteri*, n. sp., from left side. Nat. size.
FIGS. 6 and 7. *Microcosmus manaarensis*, Herdman. Nat. size.
,, 8—11. *Rhabdocynthia ceylonica*, Herdman. Nat. size.
FIG. 12.—*Polycarpa annandalei*, n. sp. Nat. size.
,, 13.—*Polycarpa cryptocarpa*, Sluiter. Nat. size.
,, 14.—*Ascidia hyalina*, n. sp. Nat. size.



Bemrose, Colls., Derby

INDIAN TUNICATES.

EXPLANATION OF PLATE II.

FIG. 1.—*Molgula simulans*, n. sp., with test removed, seen from left side, × 5.
,, 2. ,, ,, tentacle, × 100.
FIG. 3. ,, *birmanica*, n. sp., with test removed, seen from left side. Nat. size.
,, 4. ,, ,, seen from right side. Nat. size.
,, 5. ,, ,, part of branchial sac, × 10.
,, 6. ,, ,, part of branchial sac, showing the stigmata, × 40.
,, 7. ,, ,, dorsal tubercle and dorsal lamina, × 40.
FIG. 8.—*Hexacrobylus indicus*, entire animal, front view. Nat. size.
,, 9. ,, ,, branchial aperture, front view, × 3.
,, 10. ,, ,, one of the tentacle-like lobes of the branchial aperture seen from outside, × 10.
,, 11. ,, ,, seen from inside, × 10.
,, 12. ,, ,, with test removed. Nat. size.
,, 13. ,, ,, atrial siphon, × 5.

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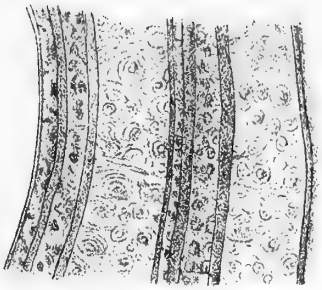

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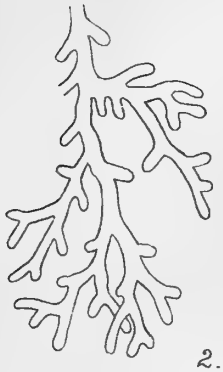

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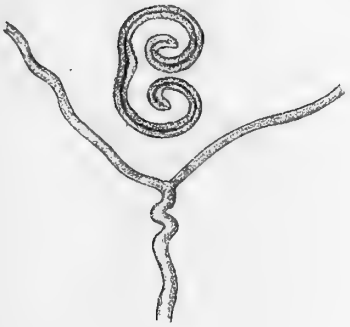

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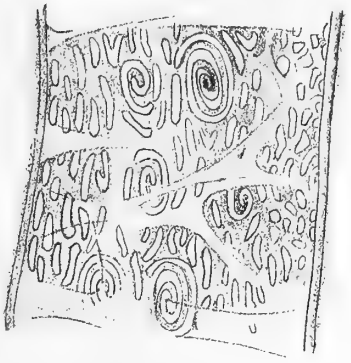

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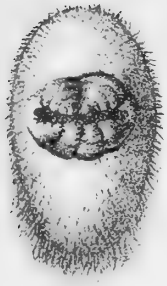

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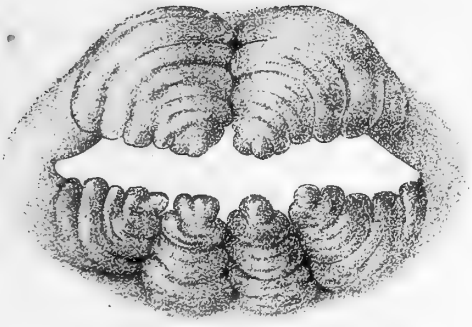

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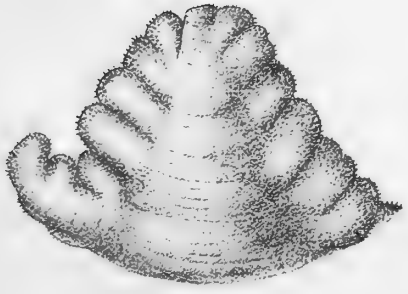

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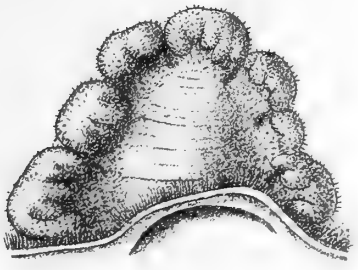

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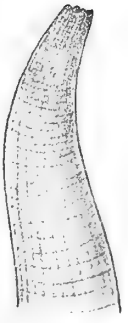


13.

A. Chowdhary, lith.

INDIAN TUNICATES.

EXPLANATION OF PLATE III.

FIG. 1.—*Hexacrobylus indicus*, lower lip of the branchial aperture, with test removed. × 5. Only the proximal portions of the axial muscles of the tentacle-like lobes are shown.

,, 2. ,, ,, Reconstruction figure from serial sections showing the internal anatomy of the animal.

FIG. 3.—*Cynthia sluiteri*, n. sp., a spine from the tip of branchial siphon, × 40.

,, 4. ,, ,, two scales from the external surface of test, × 40.

FIG. 5.—*Polycarpa annandalei*, n. sp., tentacles, × 20.

,, 6. ,, ,, part of branchial sac, × 40.

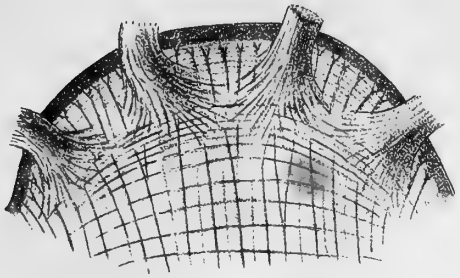
,, 7. ,, ,, alimentary canal. Nat. size.

,, 8. ,, ,, dorsal tubercle and part of dorsal lamina, × 20.

,, 9. ,, ,, one of the polycarps, × 20.

FIG. 10.—*Monobotryllus violaceus*, n. g. and n. sp., entire animal. Nat. size.

,, 11. ,, ,, ,, entire animal, × 20.



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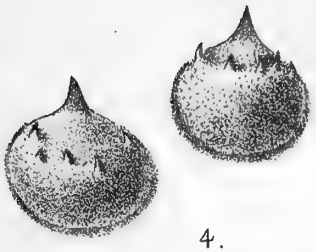

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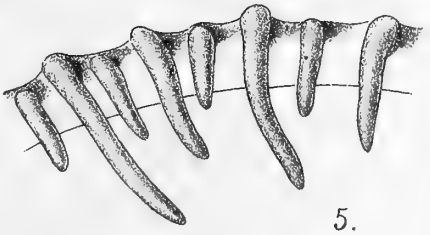

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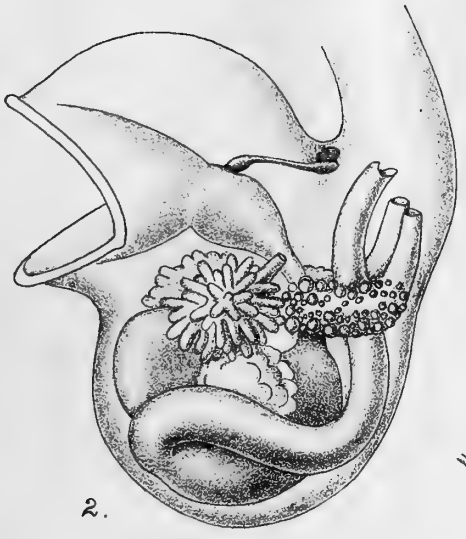

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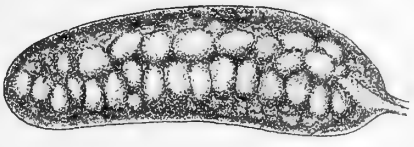

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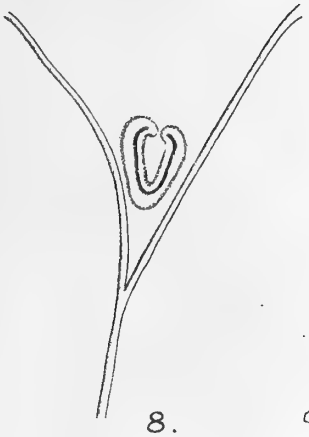

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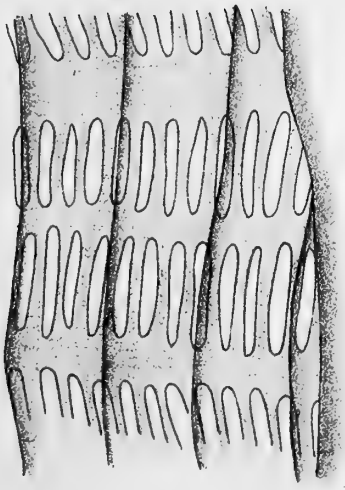

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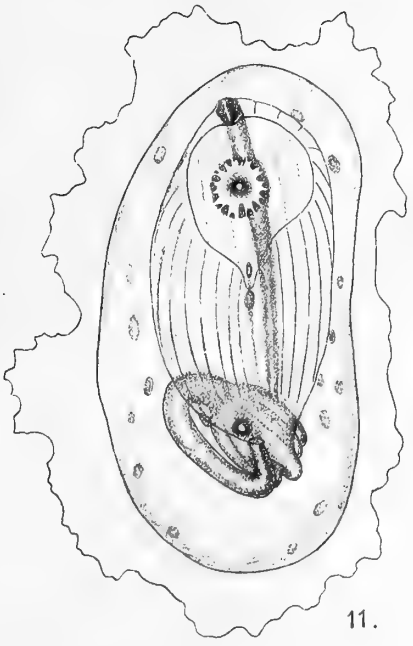


11.

A. Chowdhary, lith.

INDIAN TUNICATES.

EXPLANATION OF PLATE IV.

FIG. 1.—*Monobotryllus violaceus*, tentacular circulet, dorsal tubercle, and part of peripharyngeal band, × 50.

,, 2. ,, ,, marginal zone of test, showing knob-like terminations of blood vessels, × 50.

,, 3. ,, ,, part of branchial sac, × 50.

FIG. 4.—*Ascidia canaliculata*, Heller (?), test. Nat. size.

FIG. 5. ,, *irregularis*, n. sp., entire animal, from right side. Nat. size.

,, 6. ,, ,, with test removed, seen from right side. Nat. size.

,, 7. ,, ,, seen from left side. Nat. size.

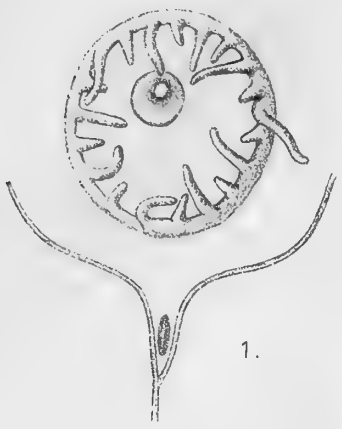
,, 8. ,, ,, alimentary canal, × 2.

,, 9. ,, ,, tentacles, dorsal tubercle, and dorsal lamina, × 10.

,, 10. ,, ,, part of branchial sac, × 40.

FIG. 11. ,, *hyalina*, n. sp., entire animal, from left side, × 3.

,, 12. ,, ,, dorsal tubercle and dorsal lamina, × 40.



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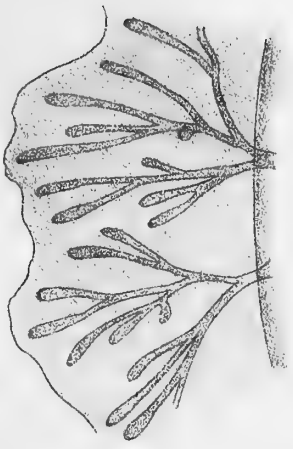

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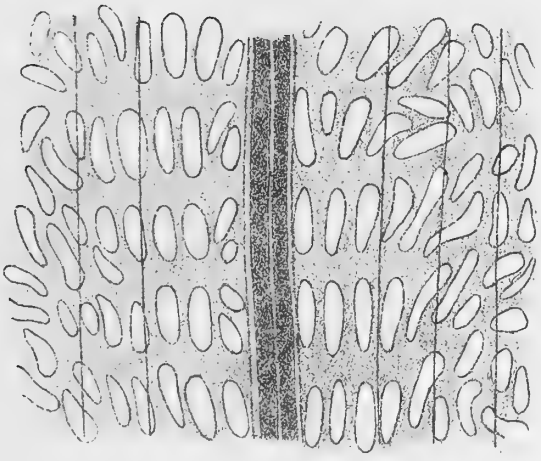

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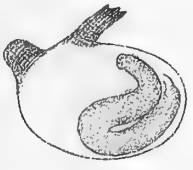

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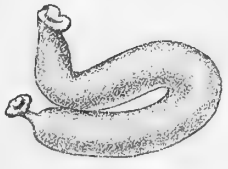

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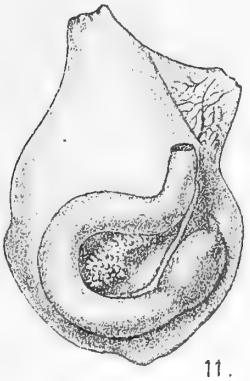

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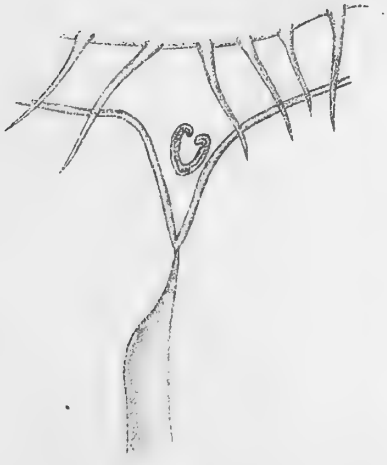

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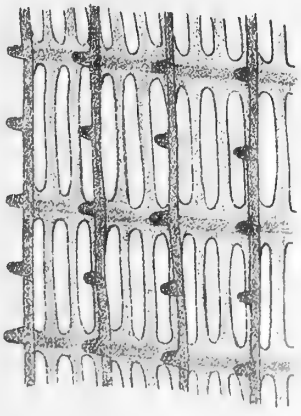

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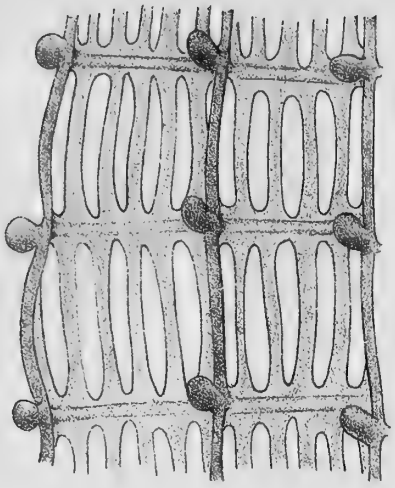
12.

A. Chowdhary, lith.

INDIAN TUNICATES.

EXPLANATION OF PLATE V.

FIG. 1.—*Ascidia hyalina*, part of branchial sac, × 40.
FIG. 2. ,, *willeyi*, n. sp., entire animal, front view. Nat. size.
,, 3. ,, ,, with test removed, seen from left side. Nat. size.
,, 4. ,, ,, part of branchial sac, × 40.
,, 5. ,, ,, dorsal tubercle and dorsal lamina, × 40.
FIG. 6. ,, *andamanensis*, n. sp., entire animal from right side. Nat. size.
,, 7. ,, ,, with test removed, seen from left side. Nat. size.
,, 8. ,, ,, tentacles, dorsal tubercle, and dorsal lamina, × 40.
,, 9. ,, ,, part of branchial sac, × 40.
FIG. 10.—*Podoclavella fecunda*, Sluiter (?), two individuals. Nat. size.
,, 11. ,, ,, with test removed, × 3.
,, 12. ,, ,, part of branchial sac, × 40.



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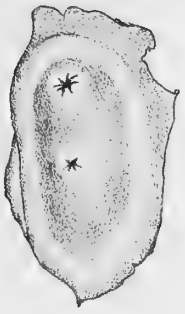

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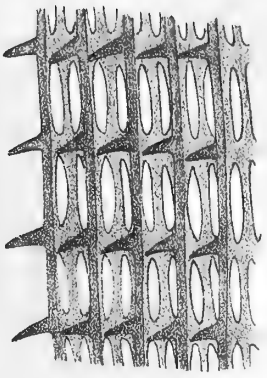

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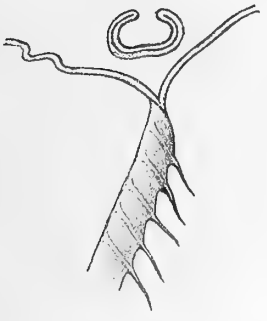

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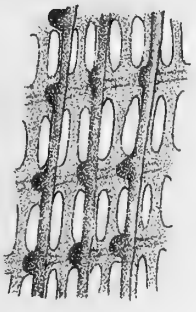

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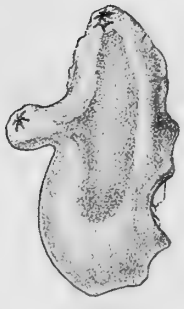

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A. Chowdhary, lith.

INDIAN TUNICATES.

ON SOME INDIAN OLIGOCHAETA, MAINLY FROM SOUTHERN INDIA AND CEYLON.

By J. STEPHENSON, *M.B., D.Sc., Lt.-Col., I.M.S., Professor of Zoology, Government College, Lahore.*

(Plates VI—IX).

CONTENTS.

GENERAL PART.

SYSTEMATIC PART.

INTRODUCTION.

The following paper deals principally with two collections of Oligochaeta from the southern extremity of the Indian region,—one made by Mr. Kemp in Ceylon in December, 1913, and one by Mr. Gravely in Cochin State in September, 1914. I have added to the account of these collections descriptions or notes of a few worms that have recently come into my hands from other sources;—two species from Bombay kindly sent me by Mr. N. Kinnear of the Bombay Natural History Society, of which one is already known and one belongs to a new genus; one found near Simla by my pupil L. Baini Parshad, M.Sc., Research Student of the Panjab University; an Enchytraeid from Darjiling District belonging to Lord Carmichael's Zoological collection in the Indian Museum; and one or two species collected by Dr. Annandale at Ennur near Madras; the occurrence of the common *Pheretima posthuma* at Allahabad, whence it was sent me by Dr. Woodland, is also worth recording because of its bearing on our knowledge of the Indian earthworm fauna in general.

To take the last point first. In a recent paper (22) I wrote:—" Though the United Provinces (the upper Gangetic plain) is one of the best investigated regions in India in the matter of terrestrial Oligochaeta, *Pheretima posthuma* has hitherto been found nowhere within its limits; though it is on the one hand the commonest worm of the Punjab, and on the other has been recorded by Michaelsen from no fewer than ten places in Bengal." Indeed the genus *Pheretima* appeared to be absent or practically absent from the region intervening between Bengal and the Punjab. On receiving a copy of the paper containing these remarks, Dr. Woodland immediately sent me some worms belonging to the species commonly used for dissection in Allahabad, asking if they were not *P. posthuma*,—which they were. *Pheretima posthuma* being a well-known peregrine form, the occurrence is of no particular importance from a zoogeographical point of view: but it is interesting as showing that we are still far from a complete acquaintance with the distribution of Indian earthworms, and that any conclusions based on the absence of any forms from this or that region are liable to be upset at any time. It is probably true that, as Michaelsen wrote (9) in 1909, " We may now be sure as regards the principal characters of this interesting fauna and are justified in drawing conclusions as to its distribution and as to the geological history on which this distribution depends"; but notwithstanding the fact that considerable collections have been worked over since that date, it would seem that India is so large and diversified that all that has been done is really not much more than the taking of a few samples here and there.

From the point of view of the Oligochaete system, the most interesting result of the investigation of the present material is the discovery of two new genera, one from

Bombay and one from Cochin State. The former, which I have named *Erythraeodrilus*, stands in a somewhat isolated position as a branch from the base of the Octochaetine stock; its nearest relative and probably its immediate ancestor would seem to be *Howascolex*, which occurs in Madagascar. The other, *Comarodrilus*, takes its place as a well-marked genus of the subfamily Megascolecinae, and is related to other South Indian genera such as *Woodwardia* and *Megascolides*.

The next most striking feature is the large number of new species which have come to hand. Thus of 37 definitely named forms no fewer than 25 (20 species and 5 varieties) are new; moreover, even of the specimens which I have referred to some previously described species, a number are characterized by peculiarities which seemed worth recording. In the genus *Drawida* three out of four forms are new, in *Megascolides* all three, and in *Megascolex* twelve out of sixteen. With regard to the latter especially, the impression left after working over these collections is that in South India and Ceylon the genus has recently undergone a notable blossoming forth, with the production of a large number of forms and intermediate forms, and that in consequence it is extremely difficult to separate species from varieties, and varieties from examples of individual variability. The (Indian) range of *Megascolex* is of very limited extent, yet the number of species is extraordinarily large; and still every collector, wherever he chooses to explore, brings back numerous novelties. So Michaelsen (14):—"Trotzdem schon mehrfach Oligochätenausbeuten von Travancore zur Bearbeitung gelangten—ich erinnere an die Arbeiten Fedarbs, Michaelsens und Cognettis, scheint die Oligochätenfauna dieses Distriktes doch noch bei weitem nicht erschöpfend erforscht zu sein. Dafür spricht die verhältnismässig grosse Zahl (fünf) neuer Formen in dieser zwölf verschiedene Formen enthaltenden jüngsten Ausbeute. Wir dürfen hieraus den Schluss ziehen, dass die Oligochätenfauna Travancores, sowie des südlichsten Vorderindiens überhaupt, eine besonders reiche ist." And the same author found the difficulty to which I have also referred (*cf. post.* under *Megascolex sextus*) since he continues:—"Leider wurde die Untersuchung dieser Ausbeute dadurch erschwert, dass gerade die neuen Arten und Varietäten nur durch je ein einziges Exemplar vertreten sind." It is interesting to compare the above with what I have previously said regarding Ceylon (20). The earthworm fauna of the extreme South of the Indian region contrasts strangely with that of the North, where there are no endemic species, and those that do occur are well defined and fixed in character.

The addition of a *Fridericia* to the small list of Indian Enchytraeids deserves mention in passing.

From the zoogeographical point of view no considerable addition to the general scheme of our knowledge is to be recorded. The significance of *Erythraeodrilus* and of its relationship to *Howascolex* can scarcely be discussed at present, and must be deferred till more is known concerning the earthworms of Western India. Indeed, this is the portion of India which is most in need of exploration; a glance through the table given by Michaelsen (12) shows that with the exception of a few localities on the West Coast which may more properly be reckoned to the South Indian region, the only places in Western India which figure in the earthworm records are Thana near

Bombay, Poona, and 'Sind',—each once. Since then I have received a few specimens from Baroda (22), as well as those from Bombay recorded below. It is probably from this region that we may look for the greatest advance in our knowledge in the future.

The finding of the first terrestrial species of *Pontodrilus* is noteworthy. With the exception of the lacustrine *P. lacustris* (Benham) (described originally as a *Plutellus*,—perhaps its generic affinities are not yet entirely free from doubt, *cf.* 4 and 11), all the previous species of *Pontodrilus* are littoral; it is therefore startling to find a representative of the genus living in crevices of quartz many miles from the shore. The ancestral *Pontodrilus* was no doubt terrestrial; and it is interesting to speculate on the possibility of *P. agnesae* as representing that ancestor,—at least in so far as it has retained the terrestrial habit,—and of Ceylon as the original home of the genus; reaching the shore, and being enabled to adapt themselves to a littoral mode of life, its descendants, on this supposition, would have been carried in well-known ways widely over the tropical regions of the globe, becoming differentiated into the various species which now exist.

In favour of this, first, is the fact that species of *Plutellus*, from which *Pontodrilus* is descended, are endemic in Ceylon. Secondly, the disposition of the seminal vesicles in *Pontodrilus agnesae* (in ix and xii) is peculiar; those organs in other species of *Pontodrilus* are in general in xi and xii (in *P. lacustris* in ix and xi). In *Plutellus*, the direct ancestor of *Pontodrilus*, the seminal vesicles vary in position, but the commonest position, which is also perhaps primitive for the Megascolecinae in general, is in segments ix and xii, as in the present species.[1] It is possible therefore that *P. agnesae* retains a primitive character in the disposition of its seminal vesicles.

On the other hand *P. agnesae* shows no trace of a gizzard. Now not only has *Plutellus* a gizzard, but certain forms or species of *Pontodrilus* are also said to possess a rudimentary gizzard (though in others it is quite absent). In this feature therefore the present species appears to be among those that have departed more widely from the parent genus.

The question is not at present soluble. It is of course just possible that, while the littoral species of *Pontodrilus* may have descended from a Ceylon ancestor represented for us to-day by *P. agnesae*, and, one step further back, from a Ceylon *Plutellus*, *Pontodrilus lacustris* on the other hand may have originated independently from an Australian *Plutellus*. We are familiar with such parallel developments in the Megascolecidae; such characters as the perichaetine arrangement of the setae, the micronephridial condition, the rudimentary gizzard, have arisen at various times in the history of the family and on various branches of the tree; so too, according to the arguments used in discussing the position of *Erythraeodrilus* (*v. post.*), we have in the past history of that genus a course of evolution somewhat similar to that which, occurring on another branch of the tree, has resulted in *Eutyphoeus*.

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[1] Of the 35 species in which the distribution of the seminal vesicles is mentioned in Michaelsen's Oligochaeta (*Tierreich*, 1900), they are in ix and xii in 18; the next commonest condition is that where they occur in xii only (8 species); other conditions are represented only by three, two, or one species.

In addition to the above remarks there are a few points of more or less general interest to students of the Oligochaeta, which have recently,—in part during the preparation of the present paper,— suggested themselves to me for brief discussion; though I cannot pretend that the species described in the main part of the paper offer more than a convenient peg on which to hang my remarks.

The Pharynx in the Enchytraeidae.

The usual condition in which what is sometimes called the 'pharynx' of Enchytraeids presents itself in sections is that of a flat raised plate of high columnar epithelium, with very definite edges, on the dorsal wall of the alimentary tube immediately behind the buccal cavity; this is shown, for example, for *Enchytraeus barkudensis* in fig. 1 of the original description of the worm (23). This plate is sometimes described as 'suckerlike',—at least it has been so by myself,—with, certainly, a suspicion that it might be everted from the mouth aperture and applied to the substratum for the purpose of adhesion after the manner of an actual sucker.

Fig. 1 shows that such eversion may take place; a number of specimens of *E. barkudensis* (belonging to a previous capture from the Chilka Lake) appear to have everted the pharynx at the moment of fixation. A similar phenomenon is recorded by Baylis (1) for a species which he describes as *Enchytraeus carcinophilus*.

But whether the plate when everted can act as a sucker, for adhesion, possibly for help in progression, seems to me more doubtful. The muscular fibres (*m. ph.*, fig. 1) attached to the epithelial plate might be supposed by contraction to withdraw the centre of the plate, and so, as for example in a sucker of *Sepia*, to produce a vacuum between the centre of the plate and the substratum; but the firm margin, capable of maintaining a close apposition, is wanting, and the high columnar epithelium seems an unsuitable sort of covering for such an organ.

The use of the everted pharynx as a means of adhesion and progression in *Aulophorus tonkinensis* (belonging to the Naididae) is well established (Annandale *apud* Michaelsen, 9; Stephenson, 18); but under 'pharynx' is here included the whole circumference of the alimentary tube ("the pharynx is large and wide"),—hence the meaning of the word is different from that in which it is used above in connection with the Enchytraeidae.

It is possible that the plate might be the central plug of the sucker, the margin being formed by the surrounding structures,—prostomium and everted portion of buccal cavity, *cf.* fig. 1). But I would suggest rather that the plate is sensory in function, and may be extruded for the purpose of exploration, or possibly also for picking up minute food particles by adhesion.

Another condition of the pharynx is shown in fig. 3; the pharynx is here retracted so as to appear as a thickwalled hollow hemisphere opening forwards into the buccal cavity. The figure is actually drawn from a specimen of *Fridericia carmichaeli*; but the same condition, only in a more exaggerated form (narrower cavity, the upper and lower walls being almost in apposition; narrower mouth projecting forwards into buccal cavity) was found in specimens of *Enchytraeus barkudensis* also.

The condition is therefore to be regarded, wherever found, as temporary only; the specimen from which Southern has illustrated the pharynx in his account of *Grania maricola* is in this condition (16)

ON THE OCCURRENCE OF SETAE IN THE BODY-CAVITY IN ENCHYTRAEIDS.

In the description below of *Fridericia carmichaeli*, reference is made to aggregations of setae and setal fragments in segments vii—ix, surrounded by masses of coelomic corpuscles. These were present in all the specimens examined, and are therefore, it would seem, not accidental but a regular character of the worm. The condition is represented in fig. 4. The masses of setae and corpuscles occupy the hinder and upper parts of the segments, the posterior septum of the segment often forming a sort of pocket, more markedly bulged backwards than in the specimen selected for illustration. The setae are in the actual specimens much more conspicuous than appears from the figure, where they are not distinguished by differential shading from the masses in which they are embedded; in reality they stand out by their brightness very markedly; the small circles in segment viii in the figure are setae or fragments cut transversely.

The fragments are of all sizes and thicknesses, from fully developed and normally shaped setae downwards. Some are miniature setae of the ordinary shape; some are spicule or needle-like, mere straight rods, often much thinner than ordinary setae, and perhaps longer too; some are stout and blunt, some stout and sharp; some are hooked at the end, others not. Along with the setae there also occur in the mass numbers of black granules. In places the masses appear to be limited by a membrane formed of flat cells—presumably the modified coelomic corpuscles of the surface of the mass.

The above appearances brought to my mind a curious condition I found on a previous occasion in a specimen of *Enchytraeus harurami*, which I did not describe in my account of the worm (22), but which may perhaps find mention here. Dorsally situated under the body-wall, to which it was adherent, was a large sac containing much granular matter (apparently disintegrating cells), one large normally shaped seta, a number of normally shaped but smaller setae, and many incomplete setae—minute fragments only. The capsule or enclosing membrane of this tumour,—for this seemed the best word to apply to it,—may have been, as I was inclined to regard it at the time, the distended setal sac itself; or as in the case of *Fridericia carmichaeli* the mass may have consisted essentially of coelomic corpuscles, and the sac wall may have been produced by the modification of an outer layer of the corpuscles. But a difference between the two cases is that in the *Enchytraeus*, so far as I know, the appearance was confined to a single specimen.

Another case which may possibly be comparable in some degree with the above is that of *Grania maricola*[1] described by Southern (16). Here "in addition to the

[1] Michaelsen (15) considers this form to belong to the genus *Michaelsena*; for convenience however I here retain the author's name for it.

normally formed functional setae, almost every specimen shows large numbers of setae of various sizes scattered about in the body-wall. These setae usually occur in parallel bunches, but may be scattered about quite irregularly. They lie in the inner layer of the body-wall parallel to the surface, and do not pierce the epidermis. In shape they resemble the functional setae." The author considers that "in order to explain the observed phenomena it is therefore necessary to suppose that the seta-producing tissue has undergone a process of proliferation and spread from the region of the normal setae over the inner surface of the body-wall. This tissue appears to be in a state of unstable equilibrium in this species." It will be observed that the supernumerary setae are not said to be in the body cavity or surrounded by coelomic corpuscles, but in the inner layer of the body-wall.

Finally, it is well known that in the Lumbricidae small brown grains, of about the size of a small pin's head, may often be found in the coelom; these when broken up are seen to consist of brown granular matter derived from broken-down discoloured amoebocytes, in which are embedded discarded setae and nematode worms (Johnson, 6). I have found such grains, one of which on examination contained an entire seta, in a species of *Perionyx*, a Megascolecid.

The above cases may not all be comparable together. In some at least, the abnormally situated setae or fragments are apparently in process of being got rid of, —in other words eaten away by the surrounding cells.

The black particles in the corpuscular masses in *Fridericia carmichaeli* recall chloragogen pigment, and so too the brown granular matter in the grains found in the coelom of Lumbricidae, etc. It seems possible that the coelomic corpuscles, dissolving the substance of the setae, separate out the matter again in the form of the brown or black granules, and that this is perhaps ultimately got rid of by the nephridia; or, of course, the effect of embedding the setae may merely be to render them harmless.

As to whether the setae are in all cases, at first, normal setae, I should say not; it might be possible to suppose that the variously shaped fragments in *Fridericia carmichaeli* had been derived from normal setae by gradual solution under the influence of the corpuscles; but the long straight needles present a difficulty; and the smaller setae of *Grania maricola* appear to have been laid down originally of smaller size than the ordinary functional setae.

The chitinous cuticle of Arthropods and Annelids, besides being important or indispensable to its possessors in the rôle of an external protective covering, is nevertheless suspected to be, in part, an excretion; and if so the same must be said of the similar material which composes the setae. It would seem possible from the above, that this may be formed, on occasion, as rods or spicules purely in the way of excretion. These purely "excretory setae" are perhaps sometimes never got rid of, and remain to the end of life (as possibly in *Grania maricola*); in other cases, possibly, they may in turn be attacked, metamorphosed into substances that can be more easily disposed of, and finally eliminated through the usual channels.

ON THE SPERM-SACS IN THE GENUS *ENCHYTRAEUS.*

In a recent paper (23) I wrote of the sperm-sacs in this genus, "The sacs do not include the funnels of the vasa deferentia"; and since they are, in the stages at which I have examined them, completely closed, it is not obvious how the spermatozoa escape. A specimen of *Enchytraeus barkudensis* perhaps explains this (*v. inf.*); the wall of the sac was apparently wanting in part,—hence it would seem that at a certain stage the sperm-sac disintegrates or ruptures, possibly under pressure from within. Indeed, unless we assume an active penetration of the sac wall by the ripe spermatozoa there would seem to be no other means of exit. I do not, however, think we are at present entitled to exclude the active penetration of the sac; a re-examination of my specimens of *E. harurami* has also shown, in one case at least, a small break in continuity of the wall of a sac;—but on the one hand it is possible that slight damage of the kind might occur during section-cutting, and on the other the appearances do, in one or two places, suggest the penetration of the sac-wall by mature spermatozoa.

The question now arises,—Are sperm-sacs present throughout the genus *Enchytraeus*? In the published descriptions of a number of species they are said to be present[1], in others they are not mentioned, while in some they are definitely said to be absent (as in *E. indicus*, 19, and compare 22, p. 322). In the latter class I am sure (as regards the specimens I myself examined) I may place *E. dubius* and *E. nodosus*, described some time ago by me from the Clyde (17). But is it possible that after rupturing, the wall of the sperm-sac entirely disintegrates, so that in the later stages not even the remains of sacs are visible? On this supposition the species in which the sacs are absent or are not noted may have been described from specimens in a late stage of maturity; it may be noted that I have never seen a clitellum in *E. barkudensis*, and in *E. harurami*, which also possesses testis-sacs, the clitellum, though distinguishable, was not conspicuous. It is, however, scarcely possible that the specimens of *E. dubius*, without testis-sacs, belonged to a late stage (*cf.* text-fig. 2 and fig. 12, pl. ii of the original description, both showing large testes,—hence an early rather than a late stage).

It may perhaps be necessary ultimately to remove *E. dubius* from the genus (I included it, as the name implies, somewhat doubtfully); or the present genus may have to be split up into two, one comprising those species which have and the other those which have not sperm-sacs. But a number of already described forms may have to be re-investigated before this can be done.

I may refer briefly to the condition in *E. carcinophilus* recently described by Baylis (1). The sperm-sacs appear to be of the nature of those described for *E. barkudensis*, etc.; but the testes are said to be in segment x on septum 10/11, *i.e.* outside the sperm-sacs,—it would be impossible so to describe them if they were within the sacs. This appears to me to be an unlikely position; apart from the analogy of *E. harurami* and *E. barkudensis*, to mention only forms with which I am myself acquainted, there

[1] So recently Stirrup (24), for *Enchytraeus albidus.*

is the apparent impossibility of the sexual cells getting *into* the testis-sac, where they are to undergo ripening; for whatever may be said as to the possibility of their getting *out*, when ripe, in order to enter the funnel, they are at least not motile when, in their early stages, before they even form the well-known morula-like masses, they are detached from the testis.[1]

On the use of the term "Iridescent Funnels."

On dissecting many of the ordinary Indian earthworms, what appear to be the funnels of the male deferent apparatus are often conspicuous by their glistening or iridescent appearance; and we find that words like metallic, glittering, iridescent, glancing, glänzend, have frequently been used in descriptions.

What I wish briefly to draw attention to, is the fact that the funnels themselves are not iridescent, but that this appearance is due to the ripe spermatozoa in their neighbourhood. The spermatozoa when fully formed constitute wisps or bundles of innumerable extremely fine threads lying parallel to each other, and the iridescence is a consequence of the parallel arrangement. The phenomenon is the same as that seen in the well-known 'diffraction grating'; in the same way the separated cuticle of a worm is iridescent, in consequence of the parallel striae of which it is composed.

While ripe spermatozoa, which have assumed the parallel arrangement, are thus iridescent in mass, sperm morulae and the various developmental stages of the spermatozoa are not. Since the spermatozoa take on the parallel arrangement before their discharge by the sperm-ducts, a quantity of matter in the testis segments (or in the testis-sacs, if these are present) will often be found to be iridescent; and if the ripe spermatozoa cluster round the funnel, this will be concealed by an iridescent investing layer.

As confirmatory, it may be recalled that in the Megascolecidae the spermathecal diverticula (which act as the storehouse for spermatozoa received from another worm) are frequently of the same glancing appearance. In some cases the flocculent mass of sperm morulae, etc. in a testis segment passes gradually into the iridescent material, without there being any definite separation between the two (I observed this in *Megascolex polytheca* var. *zonatus*). In *Drawida ghatensis* a fragment of what might have been described as a large iridescent funnel, when broken off and teased, was found to consist entirely of spermatozoa (the 'Samentrichter' in Michaelsen's figure of this species,—fig. 2,—is I think obviously merely bundles of spermatozoa). Finally, I have cut sections of the 'iridescent funnels' of *Pheretima hawayana*, after detaching as much of the surrounding matter from them as possible, and found, as was to be expected, that the actual funnels were largely overlaid by a layer of spermatozoa arranged

[1] If I might venture a further word of criticism, I would briefly advert on the non-correspondence of text and figures in the account of this worm. The segments occupied by the clitellum (xi—xiii) are said to be devoid of setae; but setae are shown on xi in fig. 1 and on xiii in fig. 8. The clitellum itself in fig. 8 seems only to extend over xii–1/2 xiii. The outline of the brain is said to be very slightly concave behind; but figs. 1 and 4 show it as slightly or markedly convex. It is hardly likely that the writer has prepared text and figures from different species; is the species variable in these points? It would have added to the value of the description if (supposing this to be the case) it had been so stated.

parallel to each other, with their axes at right angles to the epithelial surface of the funnel.

It is quite allowable, I think, to take the presence of the iridescent material, at any rate when adherent, as an indication of the presence of an underlying funnel; though probably no inference as to the actual size of the funnel can be drawn from that of the iridescent mass, and such a phrase as 'large iridescent funnels' (which I have no doubt used myself on occasions) is scarcely admissible.

Family ENCHYTRAEIDAE.

Genus **ENCHYTRAEUS.**

Enchytraeus barkudensis, Stephenson.

(Plate VI, figs. 1-2.)

Ennur backwater, Sta. 3. Two batches, one of four and one of three specimens, both obtained during January, 1915 (*N. Annandale*).

This species was recently described (23) from the Chilka Lake, and it is perhaps not surprising to find it again in a somewhat similar habitat further south. There are, however, a number of differences, some of which are interesting and have a bearing on the general anatomy of the Enchytraeidae; these are referred to below. The three chief diagnostic marks of the species however, which I gave in my former paper (number and distribution of setae, rudimentary salivary glands, and sperm-sacs enclosing testes) characterize the present specimens; as additional points of agreement may be mentioned the characters of the penial bulb and perhaps the thickening of septa 7/8–9/10.

In the first batch the specimens were 6 mm. or less in length, and comprised 46-48 segments; in the second they were 8-10 mm., and of 64-67 segments. No clitellum was seen even in those specimens which were fully sexual.

The *pharynx* was found in one of two conditions. Either it presented a dorsally situated sucker-like plate (the condition usually met with in Enchytraeids), sharply defined, of a very tall narrow epithelium; or it resembled the form of pharynx found in *Fridericia carmichaeli* (*v. inf.*),—a hemispherical thick-walled caecum with convexity backwards, the narrow lumen in this case appearing as a slit between the dorsal and ventral walls of the caecum, the oesophagus beginning ventral and anterior to its narrow mouth. For a third condition (extrusion outside the mouth) found in some later specimens from the Chilka Lake, and remarks thereon, see the Introductory section.

In both the caecal and the sucker-like condition of the pharynx a stout band or bands of muscular fibres were seen passing downwards and backwards from the pharynx to the ventral body wall, in addition to the numerous bands, universal in the Oligochaeta, which pass upwards and backwards to the dorsal parietes (*cf. Fridericia carmichaeli, inf.*). With this band the anterior prolongation of the septal glands towards the pharynx (supposed ductules of the septal gland-cells) unite.

The oesophagus certainly passes into the intestine without sudden change, as noted in the previous description; but this seems to take place in segment xi or xiii

(instead of further back in xv, xvi, or xvii). The dorsal vessel also seems to begin variously in xii, xiii, or xxii; there appears to be no doubt about the last observation, and, since the previous account of the worm gives the origin of the vessel as xv, xvi, or xvii, we may conclude that this character also shows a large degree of variation

There are four well-marked lateral *vascular commissures* in the anterior region; the first, running very obliquely downwards and forwards, ends ventrally at a level between the setae of segments ii and iii; the second, less oblique, ends between the setae of iii and iv; the third, almost vertical, ends behind the setae of iv; the last, behind the setae of v; they seem therefore to belong to segments ii—v. The *ventral vessel* is formed by the union of two trunks from the anterior end of the animal; this union takes place just behind the level of the setae of segment iv; the first two commissures therefore join the trunks before their union, the last two join the ventral vessel.

The form of the nephridia is illustrated in fig. 2*a* and *b*. The interest here again lies in the variability of characters which are commonly taken to be of specific value; and it may be noted that in this case the variability exists within the same specimen. Fig. 2*a* represents the nephridium of segment ix; it is thin, elongated, continued behind without sharp demarcation into the duct; fig. 2*b*, from a nephridium behind the genital segments, is pyramidal, with a relatively narrow duct which leads off from the ventral and posterior angle with an arched course downwards and backwards to the surface (the arching was considerably more marked in another case). The figures were drawn from an entire specimen in cedar oil; the facts were also confirmed by a subsequent examination of longitudinal sections.

The *sperm-sacs* and *testes* present the same features as the previous specimens from the Chilka Lake; but in one of the specimens which was sectioned the wall of the sac appeared to be wanting in its posterior part, and there also seemed to be a gap at one place on the antero-dorsal part of its extent. The contained sperm-morulae were nevertheless not scattered through the adjacent segments, but remained compacted together in a definite mass within the sac. Ripe spermatozoa were seen in clusters round the mouth of the funnel. The sac-wall is an extremely delicate structure, and it is of course possible that the apparent rents in its continuity are due to damage during section-cutting; I have, however, no reason to think that this is really so,—and of course a disintegration of the sac is the easiest way of explaining how the male products reach the funnel.

The *penial bulb* is a small approximately spherical cluster of cells surrounded by a membranous capsule; it might be called rudimentary. The cells of which it is composed have no very distinctive characters; muscular strands pass upwards, as usual. The penial lumen is chitin-lined; the bulk of the bulb, and the terminal portion of the vas deferens lie to its inner side. The male aperture can be seen on the surface as a semicircular slit, in the position of the (absent) ventral setae of xii.

What I think must be regarded as a rudimentary *female funnel* and *oviduct* were discovered in longitudinal sections. A few nuclei are seen on a slight backward pouching of the ventral portion of septum 12/13 in one of the series; and from this

situation a cord of cells leads downwards, apparently losing itself in or on the body-wall.

To the previous description of the *spermathecal apparatus* it may be added that there are no glands found round the end of the duct, which opens in 4/5 just below the level of the lateral setae.

Genus FRIDERICIA.

Fridericia carmichaeli, sp. nov.

(Plate VI, figs. 3-5.)

Rungneet Tea estate, 4000—5000 ft., Darjiling District; ii–iii, 1914. Thirteen specimens.

The average *length* was about 15 mm., *breadth* 4 mm.; 64 *segments* were counted in one of the specimens.

The *prostomium* is rounded, more or less semicircular in shape. The first six segments are relatively short.

The *setae* are of the '*Enchytraeus* type'. The lateral bundles contain each two setae; and this was also the case in the ventral bundles of four out of five worms examined carefully for their setal characters. In the fifth specimen, however, the number of setae was mostly three per ventral bundle in front of the clitellum and two per bundle behind it; bundles of replacing setae, three or two, were also seen. Both ventral and lateral bundles are absent in segment xii.

A *head-pore* is present, and also *dorsal pores* from segment vi onwards.

The *clitellum* is only slightly marked; it covers segments xii—xiii. The *male apertures* are situated on bluntly conical papillae on segment xii at the sites of the missing ventral setae.

The internal anatomy was elucidated principally by means of sections.

The *coelomic corpuscles* are large, oval, and granular, with a very distinct nucleus. There are definite aggregates of these corpuscles dorsally in segments vii, viii and ix (fig. 4), surrounding numbers of setal fragments; these are not chance collections, since they occur in the same situations in all four of the sectioned specimens; they are further referred to on p. 41, General Part.

The epithelial lining of the *buccal cavity* is approximately cubical, and is thrown into folds both dorsally and ventrally, especially ventrally (fig. 3, *buc. cav.*). The dorsal wall of the *pharynx* is not in these specimens marked by the flat sucker-like elevation, composed of tall columnar cells, which is commonly seen in sections of Enchytraeids; the pharynx may be described as a hemisphere with its convexity directed backwards, with thick wall composed of an elongated columnar epithelium, and a lumen opening anteriorly into the buccal cavity (fig. 3, *ph.*) but the condition is probably temporary, as explained in the General Part *ant.*; the oesophagus begins from the floor of the buccal cavity in front of the pharynx. The pharyngeal musculature forms a layer behind the hemispherical projection; especially noticeable is a sheet, well marked on each side of the oesophagus, at the anterior limit of segment iv, which passes downwards and backwards to the ventral body-wall (fig. 3, *m.*). Further remarks on the pharynx of Enchytraeids will be found on p. 40.

The *salivary glands* are small; they originate from the junction of pharynx and oesophagus as diverticula which are prolonged backwards each as a solid club-shaped mass of cells (fig. 3, *sal.*), the posterior end being rather broader than the stalk, and appearing to be somewhat curled inwards behind the pharynx towards the middle line. These structures are limited behind by the sheet of muscle-fibres passing downwards and backwards from the pharynx. In their club-like form and small extent of the lumen they resemble the structures described in *Enchytraeus barkudensis* (23).

Septal glands are present in segments iv, v and vi; they are bulky, filling the segments at the sides of the oesophagus; those in v and vi have forwardly extending ventral lobes in addition.

Chloragogen cells begin in v, and are numerous in vi and behind. The *oesophagus* passes into the *intestine* without the appearance of any marked difference between these two portions of the canal.

The *chyle cells* which are a character of the genus extend in this species through segments xiv—xviii. In these segments they form a considerable portion of the alimentary epithelium, indeed in a number of sections apparently the whole, though usually other more cubical cells are present along with them. The chyle cells are elongated columnar cells, their peculiarity, as is well known, being the possession of a central canal which opens into the lumen of the gut. In the present species the canal is straight for the greater part of its length, but at the basal end of the cell it is often bent to a right angle or curved into a semicircle; the portion of the canal near its mouth seems to be ciliated, but only that portion. The free surfaces of the cells are ciliated; the nucleus, containing a central karyosome, is situated at about half the height of the cell or a little lower. The lumen of the canal within the cell is bordered by a zone of hyaline non-granular protoplasm, and beyond this again is a zone of deeply-staining (with iron haematoxylin) granular particles. The cells are not in close apposition throughout their length; there appear to be considerable intervals between them; the intestinal blood-sinus bathes their basal ends.

The *dorsal vessel* can be traced backwards in sections as far, at least, as segment xv; in the posterior part of ix, just in front of its passage through the septum, a number of cells are aggregated inside its lumen, but these are not definite enough to be called a cardiac body. A sinus-like space containing blood can be traced in the intestinal wall as far forwards as segment vi.

The *nephridia* begin from segment vii. The anteseptal portion is of relatively considerable size, perhaps a third as long as the postseptal, and the tube undergoes some windings in the anteseptal portion before piercing the septum. The duct appears to leave the lower surface at the posterior end. The determination of the characters of the nephridia in preserved material is not always satisfactory.

The *cerebral ganglion* is rounded behind, concave anteriorly; it is a little longer than broad, and lies above the buccal cavity, in front of the hemispherical pharynx. The *ventral nerve cord* shows a giant fibre dorsal in position.

The *testes* were doubtfully identified ventrally in segment xi. The *funnel* begins anteriorly as a collar of cubical cells; the main bulk of the funnel, which succeeds the

collar, appears as a large spongy mass, in which it is mostly impossible to discern cell boundaries ; each funnel is larger in section than the alimentary tube, the space between which and the lateral body-wall it entirely fills out. The lumen is small, excentric, nearer the inner side of the funnel ; the cells of which the mass is composed appear, so far as they can be distinguished at all, not to radiate directly outwards from the lumen to the periphery, but to be disposed in a spiral manner.

Sperm morulae are free in large numbers in xi ; septum 10/11 is much bulged forwards, so that segment x is almost non-existent as a cavity in the mature animal (*cf.* fig. 4.) The *vas deferens* is an extremely fine much coiled tube situated in the ventral portion of xii ; the amount of coiling is illustrated by the fact that it may be cut about 16 times in a single section.

The *penial body* (fig. 5) is a small compact ovoid structure, with a muscular or fibrous capsule ; strong strands pass dorsally and laterally to the body-wall. The mass lies to the inner side of the penial lumen, which latter extends upwards and outwards beyond the point where it is joined by the vas deferens. The cells of the bulb do not extend on to the body-wall ; but I am unable to give more precise details of its structure since the condition of the specimens scarcely permits of refined histological study.

The *ovaries* and detached ova are present in segment xii ; funnel and oviducts were not distinguished.

The *spermathecae* have the usual situation. The *ampullae* are ovoid in shape, situated dorsally somewhat above the level of the oesophagus, with which their lower ends are continuous ; though the cells of the one organ are continued into those of the other I did not make out an actual continuity of the lumina of the two. The epithelium of the ampullary wall consists of columnar cells of variable height, but mostly considerably elongated, with granular protoplasm and basally situated nucleus ; owing to the height of the cells the cavity is relatively small. At the upper end where the duct takes origin the walls are thinner and the elongated granular cells have disappeared. The commencement of the duct is invaginated into the cavity of the ampulla ; its first portion continues the direction of the ampulla obliquely upwards towards the dorsal body-wall ; it then bends downwards and outwards to open on the lateral surface in about the mid-lateral line of the body. There are no gland cells round the aperture.

Family MONILIGASTRIDAE.

Genus **DRAWIDA.**

Drawida ghatensis, Mchlsn.

(Plate VII, fig. 6.)

Kavalai, 1300-3000 ft., Cochin State ; 24—27-ix-1914 (*F. H. Gravely*). Two specimens.
Forest tramway, mile 10-14, alt. 0-300 ft. ; Cochin State ; 28--29-ix-1914 (*F. H. Gravely*) Two specimens.

This species has recently been described by Michaelsen (12) ; it will therefore suffice to draw attention to a few differences between his specimens and mine, and to mention a few additional facts of structure.

External characters.—Length of largest specimen 195 mm., diameter 7 mm. Dorsally the colour is a slaty grey, with a pink tinge posteriorly, ventrally a lighter grey; the lateral region in the anterior portion of the animal appears thickened, the intersegmental furrows being deeper as they cross this lateral region than above or below it; this lateral region is in tint the lightest portion of the body.

Segments 183—186; posterior end tapers rapidly, the segments being very small. The prostomium is small and zygolobous.

With the higher powers of the dissecting binocular rings of minute papillae, light in colour, are seen on the anterior or on most of the segments of the body. These papillae resemble those caused by extremely numerous and minute perichaetine setae, and are possibly of the nature of sense organs.

I could not in all cases be certain as to the segment on which the setae begin. In one specimen the ventral bundles began in ii, the lateral apparently in iv; in another both bundles began from iii, and in a third from iv, though lateral setae were doubtfully present in iii.

A few of the setae were examined microscopically. A seta from segment viii is shown in fig. 6; its length is 52 mm., breadth at nodulus ·041 mm.; the basal portion is seen to be very stout, the free end being curved and pointed. The distal fifth or thereabouts shows a number of very fine sculpturings; under the oil immersion lens these appear to be angular, with point directed backwards (basalwards); they are possibly spines, though they cannot be seen to project from the sides of the shaft. A second seta from the same segment was considerably thicker at the nodulus (·054 mm.). A seta from a few segments further back showed the thickening of the base in a more exaggerated form; but this curious deformation was not present in a seta taken some distance behind the genital region. The sculpturing appears to be constant. It should be added that probably all the setae examined were of the nature of reserve setae, which had not yet come to project freely on the surface.

There was no clitellum in any of the specimens, notwithstanding that dissection showed them to be sexually mature.

The nephridiopores in the anterior part of the body are in the line *cd*; in the middle and posterior regions they are mostly lateral, in *cd*, but occasionally ventral, in *ab*.

Internal anatomy.—Septum 4/5 is distinct and somewhat thickened. Septa 10/11 and 11/12 are fused in such a manner as to form a ring-like ovarian chamber above the alimentary canal.

The gizzards vary; the most posterior is the largest, and the anterior ones are successively smaller. It is really scarcely correct to speak of separate gizzards; there are only slight segmental constrictions in a continuous hard muscular tube. One might reckon six gizzards, in xvi to xxi, in the specimen first dissected, though the anterior one or two were weaker than the rest; the oesophagus was still firmer than normal and somewhat thickened in xv. In a second, six were counted, in xiv to xix, the first being less firm than the rest. In a third, belonging to the second batch of specimens, there were four only, in xix to xxii, though the oesophagus was still rather firm in xviii.

The diverticula of septum 9/10, which pass backwards as elongated sacs, and in which the male genital products are formed, reached as far as segment xii, xiv, or xv. After crossing segment x each sac passes dorsal to the gut underneath the ovarian chamber representing segment xi, previously described. The sac is quite free, and does not fuse with the floor of the chamber; the ovarian chamber can be cut through in the middle line and lifted up quite clear of the subjacent structures. On opening the posterior swollen end of the sac I did not discover a testicular vesicle,—*i.e.* a second, closed sac within the bag-like diverticulum of 9/10; the testis and developing genital products appeared to me to lie free in the cavity of the diverticulum itself.

The prostate (male atrium) is an ovoid mass, with its long axis antero-posterior, conspicuous on the body-wall, taking up the length of segment x; it is joined by the vas deferens on its anterior face. The ovaries are crescentic fringes on the anterior wall of the ovarian chamber (segment xi), lying alongside and underneath the arch of the nephridium.

The shape of the spermathecal atrium varies. It may project upwards, papilla-like, from the ventral body-wall; or it may appear as an ovoid structure, with its long axis antero-posterior, sessile on the body-wall; in these cases the duct joins the atrium not on its upper surface but at the middle of its height. Or it may be embedded in a recess in the body-wall,—easily defined and isolated but not projecting, its surface being flush with the inner surface of the parietes.

Remarks.—Drawida ghatensis is thus a variable species. After dissecting the first example, I thought it would be necessary to erect a separate variety for it, on the ground, principally, of differences in the gizzards and spermathecal atrium. In no case where these features were examined, do they correspond with the condition described by Michaelsen; but neither do they agree among themselves. A comparison of the original description of the species with the above notes will show a few other differences, though none of much importance.

Drawida brunnea, sp. nov.

Parambikulam, 1700-3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen.

Length 40 mm., maximum breadth 5 mm. A short, relatively very broad, dorso-ventrally flattened worm, perhaps much contracted antero-posteriorly as all the segments are very short. The colour is a very dark brown, almost black, dorsally, and very slightly lighter ventrally. Segments 120. Prostomium not recognizable.

Dorsal pores apparently absent. The setae are very small and very closely paired; they are difficult to detect in the anterior part of the body, and I could not distinguish them at all in segment ii. Setae *cd* are in the lateral line of the body: and since the mid-ventral interval is rather less than the ventro-lateral, *aa* $<$1/6 circumference, *bc* $>$1/6 circumference.

The male apertures are in furrow 10/11; they are bordered by prominent lips, which are swellings of the margins of the furrow. They are situated midway between *b* and *c*, or rather nearer to *c*.

There was no clitellum, and no other genital apertures were visible. From an

examination of the base of the female funnel in the dissection, the female aperture would appear to be between *b* and *c*, probably near *b*.

Internal anatomy.—Septa 5/6—8/9 are somewhat thickened.

There are three gizzards in segments xiii—xv; the anterior one is, however, less firm than the other two.

The last heart is in ix.

The testis-sacs are large, massive, projecting on both sides of septum 9/10, not constricted by the septum; the part in x is larger than that in ix. On opening the sac the testis is seen, after clearing out the contents, as a small bushy structure. The vas deferens is a fine tube which leaves the posterior side of the sac and presents numerous closely packed coils. The prostate is an opaque-white ovoid body in x; it has a short moderately thick stalk, a smooth surface but without muscular shimmer, and is joined by the vas deferens on its inner side.

The ovarian chamber is formed by the fusion of septa 10/11 and 11/12. It was opened into while opening the specimen, which seems to show that the roof of the chamber is at the dorsal parietes. The chamber encircles the gut dorsally and laterally, and in the present case was full of ova.

The ovary is a considerable fringe-like band on the anterior wall of the ovarian chamber. The funnel is on the posterior wall, in the lateral region; it extends upwards, however, lateral to the gut by a greatly drawn-out dorsal lip which reaches to not very far from the mid-dorsal line; the base of the funnel is ventro-lateral, on the body-wall.

The ovisac, originating dorsally from the posterior wall of the ovarian chamber, is tubular, elongated, and contained within segment xii. It passes laterally round the alimentary tube, and tapers towards its lower end.

The ampulla of the spermatheca is situated dorsally in viii, on the posterior face of septum 7/8; it is ovoid in shape, and the duct leads off from its lower and outer end. The duct coils considerably, some coils lying on the septum while others are free in segment viii; it then pierces the septum ventrally and immediately joins the atrium, which is wholly in vii. The atrium is a mammillary projection, sessile on the parietes in the line of the lateral setae (or rather in the longitudinally running interruption of the muscular layer of the body-wall which marks this line); it is joined by the duct at its base.

Remarks.—The species which, perhaps, the present form most resembles is *D. travancorensis*, Mich. (12). It is indeed just possible that the two are identical, since Michaelsen's specimens were in a bad condition of preservation, and the present account is based on a single specimen; and future opportunities may bring to light specimens which bridge over the differences. The size, proportions, and shape of the present specimen seem however to distinguish it; I should be inclined to put the colour as characteristic,—unfortunately the condition of Michaelsen's specimens did not allow him to state the colour. The shape of the egg-sacs, of the spermathecal atria, perhaps also of the prostates and of the male apertures, may be valid distinguishing marks between the two.

Drawida parambikulamana, sp. nov.

Parambikulam, 1700-3200 ft. Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen.

External characters.—Length 84 mm., diameter $3\frac{1}{2}$ mm., colour a bluish grey, darker on dorsal, lighter on ventral surface and laterally. The body-wall in the lateral region on each side appears rather thickened (*cf. D. ghatensis, ant.*) The situation of the ventral setal bundles is marked on each side by a dark line extending the whole length of the ventral surface (due probably to the interruption along this line of the continuity of the longitudinal muscular coat); there is a similar dark line in the situation of the lateral bundles in the posterior half of the body, though this lateral dark line is less marked than the ventral.

Segments 140. Prostomium indistinguishable.

The setae are small and closely paired; *aa=bc*; *dd* is approximately equal to half the circumference of the body,—perhaps a little more, but not as much as $\frac{4}{7}$. The lateral bundles are situated a little below the middle in height of the thickened lateral region of each segment. The setae are less closely paired in the anterior region of the body, where (segment vii) *aa=5ab*, while further back *aa=7ab*.

A considerable number of nephridiopores are lateral in position, a few however ventral.

No clitellum was distinguishable.

The male apertures are on minute papillae in furrow 10/11 outside the line *b*, but nearer *b* than *c*. The female apertures were perhaps represented by a pair of minute pale spots in furrow 11/12, in the line *b*. The spermathecal apertures are in 7/8, small, and their centre in the line *c*.

Internal anatomy.—Septum 4/5 is perhaps represented by a sheet of a muscle directed rather backwards from its insertion round the alimentary canal towards the body-wall, which it joins a little in front of the level of furrow 5/6; being thus concave backwards it may not be homologous with a septum, the septa being usually in the anterior part of the body concave forwards. Septum 5/6 is attached to the body-wall rather behind the level of the corresponding groove; it and subsequent septa up to 8/9 are considerably thickened; the rest are thin.

There are three gizzards, in segments xiii—xv, that in xiii being smaller than the other two. The last heart is in ix.

The testis-sacs are on septum 9/10, projecting backwards into segment x, and only slightly (right side) or not at all (left side) forwards into ix. A sac was opened, but the contents were so intimately adherent to the wall that testis and funnel could not be recognized; part of the adherent mass itself was presumably testis.

In segment ix, ventral to the level of attachment of the testis-sac, and sessile on the anterior face of the septum 9/10, is a white mass with a delicately mammillated surface. On teasing out and examining microscopically this proves to be the extremely fine and tightly coiled vas deferens. The tube has in this part of its course a diameter of ·04 mm.; it is broader and easily visible under the dissecting binocular in its terminal portion, before it joins the prostate. In this specimen the duct was full

of spermatozoa, and had while still *in situ* a rather glancing opalescent appearance.

The prostate is an ovoid sac-like mass of considerable size, attached by a broad base to the body-wall. It is rather flattened laterally, and its lower part is yellower and apparently more muscular. A flocculent substance (? glandular cells) can be scraped off its surface by needles; the surface is however in the natural condition smooth. A small central cavity can be demonstrated by cutting across with scissors. The vas deferens joins it on its anterior margin.

Segment xi is short antero-posteriorly; septa 10/11 and 11/12 are fused immediately above and at the sides of the alimentary canal, and thus form the floor of an ovarian chamber. The roof of the chamber is at the dorsal parietes, where the two septa mentioned are close together though separate. The ovarian chamber (=segment xi) is thus opened in the ordinary dissection. The ovaries are seen as narrow fringes lateral and dorso-lateral to the intestine on the anterior wall of the chamber; the funnels were not identified.

The egg-sacs, diverticula of septum 11/12, are small, tubular, wider at the mouth and narrower at their hinder end, which is turned forwards. They are entirely contained within segment xii.

The spermathecal ampullae are broadly oval sacs of considerable size in segment viii, on the anterior wall of the segment, one on each side dorsal to the gut and almost touching each other in the middle line. The duct is narrow, coils considerably in viii, and pierces septum 7/8 to join the atrium at the base of the latter. The atrium is of moderate size, teat-like, with a cavity (as seen when examined microscopically after clearing with acetic acid) of simple form.

Remarks.—With the exception of *D. parva* (Bourne) no species of the genus seems closely to approach the present one. A comparison with *D. parva* is difficult, because on the one hand Bourne's description (5) presents the extreme of brevity and baldness, and on the other I have only a single specimen of the present form, and there is thus no indication of the amount of variability which may be expected to occur. I separate the two partly on the ground of differences in the testis-sac, prostates, and, probably, colour; but perhaps more on the ground of the bodily proportions; Bourne's specimen, though but little shorter than mine (75 as against 84 mm.) is only slightly over one-third the thickness (Bourne gives the circumference of his worm as 4·25 mm., which corresponds to a diameter of $1\frac{1}{3}$ mm.; the coloured drawing, however, which represents the living worm of natural size, shows it as $2\frac{1}{2}$mm. diameter; the colour during life might, from the plate, be described as light brown with a pinkish tinge due to blood vessels).

Drawida chalakudiana, sp. nov.

(Plate VII, fig. 7.)

Chalakudi, Cochin State; 14—30-ix-1914 (*F. H. Gravely*). Three specimens, of which one, the largest, bears sexual marks.

External characters.—Length 41 mm., diameter $1\frac{1}{2}$ mm.; colour bluish grey, dark on the dorsal, light on the ventral surface. Segments 135.

Prostomium prolobous,—an oval lobe filling up the circle of the anterior margin of the first segment.

The setae are paired, but not very closely in the anterior region; in the segments near the male aperture $aa=3\frac{1}{2}ab$, further back $aa=6ab$. The other relations may be given as $aa=bc$, dd=half circumference. The setae begin on segment ii.

No clitellum is distinguishable. The sexual apertures also were distinguished only doubtfully, though the specimen was quite mature; they all were extremely minute, the male pores apparently in *b*, the female as whitish spots in *a*, the spermathecal apertures in *c*, in the usual furrows.

Genital markings were present as follows (fig. 7):—On segments x and xi, bisected by furrow 10/11, is a transversely oval area, which extends antero-posteriorly from the setae of x to those of xi, and laterally on each side to a point outside the line *b*. Thus in lateral extent it comprehends the whole ventral surface; while antero-posteriorly it is more than the equivalent of a segment, since the ventral setae of x are in front of, and those of xi very considerably behind, the middle of the length of their respective segments. The margin of the area (*b*) is white, the interior (*c*) darker. Within the dark region, medially situated on the posterior half of x, is a semicircular raised patch (*e*) with its base lying at furrow 10/11; the furrow is here slightly curved with its convexity backwards, and this portion of the furrow is deepened as compared with the portions in proximity to the lateral margins of the raised semicircle, which are shallow (*d*).

A slightly thickened lighter oval area, also transversely elongated, is present on segments vii and viii, bisected by furrow 7/8; it is however less well marked and less extensive than that on x - xi.

Internal anatomy.—Septum 5/6 is moderately, septa 6/7—8/9 are considerably strengthened.

The gizzards are three, in segments xiii—xv; this region might be described as a fortified part of the oesophagus; it is not very hard, there is not much constriction at the septa, and the septa are not displaced at all.

The last heart is in ix.

The nephridia arch round the gut on each side, each nephridium being adherent to the posterior face of a septum. The nephridiopores are (? always) in the line of the lateral setae.

The testis-sacs are large, suspended by septum 9/10 and slightly constricted by it. The portion of the sac which projects forwards into ix is larger (considerably larger on the left side) than that which projects backwards into x. After opening one of the testis-sacs and clearing out the detachable flocculent matter, a quantity still remained intimately adherent to the sac-wall as a sort of fur; this perhaps indicates that the testis is a diffuse proliferation of the wall. The site of the funnel was perhaps indicated by a small iridescent mass on the floor of the sac in the neighbourhood of the septal attachment, where the vas deferens could also be seen arising. The vas deferens undergoes a number of windings on both sides of the septum; it enters the prostate on its anterior face at about the middle of its height.

The prostate is large, and presents itself as a rectangular block beneath and rather to the outer side of the hinder half of the testis-sac; it takes up the whole length of the segment, and is somewhat constricted where it is attached to the parietes,—or it might be described in other words as sessile on the body-wall by a somewhat narrowed base. It is soft in texture; no muscular lower portion or duct is distinguishable.

The ovarian chamber is of a less specialized form than in a number of other species of the genus. On opening the specimen the appearances in this region did not suggest the presence of a chamber at all, and septa 10/11 and 11/12 appeared to have the usual disposition (*i.e.* that usual in other families). On closer examination, however, 11/12 appeared to pass forwards above and close to the gut to be united with 10/11, thus forming the floor for an ovarian chamber, which has as its roof the dorsal body-wall, where the septa are not approximated at all. I believe I passed a needle forwards, from segment xii underneath the chamber and dorsal to the alimentary tube, so that its point appeared in x, without penetrating a septum: but the whole worm is very small.

The space,—segment xi, ovarian chamber,—was filled dorsally and laterally to the alimentary canal by a block of soft white substance, which on microscopic examination proved to be ovary,—not ova which had been shed. The block is divided in the mid-dorsal line and each half is attached ventrally in the segment. The ovaries are thus particularly massive.

The ovarian sacs extend backwards from septum 11/12 as far as segment xvi; they are of an elongated tubular shape, constricted at the septa and narrowing gradually towards the posterior end.

The funnels, on the anterior face of 11/12, may be described as each consisting of a couple of much thickened rounded folds, parallel and almost close together, and hence forming the borders of a groove; at their upper end, near the mouth of the ovisac, these folds unite in a bluntly pointed freely projecting tip. The folds and the contained groove, passing ventralwards, reach the floor of the segment just posterior to the attachment of the ovary.

The spermathecal ampulla is spherical, attached to the posterior surface of septum 7/8 dorso-lateral to the oesophagus; the duct is thin, and is coiled in the lower part of segment viii. The atrium, in vii, is relatively fairly large, and is a conspicuous structure in its segment; it is of simple shape,—a stumpy cylindrical sac-like structure projecting upwards. The junction of the duct was not seen,—possibly it is situated in the body-wall. So far as could be seen from inside, the atrium was situated in or about the line *ab*,—near the middle line immediately adjacent to the oesophagus.

Remarks.—This would appear to be one of the more primitive species of the genus. As primitive characters may be mentioned the slight differentiation of the gizzard region of the alimentary tube and non-displacement of septa in this tract; the condition of the ovarian chamber; the well-marked prostomium (in the species which I have had the opportunity of examining, both in connection with the present collection and previously, it is very common for the prostomium to be either small or quite invisible);

and, perhaps, the fact that the setae begin, as normally, in ii, and are certainly not so relatively small and very closely paired as in a number of species of the genus.

Genus MONILIGASTER.

Moniligaster deshayesi, E. Perrier.

Parambikulam, 1700-3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Two specimens, one without clitellum.

External characters—Length 150 mm., breadth 6·5 mm.; colour a medium olive ventrally, considerably darker dorsally with a bluish tinge. Segments about 184.

Prostomium not distinct; slight lateral thickened regions in each segment (*cf.* some species of *Drawida*, *ant.*) No dorsal pores.

Setae minute, closely paired; *aa*=*bc*; *dd* estimated at slightly more than half circumference, so that *d* is just below the lateral line of the body.

The sensory papillae, if they are such, described in the next variety (var. *gravelyi*) were scarcely visible and irregularly distributed in the first specimen examined: they were more regular and more marked in the second.

Clitellum x—xiii=4, not well marked, distinguished by a rather lighter colour and a yellowish tinge.

Male apertures small, in groove 10/11, outside *b*, but nearer *b* than *c*. Female apertures indistinct, in groove 11/12 in *b*. Spermathecal apertures minute, in groove 7/8, just below *c*.

The nephridiopores may be in line either with the ventral or the lateral setal bundles, but there is no regular alternation.

Internal anatomy.—Amongst the numerous muscular sheets and strands which pass from the anterior portion of the alimentary canal to the parietes, those which represent septa are to be distinguished by their relation to the nephridia; since the rule throughout the body is that the nephridia lie against the posterior face of a septum. The first nephridium is that of segment iv, and the sheet of tissue on the posterior face of which it lies will be septum 3/4. Taking the nephridia as guides, it is found that septa 4/5 and 5/6 are fused at their peripheral attachment, so that segment v is not necessarily opened in the usual procedure for displaying the interior of the worm. On opening the chamber representing segment v the nephridia of the segment are seen, as well as a section of the dorsal vessel, and a pair of small lateral vessels; the attachment of the conjoined septa 4/5 and 5/6 to the parietes is at the level of groove 5/6. Septa 6/7—8/9 are much thickened.

The gizzards are four in number, in xv—xviii; the oesophageal wall is however muscular in xiv, so that an additional rudimentary gizzard might also be enumerated.

The last heart is in ix. The hearts are not attached to the posterior septum of the segment, as is perhaps generally the case in the Oligochaeta, but are free in the cavity of the segment.

The nephridia, attached to the posterior face of the septa, arch over the alimentary tube so as almost to meet each other in the middle line dorsal to the gut.

The testis-sac is in segment x,—large, rectangular, attached to the posterior face of septum 9/10. On opening and emptying one of the sacs, the testis is perhaps seen to be represented by a small bushy projection on the ventral wall; there was also seen on the ventral wall of the delicate and transparent sac an oval ring-like opaque thickening, perhaps representing the margin of the funnel; the vas deferens leads off from the anterior end of the ring, near which the testis is also situated. Curiously, in the second specimen examined, the right testis-sac was not contained in x at all, but in xii. Its empty neck passed beneath the ovarian chamber, and expanded in xii to a rectangular bag filled with genital products. The condition here therefore somewhat resembles that in *Drawida ghatensis*. A number of coils of the vas deferens also accompanied the testis-sac in xii.

The vas deferens is a very long and much looped tube; the loops are long, straight, the two limbs running closely side by side; there are two bunches of such loops, one projecting forwards from septum 9/10 into ix, another on the posterior face of the septum, ventral to the testis-sac, projecting into x. The first part of the vas is thinner than the rest.

The prostates are very large, sausage-shaped, extending back dorsal to the alimentary canal as far as septum 14/15; but this does not represent their full length, since 14/15 is so much bulged back by them that it comes to lie at the same level as 16/17 dorsal to the gut. The prostates are rather bent to one side at their hinder ends; they are of a pearly white colour, thus differing from the egg-sacs, testis-sacs and spermathecal ampullae, which are (in the preserved specimen) yellowish. The vas deferens in its terminal portion runs backwards on the surface of the prostate, opening into the latter some little distance from its hinder end. The terminal (anterior, ectal) part of the prostate is narrower than the rest, more shining and more like a duct: it is rather twisted, and appears finally to become rather broader again as it enters the body-wall.

The ovarian chamber, situated dorsally and laterally to the alimentary tube, is morphologically the eleventh segment. The ovaries are contained within it, as a pair of fringes on the anterior wall of the chamber, arching dorsalwards over the gut so as to approach each other near the middle line. The funnel is seen as folds on the posterior wall which pass downwards to the ventro-lateral portion of the chamber.

The ovarian chamber is quite free from the alimentary tube, and a needle can easily be passed between them.

The ovisacs are large, lying alongside and of equal extent with the prostates; anteriorly they open by a narrow neck into the ovarian chamber.

The spermathecal ampulla is broadly ovoid, situated on the posterior surface of septum 7/8, to which it is attached underneath the arch of the nephridium. The duct leaves the lower end of the ampulla, forms a number of coils in segment viii, and pierces septum 7/8 ventrally, close to its attachment to the parietes; it then has a considerable course in vii passing finally between the two lobes of the atrial appendage to join the inner (internal) end of the stalk of the mass at the point where it bifurcates (*v. inf.*).

The glandular mass in connection with the ectal end of the spermathecal apparatus is of large size, situated in vii, bifid, each half compact and rounded, with a yellowish mammillated surface; one half lies higher in the segment, the other ventrally to this, the whole bound down to the ventral body-wall and to the septum (7/8) by loose areolar tissue. The stalk (atrium) is relatively narrow, and bifurcates, one branch going to each half of the mass. Neither the stalk nor its two branches are in any sense sacs; the appearance is that of two ducts proceeding one from each half of the mammillated glandular mass, which unite to form a common duct; this common duct is less than half as long as the glandular part and nowhere dilated.

In the second specimen the division of the glandular mass into two lobes was not obvious; a division could however be made by means of needles, though not without some slight damage to the substance of the gland. But I am quite certain that the idea of trying to separate the mass into two parts would never have occurred to any one who had no previous knowledge of the species. The duct from the spermathecal ampulla entered the lower surface of the mass.

Remarks.—This species is especially interesting as being the first of the family Moniligastridae to be described (E. Perrier, in 1872, from Ceylon). The type specimen (the only one of the species then known) was re-examined about 1909 by Michaelsen (9), who corrected some errors in the original description. Michaelsen himself became possessed of other specimens in 1910 (12), and made a few remarks on them, especially throwing doubt on the alleged locality of the type. In 1913 he also received from Travancore (14) a badly preserved specimen of a new variety (var. *minor*).

The present is therefore the fourth occasion on which specimens of this historic species have come to hand. Since it is possible that the present specimens also differ sufficiently from the type to constitute a variety (in the prostomium, setal relations, position of nephridiopores, and perhaps the form of the atrial glands of the spermathecal apparatus), though I do not at present name them as such, I have given an account of them at some length.

Var. **gravelyi**, var. nov.

Trichur, 0–300 ft., Cochin State; 1-4-x-1914 (*F. H. Gravely*). A single specimen.

External characters.—Length 130 mm., diameter 5 mm.; colour on dorsal surface an even, beautiful bluish grey, on ventral surface a lighter tint of the same, the lateral surfaces different from and sharply marked off from both, of a still lighter drab colour; these lateral regions appear thickened, and the intersegmental grooves are deeper here than dorsally or ventrally (*cf.* some spp. of *Drawida, ant.*). Segments 139.

Prostomium absent (or invisible). No dorsal pores.

The setae are minute and very closely paired; *aa* and *bc* appear to be, in general, approximately equal. The lateral couples are a little below the middle of the height of the lateral lighter-coloured regions (*v. sup.*) in the anterior part of the body, about the middle of their height in the middle, and slightly above in the posterior part of body.

In the first 10 or 11 segments are a number of small whitish spots, arranged as a ring in each segment, each spot slightly raised. These rings at first sight simulate

rings of minute perichaetine setae; in the most anterior segments of all they are smaller than in the rest of the segments in which they occur. They may possibly represent sensory papillae (*cf. Drawida ghatensis, ant.*).

No clitellum was distinguishable.

The male pores appear as slits in furrow 10/11, marked only by a slight thickening and whitening of the intersegmental furrow at the junction of the lateral and ventral areas of the body-wall, *i.e.* between *b* and *c*. No other apertures or genital marks were visible.

The nephridiopores are some in the line *ab*, others in *cd*; but there is no regular alternation.

Internal anatomy.—The anterior septa have the exact relations described in the case of the preceding form; septa 5/6—8/9 are much thickened.

The gizzards are four in number, in segments xv—xviii; they are spherical or somewhat flattened antero-posteriorly, are all about the same size, and are preceded by a firm portion of the oesophagus in xiv.

The testis-sacs are ovoid, attached to septum 9/10, projecting backwards into segment x but not forwards into ix. The vas deferens consists of large bunches of loops, in both ix and x, which are prominent and look at first sight like a bushy gland, an ovary for example. The loops are all attached to the septum, or to the base of the testis-sac where it joins the septum, and cannot be seen to communicate with one another at their attached ends. The vas emerges from the tangle near the body-wall in x, passes back to the prostate to which it applies itself near its ectal end, ascends along the inner face of the prostate, bound down to the latter by connective tissue, and enters the substance of the prostate at its posterior (ental) end.

The prostate, attached to the body-wall in the situation of 10/11, is narrow at its origin, rather twisted, firm and indistinctly shiny,—hence probably muscular. The organ passes back as far as segment xiii, becoming much broader, and with its fellow entirely covering the dorsal aspect of the gut. Segment xiii is bulged both forwards and backwards by the swollen and curved posterior ends of the glands, these posterior ends, as said above, being joined by the vasa deferentia. The glands are of an opaque white colour, their surface is marked out by shallow depressions into slightly marked lobes, but is otherwise smooth. The organs are bulky, and with the gizzards are the most conspicuous objects on opening the worm.

Though the male apparatus and, as will be seen, the spermathecal apparatus were quite fully developed, I could find but little trace of the female organs. Ovaries and egg-sacs were absent; there appears to be an ovarian chamber, as in the previous species and in *Drawida*; rudiments of the female funnels were identified, though somewhat doubtfully.

The spermathecal ampulla is in segment viii, attached, as usual, to the posterior face of 7/8 and overarched by the nephridium; it is of ovoid shape, and is continued into a narrow duct, the coils of which project backwards into segment viii. The duct penetrates septum 7/8 near the body-wall, and, having become more transparent and difficult to follow, it joins the atrial gland on its upper border. The atrial

glands are a pair of structures in segment vii, one on each side, in shape an elongated and rather flattened ovoid, and lying obliquely in the segment so that the anterior end is more external; in the natural condition this position is probably represented by saying that the glands are flattened between the cone-like septa 6/7 and 7/8. The gland is bound to the parietes by a quantity of connective tissue; there is no trace of its being bifid; its surface is however mammillated, or composed of a number of small slightly projecting lobules. The duct is given off from the under portion of the gland; it is short, moderately stout, and opens apparently ventro-laterally on the surface,—at a rough guess, as seen from inside, about one-third of the circumference from its fellow of the opposite side.

Remarks.—When I first examined this form I had no doubt that it was a distinct species, since the large atrial gland of the spermathecal apparatus was a single undivided structure on each side; in the other species of the genus these glands are double on each side. But the dissection of the other specimens of the genus contained in the present collection has rendered necessary a revision of my first impression; as has already been seen, in one of the specimens which I refer to *M. deshayesi*, the double character of the glands was obvious, and each portion had its own stalk leading to the common atrium; in the other specimen the double nature of the glands was much less apparent, and could only be demonstrated at the cost of some damage to the glandular mass. Since therefore the division into two of the organ seems to vary in its completeness, the purely single character of the gland in the present specimen is of less importance; and since there are no other considerable differences between the two forms, it seems best to be content with establishing a variety for the present example.

Subfamily *MEGASCOLECINAE.*

Genus **PLUTELLUS.**

Parambikulam, 1700–3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen, but unfortunately immature, wanting spermathecal and seminal vesicles; the species is therefore indeterminable.

Genus **PONTODRILUS.**

Pontodrilus bermudensis, Bedd. f. **ephippiger** (Rosa).

Ennur backwater, Madras; 18-i-1915 and 21-i-1915 (*N. Annandale*). Several batches, taken on separate occasions.

Pontodrilus agnesae, sp. nov.

Horton Plains, Ceylon, 7000 ft.; in crevices of quartz. Dec., 1913 (*S. W. Kemp*). Three specimens, none complete; two of them represent the anterior end, one the posterior.

Elk Plains, Nuwara Eliya, Ceylon, 6200 ft., Dec., 1913 (*S. W. Kemp*). One complete though damaged specimen; one fragment incomplete at both ends.

External characters.—Length 65 mm., diameter (average) 1 mm.; colour dark brown. Segments 116.

Prostomium prolobous, but the groove marking off the prostomium is slight, so that the condition is almost zygolobous.

The setae are paired; $aa=2ab$, $bc=1\frac{1}{2}ab=cd$; the setae *d* are dorso-lateral, and *dd* =about $3cd$, and is approximately one-third of the circumference. In the anterior part of the body *dd* is rather greater. Setae *a* and *b* are absent on xviii.

The clitellum is a little lighter in colour than the rest of the body, and extends from $\frac{1}{2}$ xiii to $\frac{1}{2}$ xvii or over the whole of xvii=4 or $4\frac{1}{2}$. The mid-ventral region has here the form of a longitudinal groove.

The male apertures are on small papillae on segment xviii, between the positions of setae *a* and *b* which are absent here. The female apertures were not seen; in sections they were found to be paired, opening at the level of the setae of xiv. The spermathecal apertures are minute, in furrows 7/8 and 8/9, in the line *b*. There were no other genital marks.

Internal anatomy.—The internal structure was elucidated by sectioning one and dissecting another specimen.

Septa 4/5, 5/6 and 6/7 are all thin, 7/8 and 8/9 are slightly thickened, 9/10—11/12 are moderately thick, and finally 12/13 is also slightly thickened.

The pharyngeal glands appear, as usual, as deeply staining masses in sections; in iv the cells are mingled with the muscular bundles on the dorsum of the pharynx; and the mass extends backwards as far as vii. The oesophagus is straight throughout its length; it is dilated in v, but its wall is not thickened. There is no gizzard, nor any calcareous glands.

No heart was seen posterior to segment xii.

The excretory system is meganephric; the nephridia begin in xii (sections) or xiii (dissected specimen).

Testes and spermatozoa are free in x and xi. A funnel is present in xi; none were identified in x.

The vesiculae seminales are two pairs, in ix and xii, depending forwards and backwards from septa 9/10 and 11/12 respectively.

The prostates are tubular: but the condition is liable to be mistaken at first sight, both in sections and in dissection, for the compact branched form. The gland is moderate in size, and confined to segment xviii. The coils of the tube are closely pressed together, and both in sections and in the dissection resemble lobes of a *Pheretima*-prostate; but by careful manipulation the coils can be loosened from each other. The terminal portion of the duct is at first thin-walled and winding; near its ending in the body-wall it becomes stouter and more muscular.

The ovaries and funnels are in segment xiii; the oviducts pass back into xiv and open, separately from each other, at the middle of the length of the segment.

The spermathecal ampullae are ovoid or subspherical in shape; in sections they reach upwards to the dorsal body-wall. The duct is stout, narrowing towards its termination, and about half as long as the ampulla, from which it is not sharply demarcated. There is a single diverticulum, given off from the middle of the length of the duct; in shape it is elongated, spindle or club-shaped, and reaches upwards by the side of the ampulla to about half the height of the latter.

Remarks.—The above account (except the measurements and enumeration of seg-

ments) is the result of the examination of the Horton Plains specimens The specimen from Elk Plains, examined later, showed a few differences. The prostomium was small; its character was difficult to ascertain,—I thought at first it was zygolobous but afterwards concluded that it was $\frac{1}{3}$ epilobous. The clitellum extended only slightly into xvii, *i.e.*=rather over $3\frac{1}{2}$. The setal relations seemed to vary, perhaps in consequence of the uneven contraction of the surfaces in different parts of the worm; $aa=1\frac{1}{2}$-$2ab=bc=cd$ approximately. The nephridia began in xii on one side, xiii on the other. The duct of the spermathecal apparatus was relatively longer and thinner, the diverticulum smaller and attached nearer the ectal end of the duct. The prostates were destroyed by the injury to the specimen.

Genus **MEGASCOLIDES.**

Megascolides hastatus, sp. nov.

(Plate VII, fig. 9.)

Parambikulam, 1700–3200 ft., Cochin State; 16—24-xi-1915 (*F. H. Gravely*). Seven specimens.

External characters.—The specimens are of various sizes; some of the smaller ones show the porophores as well as the larger,—*e.g.* they are present in a specimen 55 mm. long and $1\frac{1}{4}$ mm. in maximum diameter.

The largest specimen measures 175 mm. in length, and has a maximum diameter of $2\frac{1}{2}$ mm. Colour grey, with a slaty tinge in places. The body is rather flattened in the anterior portion behind the genital region, and posteriorly is cylindrical. Segments 216.

The prostomium is small or invisible; where it was best seen it was epilobous $\frac{1}{2}$, and bent downwards into the buccal cavity.

The dorsal pores begin from furrow 10/11.

The clitellum extends apparently over $\frac{1}{2}$ xiv—xvii=$3\frac{1}{2}$, but is not well marked; in one specimen it was only distinguished by being of a browner colour.

The setae are paired. In front of the clitellum $aa=2\frac{1}{2}$—$3ab$, $bc=1\frac{1}{2}$—$2ab$, $cd=1\frac{1}{4}$—$1\frac{1}{2}ab$; behind the clitellum $aa=3ab$, $bc=2ab$, $cd=1\frac{1}{2}ab$; near the posterior end $aa=2ab$, $bc=cd=1\frac{1}{2}ab$; the pairing of the lateral setae is thus not very close, the interlateral setal distance being about half as much again as the ventro-lateral. The mid-dorsal interval (*dd*) is equal to half the circumference. The setae of the first twenty segments are smaller than those behind.

The male apertures are on small circular papillae on segment xviii, between the lines of setae *a* and *b*.

The female apertures are probably represented by minute white spots on xiv near the middle line, between and just in front of the level of setae *a*.

The spermathecal apertures are small, in furrows 7/8 and 8/9, in line with setae *a*.

There are no other genital marks.

Internal anatomy—Septum 4/5 is apparently present, thin and delicate, as is 5/6; 6/7 is slightly, 7/8—11/12 are moderately thickened, and 12/13 again is slightly thickened.

The gizzard is well-developed, barrel-shaped, in vi; in front of the gizzard the oesophagus is soft, dark and bulky. There are no calcareous glands; the oesophagus is dark, vascular and rather bulged in xiii—xvi. The intestine begins in xix.

The last heart is in xiii.

Micronephridia are present as large tufts at the sides of the oesophagus and gizzard, and throughout the anterior part of the body they appear as a single bush-like bunch laterally on each side in each segment, each bunch attached apparently to the body-wall by a single narrow stalk; there are none elsewhere on the body-wall, and there are no meganephridia. In the posterior segments the micronephridial tuft is still present; and in addition there is a relatively large (meganephridial) loop, intimately connected at its lower end with the tuft, which is here ventral in the segment; the loop extends dorsalwards on the body-wall nearly to the mid-dorsal line.

Testes and funnels are free in segment xi, none are present in x (confirmed on a second specimen). The seminal vesicles are one pair only, attached to the anterior wall of segment xii; they are small and grape-like.

The prostate, in the specimen first dissected, was an elongated straight, narrow and somewhat flattened ("tongue-shaped") structure with smooth borders and tapering hinder end; the duct was short, cylindrical and slightly glancing; the glandular portion extended back to segment xxi. The prostate of the second specimen however was coiled. One of the glands of the first specimen was examined microscopically; the edge of the gland, under magnification, was seen to be cut up here and there by fine incisures. Transverse sections showed a minute, more or less central, lumen, round which the cells have an epithelial arrangement; and also numerous small ducts of similar structure in the substance of the gland, which unite with the central channel; the main mass of the gland consisted of a compact tissue in which cell outlines were not visible under ordinary magnifications, but the specimen was not in good condition for histological details.

The spermathecae lie in segments viii and ix; they are of simple form. The ampulla, in the specimen in which they appeared to be best developed, was elongated and cylindrical but bent once or twice on itself. A duct can hardly be described; a single diverticulum rises from the base of the ampulla close to where it joins the body-wall; it also is cylindrical, is about two-thirds as long as the ampulla when the latter is straightened out, and about two-thirds as thick also.

Penial setae (fig. 9) are contained in a sac which, situated to the inner side of the prostate, extends back as far as segment xxii. In length they are 3—3·5 mm., in diameter (at middle of shaft) ·016 mm. They are almost straight for the greater part of their length, slightly bowed distally, and the terminal seventh is sinuous. The tip is excavated crescentically; the lateral margins of the extreme end are stouter than the central portion, which latter therefore forms a sort of web. Numerous fine sculpturings are present from near the tip to some little distance beyond the sinuous portion of the shaft; these are triangular with the point forwards; they do not seem to be spines, since they do not stand off from the side of the seta on focussing the margin; they need the oil immersion lens to be well seen.

Remarks.—This species is interesting, since it seems to show stages in the transition from the meganephric to the micronephric condition, and from the tubular to the branched prostate.

The micronephridia are here not scattered over the septa or body-wall, but arise as a single tuft from the ventral end of the meganephridia in the posterior part of the body, as if constituting a branched proliferation of the originally single nephridium.[1] Anteriorly the main portion of the nephridium has disappeared, leaving only the branching tuft. The micronephridial condition has been evolved more than once within the family Megascolecidae, and possibly therefore in different ways on different occasions. The above may represent one mode of origin; further evolution along this line might consist in the dissolution of the tuft and the scattering of the individual branches on the body-wall. The genus *Trinephrus* may represent another mode; here three such tufts may have appeared before the disappearances of the main portion of the original nephridium.

It is interesting to note that a number of micronephridial genera of the Megascolecidae (*e.g. Notoscolex, Megascolex, Pheretima, Lampito*, other species of *Megascolides* (21), as well as *Eutyphoeus* of the subfamily Octochaetinae) regularly present the tufted condition, and the attachment by a narrow stalk, in one or more of the anterior segments; these tufts, just behind the pharynx, in segments v and vi or thereabouts, are conspicuous in the ordinary dissection of the worms. Comparison with the tufted condition which exists in the present species would suggest that these "pharyngeal tufts" also are proliferations from the ventral end of a now vanished meganephridium, though the diffused micronephridia on the septa and body-wall may quite possibly have originated otherwise.

With regard to the prostates, these must be designated as tubular. At the same time the slight indentation of the margin, and the presence of branches of the main tube in the interior of the gland, seem to show a passage towards the lobed or branched condition of *Notoscolex, Megascolex, Pheretima*, etc. If Michaelsen is right in supposing that the branched prostate has arisen only once in the history of the Megascolecidae, the present form would presumably be placed somewhere near the main line of descent of the above genera.

Megascolides duodecimalis, sp. nov.

(Plate VII, figs. 10-11.)

Parambikulam, 1700-3200 ft., Cochin State; 16—24-xi-1914 (*F. H. Gravely*). A single specimen.

External characters.—Length 160 mm., diameter 5 mm.; colour a dirty grey, somewhat mottled, lighter at the anterior end. Segments *ca.* 317; segments v and vi biannular, most or all of the subsequent ones triannular; vii, viii, ix indistinctly quadriannular dorsally.

Prostomium invisible.

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[1] Michaelsen however (9, pp. 200, 202) would derive such tufts from the aggregation of originally scattered micronephric villi.

First dorsal pore in groove 11/12.

The setae are paired,—the ventral setae very closely in the anterior part of the body; they are small, especially towards the front end, and the ventral setae are not recognizable in a number of segments in front of vii; lateral setae are apparently present throughout, but they also are difficult of recognition in front of vii. In the anterior region *aa*=*ca.* 10*ab*; *bc* is about $\frac{2}{3}aa$ and *cd* about $\frac{1}{3}aa$, *i.e.* the setae of the lateral couple are separated by an interval three times as great as that between the setae of the ventral couple. Behind the clitellum *aa*=8*ab*, in the middle of the body *aa*=6*ab*, *i.e.* the pairing of the ventral setae is not so close. The setae *d* are below the lateral line of the body; *dd*=$\frac{4}{7}$ of the circumference.

The clitellum is slightly marked, and apparently extends over xiv-xvii=4. The ventral surface is here slightly flatter and smoother.

The male pores are on xviii; the ventral surface of the segment between the situation of the apertures appears as a rectangular depression. The porophores occupy the lateral walls of the depression, and so face inwards (strictly inwards and ventralwards); they are relatively small projections situated in *ab*.

The female apertures are minute, paired, on xiv, in front of the line of the setae, near each other and considerably internal to *a*.

The spermathecal apertures are small, in grooves 7/8 and 8/9, in line with *a* or *ab*.

Internal anatomy.—Septum 5/6 is slightly, 6/7—11/12 considerably thickened; 12/13 is somewhat and 13/14 slightly thickened.

The gizzard is large, globular, in segment v. I at first placed it in vi, but my attention was arrested by a baggy membrane around its posterior end; this proved to be the hinder portion of septum 5/6; the septum is closely adherent to the surface of the gizzard, but can be separated by careful dissection.

Calcareous glands are present in segments x—xiii. They are well set off, being attached to the oesophagus by a narrower portion or pedicle; they are flattened antero-posteriorly between the successive septa; their margins are rounded, and semi-circular in outline. Vascular channels radiate on anterior and posterior surfaces in a fan-like manner towards the periphery of the gland. In segment xi the seminal vesicle extends as a lobed fringe all round the margin of the gland.

The intestine begins in xvi.

The last heart is in xii.

The anterior part of the body presents micronephridia, which are situated mainly on the septa, and so appear in the dissection as a ring round the alimentary canal at the site of each septum; there are the usual large tufts behind the pharynx, in between the anterior septa. Towards the posterior end of the animal, besides a number of micronephridia which on dissecting in the usual way remain on the septa around the gut, there are distinguishable (i) a very regular longitudinal chain of micronephridia on the body-wall, between setae *a* and *b* of each segment; these might be said to be of moderate size,—large for micronephridia, though very minute for meganephridia; they are visible without difficulty by the naked eye; (ii) a similar but less regular series, with a similar relation to setae *cd*; these are about of the same size

as the preceding; some segments appear to want them, and the line of the series is not as straight; (iii) other scattered nephridia, also of the same size, further out on the body-wall, not in line with each other, and not present in every segment.

Testes could not be distinguished. Funnels however were distinguished, free in x and xi, as a minute gleam posteriorly by the side of the nerve cord in each segment (the left side only was examined, since the specimen is single).

The vesiculae seminales are small, in xi and xii. In xi, as already said, the vesicle appears as a lobed fringe round the margin of the calcareous gland; its connection with the anterior septum could not be made out,—possibly the genital products travel by the side of the alimentary canal; on the other hand it was adherent, in places at least, to the posterior septum. The seminal vesicles in both segments are dorsal, and those of opposite sides are fused over the gut, so that a single structure in each segment results; they are much cut up into small lobes, and so present a racemose appearance.

The prostates, situated in segments xviii and xix, are tubular. At their beginning (ental end) in xix they are rather coiled; the terminal portion forms a short and narrow duct. At a distance equal to about one-fourth of its length from its ectal end, the prostate is bound down to the body-wall by the sac of the penial setae which here crosses over it.

Ovary and funnel, the latter very small, were identified in xiii.

The spermathecae (fig. 10) are elongated and finger-like, with a dilated basal portion; this basal portion is smoother than the rest, which appears slightly crenulated, or rather, perhaps, marked by a number of indistinct transverse striations, due possibly to the folding of the inner surface of the wall. The finger-shaped portion is double as long as the dilated base, and may be bent on itself (three out of the four). A small spherical diverticulum arises from the basal dilatation where it joins the body-wall; in breadth it is only equal to a fourth or a third of the base to which it is attached. It contained a small glistening mass;—the specimen had therefore undergone copulation.

Penial setae (fig. 11) are present, in length ·82 mm., in breadth 14μ. The shaft is straight for the most part, curving slightly towards the free end, the tip tapering, bluntly pointed and curved slightly in the opposite direction. A few minute pointed projections, the points directed towards the base of the seta, are irregularly scattered near the free end.

Remarks.—In spite of the indistinctness of the clitellum, apparent absence of testes, and small size of vesiculae seminales, the specimen appears to be mature;—penial setae are present, as are ovary and ovarian funnel, and as noted above copulation had occurred. The appearances are possibly to be explained by the opposite supposition,—that the period of most active functioning, of the male organs at least, is over.

The condition of the nephridial system in the hinder part of the body is somewhat reminiscent of *Trinephrus*,—a genus which has not so far been found in India.

Megascolides pilatus, sp. nov.

(Plate VII, fig. 12.)

Parambikulam, 1700—3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen, incomplete posteriorly.

External characters.—Length 123 mm.; diameter 4 mm.; colour grey, mottled bluish or slaty in places, anterior end lighter, not pigmented. Probably the mottling, here and elsewhere, which occurs in rather badly preserved specimens, is due to the earth in the alimentary tube appearing through the thinned walls. Segments not counted; viii is biannular, and a number of succeeding segments triannular,—perhaps originally all, but the present specimen is much softened.

Prostomium not distinguishable.

First dorsal pore in groove 11/12.

The setae are paired; but anteriorly the lateral setae almost or quite lose the paired character, the interlateral being equal to the ventro-lateral setal interval. Thus near the anterior end $aa=2ab$; bc is only slightly greater than cd, which in turn is slightly greater than ab; in front of the male pores $aa=3\text{-}4ab$, $bc=2\text{-}3ab=2cd$; behind the male pores the setae are very small, $aa=6\text{-}7ab$, $bc=3ab=2cd$.

The clitellum was not distinguishable.

The male apertures are situated on small porophores on segment xviii in the line *ab*. An oval thickened area, slightly marked, takes up the whole of the ventral surface of xviii, extending laterally almost to the line of setae *c*, and posteriorly encroaching slightly on to the anterior part of xix. The level of the male apertures is slightly behind the middle of the length of segment xviii, so that the thickened area is symmetrical with regard to the male apertures.

The female apertures, with difficulty distinguishable, are apparently just in front of the level of the setae of xiv, on the anterior part of the second of the three annuli of the segment; they are paired, and their positions divide the interval *aa* into three equal parts, so that *a* ♀ = ♀ ♀ = ♀ *a*.

The spermathecal apertures are represented by minute papillae in grooves 7/8 and 8/9, in the line *a*.

Internal anatomy.—The whole of the internal organs were much softened. Septum 5/6 is thin, septa 6/7—12/13 probably originally considerably thickened, 13/14 less so, 14/15 perhaps slightly so, the rest thin.

The gizzard is large and spherical, in v. Calcareous glands are present, four pairs in segments x—xiii; they are rather bean-shaped, flattened antero-posteriorly, and embrace the sides of the oesophagus, to which they are attached only at their ventral ends. The attachment takes place by a narrow stalk which joins the oesophagus where it comes through the anterior septum of the segment. The hearts are applied to the outer convex edges of the glands.

The intestine begins in xvi.

The last heart is in xiii.

Micronephridia are present as considerable tufts by the side of the alimentary tube in certain of the anterior segments; elsewhere they are numerous and small,

and situated on the septa, so that in dissection they appear as a ring round the intestine at the position of each septum. The posterior end of the specimen (not the posterior end of the animal, which was lost) showed micronephridia only; a regular row of small tufts occupied the line *ab*, and these constituted the ventralmost tufts in each segment; the rest, irregularly arranged, are seated mostly on the parietes, a certain number however being connected with the septa.

Testes and funnels are small, and free in segments x and xi. The seminal vesicles are small, in xi and xii, on the anterior wall of the segment. They consist each of a double row of grape-like lobes; in other words, the attachment of each vesicle to the septum is linear, and on each side of this axis is a row of grape-like lobes; the whole is flattened against the septum.

The prostates are tubular, small and narrow, consisting of a few windings only. Each begins in xix; the terminal portion, in xviii, is straighter, slightly shiny, and runs inwards to the male aperture; though it must be called the duct, it is not narrower than the rest, and does not differ much in appearance.

The ovary was identified in xiii, but not the funnel.

The spermathecae are two pairs; they are quite small, near the middle line, are simple cylindrical or finger-like sacs,—perhaps very slightly wider at their inner end. There is no diverticulum or duct.

The penial setae (fig. 12) are in length from end to end neglecting any curves, 57 mm., and in thickness 21μ. The shaft is curved in various degrees. The free end is bayonet-shaped, the tip flattened and markedly hollowed, the edge apparently semicircular, thin and sharp. A few small irregularities or indentations may be seen on one or both margins near the distal end.

Genus **COMARODRILUS**, gen. nov.

Comarodrilus gravelyi, sp. nov.

(Plate VII, fig. 13.)

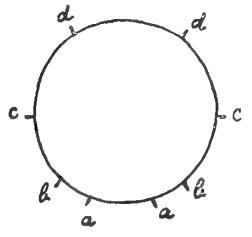
Trichur, 0-300 ft., Cochin State; 1—4-x-1914 (*F. H. Gravely*). A single specimen.

External characters.—Length 92 mm.; diameter (average) 1 mm., max. 1·25 mm., a long thin worm, constricted at the clitellum. Colour grey, no notable difference between dorsal and ventral surfaces, clitellum light brown. Segments 135.

Prostomium indistinguishable.

First dorsal pore in groove 6/7.

The ventral setae are arranged in pairs, but not the lateral setae. In front of the clitellum *aa*=approximately 2*ab*, while *c* is about and *d* much above the lateral line of the body; *bc*=2-2$\frac{1}{4}$ *ab*, and *cd* is greater than *bc*; the interdorsal distance is a little greater than the interlateral (*dd* > *cd*.) In the middle and posterior parts of the body the setae *d* are much closer together, indeed not far from the mid-dorsal line, and *dd* is obviously less than *cd*.



TEXT-FIG. 1.—*Comarodrilus gravelyi*; ideal transverse section, to show setal distribution in preclitellar region.

The clitellum covers segments xiv-xvii=4; in sections it is seen to encroach on xiii.

The male apertures are on small conical papillae which abut on each other in the mid-ventral line in segment xviii; the apertures are thus fairly close together.

The female pore or pores were not seen.

The spermathecal apertures appear as minute whitish rings, mid-ventrally in grooves 7/8 and 8/9.

A genital area (fig. 13) is constituted on segment xviii by a couple of semicircular depressions, with well-defined margins, one anterior and one posterior to the male papillae. The bases of the semicircles are at the margins of the porophores, and hence face each other. The porophores take up the middle third of the length of xviii, and the two depressions the anterior and posterior thirds respectively, extending, the anterior one to the border of the clitellum, and the posterior slightly onto xix.

Internal anatomy.—The internal anatomy was investigated by a series of longitudinal sections of the first twenty-five segments.

Septum 4/5 is present, but very thin; 5/6 and 6/7 are somewhat thickened, 7/8-9/10 considerably so; 10/11 is somewhat thickened, and 11/12 slightly.

The usual 'pharyngeal glands', deeply staining, are present in segments iv and v, projecting back over the oesophagus.

The gizzard, in v, is, at least in some degree, rudimentary; it is a very muscular portion of the oesophagus, with marked cuticular lining; this is bent on itself, and seems to have lost the usual form of a gizzard.

The wall of the oesophagus is folded, and the blood sinus extends into the folds in segments vii and viii and all the segments x—xvi; there are no proper calcareous glands.

The anterior part of the body presents the micronephridial condition; they can be recognized in all segments from ii to xii, on the body-wall, on strands of connective or muscular tissue, and on the septa by the side of the alimentary canal. But behind segment xii the micronephridia cease, and are replaced from xii onwards by meganephridia of relatively large size. The portion of the specimen which had not been used for sectioning was dissected to confirm the latter condition; only meganephridia were found, of considerable size for the size of the animal; occasionally nephridia are absent from one or both sides of a segment.

Testes were not identified, but funnels are seen free in segments x and xi; these segments also contain spermatozoa and sperm morulae. The vesiculae seminales are lobed, in segments xi and xii, attached to the posterior face of septa 10/11 and 11/12. I was unable to trace the vas deferens or to see its junction with the prostatic duct.

The prostate is confined to segment xviii, the anterior septum of which is somewhat bulged forwards by it; it forms a compact glandular mass (not a twisted cylindrical or tubular structure). The duct is strongly muscular, with a small central lumen; its first portion (after emerging from the gland) is contorted, and may be cut four times in a single section; its terminal portion is straight, and enters the conical porophore to terminate on the surface near the middle line.

The ovaries are in xiii; the oviducts and pore or pores were not seen.

The spermathecae are single in each of the segments viii and ix. The ampulla of each is ovoid with the longer axis transverse, or perhaps spherical; the sections being longitudinal, a calculation from the number of sections in which the spermatheca appears and the thickness of each section gives ·5 mm. as the breadth, while direct measurement gives ·4 mm. as the height of the ampulla. The duct is thick, in length equal to the ampulla; in one case the duct makes a considerable bend, in the other it is straighter and so shorter. The ducts are placed on opposite sides of the nerve cord, the anterior on the left, the posterior on the right; each passes underneath the cord to end in the mid-ventral line. A small diverticulum is given off from the duct near its junction with the body-wall.

There are no penial setae.

Remarks.—The combination of lumbricine setae, rudimentary gizzard, coexistence of mega- and micronephridia (with a characteristic distribution), '*Pheretima*-prostate', and unpaired spermathecae gives *Comarodrilus* a somewhat isolated position in the subfamily; and apparently the genus is without any very near relations.

The single series of spermathecae immediately recalls *Fletcherodrilus*, an Australian genus; but the coexistence of micro- with the meganephridia in the present form, and the compact, not tubular, prostate, divide the two genera rather widely. In these two characters *Fletcherodrilus* shows the more primitive, *Comarodrilus* the derived condition; *Fletcherodrilus* however cannot be the ancestor of *Comarodrilus*, since in the former the male pores also have fused in the middle line, while they are separate in the latter.

The present worm recalls *Pontodrilus* in the limitation of the meganephridia to the segments xiii onwards, and in the reduction of the gizzard. It would, however, seem to be impossible to derive *Comarodrilus* from *Pontodrilus*; nephridia have disappeared altogether from the anterior region of the latter, and according to current views of evolution they can hardly,—whether of the same or of a different type,—reappear in a descendant. There can of course, in view of the unpaired spermathecae and compact prostate of the present genus, be no question of deriving *Pontodrilus* from *Comarodrilus*.

On the whole it seems to me that *Woodwardia* must be taken as the connecting link between this form and the rest of the subfamily. *Woodwardia* inhabits Australia, Tasmania, Java, Burma (one species) and Ceylon (one species); it is characterized by a lumbricine arrangement of setae, presence of a gizzard, '*Pheretima*-prostate', meganephridia only, and, of course, the usual double series of spermathecae. In those points in which it differs from *Comarodrilus*, therefore, it shows the primitive, *Comarodrilus* the derived condition; in other words, *Comarodrilus* may be supposed to have arisen from *Woodwardia* by the substitution of micro- for meganephridia in the anterior part of the body, the reduction of the spermathecae to a single series, and some degree of degeneration of the gizzard. *Megascolides* is less suitable as a starting point, since the nephridial system is already in that genus more broken up than it is in *Comarodrilus*.

It is interesting to note, in the present form, the considerable separation of the setae of the lateral bundles, and their shifting dorsalwards,—especially the remarkably high position, near the mid-dorsal line, of the setae *d*. This may perhaps represent a first step towards the perichaetine arrangement.

Finally I may perhaps add that the single series of spermathecae presented itself to me as being possibly related to the long thin conformation of the worm,—until I looked up the dimensions of the only species of *Fletcherodrilus* (the other genus with unpaired spermathecae), and found that this has a diameter of 6—10 mm! It is true that *Fletcherodrilus* is also longer than the present form, but in nothing like the same proportion.

Genus **PERIONYX.**

In addition to two new species described at length below, examples of the genus, unfortunately indeterminable as regards the species, came to hand from the Rungneet tea estate, 4500-5000 ft., Darjiling district; Horton Plains, 7000 ft., Ceylon, in water at the base of a cardamom flower a few inches from the ground (this possibly *P. excavatus*, E. Perr.); and Kavalai, 1300-3000 ft., Cochin State.

Perionyx bainii, sp. nov.

(Plate VII, fig. 14; pl. VIII, fig. 15.)

Simla, 1½ miles below Sanjauli; 7-viii-1914 (*Baini Parshad*). Two sexually mature specimens.

External characters.—Dimensions of the larger, 50 mm. in length, 2½ mm. diameter; of the smaller 23 mm. and max. diameter 2 mm. Colour dark bluish purple dorsally, grey ventrally. Segments 94.

Prostomium epilobous ½, the posterior 'tongue' delimited by a transverse groove behind.

The dorsal pores conspicuous, begin from groove 4/5.

The setal ring is closed ventrally in the post-clitellar portion of the body; in front of and on the clitellum the ring may or may not be broken. There is a definite though small dorsal break in the ring; in front of the clitellum $zz=2yz$, behind $=1\frac{1}{2}yz$. The numbers of setae counted were vii/52, xiii/*ca.* 55, xx/56.

The clitellum extends over the 5 segments xiii-xvii; setae are present, but the furrows are almost obliterated.

The male pores (fig. 14, ♂) are on segment xviii, near the middle line, and appear as transverse cracks, each bounded at the outer end by a small tag-like papilla (*t*) (the 'tags' very slight in the second specimen). In front of and behind each aperture, near the anterior and posterior borders of the segment respectively, is a slightly curved groove, the concavity facing the male aperture; each groove is deepest laterally, shallower towards the middle line. In the second specimen the grooves of opposite sides are continuous across the middle line in front of and behind the male pores, and the whole region constitutes an oval genital field. A number of small fissures mark the surface in the vicinity of the apertures; some join the margins of

the apertures. No setae are present between the male pores; the distance included between the centres of the apertures is about $\frac{1}{10}$ of the circumference.

The female aperture is single, median, on xiv, midway between the line of the setae and the anterior border of the segment.

The spermathecal apertures are in grooves 7/8 and 8/9, surrounded by slightly whiter areas. They are considerably further apart than the male apertures,—about $\frac{1}{5}$ or $\frac{1}{6}$ of the circumference.

Internal anatomy.—The first distinctly recognizable septum is 6/7, though 5/6 appears to be slightly developed. None are thickened.

There is a smooth rounded dilatation of the alimentary tube in segment vi, but its walls are soft, and it is therefore not to be reckoned as a gizzard. There are no calcareous glands; but the oesophagus is bulged in segments x—xiii, and the bulgings are marked by a transverse striation due to vascular channels. The intestine begins in xvi.

The last heart is in xii.

The excretory system is meganephric; the nephridia are all in the same line.

The testes are free in x and xi and have the form of finger-like lobes: the funnels, in the same segments, are of relatively considerable size, folded, and not (in the specimen dissected) iridescent.

The seminal vesicles, in segments xi and xii, arise from the anterior septa of their segments. Those in xi almost meet over the alimentary canal, those in xii actually meet and fuse.

The prostates, of the '*Pheretima*' type, form a compact mass in xviii, not overstepping the boundaries of the segment, but causing the septa to bulge somewhat both in front and behind. The duct is almost straight, is moderately stout and short, and has a transverse direction from the middle of the gland to its termination.

Ovaries and ovarian funnels, both of considerable size, occupy the usual position.

The spermathecae are two pairs, large, and situated in segments viii and ix; the anterior pair, in the specimen examined, were larger than the posterior. The ampulla is a regular ovoid in shape; the duct is stout (in the posterior pair almost as thick as the ampulla), and about equal in length to the ampulla, from which it is marked off by a constriction. There is no diverticulum.

Penial setae (fig. 15) are present, in length 1 mm., and in breadth, at the middle of the shaft, 20μ; they form a considerable group, of six or more on each side. The shaft is straight except for a slight curve towards the distal end; this end shows a very slight bulbous swelling immediately proximal to the extreme tip, which is bluntly pointed. There are about eight rings of spines around the free end; the individual spines are of moderately large size.

Remarks.—The present species appears to come nearest to *P. koboensis* Stephenson (21), from which it is distinguished by the more anterior position of the first dorsal pore, the greater extent of the clitellum, the closer approximation of the spermathecal apertures, the presence of two instead of three pairs of vesiculae seminales,

and other minor characters such as the complete absence of a gizzard and the much smaller number of rings of spines on the penial setae.

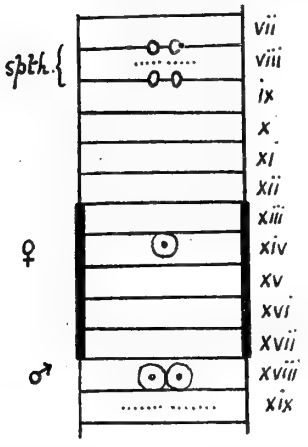
Perionyx millardi, sp. nov.

Malabar Hill, Bombay; 1914 (*W. S. Millard*). Three specimens, in bad condition, much softened.

External Characters.—Length 60-75 mm., diameter 2 mm.; colour a deep purple dorsally, brown ventrally, with a fairly sharp demarcation between the two colours. Segments 126.

Prostomium epilobous $\frac{1}{2}$—$\frac{2}{3}$, the lateral grooves converging behind, but the tongue included between them not closed behind by a transverse groove.

Dorsal pores begin from 4/5 or 5/6.



Text-fig. 2.—*Perionyx millardi*; diagram of genital region, a few setae shown on segments viii and xix to indicate the relative position of the neighbouring apertures.

The setae are in rings, the rings being broken in the mid-dorsal and mid-ventral lines, though the gaps are small,—largest ventrally in the preclitellar region, where *aa*=2*ab* or perhaps rather more. The setae were very difficult to count, owing to the small size of the worm, and to its dark colour forming a background against which the setae were almost or quite invisible; in segment vi there are about 40, and the same in xxi.

The clitellum embraces segments xiii—xvii=5.

The male apertures are on xviii, on small papillae, close to the middle line; they are small round pores, not slit-like.

The female aperture is single, in a considerable round pale patch on xiv.

The spermathecal apertures, in grooves 7/8 and 8/9, are fairly conspicuous round apertures, very near the middle line,—about as near each other as the male pores, and in line with the second seta (seta *b*).

Internal anatomy.—It is impossible to give any details of the septa.

There is a trace of a gizzard, apparently, in segment vi; shining longitudinal muscular bundles were seen in the softened walls of the oesophagus. The intestine begins behind the prostates.

The last heart is in xiii.

The meganephridia are all in the same line.

Male funnels were identified in x and xi; seminal vesicles are present in xi and xii. The prostates are compact masses of moderate size, taking up the whole of segment xviii; the duct runs transversely inwards.

The female organs have the usual position.

The spermathecae, in viii and ix, are of considerable size; the ampulla is of an irregular ovoid shape, the duct is short and narrow, and there are no diverticula.

Penial setae are present, in length ·65 mm., and 18μ in diameter. The curve towards the free end and the slightly bulbous swelling close to the bluntly pointed tip

are an almost exact counterpart of the appearances in the foregoing species. The number of circles of spines is perhaps rather greater (9-10), and the spines themselves are apparently a little smaller and more numerous; but the similarity of the setae in the two species is very striking.

Remarks.—This species happened to present itself for dissection almost immediately after the foregoing; and I was naturally much struck by the great similarity of the penial setae. I was tempted to unite them in the same species, notwithstanding the wide distance between their respective habitats; and it may possibly still be true that they should be considered as varieties only of a single species. A more extended knowledge of Indian earthworms, which may result in the discovery of intermediate forms, may decide the matter. I made a complete dissection of two specimens and in addition examined the external characters of a third of the present batch, with the result that the differences between this form and the last may be said to consist in the much closer approximation of the spermathecal apertures in the present form, the position of the last heart in xiii instead of xii, the short narrow spermathecal duct, and the simple form of the male apertures.

Genus **LAMPITO.**

Lampito mauritii, Kinberg.

Ennur, Madras, under bricks on sandy soil in garden; 20-i-1915 (*N. Annandale*). One large and five small specimens.

Genus **MEGASCOLEX.**

Megascolex nureliyensis, Mich.

Horton Plains, 7000 ft., Ceylon; dug from earth; Dec., 1913 (*S. W. Kemp*). Three specimens.
Same locality, under stones and logs; same date and collector. A single specimen

A full description need not be given; but the following points may be of interest for comparison with the original description of the species.

The mid-dorsal setal interval is irregular,—zz=2-3yz, and the intersetal distances are also irregular. Ventrally there is a difference in the setal relations between the preclitellar and postclitellar regions; in the former aa is slightly greater than ab,—up to $1\frac{1}{2}ab$; behind the clitellum it is considerably greater,—aa=2-3ab. I could not confirm the details of the original description regarding the diminution of intersetal intervals and size of setae on passing outwards from the middle line; but the enlargement of the ventral setae on a number of anterior segments appears to be a character worth mentioning; those of iii or iv to viii or ix are enlarged, while those of x may be noticeably small.

The clitellum may be absent in fully sexual specimens; in any case it seems to be indefinite in extent,—perhaps xiii-xvii=5, and marked only by a more pronounced purple colour on the dorsal surface.

The gizzard is in vi (in two specimens dissected).

Testis-sacs enclose not only the testes and funnels, but the alimentary canal and hearts also, in segments x and xi. On opening the worm, a thin membrane is

seen, stretching as a second roof over these segments; the organs only come into view after tearing through the membrane and liberating a large amount of flocculent matter.

The seminal vesicles vary in their distribution. In one of the dissected specimens there were four pairs, in segments xi-xiv; those in xi were contained within the testis-sac; those in xii were the largest; in xiii and xiv they were small. In the other they were found in xii only. The vesicles are attached to the anterior septum of the segment, and are of a somewhat pyriform shape, the lower end being the broader. The tapering upper end curves inwards towards the middle line; their surface is finely mammillated all over, or mammillated in the upper, smooth in the broader lower portion.

The prostates extend back to the posterior septum of segment xxiii, or in the second specimen to xxv. They lie on the intestine and almost or quite conceal it from view.

The penial setae were 1·6—2 mm. in length. I could not see any reason for supposing that the concave margin of the curved distal end of the seta was sharp rather than, as usual, rounded.

Remarks.—This species must, according to the finding of these specimens, be removed from the small number of species which have the gizzard in segment vii (Michaelsen, 12).

Megascolex singhalensis, Mich.

Horton Plains, 7000 ft., Ceylon; under stones and logs. Dec., 1913 (*S. W. Kemp*). A single specimen.

A few notes will be sufficient, for comparison with the original description.

Prostomium epilobous $\frac{4}{5}$, almost tanylobous, the tongue not delimited posteriorly by a transverse groove.

Dorsal pores are present, the first in groove 5/6.

The dorsal break in the setal rings is irregular; in front of the clitellum *zz* is about equal to 3*yz*; behind, about 2*yz*. Ventrally, in front of the clitellum the break is small, practically absent anteriorly, increasing just in front of the clitellum so that here $aa=1\frac{1}{3}ab$; behind the clitellum $aa=2ab$ very regularly. The setae of segments iv-viii are very large, those of ix and x smaller but still larger than those of succeeding segments. In the segments behind the clitellum only, *ab* is greater than the succeeding intersetal intervals, but the difference is not great. I did not notice any progressive diminution in the size of the setae on passing lateralwards from the mid-ventral line. The numbers counted were:—vi/39, xii/*ca.* 40, xix/*ca.* 46, more posteriorly *ca.* 50.

There were a pair of genital papillae, small and whitish, in the situation of furrow 18/19, a little outside of and just posterior to the porophores.

The gizzard was in segment vi, partly at least, and probably wholly; but I could not be sure that the very delicate septum 6/7 was not attached round the gizzard itself; in this case the gizzard would be partly in vii.

The testis-sacs are exactly similar to those described in the preceding species.

The penial setae, of the form described by Michaelsen, are here considerably shorter than in his specimens,—measured across the curve they are just under 3 mm.

Remarks.—With regard to the position of the gizzard (said in the original description to be in vii) Michaelsen (12) has already suspected that it might prove to be in vi.

Megascolex escherichi, Mich. var. **papillifer,** var. nov.

(Plate VIII, fig. 16.)

Horton Plains, Ceylon, 7000 ft.; under stones and logs; Dec., 1913 (*S. W. Kemp*). Numerous specimens.

Same locality, date and collector; in jungle paths. Four specimens.

This interesting species has recently been described by Michaelsen (12). There can, I think, be no doubt about the specific identification of the present specimens; but the presence of genital papillae, and especially the coexistence of "meganephridia" along with micronephridia, give them a peculiar interest. I append a description of the external characters, together with a few remarks on points in the internal anatomy.

External characters.—Length 55 mm., max. diameter 3 mm.; colour dorsally a brownish purple, deepest anteriorly, but of varying depth in different specimens, grey ventrally; position of setal ring marked by a white line. Body slightly flattened dorso-ventrally. Segments 121.

Prostomium epilobous $\frac{1}{2}$, the dorsal process (tongue) cut off or not by a transverse groove behind; segment i divided ventrally by a longitudinal cleft.

First dorsal pore in 5/6; none seen anterior to 11/12 in another specimen.

The setal ring presents a mid-dorsal break,—$zz=2\text{-}2\frac{1}{2}yz$. Ventrally the ring is almost closed, $aa=1\frac{1}{2}ab$. The numbers counted were:—v/36, xiii/40, xix/40, more posteriorly 44.

Clitellum xiv—xvii=4, distinguishable only by being of a redder tinge.

The male pores are small, close together on xviii, in the middle of an oval slightly raised whitish patch (fig. 16) which encroaches forwards on xvii, but not always backwards on xix. The surface of the patch may be marked by one or more of the following grooves:—a transverse, near its anterior border, a similar groove near its posterior border, and a median longitudinal joining the two former.

Female apertures as in the original description.

Spermathecal apertures minute, quite close to the middle line, in 6/7, 7/8 and 8/9.

A genital papilla may or may not be present in groove 19/20; or occasionally two, in 19/20 and 20/21. The papillae are small, transversely oval, whitish, and situated rather to one side of the middle line, never mid-ventrally. Of twenty-four specimens examined, there were no papillae in 5 (of these perhaps two were not fully mature), there was one on the left side in 9, one on the right in 9, two both on the right (*v.* fig. 16) in one.

Internal characters.—The gizzard is partly in segment vi, septum 6/7 being attached round its anterior part, behind its anterior third. The gizzard appeared to me rather soft, but not in any degree rudimentary.

There are considerable tufts of micronephridia by the side of the alimentary tube in segments v-ix; and micronephridia are thinly scattered over the body-wall throughout. The remarkable feature is the presence, in addition, of a large nephridium on each side from segment xvii backwards; these have however no connection with the septa. On opening the specimen and pinning out in the usual way they appear as wavy or curled tubes, emerging on each side from under the intestine, and extending outwards on the body-wall for a distance equal to half the diameter of the intestine or less. Their ventral ends are as a matter of fact only just covered by the intestine in this position, as may be seen by drawing the intestine slightly to one side. Towards the posterior end of the body these nephridia are smaller though still easily visible to the naked eye; they may here be absent on one or both sides, or there may be more than one minute tuft.

The anterior male organs are proandric, with testis-sac and a single pair of seminal vesicles, as described by Michaelsen.

In the first batch of specimens, the spermathecal diverticulum was longer than in the original account of the species, finger-shaped and of equal thickness throughout, not stalked. In the second, while the shape of the diverticulum was more like that of the type form of the species, main duct and diverticulum were attached quite separately to the body-wall.

The spines of the penial setae are more numerous than in the original (6-7 rings), and do not stand off so much from the shaft; the truncated distal end is narrower.

Remarks.—Here again the dissection shows that the gizzard is at least not wholly in segment vii; the small number of forms which (constantly at any rate) possess this peculiarity is thus still further diminished.

In may be noted that the spermathecal apertures are not here fused in the middle line, as in the original.

Megascolex campester, sp. nov.

(Plate VIII, figs. 17-18.)

Horton Plains, Ceylon, 7000 ft.; in jungle paths; Dec., 1913 (*S. W. Kemp.*) Three specimens.

External characters.—Length 60-74 mm., maximum diameter 4 mm.; colour dark slate, only slightly lighter on ventral surface and over first few segments. Segments 139.

Prostomium epilobous $\frac{1}{2}$—$\frac{2}{3}$, the posterior process delimited behind by a transverse groove.

Dorsal pores begin in groove 5/6, and are present on the clitellum.

The setal rings are situated on a whiter line round each segment. Ventrally the ring is closed, or almost so; dorsally there is a short interval, so that $zz=2yz$. The intersetal distances are rather greater dorsally than elsewhere, and are narrowest laterally. The numbers counted were:—v/46, ix/*ca.* 50, xiii/48, xix/50, and in the middle of the body *ca.* 47.

The clitellum extends over segments xiii—xvii=5. It is purple in colour, in one

specimen mottled with lighter spots; indeed this colour difference is the only means of distinguishing it.

The male pores are on segment xviii; they are small, each in the middle of a whitish oval depressed area, the two areas being united across the middle line by a tract of whiter colour than the regions in front and behind. In front of and behind each aperture is a slight groove. The pores are distant from each other $\frac{1}{5}$—$\frac{1}{6}$ of the circumference, and lie in line with setae *f*, or *fg*.

The female pores were perhaps rather doubtfully recognized as a couple of minute pale spots close to the middle line in segment xiv, in the line of the setae.

The spermathecal apertures are three pairs, inconspicuous, marked also by a slight whitening of the posterior border of the intersegmental grooves 6/7, 7/8 and 8/9; they are in line with seta *g*.

In one of the three specimens there were a pair of small, oval, whitish and scarcely raised flat genital papillae, internal and posterior to the male apertures, in groove 18/19; in the other two specimens these were represented only as slightly lighter patches.

Internal anatomy.—The first septum is 4/5, from which backwards the series is complete. None are notably thickened.

The gizzard is large, firm, barrel-shaped, in vii.

The oesophagus is dilated in x on the right side only, and in xi, xii, xiii on both sides; the swellings are not set off from the alimentary canal, but have a striated appearance, due to a series of transversely arranged lamellae.

The intestine begins in xiv.

The last heart is in xiii.

The nephridial system here again shows a combination of mega- and micronephridia. The micronephridia are very numerous and minute, on the inner surface of the whole body-wall; at the anterior end they are very noticeable on the dorsal wall of the pharynx and buccal cavity around the cerebral ganglion.

Commencing from segment xx there are larger nephridia also; but in calling these meganephridia I do not wish to imply that they are necessarily different in kind from the smaller micronephridia. These larger nephridia are not, at first, present in all segments or always on both sides of the same segment; the series becomes more regular further back. At the posterior end there is a difference; the number of the small micronephridia is still large, but the larger nephridia, much more opaque, and obviously of far greater calibre, standing out distinctly on opening the worm and easily visible to the naked eye, are more numerous. There are usually two on each side in each segment and sometimes three; each is a small coil of a few turns or loops, without any connection with a septum.

Testes and iridescent funnels are present in segments x and xi, enclosed in testis-sacs. The sacs of one side communicate with those of the other underneath the alimentary canal; and the anterior sac of each side with the two anterior seminal vesicles, the posterior with the two posterior.

The seminal vesicles are four pairs, in segments ix, x, xi and xii. Those in ix

are attached to the posterior wall of the segment, those in the other three segments to the anterior walls. All are of moderate size, situated laterally in the segment, and not nearly meeting over the alimentary canal; the edges are produced into a number of small rounded lobules.

The prostates are flattened lobed structures, which do not constrict the alimentary tube at all; they occupy segments xviii-xix or xviii-xx. The duct, relatively stout, almost straight, shining, and of equal diameter throughout, leaves the gland in segment xix and runs forwards and inwards.

The ovaries are large and branching, in xiii.

The spermathecae (fig. 17) are three pairs. The ampulla varies in form; it may perhaps be described as roughly pear-shaped, with narrow end internal, and broader end at its junction with the duct. The duct is also pear-shaped, but in the reverse direction, so that the broad ends of ampulla and duct join each other, and are separated by a marked constriction. The duct is more regular in shape than the ampulla; it is as long and, at its broad end, about as wide as the latter, but it becomes much narrower at its ectal end. A small diverticulum arises from the outer side of the duct, not far from its junction with the ampulla; the diverticulum is stalked, and dilated at its free end, in which a few chambers can be indistinctly seen. A number of micronephridia invest the broad portion of the duct.

The penial setae (fig. 18) are in maximum length 1·7 mm., in breadth at the middle of the shaft ·02 mm.; the shaft is almost straight, with a slight curve distally; it does not become notably slenderer till close to the tip. Owing to the curve of the shaft, the setae are always seen on the slide from one of two aspects; the appearances on focussing up and down, however, indicate that the tip is flattened in one plane, and ends in two projecting points with an incisure between. There are a few,—perhaps half a dozen,—irregular rings of fine sculpturings near the free end, which are not resolvable into distinct spines under the oil immersion lens.

Remarks.—This species seems to be closely related to *M. brachycyclus* (Schmarda), from which however it differs in colour, in the greater interval between the male pores and spermathecal pores, in the distribution of the copulatory areas, in the shape of the penial setae and the characters of the spermathecal duct. The peculiar nephridial condition also would, I think, certainly have been mentioned by previous investigators if it were present in *M. brachycyclus*; but in view of what has been found in *M. escherichi* var. *papillifer* (*v. ant.*) this by itself would not necessitate a separation.

Michaelsen (12) suspects that *M. brachycyclus* may prove to have the gizzard in segment vi, not vii as stated. In this, a near relative, however, the gizzard was in segment vii.

Megascolex bifoveatus, Stephenson.

Horton Plains, Ceylon, 7000 ft.; in jungle paths; Dec., 1913 (*S. W. Kemp*). Two complete sexual specimens, with some fragments.

Same locality; under stones and logs; same date and collector. Seven specimens, mostly fully mature.

This species was recently described by me (20) from Pattipola, Ceylon. I give below an account of the external features of the present specimens, which differ somewhat from those of the type, together with a few additional notes on the internal anatomy.

External characters.—Length 48-80 mm., maximum breadth 2-2½ mm.; colour grey with a purplish tinge on the anterior half of the dorsal surface, and a purple mid-dorsal line, clitellum browner. Segments 100—126.

Prostomium epilobous ½; 'tongue' cut off behind by a transverse groove.

First dorsal pore in groove 4/5.

The setae are arranged in fairly regular longitudinal rows. The ventral break in the continuity of the rings diminishes backwards: in front of the clitellum aa= 2-2½ab; in middle of body = 1½ab; towards the posterior end the ring is closed. Dorsally, in the anterior and middle regions zz=1½-2yz, posteriorly the interval is small and irregular. The setae are small and difficult to count:—v and vi/ca. 34, ix/38, xii/38, in middle of body 36 or 38.

Clitellum as in previous description, xiv—xvi=3; in one specimen extended over posterior two thirds of xiii also.

The male apertures, in xviii, on whitish round papillae, the bases of which take up the greater part of the length of the segment. Their position corresponds to line *c*; there are no setae between the apertures.

The female apertures are in a transversely extended whitish area on xiv, probably paired and in front of setae *a*,—though they could not be made out distinctly.

The spermathecal apertures, in 7/8, 8/9, have their centres in *e*.

While in the second batch of specimens the genital markings appear as pits (as in the type, whence the specific name), in the first batch they were not depressed, though on the other hand scarcely elevated. They were here a pair of oval, almost circular, patches, flat, darker in colour in their centre, situated in 19/20 rather internal to the line of the male apertures,—their centre being just outside *b*, and their whole transverse extent from *a* to between *c* and *d*.

Internal anatomy.—The first septum is 4/5; thereafter all are present; 12/13 and apparently a variable number in front of and behind this are slightly to moderately thickened.

In segment vii is the gizzard, which does not take up the whole of the interval between the septa. In the anterior part of vii the alimentary canal is dilated, soft and transparent; in the posterior half its character suddenly changes, and it becomes a gizzard, though a somewhat rudimentary one,—short and cylindrical, ending abruptly in a thickened ring at the posterior limit of the segment, and bulging back septum 7/8 considerably. The gizzard is not, as usual, obvious on first opening the animal, but is seen only on looking for it by displacing segment 7/8.

Here again the nephridial system is of considerable interest. Micronephridia are few or absent on the inner surface of the body-wall in front of the clitellum; they are thickly present on the ventral half of the body-wall in the clitellar segments, and are also numerous behind the clitellum. In addition, in specimens of each of the two

batches there were present behind the clitellum larger nephridia. These were most closely examined in a specimen of the first batch; they were present, one on each side of most if not all segments, as a wavy or twisted tube in the lateral region, and in relative size about as large as those described (*v. ant.*) for *M. escherichi* var. *papillifer*. At the posterior end of the animal there were, easily visible to the naked eye, two or three nephridia on each side of each segment, sometimes attached, sometimes not, to the anterior septum; with the dissecting binocular a larger number of minute micronephridia, previously invisible, came into view.

Since these larger nephridia were not mentioned in my original account of the worm, I asked for and obtained, through the kindness of Dr. Annandale, permission to re-examine the type of the species. The actual type specimen is mutilated posteriorly; there are no larger nephridia in the anterior part of the body, where it had been opened in the previous dissection; but on opening the specimen at its hinder end (probably corresponding to a place rather behind the middle of a complete worm) some of the nephridia (*i.e.* micronephridia) in each segment were found to be larger than the rest:—not one only, and the difference in size was in some cases relatively considerable.

The second specimen of the original batch, hitherto undissected, was also opened in its posterior portion for nearly half its length. Where this dissection begins, there is one larger nephridium on each side per segment (sometimes only on one side); these are considerably larger than the rest, and consist of a number of coils, in marked contrast to the micronephridia which consist of single tiny loops;—still they are not more than half as large, relatively to the other structures, as those of *M. escherichi* var. *papillifer*. Passing backwards, they very soon become smaller, and in the posterior third of the body increase in number, there being frequently two on each side. At the posterior end they are quite small, though still very obviously distinguishable from the numerous minute nephridia among which they lie.

The remaining organs present no considerable differences from the original description.

Remarks.—It may be taken as established that the present species is one of the few belonging to the genus *Megascolex* which have the gizzard in segment vii; furthermore, it is actually in the posterior part of vii, thus approaching in this respect more nearly to the condition in *Pheretima* than, perhaps, any other species of the genus. There are however no testis-sacs.

It is interesting to compare the condition of the nephridia in the several specimens with those in the preceding species. It does however not seem possible here to distinguish a "meganephric" variety.

I append a brief note on a specimen, found along with the example of *M. nureliyensis*, which represents perhaps a mere abnormality, but possibly a distinct variety:—Length 64 mm, diameter $2\frac{1}{2}$ mm. Epilobous $\frac{1}{2}$, tongue not cut off behind. First dorsal pore in 5/6. Male apertures on small, slightly elevated whitish papillae, with their centres a little external to line *c*; spermathecal apertures with their centres in *fg*, if not in *g*. The two pits however constitute the chief difference; they

are in 18/19 instead of 19/20,—oval depressions with whitish margins, their centre just internal to *b*, the whole pit extending from *c* to *a* or a very little further inwards.

The gizzard takes up the posterior three-quarters of segment vii, and vii being a segment of considerable length the gizzard is thus of some size, certainly larger than in the former specimens; it is cylindrical, rather soft, but harder in its hinder than in its front part. The micronephridia are fairly numerous in front of the clitellum: behind the clitellum there can often be distinguished larger tufts, but these are not regularly present in each segment, are not visible to the naked eye and have to be searched for under the binocular; they would certainly not have been remarked in an ordinary dissection. The shape of the spermathecal ampulla was irregular in some cases, and in one case the diverticulum was bifid; the short stout duct is fairly well marked off from the ampulla. Penial setae as before.

Megascolex hortonensis, sp. nov.

(Plate VIII, figs. 19-20.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). A single specimen, injured near the anterior end.

External characters.—Length 72 mm., maximum diameter 3 mm.; colour light grey throughout. Segments 141.

Prostomium prolobous.

Dorsal pores begin from groove 8/9 or in front of this (the injury obscures this region).

The setal rings are broken dorsally and ventrally; $zz=2yz$, but as the setae are not very numerous the interval is actually of fair extent; ventrally $aa=2\frac{1}{2}ab$. The setae are larger in the anterior part of the body in front of segment viii, and are also somewhat enlarged again at the hinder end. They are arranged in fairly regular lines, especially *a*, *b* and *c*, but not in pairs; $ab=2\frac{1}{2}bc$. The numbers are iv/20, v/20, vii/22, xiii/22, behind clitellum 24, and in the posterior part of the body 28.

The clitellum extends over segments xiv-xvi = 3. It is smooth, of the same colour as the rest of the body, with very slight indications of the intersegmental grooves; the setae are just visible in places, but dorsal pores are absent. It is delimited at both ends by a very definite constriction.

The male genital area (fig. 19) is an almost rectangular thickened patch, taking up the ventral surface of xvii, xviii and ½xix. In this area are distinguishable—(*a*) a pair of conical pointed penis-like projections (*pen.*), somewhat compressed antero-posteriorly, near the lateral border of xviii, and slightly behind the middle of the length of the segment; (*b*) a pair of circular depressions (*pit*), one on each side of the middle line, on the anterior part of xviii, internal to and slightly in front of the pores, near each other, and connected together by a transverse crack; (*c*) a pair of flat oval areas (*pap.*) at the postero-lateral corners of the rectangle, scarcely raised above and yet sufficiently well marked off from the rest of the field. No setae are visible on the male area. The penes are about ⅓ of the circumference apart.

The female aperture is single on xiv, appearing as a small depression about the middle of the length of the segment.

The spermathecal apertures are one pair, in furrow 8/9; they are fairly widely separated, perhaps about $\frac{1}{3}$ circumference (the injury to the specimen prevents an exact computation).

A thickened genital area includes nearly all the ventral surface of segment viii. This area is limited anteriorly by the furrow 7/8; its lateral limits are also definite; but posteriorly, where it extends on to the anterior part of ix, its hinder margin is not well defined. The spermathecal apertures are near the lateral limits of this area. A pair of slightly darker oval, almost circular, patches, in the posterior half of viii, are included in this area; the patches are not raised above the general surface; the outer border of each is in line with the spermathecal aperture.

Internal anatomy.—I am unable to state whether any septa exist in front of 6/7; from this level backwards all are present, and all as far as about 13/14 are slightly thickened.

The subspherical gizzard is in vi. The intestine begins in xix. No calcareous glands were seen.

The last heart is in xiii.

The excretory system is micronephridial.

Large transversely elongated funnels are present in x and xi. The seminal vesicles, in xi and xii, are lobulated, and those of a pair meet dorsally over the alimentary canal.

The prostates, of moderate size, are flattened and compact in appearance, and occupy xvii and xviii. The duct is shining, moderately stout, almost straight, and of equal diameter throughout.

Ovaries and funnels are present in xiii.

The spermathecae (fig. 20) are a single pair. The ampulla is of an elongated ovoid shape; the duct is short and relatively wide,—$\frac{1}{3}$—$\frac{1}{4}$ as wide as the ampulla; the single diverticulum is finger-like and about as broad as the duct, from which it arises near its termination at the body-wall; in length the diverticulum is two-fifths of the conjoined ampulla and duct.

There are no penial setae.

Remarks.—The present species appears to be related to *M. willeyi* (Michaelsen, 10, 12); from which however it is distinguished by the setae, the number and form of the spermathecae, the character of the genital areas, and the absence of penial setae.

Megascolex kempi, sp. nov.

(Plate VIII, fig. 21.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). A single specimen.

External characters.—Length 44 mm., diameter 2 mm.; colour grey, clitellum rather lighter than the rest. Segments 115.

Prostomium prolobous. Dorsal surface flattened, with a slight groove along the middle in the middle and posterior thirds.

The dorsal pores begin from groove 6/7, and are present on the clitellum.

The setal rings are broken dorsally and ventrally, $aa=2ab$, $zz=2yz$. The setae are in regular longitudinal lines, but are not grouped in pairs; $ab=bc$. The ventral setae are larger in the anterior part of the body, and at the posterior end they are again larger than in the middle. In front of the clitellum the setae are 12 per segment, *i.e.* 6 on each side (on some of the most anterior segments apparently only 4 or 5 on each side), behind the clitellum the ring consists of 16.

The clitellum extends over xiv—$\frac{1}{3}$xvii=$3\frac{1}{3}$. It is smooth, without setae, distinctly limited at each end.

The male pores are on xviii, on relatively large conical papillae, in line with *b*, and distant from each other rather more than $\frac{1}{4}$ of the circumference.

The female pore is a minute pit, single, on xiv.

The spermathecal apertures are inconspicuous, in groove 8/9, in line with *b*.

A genital area is present on segment xii, a transversely oval, mesially situated, relatively large flat papilla; its general colour is whitish, its central portion darker. It is defined sharply behind by groove 12/13; it extends slightly at its rather indefinite anterior margin on to xi, obliterating the mid-ventral portion of groove 11/12. Its transverse diameter is about twice its longitudinal; it extends laterally as far as the line *b*; setae *a* are prominent on it.

Internal anatomy.—Septum 4/5 is doubtfully present; 5/6 is very thin. No septa are markedly thickened, though all from 6/7 as far as the prostates appear somewhat thicker than those behind; but degrees of thickness, when slight, are not easy to estimate in such a small worm.

The gizzard is in vi, well developed, barrel-shaped. No calcareous glands were seen.

The last heart is in xiii.

Large tufts of micronephridia are present at the sides of the alimentary canal in front of the gizzard; and behind the clitellum there are regular transverse rows in each segment.

Testes and funnels are free in x and xi. Seminal vesicles are present in xi and xii, on the anterior wall of the segment; those in xi are small, and consist of a few rounded lobules; those in xii are larger grape-like masses, which nearly meet above the oesophagus in the middle line.

The prostates are conspicuous rectangular masses, only slightly incised into lobes; they cause a considerable constriction of the intestine; they occupy segment xviii, and by bulging back septum 18/19 appear to extend through xix also. The duct is short, relatively narrow, almost straight, shining, and of equal diameter throughout.

The female organs are normal in position.

The spermathecae (fig. 21) are one pair, lying in segment ix. The ampulla is much elongated, fusiform in shape; the duct is very short and narrow. A single diverticulum is given off from the base of the ampulla; it is finger-shaped, two-thirds to three-quarters as long and half as wide as the ampulla.

There are no penial setae.

Megascolex varians, Mchlsn. var. **insolitus**, var. nov.

(Plate VIII, figs. 22-23.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). Six specimens, all mature.

External characters.—The size varies; two of the specimens are considerably larger than the rest. Length up to 70 mm., maximum diameter 3 mm.; colour light grey, both dorsally and ventrally. Segments 111.

Prostomium prolobous. Dorsal pores begin from 6/7; they are just visible on the clitellum.

The rings of setae are broken dorsally and ventrally; dorsally in front of the clitellum $zz=2\text{-}2\frac{1}{2}yz$, behind $=3\text{-}3\frac{1}{2}yz$; ventrally, in front of the clitellum $aa=2\frac{1}{2}ab$, behind $=3ab$ and more posteriorly $=4ab$. The setae of segments ii-vii are enlarged. The lines of setae *a* and *b* are very regular, and setae *a* and *b* are larger than the others of the same segment. As to the intersetal intervals, $ab=bc>cd$, *de*, etc.; the intervals after the first few are more irregular.

The clitellum, extending over xiv—xvii $=4$, is smooth, and marked off by constrictions at each end.

The male apertures, on xviii, are small, round, and situated on slight papillae which are partly surrounded by grooves in front and behind. They are distant from each other about $\frac{1}{5}$ of the circumference, and are situated in line with setae *b*. There is no wall external to the apertures.

The female pore is single, but in a very anomalous position,—on segment xv, instead of on xiv as is the universal rule throughout the Megascolecidae. The aperture is rather in front of the line of the setae, in a slightly depressed darker area. The anomalous position was found in all six specimens.

The spermathecal apertures are a single pair, in groove 8/9, in line with *b* and distant from each other one quarter of the circumference.

The only constant genital papilla is one on segment xii; this is oval, its long axis transverse; it presents on its rather flat surface a darker coloured oval ring; it takes up the whole length of the segment from 11/12 to 12/13, and is not quite symmetrical about the middle line (rather to the right in the type specimen, with its centre in *a*). In one of the specimens an additional papilla of the same kind is present on segment xx, in this case in the middle line, extending from beyond the line of seta *a* on one side to a corresponding point on the other; in another specimen, along with the papilla on xii one is present on xiii, but on the opposite side.

Internal anatomy.—The anterior septa are very thin, and apparently incomplete; thus 5/6, the first, seemed to be wanting on the right side, and 6/7 was perhaps partly wanting on the right side also; in another specimen these two septa were not noted at all. Septum 7/8 is quite thin; 8/9, close behind the former, is slightly thickened; 9/10 is considerably thickened. From this, which is the stoutest of the septa, the thickness diminishes progressively, but so slightly that even at the level of the prostates the septa are in some degree stouter than those behind.

The gizzard is large, stoutly barrel-shaped; septum 5/6 appears to be inserted on to it, so that it would be partly in v and partly in vi; but the extreme tenuity of the anterior septa renders an exact determination difficult.

There are no definite calcareous glands; but paired ovoid swellings of the oesophagus, not marked off from the main tube, are present in segments xiv—xvi and, less marked, in xvii; these show transverse vascular striations on their surface. The intestine begins in xviii.

The last heart is in xiii.

The excretory system is micronephridial. There is a large tuft on each side of the posterior part of the pharyngeal mass, but none on the body-wall in the region of the gizzard or in front; from this point they are few till the clitellum is reached. In the clitellar region they are thickly set, and behind this they form a transverse line in each segment behind the anterior septum.

The testes and iridescent funnels are free in x and xi. The vesiculae seminales, in xi and xii, are attached to septa 10/11 and 11/12, and are racemose in form, consisting of a number of small globular or ovoid lobules.

The prostates are lobulated, rather small, confined to xviii or extending into xix; the duct is narrow, almost straight, and transverse in direction.

The ovaries are large, flattened and plate-like, in xiii; the funnels are in the same segment. The oviducts pierce septum 13/14, converge underneath the nerve cord, and, meeting, enter the body-wall just in front of the line of attachment 14/15,—practically in that line.

The spermathecal apparatus (fig. 22) varies, even on the two sides of the same specimen. The ampulla is large, somewhat ovoid, and delimited from the duct by a slight constriction; the duct, which may either be fully as long as, or considerably shorter than the ampulla, is stout, and narrowest at its outer (ectal) end. The diverticulum, arising from the duct near its junction with the body-wall, is long,—longer than ampulla and duct together, cylindrical and bent on itself; in width it is about equal to the duct.

The penial setal sacs are remarkable for their enormous length; they stretch back to be attached in segment xxvi. The setae themselves (fig. 23) are 5 mm. long, and 27μ in thickness near the tip. They are nearly straight, the free end slightly expanded, transversely cut across, and thinned in the middle, so that the condition is that of a web stretching between the two limbs of a fork. A number of spines, of fair size, project somewhat from the distalmost portion of the shaft; the spines have no regular arrangement.

Remarks.—The only case of the female pore or pores opening on segment xv, according to Beddard, is that of *Libyodrilus* (Geoscolecidae) (2, p. 102), where however dissection "shows that the septum dividing the fourteenth and fifteenth segments lies behind the point of opening of the ducts," and the abnormal position of the external opening is due to non-correspondence of septa and external grooves (3).

The propriety of the specific name is illustrated by a comparison of the above

account with previous descriptions. Like *M. varians* var. *simplex*, the present form has only one pair of spermathecae.

I may add here that I am now of opinion that my *M. annandalei* (20) is to be identified with the var. *simplex* of the present species; in view of the range of variation in this species the differences I formerly described are not sufficient to entitle the single specimen I had at my command to separate recognition.

Megascolex sextus, Stephenson.

(Plate VIII, fig. 24.)

Pattipola, 6200 ft., Ceylon; under rotten wood, etc. Nov.-Dec., 1913 (*S. W. Kemp*). A single specimen.

The species was recently described by me (20) from a single specimen, also obtained at Pattipola. I was at first inclined to separate the present specimen as a distinct variety, on the ground of differences in the genital markings, penial setae, and certain minor points. But since this is only the second specimen of the species that has come to hand, we have as yet no knowledge of the amount of variation that occurs; the present collections have shown me, however, that the limits of variation in the Ceylon and S. Indian species of *Megascolex* are wide, and it is at least probable that the comparatively slight differences between the present and the former specimen will be bridged in the future.

The following notes of the present specimen are given for comparison with the previous description.

Number of setae 50/v, 50/ix, 52/xii, 46/xix, and in the middle of the body 46.

A pair of genital papillae are present in groove 18/19; these are small, almost circular, eye-like, and in line with but smaller than the papillae of the male pores.

The first distinguishable septum is 6/7; none are noticeably thickened. The gizzard, barrel-shaped and comparatively soft, is as previously found, in vii. The intestine begins in xv.

The micronephridia are in two rows per segment, one in front of and the other behind the line of the setae.

A dorsal connection of the testis-sacs of the two sides was not made out; but they approach each other over the gut near the middle line.

The spermathecae, in vii and viii, open (as in the original) in 6/7 and 7/8; the diverticulum here arises from the middle of the length of the duct.

The penial setae (fig. 24) are 1 mm. long, and 15/ broad at the middle of their length. The shaft is straight in its proximal two-thirds; in its distal third it has a wavy outline, of two successive gentle curves. The tip is curved through a quadrant, and sharply pointed. About ·08 mm. from the point a slight swelling marks the situation of a ring of tooth-like sculpturings, which however do not stand off as spines from the surface; a little proximal to this is a second swelling or irregularity on the shaft, with more rudimentary sculpturings; and there may, further along, be a sign of a third.

Remarks.—The species belongs to the small group in which the gizzard is undoubt-

edly in segment vii, and which also possess testis-sacs. The possession of two pairs of spermathecae opening in 6/7 and 7/8 is noteworthy.

Megascolex polytheca, sp. nov.

(Plate VIII, fig. 25.)

Kavalai, 1300—3000 ft., Cochin State; 24—27-ix-1914 (*F. H. Gravely*). Two specimens.

External characters.—Length 160—250 mm., maximum diameter $3\frac{1}{2}$ mm.; colour a uniform grey except at the anterior end, which is darker with a purplish tinge. The anterior part of the body as far as segment xi is stout, firm and cylindrical; but the anterior half of the animal behind the genital segments is rather depressed, with a mid-dorsal groove. Segments (of the shorter specimen) 264; the setae on v—xi are implanted on raised circular bands,—especially so in the middle segments of this series, which have thus an indistinctly triannulated appearance.

Prostomium proepilobous in one specimen; in the other epilobous $\frac{1}{2}$, with the hinder end of the 'tongue' open, but an indication of a transverse groove at the front end of the tongue.

Dorsal pores begin in groove 4/5.

The setal rings are almost closed dorsally; in front of the genital region $zz = 1\frac{1}{2}yz$ on the average; behind, $zz = 1\frac{1}{4}yz$ or the ring may be quite closed. Ventrally the interval is larger; in front of the genital region $aa = 3ab$, behind the male apertures $= 4ab$, or further back as much as $5ab$; $ab > bc$. Setae *a* and *b* are in regular longitudinal lines, and are larger than the other setae; *c*, *d*, and *e* may also be arranged in fairly regular lines behind the genital region. The setae of the preclitellar region are smaller and more numerous than those behind; the numbers counted were 54/ix-53/xiii, *ca.* 46/xix, and 46—48 more posteriorly.

No clitellum was distinguishable.

The male apertures, in xviii, are situated on circular white papillae which take up nearly the whole length of the segment; the pores themselves are in *bc*.

Female apertures were not distinguished.

The spermathecal apertures, in grooves 7/8 and 8/9, are numerous. On separating the lips of the groove a row of white points, 6—9 in number on each side, are seen; these begin internally between the lines *b* and *c*, the intervals between the successive points are rather greater than the intersetal intervals. Each white dot corresponds to a spermatheca, is of an opaque glistening appearance, and is surrounded by a small darker area. The actual numbers in each row were 6, 8, 8 and 9.

Internal anatomy.—The shorter specimen was dissected, as being possibly more mature. Septum 4/5 seems to be represented, though very delicate; 5/6 and 6/7 are slightly thickened, 7/8—11/12 considerably so (7/8—9/10 most of all), and the following one or two are slightly thickened.

The barrel-shaped gizzard is in segment v. There are no calcareous glands; the oesophagus is dilated, deep yellow, and vascular in xii, and there are similar but rather smaller swellings in xiii and xiv; all are marked by large transversely directed

bloodvessels. The intestine begins in xix, after the alimentary tube has escaped from the compression of the prostates.

The last heart is in xiii.

The excretory system is micronephridial.

The testes were not identified; funnels were present, free in x and xi. The seminal vesicles, attached to the anterior walls of xi and xii, are cut up into small ovoid lobules like bunches of grapes.

The prostates, in xviii, are of moderate size, and cause the septa 17/18 and 18/19 to bulge forwards and backwards respectively; they consist of a number of small lobes closely compacted together. The duct is short, shining, stout, and even further widened near its termination.

The ovaries are of comparatively large size, composed of parallel finger-like lobes, and break up at their free ends into moniliform strings of ova.

The spermathecae (fig. 25) are small and numerous, and correspond to the white dots seen externally. Each is a club-shaped organ, with a long stalk, and the internal end dilated to a greater or less degree; they are disposed more or less parallel to each other in a closely set row, their dilated inner ends directed backwards. The length varies,—up to 1 mm.; the breadth at the wider end is about ·2 mm. Examined in glycerine, the wall is seen to be moderately thick, the greater part of its thickness due apparently to a tall columnar epithelium (*ep.*); in the ectal portion (duct) the lumen is narrow, a chink only; the bulbous portion contains a transparent mass (*x*) which nearly fills it, leaving a space (*cav.*) at the inner end.

There are no penial setae.

Var. **zonatus**, var. nov.

(Plate IX, fig. 26.)

Parambikulam, 1700—3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen.

External characters.—Length 110 mm., diameter 2·75 mm.; colour a medium grey, with darker mid-dorsal groove over greater part of length; clitellum rather browner. Segments 145.

Prostomium epilobous $\frac{1}{2}$, the longitudinal grooves bounding the 'tongue' converging behind, but the 'tongue' not cut off posteriorly by a transverse groove. No appearance of secondary annulation in the anterior segments.

First dorsal pore in groove 5/6.

The dorsal and ventral interruptions in the setal rings differ a little from the type form; thus dorsally in front of the clitellum $zz=2\frac{1}{2}$-$1\frac{1}{2}yz$, diminishing backwards, while behind the clitellum $zz=2$-$1\frac{1}{2}yz$, ultimately diminishing so that near the posterior end the ring is closed. Ventrally, in front $aa=2\frac{1}{2}$-$3ab$, behind the clitellum $=3\frac{1}{2}$ ab, and the same towards the posterior end. The setae of the pregenital region are on the whole smaller than the rest; *a* and *b* are not larger than the other setae, and are not in regular lines; *ab* is not regularly greater than *bc*. The numbers (counted on the two sides) were:—22+23/ix, 21+24/xiii, 18+21/xix, and further back 14+21, 20+18.

The clitellum extends from xiv to nearly the hinder end of xvii, and thus includes nearly 4 segments; it is well delimited in front and behind, rather narrower than the neighbouring segments, smooth, and shows setae and dorsal pores.

The male pores are on small whitish papillae on xviii in line with setae *b*; the surface between the apertures is depressed.

The female pore is single, mid-ventral in xiv, just in front of the line of the setae.

The spermathecal apertures are similar in appearance to those of the type form; in number they are 4 or 5 on each side of each groove (7/8 and 8/9); they begin in *ab* or *b*, and are continued outwards at intervals corresponding about to the intersetal distances.

Internal anatomy.—This agrees closely, on the whole, with that of the type form. The prostatic duct has a somewhat wavy course; its terminal portion is notably broader.

The spermathecae (fig. 26) are 4, 5, or 6 on each side in each of the two segments. Here an ampulla can be distinguished from a duct in each; the ampulla is ovoid, the duct is cylindrical, rather longer than and about half as wide as the ampulla. In most cases there is also a diverticulum, from the terminal portion of the duct, in form slightly club-shaped, glistening, and in length from half as long to nearly as long as the duct; the cavity of the diverticulum is simple. The diverticulum may be wanting; this happens in the outermost spermathecae of three of the four rows (in the row of six the outer two spermathecae lack a diverticulum).

There are no penial setae.

Remarks.—Though not uncommon in the Glossoscolecidae, the possession of numerous spermathecae in a single segment is rare in the Megascolecidae,—indeed is apparently found only in a few species of *Pheretima*.

The more important differences between the type form and the variety are the following:—in the former, setae *a* and *b* are larger than the rest, and the setal interval *ab* is greater,—characters which are not found in the variety; the number of setae is greater in the type form; the variety has a clitellum, the type form not; the number of spermathecae is smaller in the variety, an ampulla and duct are differentiated, and a diverticulum is usually present.

Megascolex kavalaianus, sp. nov.

(Plate IX, fig. 27.)

Kavalai, 1300–3000 ft., Cochin State; 24–27-ix-1914 (*F. H. Gravely*). A single mature specimen.

External characters.—Length 57 mm., maximum diameter 1·5 mm.; colour pinkish grey, the anterior end purplish, clitellum grey without the pink tinge. Segments 94.

Prostomium epilobous $\frac{1}{2}$, small, folded downwards into the mouth aperture.

First dorsal pore in groove 5/6.

The dorsal break in the setal ring is small, $-zz=2\,yz$; ventrally $aa=4ab$ in front of the clitellum, $=3ab$ behind, and further back $3\frac{1}{2}ab$. The setae are often small and difficult to see. The numbers counted were 40/ix, 38/xii, *ca.* 32/xix, and in the middle of the body approximately 28, but the number is not constant.

The clitellum extends over $\frac{1}{2}$xiii—$\frac{3}{4}$xvii = $4\frac{1}{4}$; it is well delimited in front and behind, is slightly swollen, shows the dorsal pores, and setae are just visible on it.

The male apertures appear as minute white dots each in the centre of a circular slightly raised area. These areas touch each other in the middle line, and take up the greater part, about two-thirds, of the length of segment xviii; they are white with a darker centre. The pores are in the transverse line of the setae, in a position corresponding to seta *b*; the areas are void of setae.

The female aperture is single, a minute dot in a small shallow depression in the line of the setae of xiv.

The spermathecal apertures are minute, in grooves 7/8 and 8/9, near the middle line, approximately in *b*.

There were no other genital markings.

Internal anatomy.—The first septum is 4/5; none are noticeably thickened.

The gizzard is barrel-shaped, of considerable size but soft, in segment vi. The oesophagus is bulged in xv, xvi and xvii, with transverse vascular striations; on opening this portion, small folds are seen projecting into the lumen. The intestine begins in xix, behind the prostate.

The excretory system is micronephridial; the nephridia are relatively few and scattered,—most numerous on the body-wall in the clitellar segments.

The last hearts are in xiv; these are smaller than those in xiii.

Testes and funnels are present in x and xi (testes not identified in the latter segment). Vesiculae seminales are attached to the posterior surface of septa 10/11 and 11/12; they are racemose in form and each meets its fellow above the oesophagus.

The prostates are confined to xviii; they are cut up into lobes which are tightly compacted together. The duct runs straight inwards to open near the middle line; its first part is narrow, the rest stout; it has the usual shining appearance.

The ovaries are large, with moniliform branches. Ovisacs are present in xiv, on the anterior septum, each containing six to twelve eggs. I satisfied myself that these were not a second, abnormal pair of ovaries; they are sessile on the septum, and all the contained ova appear to be of full size.

The spermathecae (fig. 27) are two pairs, in viii and ix. The ampulla is of a flattened ovoid shape. The duct is well marked off from the ampulla, is moderately wide, and about $\frac{1}{3}$—$\frac{1}{2}$ the length of the ampulla. The diverticulum is given off from the termination of the duct; it is a long and narrow glistening tube with a slightly dilated inner end; it is longer than the ampulla, and when laid alongside it may reach beyond the ampulla for a distance equal to the length of the ampulla itself, but its length varies.

There are no penial setae.

Remarks.—The presence of an additional pair of hearts beyond what is usual and the existence of egg-sacs, are peculiarities which mark out the present species as occupying an isolated position in the genus.

Megascolex phaseolus, sp. nov.

(Plate IX, figs. 28-29.)

Parambikulam, 1700-3000 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Three specimens, two incomplete posteriorly.

External characters.—Length 180 mm., maximum diameter 3 mm.; colour grey, with a bluish tinge in parts; clitellum olive. Segments 270.

Prostomium small, bent downwards into the opening of the mouth, proepilobous or epilobous $\frac{1}{3}$.

Dorsal pores begin from groove 5/6.

The setal rings are broken dorsally and ventrally. In the preclitellar region dorsally the setae were difficult to see; immediately behind the clitellum $zz = 3yz$, further back $= 2yz$, in the middle and hinder parts of the body $= 1\frac{1}{2}yz$. Ventrally the interval is small in front of the clitellum, $-aa = 2ab$ or less; behind the clitellum and in the middle of the body $aa = 4ab$, and posteriorly rather less, about $3ab$. The setae are closer together ventrally than dorsally and laterally, and in front of the clitellum those on the dorsal and lateral surfaces of the body are arranged in pairs, the pairs separated by a considerable interval. The numbers counted were:—34/v, 35/ix, 36 (16+20)/xii, 38/xix, and 26—28 in the middle of the body. The intersetal intervals in the middle of the body are very irregular.

The clitellum extends over xiv—xvii = 4; it is smooth, and limited by constrictions in front and behind; setae are not visible, but there is an indication of dorsal pores.

The male genital field (fig. 28) is characterized by a kidney-shaped elevation (*b*) placed transversely across segment xviii, with its concavity directed backwards; this elevation is surrounded by a groove or valley, around which again is a more or less elliptical raised ring (*w*), with a cleft behind in the middle line, *i.e.* behind the 'hilus' of the kidney-shaped elevation; the 'ring' is narrower in front than behind. The whole area as described above takes up the length of segment xviii, and may slightly encroach on xvii; laterally it includes the whole of the ventral surface.

The male apertures appear as oblique slits, or it may be little more than points, on the ring-like elevation, near the median cleft in the latter, and behind the concavity in the margin of the kidney-shaped cushion. From the apertures a groove may lead forwards and outwards, on one or both sides, crossing the valley between ring and included cushion, and ending on the latter.

The female pore is single, just in front of the line of setae of segment xiv.

The spermathecal apertures, in 7/8 and 8/9, are minute and close to the middle line, in *a* or between *a* and *b*.

In one specimen only there was present on the anterior part of segment xix a median papilla (*p*, fig. 28), the posterior border of which was semicircular, and caused the line of setae to bend backwards; the anterior border, situated at groove 18/19, was flatter.

Internal anatomy.—Septum 4/5 is present but very thin; 5/6 is also thin, 6/7—13/14 are all somewhat thickened.

The gizzard is well developed, ovoid, situated in segment v. There are no calcareous glands. The intestine begins in xix, behind the prostates.

The last heart is in xiii.

There are numerous small micronephridia.

Testes were not identified; from the presence of iridescent masses in x and xi, they and the funnels are doubtless contained in these segments. The vesiculae seminales, comparatively small, racemose in form, depend from septa 10/11 and 11/12 into segments xi and xii.

The prostates, in xviii, are relatively small; they form somewhat flattened masses, roughly circular in outline, and are much cut up into small lobes tightly compacted together. The duct is relatively stout, shining, almost straight, its terminal portion slightly widened.

The female organs have the usual position.

The spermathecae (fig. 29) are two pairs, in segments viii and ix. The ampulla is elongated and cylindrical, and passes without sharp demarcation into the duct, which is as long as the ampulla. The diverticulum, given off from the duct where it enters the body-wall, is elongated and club-shaped; and lying alongside the duct, it reaches as far as the base of the ampulla.

There are no penial setae.

Megascolex filiciseta, sp. nov.

(Plate IX, figs. 30-31.)

Parambikulam, 1700—3000 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Three specimens.

External characters.—Length 63-70 mm., diameter 2-3 mm.; colour dorsally bluish grey behind, purplish in front, a purplish tinge also at the extreme posterior end, ventrally a slaty grey; a fine dark mid-dorsal stripe, better marked posteriorly. Segments 118.

Prostomium epilobous $\frac{1}{4}$, dorsal process delimited behind by a transverse groove, the process itself marked by a median groove.

The first dorsal pore is in groove 5/6.

The setal rings are broken dorsally; $zz = 2yz$,—a little less ($1\frac{1}{2}yz$) in the most anterior segments, a little more ($3yz$) for some distance behind the genital region. Ventrally the ring is closed in the anterior segments as far back as xi; the interval soon becomes and remains of moderate extent,—$aa = 2\frac{1}{2}ab$; *a* seems as a rule smaller than the other setae, and *ab* on the average less than *bc*. The setae are not arranged in regular longitudinal lines. The numbers are 33/v, 41/ix, 18+19/xii, 20+22/xix, and in the middle of the body 36 or 38.

The clitellum extends perhaps over xiv—xvi = 3; it was only marked by the presence of a little flocculent mucus between the cuticle and the epidermis.

The male apertures are inconspicuous, on very small porophores, on segment xviii, between the lines *a* and *b*. The regular circle of setae begins outside the porophores with seta *c*.

The female aperture or apertures were not seen.

The spermathecal apertures are minute and close to the middle line, in grooves 7/8 and 8/9.

Internal anatomy.—Septum 5/6, the first, is extremely delicate, 6/7 is also delicate, 7/8 slightly and 8/9—11/12 moderately thickened, 12/13 and 13/14 again slightly thickened.

The gizzard, well developed and barrel-shaped, is in segment vi; it is preceded by a dark, soft-walled, dilated and crop-like portion of the oesophagus There are no calcareous glands. The intestine begins in xv.

The last heart is in xiii.

The excretory system is micronephridial; but its peculiarities merit a short description. In each segment the nephridia,—one might almost say the nephridium,—appear on either side as a bushy tuft attached by a narrow base, as numerous twigs springing from a common stem, or sometimes radiating from a common centre. The tufts of successive segments form a regular longitudinal series; there is no connection with the septa. The tufts begin in front just behind the pharynx, where they are large structures lying at the sides of the oesophagus, between the successive cone-shaped septa. Some distance behind the clitellum it may be possible to distinguish a dorsally (laterally as the parts lie in the dissection) directed loop which is rather larger than the rest; towards the posterior end this loop gains an increased prominence, but it still has no attachment to the septum; no funnel could be seen microscopically in tufts from either anterior or posterior regions, but I can scarcely regard this observation as conclusive.

Testes and funnels are free in x and xi; seminal vesicles, small, lobed and flattened, in ix and xii, on the posterior and anterior walls of these segments respectively.

The prostates are small, flattened, confined to xviii, the margin lobed; the duct was not visible as a separate structure.

The ovaries are in the usual situation.

The spermathecae are small, and probably not fully developed; they are situated close by the side of the nerve cord in segments viii and ix; the ampulla is ovoid, and no duct is distinguishable; the diverticulum, half as long as the main pouch, arises with the latter from a common base on the parietes.

The penial setae (figs. 30, 31) are characteristic. They are 1·3 mm. in length as measured along the base of the arc, and 22μ in diameter. The shaft is bent to form a bow and it tapers towards the distal end, the tip being slightly recurved. On each side of the tip is a row of straight stout teeth, arranged like the pinnae of a fern; the longer of the teeth are fully 20μ long and 5—6μ in breadth. The number of teeth on each side is from 8 to 16; the smallest number was found in a seta in which the tip was free from the sac (fig. 30), the largest in a very young seta, where only this portion had been formed (fig. 31).

Remarks.—The specimens were probably not fully mature, and the description of the spermathecae, and perhaps the prostate, may prove to be defective. The curious penial setae, which will permit recognition of the species, and the interesting nephri-

dial condition, determined me to give the above description. The condition of the nephridia may be compared with that in *Megascolides hastatus*.

Megascolex cochinensis, sp. nov.

(Plate IX, figs. 32-33.)

Forest tramway, mile 10-14, alt. 0-300 ft., Cochin State; 28—29-ix-1914 (*F. H. Gravely*). Two specimens.

External characters.—Length 175-220 mm., diameter 4 mm.; colour an equable light grey, nonpigmented. Segments 224.

Prostomium epilobous $\frac{1}{3}$—$\frac{1}{2}$, the 'tongue' being cut off behind.

The dorsal pores begin in groove 5/6.

The setal rings are broken; dorsally $zz = 2yz$, ventrally $aa = 2ab$ or rather more in front of the clitellum, and $= 3ab$ behind it. The setae are closer together ventrally; the intersetal intervals are not very regular, so that the setae are not arranged in longitudinal series. The numbers counted were 41/v, 54/ix, 57/xii, 48/xix, and in the middle of the body 36 and 38.

The clitellum, extending over xiv—$\frac{2}{3}$xvii ($= 3\frac{2}{3}$), is smooth; setal rings and dorsal pores are present on it.

The male pores (fig. 32) on segment xviii, are elongated wavy slits, obliquely disposed, their posterior ends nearer the middle line than their anterior. These slits are situated each on a white oval elevation, the long axis of each elevation being oblique and corresponding with the slit, so that the hinder ends of the elevations approach one another, or almost touch in the middle line. Around and between these oval papillae the surface is depressed and darker; and surrounding the whole is a well defined wall, the 'moat' between papilla and wall being deepest anteriorly (fig. 32). The centres of the male apertures are about $\frac{1}{1\frac{1}{2}}$ of the circumference distant from each other.

The female aperture is indicated by an oval patch with its long axis transverse, whitish in colour, mid-ventrally situated in the line of the setae of xiv; its lateral extent is from *a* to *a* or slightly more.

The spermathecal apertures are transverse slits with distinct anterior and posterior lips, in 7/8 and 8/9, in line with *a*; each is surrounded by a small area rather darker in colour than the surroundings.

Internal anatomy.—Septa 4/5 and 5/6 are thin, 6/7—11/12 moderately and 12/13 –13/14 slightly thickened.

The gizzard, in v, is large and barrel-shaped. There are no calcareous glands, but the oesophagus is swollen and vascular in xii, xiii and xiv. The intestine begins in xix.

The last heart is in xiii.

The excretory system is micronephridial. There are the usual tufts, here very large, by the side of the oesophagus behind the pharynx, and similar tufts are continued backwards between the successive cone-like septa for some distance behind the gizzard. In the clitellar region the nephridia appear as bushy tufts, about six in

number, in a transverse row on each side in each segment (xv, xvi, xvii). There are no nephridia on the parietes in front of the clitellum; behind, however, they are very numerous and very small, and form a transverse band (not a single line of nephridia) between the row of setae and the anterior septum of the segment.

Testes and funnels are free in x and xi. The seminal vesicles, moderately large masses resembling bunches of grapes, are in xi and xii, attached to the anterior septum.

The prostates are limited to xviii, and consist of a mass of small roundish lobules closely packed together into a solid-looking mass. The muscular duct, wider at its termination than at its beginning, passes straight inwards.

Ovaries, with moniliform branches, and funnels are present in xiii. An additional pair of small ovaries but no funnels were seen in xiv.

The spermathecae (fig. 33) are two pairs, in viii and ix. The ampulla is ovoid in shape; the duct is as long as the ampulla and less than half as wide. The diverticulum, arising from the termination of the duct, is club-shaped; in length it reaches to about the middle of the length of the ampulla, *i.e.* is nearly $\frac{5}{4}$ as long as duct and ampulla together; its cavity is simple.

There are no penial setae.

Remarks.—The present species has no marked peculiarities, except the form of the male genital field; it is difficult therefore to assign it to any definite position within the genus, but it may perhaps be allied to *M. insignis* Mchlsn. (12).

Megascolex konkanensis, Fedarb var. **longus,** var. nov.

(Plate IX, figs. 34-35.)

Parambikulam, 1700-3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Two specimens, with perhaps a posterior fragment of another.

External characters.—Length 345-570 mm., maximum diameter 3 mm. in one, 4 mm. the other. They are thus extraordinarily long and (relatively) thin worms. The anterior end does not taper, but appears as if suddenly cut off; the front portion of the body is flattened, but behind the first third it becomes cylindrical, and much narrower (about 2 mm. only). Colour grey, with in parts a bluish or slaty mottling. Segments of longer specimen, estimated, after counting the anterior third, 550; of the shorter, estimated, after counting the anterior half, 400.

Prostomium bent downwards within the buccal cavity; proepilobous, with in addition two short longitudinal grooves continued backwards a little distance on the dorsal surface of the first segment.

First dorsal pore in furrow 5/6.

The setal ring is broken dorsally, in front of the clitellum, so that $zz = 3yz$ approximately, but the ratio varies, not so much on account of the width of zz as of that of yz, which is irregular. Behind the clitellum the break is absolutely and relatively less, so that $zz = 1\frac{1}{2}yz$; further back the ring is closed dorsally. Ventrally, in front of the clitellum $aa = 2ab$; behind, $aa = 3\frac{1}{2}ab$ ($3ab$ to $4ab$ at various parts).

The setae in front of the clitellum are mostly very small; the ventral setae of xii—xvii are enlarged, and the interval *ab* is greater than *bc* (= $1\frac{1}{2}bc$). This relation between *ab* and *bc* is continued backwards for a considerable distance; there is no constant difference between *bc*, *cd*, *de*, etc. The numbers counted were :—16+16/v, 16+17/xii, 15+15/xv, 16+16/xix, behind the clitellar region 14+16, and 18+19; at the end of the first third of the body 30, and in three segments near the posterior end of the body 28, 29 and 30.

The male apertures, on segment xviii, are situated apparently (the actual pores being unrecognizable) on a pair of transversely oval papillae, placed towards the lateral parts of the segment, with their centres in or not far from the line of setae *d*. These papillae are connected across the middle line, the whole having the outline of an elongated dumbbell, and being surrounded by a darker area of corresponding shape.

The female aperture is minute, single, on xiv, in the line of the setae.

The spermathecal apertures are small, in 7/8 and 8/9, in line with setae *d*, or between *d* and *e*.

In one of the two specimens there was a curious shifting back of all the genital apertures; the female to xvi, the male to xx, the spermathecal to grooves 9/10 and 10/11; and the latter were in line with *b* or *bc*.

Internal anatomy.—The gizzard is in v.

The prostates (fig. 34) are small, confined to xviii; the septa are not bulged at all. The whole has a bushy appearance, since the gland is divided up into a large number of lobules, of various shapes from spherical to finger-shaped. The duct passes straight inwards; it is soft, slightly glistening, thin in its first and bulged in its terminal portion.

The ampulla of the spermathecal apparatus (fig. 35) is a rather elongated oval. The duct is half as wide, and one and a half times as long as the ampulla. The diverticulum, full of glistening spermatozoa, and given off from the termination of the duct at the body-wall, is small, club-shaped, and half or less than half as long as the duct, alongside which it lies.

Remarks.—Michaelsen has recently (12) redescribed this species, having had at his disposal more than 100 specimens belonging to 16 captures from 14 localities. Out of this number the longest specimen measured 415 mm. and consisted of about 370 segments; these figures may therefore probably be taken to represent pretty nearly the extreme limits reached by that particular form. Consequently, when one out of two specimens here described exceeds the previous maximum length by nearly two-fifths, there is ground for supposing that we are dealing with a different variety, one of the distinguishing marks of which is a greater size. Other distinctions are to be found in the single female aperture (though this was originally stated by Fedarb for her specimens), shape of spermatheca, and smaller size of prostate; as well as, perhaps, the absence of a clitellum (though copulation had occurred, as evidenced by the glistening mass of spermatozoa in the spermathecal diverticulum), the differing details of the male genital field, and larger number of setae in the hinder region.

Genus PHERETIMA.

Pheretima heterochaeta (Mchlsn.).

Simla, 1½ miles below Sanjauli; 7-viii-1914 (*Baini Parshad*). Two specimens.
Horton Plains, 7000 ft., Ceylon; dug from earth; Dec., 1913 (*S. W. Kemp*). Three specimens.
Pattipola, 6200 ft., Ceylon; under rotten wood, etc. Nov.-Dec., 1913 (*S. W. Kemp*). Two specimens.
Cherrapunji, Assam, 4400 ft.; 2—8-x-1914 (*S. W. Kemp*). Four specimens.

Pheretima posthuma (L. Vaill.).

Allahabad; Dec., 1914. A few specimens sent by Dr. Woodland; said to be common in the neighbourhood.

This species is referred to in the introduction.

Pheretima lignicola, Stephenson.

Malabar Hill, Bombay; 30-x-1914 (*W. S. Millard*). Five specimens, soft and in bad condition.

This species was previously described by me (21) from the Abor country. The correspondence between the present specimens and the previous description is close; since however I had then only a single specimen at my disposal, which was necessarily handled with care, I subjoin here a few additional notes.

External characters.—Length 165 mm., diameter 6½ mm.; colour a dark brownish purple dorsally, but pure brown after stripping off the iridescent cuticle; brown ventrally; clitellum lighter brown. Segments 130.

Male apertures large, pit-like, on xviii, distant from each other $\frac{2}{7}$ of the circumference. The margins of the pits are whitish, swollen and puckered, and much less well defined on the inner side.

Female aperture single, small, in a transversely oval, dark, moderately shallow but conspicuous pit, on xiv about the middle of its length.

The small spermathecal apertures, surrounded by whitish lips, are approximately in line with *f*.

The numbers of setae counted were 33/v, 45/ix, 56/xii, 64/xix.

Internal anatomy.—Septum 4/5 is definitely present, and slightly thickened. Septum 10/11 is attached to the parietes at the level of the setae of xi; 11/12, 12/13 and 13/14 are also all attached behind the level of the corresponding intersegmental grooves.

The intestine here begins in xvi, and the diverticula originate in xxvii; these latter are simple, finger-shaped, and extend forwards through xxvi and xxv.

I am able to give a better account of the anterior male organs than in the first description. The testes and funnels are enclosed in sacs, those of segment x being small; funnels, but not testes, were distinguished within them; they are situated on the anterior face of septum 10/11, and probably communicate with each other across the middle line below the alimentary canal. The sacs in segment xi were larger, separated by the alimentary canal between them, and contained both testes and funnels, as well as the anterior seminal vesicles, which depend backwards from septum

10/11; the testis-sacs in xi extend over the whole length of the segment, from 10/11 to 11/12, and do not communicate with each other either above or below the gut.

The spermathecal ampulla is rather heart-shaped, the duct leading off from the broad end. The duct is fusiform, narrower at its two ends and swelling gently in its middle portion; it is $\frac{1}{2}$—$\frac{2}{3}$ as long as the ampulla. The narrow tubular diverticulum, arising from near the termination of the duct, is nearly as long as duct and ampulla combined; it may be twisted; it is broader and rather mammillated towards its free, and narrower and smoother towards its attached end.

There are no penial setae.

Subfamily *OCTOCHAETINAE*.

Genus **ERYTHRAEODRILUS**, gen. nov.

Erythraeodrilus kinneari, sp. nov.

(Plate VII, fig. 8.)

Castle Rock, Bombay; 17-x-1913 (*S. H. Prater*). Three specimens.

External characters.—The specimens were much softened; one had apparently autotomized itself, and another almost so. Length 120 mm., maximum diameter $3\frac{1}{2}$ mm.; colour brown, with an iridescent appearance due to the cuticle,—rather darker in the anterior part of the body, and the ventral surface slightly lighter than the dorsal. Segments 90+22 = 112.

Prostomium apparently prolobous.

The first dorsal pore is in groove 3/4; pores are absent on the clitellum.

The setae are in rings; they are small, and there are no notable differences in size or in the intersetal intervals; they are present on the clitellum. The mid-dorsal and mid-ventral intervals are about the same in both anterior and posterior parts of the body,—$aa = 1\frac{1}{2}ab$ throughout, and $zz = 2$-$3yz$. The numbers of setae were vi/46, ix/53 approx.; xiv/43, xix/40.

The clitellum covers $\frac{1}{2}$xiii—$\frac{2}{3}$xvi = $3\frac{1}{6}$; it is darker in colour than the rest of the animal.

The male apertures are on segment xvii, behind the setal ring, and fairly near each other, in about the line of setae *cd*; this is equivalent to an interval of about $\frac{1}{7}$ circumference. In the specimens first examined, the pores, on small whitish papillae, were situated at the postero-lateral angles of a rectangular glandular area which took up the whole length of xvii; in the other two specimens the glandular area was not visible, though in one there was an elevation between the two papillae.

The female aperture is single, mid-ventral, on xiv, in a small whitish oval area between the line of setae and the anterior border of the segment.

The manner of opening of the spermathecae will be described later.

Genital markings vary in the several specimens. In one there are on segment xviii a pair of small rounded papillae, situated posteriorly in the segment between

the setal ring and groove 18/19; the centres of these papillae are very slightly internal to a line drawn through the centres of the papillae of the male pores. These papillae were not present in the other two specimens; but in one of these there were seen a couple of oval patches with a whitish circumference and dark centre, situated near the posterior border of segment vii,—each small, with its centre in line with seta *e*; as well as a single eye-like marking in groove 16/17 just internal to the line of the male papilla of the right side.

Internal anatomy.—The septa are all very thin and transparent,—a condition which is no doubt due partly to the bad state of preservation; still it seems safe to say that none are notably thickened. The series of septa is complete from 4/5 onwards.

The gizzard is an ovoid mass in vi. The calcareous glands are four pairs, set off from the oesophagus, in segments x—xiii, the glands in x and xi are smaller than the others. Each gland receives its blood from a very distinct branch of a supraoesophageal trunk. The intestine begins in xv or xvi.

The last heart is in xii; the dorsal vessel can be followed forwards on to the pharynx, but no regular series of lateral commissural vessels can be distinguished in front of viii.

The nephridial system consists of both mega- and micronephridia. The meganephridia begin in xx or xxi, and are continued backwards to near the posterior end of the body; they are of large size, extending, in the dissection, from underneath the margin of the intestine outwards and dorsalwards almost to the mid-dorsal line; they consist of three parallel, more or less winding, limbs The condition of the specimens is unsuitable for histological work, and I was unsuccessful in obtaining a preparation of the funnel, which however appears to be situated on the anterior side of the septum behind which the nephridium lies; the tube itself is differentiated into broad and narrow, nonciliated and, apparently, ciliated portions. The micronephridia extend throughout the body, they are especially numerous (as is often the case) on the inner surface of the body-wall in the clitellar segments, and occur (again a common condition) in the form of large conspicuous tufts on each side of the hinder end of the pharynx in segments iv and v.

The testes, along with large much folded iridescent funnels, are contained within testis-sacs, in segments x and xi. The vesiculae seminales are three pairs, in ix, x, and xii; those in ix and x depend forwards from the posterior wall of their segments, and are large and lobed; those in xii depend backwards from septum 11/12, are of moderate size, and not cut up into lobes. Thus segment x contains both testis-sacs and seminal vesicles, xi testis-sacs only; in this latter segment the sacs extend towards the dorsal surface, and contain also the hearts.

The prostates are tubular; the terminal portion forming the duct is thinner and more transparent than the coils of the gland itself, and ends in segment xvii. On the left side of the specimen examined the gland extended back to xxi, on the right it first passed forwards from the duct into xvi, and ended behind in xix. The vas deferens cannot be distinctly followed in its course on the body-wall; but it appears in segment xvii to be situated to the outer side of the prostatic duct, and I would

suggest that it probably curves round behind the latter to end on its posterior or perhaps its inner side.

Ovaries and funnels were identified in xiii.

The chief peculiarity of these specimens is the condition of the spermathecae (fig. 8). There is on each side a cluster of spermathecae, of two sizes, larger and smaller, which open either in common or near each other on the eighth segment.

To take first the larger spermathecae. These are four in number, two on each side, and appear to represent the original two pairs. They are large, and either regularly or irregularly pear-shaped; in the latter case the irregularity is due to indentations and the consequent production of a lobed outline. The narrow end, narrowing still further, becomes the duct, which is thus not demarcated from the ampulla. The diverticula form two considerable clusters at the base of the ampulla; these clusters leave one face of the ampulla (or duct) largely free, but cover the other face.

As to their external openings:—the anterior spermatheca of each side becomes attached to the body-wall between segments vii and viii, and the posterior at or in front of the posterior boundary of viii; but by gently scraping the body-wall the duct of the anterior can be traced backwards, and that of the posterior forwards, so that the two approach and almost meet at the level of the setae of viii, and not far from the middle line. Moreover the condition of the worm is such that the external ends of the ducts can be seen from the ventral surface through the softened walls, and though (in the dissected specimen) the actual opening cannot be distinguished with certainty, from the situation of the converging ducts as seen from the outside it must be about in a position corresponding to seta *d*.

The smaller associated sacs are either two (left) or three (right side) in number. They are narrow, apparently tubular, finger-like structures, of varying length, the longest about half as long as one of the larger spermathecae. The surface is slightly mammillated; they converge to their attachment on the body-wall between the ends of the larger spermathecae.

It has already been said that no definite external aperture could be seen in the dissected specimen. In another example however a roundish marking, with a whitish circumference and darker interior, was visible on both sides in the line of the setal ring of segment viii, slightly external in position to the genital marking previously described as situated posteriorly in vii; on the left side a small similar marking could be made out internal to the first. These marks perhaps represent the position of the spermathecal aperture or apertures, though the latter are themselves not visible.

No penial setae were discovered.

Remarks.—The position of the genus is not determinable without some little difficulty. Since it has obvious relations to the Octochaetinae, it will be helpful to note in the following form the chief distinguishing characters of the genera of the subfamily and their relations to the ancestral Acanthodrilinae.

Notiodrilus[1]
(or primitive Acanthodriline; holoandric, acanthodriline ♂ apparatus, lumbricine setae, meganephridia, spermathecae $\frac{7}{8}$—$\frac{8}{9}$.)

Howascolex
(as *Notiodrilus*, except that meganephridia and micronephridia coexist.)

Octochaetus
(as *Notiodrilus*, except micronephridial.)

Eutyphoeus
(as *Octochaetus*, except microscolecine ♂ apparatus; a majority of forms are proandric; spermathecae $\frac{7}{8}$ only.)

Dinodrilus
(as *Octochaetus*, except commencing perichaetine increase of setae.)

Hoplochaetella
(as *Dinodrilus*, except that perichaetine condition fully established.)

Now if it were allowable to derive the mixed mega- and micronephridial condition of *Erythraeodrilus* from a pure micronephridial, it would be easy to suppose *Erythraeodrilus* a descendant of *Hoplochaetella*; the evolution would be, in some respects, parallel to that which has given rise to *Eutyphoeus* from *Octochaetus*. *Eutyphoeus* has undergone the microscolecine reduction of the posterior portion of the male genital apparatus; *i.e.* of the original two pairs of prostatic glands with openings on xvii and xix, those of xix have disappeared, and the ending of the vas deferens, originally on xviii and so between the prostatic pores, has approached or fused with the remaining prostatic aperture, that of xvii. Along with this in *Eutyphoeus* there goes the reduction of the spermathecae to one pair instead of two, and the disappearance, in the majority of cases, of the posterior pair of testes (proandric condition).

The same changes appear to be in progress in *Erythraeodrilus*; the microscolecine reduction has taken place, but it has not as yet been followed by the disappearance of the posterior pair of testes; in the spermathecal apparatus there is a tendency to the reduction in the number of apertures, even if this has not actually been attained. It is interesting to note the way in which the reduction of spermathecae is being brought about,—those of the same side have approached and met at their external ends in the middle of segment viii. In *Eutyphoeus* (if this genus has really had a parallel evolution) we may suppose that after fusion of the apertures, fusion of the spermathecae themselves followed; and that then the point of opening of the single organ moved forwards to groove 7/8, the situation of the anterior of the original two pairs of apertures.

[1] I use the generic name *Notiodrilus* in the sense in which it was used, for example, by Michaelsen in his "Geographische Verbreitung der Oligochäten."

But there are difficulties in supposing that the micronephridial condition, itself derived from the meganephridial, can retrace its history; and it seems better therefore to derive *Erythraeodrilus* from a situation on the line of descent anterior to the point of appearance of micronephridia, *i.e.* from some place between *Notiodrilus* and *Octochaetus*.

Howascolex (Michaelsen, 7, *cf.* also remarks of the same author, 12 and 13) here suggests itself as a possible point of departure I have placed it, in imitation of Michaelsen (8), at the side of the basal stem in the preceding scheme. *Howascolex* already presents the mixed mega- and micronephridial condition found in *Erythraeodrilus*, and the latter could be derived from it by (*a*) the microscolecine reduction, which as we have seen takes place in the younger branch represented by *Eutyphoeus*, and (*b*) an increase in the number of setae, such as also occurs in the *Hoplochaetella* branch. If geographical considerations (*Howascolex* has only been found in Madagascar) stand in the way of this, then the only remaining possibility would be a derivation from the original Acanthodriline itself,—which scarcely make things easier.

Assuming provisionally therefore that *Erythraeodrilus* is a descendant of *Howascolex*, there remains the question whether it is to be reckoned to the Acanthodrilinae or Octochaetinae (there is at present no known indigenous Acanthodriline in India).

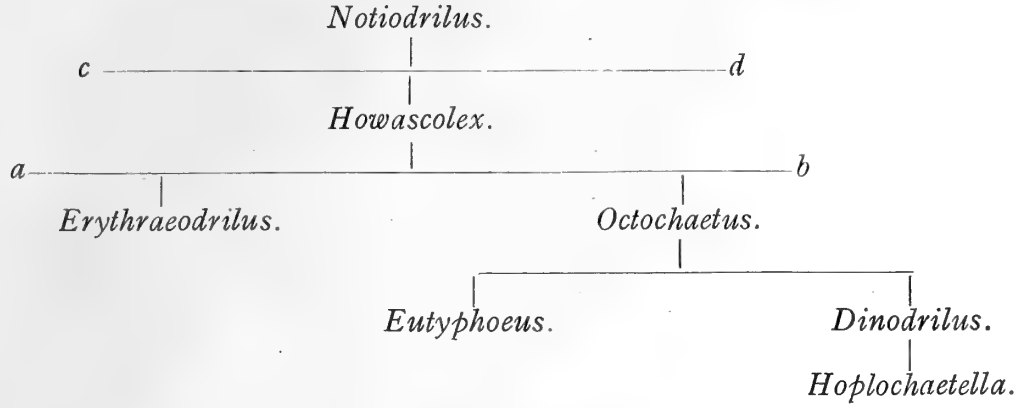
Howascolex is placed (with some reserve) by Michaelsen in the Acanthodrilinae, and is considered as possibly but by no means certainly in the line of descent from *Notiodrilus* to *Octochaetus*, *i.e.* the ancestral line of the Octochaetinae (8, 12, 13).

If *Howascolex* is judged not to be in the direct line, its descendant *Erythraeodrilus* obviously cannot be included in the Octochaetinae. Even if *Howascolex* is a direct ancestor, *Erythraeodrilus* cannot be so included unless *Howascolex* is included also, for this would offend by making the Octochaetinae diphyletic (*cf.* table *inf.* If the Octochaetinae are to begin below the line *ab*, then to reckon *Erythraeodrilus* to them would deprive them of genetic unity). So long as *Howascolex* is placed in the Acanthodrilinae therefore, *Erythraeodrilus* must also go to the Acanthodrilinae, or must constitute a separate subfamily.

The very wide difference between *Erythraeodrilus* and the rest of the Acanthodrilinae, and the inconvenience of instituting a subfamily for a single species, render both these solutions of the problem undesirable. I think the best way of dealing with it is to consider *Howascolex* as already, in virtue of its micronephridia, an Octochaetine, and as the direct progenitor of *Octochaetus*. There will then be no difficulty in placing *Erythraeodrilus* as an Octochaetine also,—as a twig which arises independently from the base of the subfamily.

I may add that morphologically there is no reason why *Howascolex* should not be in the direct line between *Notiodrilus* and *Octochaetus*; the only essential difference between *Howascolex* and *Octochaetus* is the coexistence of meganephridia with the micronephridia in *Howascolex*,—a difference which has not always been considered as necessitating even a generic separation. I presume that the reason why Michaelsen hesitates to consider *Octochaetus* as the direct and immediate descendant of *Howascolex* is that the latter is found in Madagascar, the former in India and New Zealand.

But let us state the case a little more fully. The characters of *Notiodrilus* which are important from a phylogenetic and therefore from a systematic point of view are:—acanthodriline disposition of the posterior portion of the male organs, holoandric



condition of the anterior male organs, lumbricine arrangement of the setae, meganephridia only, and spermathecae opening in 7/8 and 8/9. *Howascolex* is exactly the same in all these features, except that micronephridia coexist with the meganephridia. *Octochaetus* also presents the same features, except that micronephridia exist alone. Now we have reason to suppose that a pure micronephridial condition did not arise throughout the body at a single bound, but that it was preceded by a mixed mega- and micronephridial condition;—one in which, apparently, the whole of the meganephridium in each segment had not dissolved into micronephridia, but a portion remained still as a recognizable meganephridium. Such intermediate forms exist elsewhere at the present day (*Megascolides*, *Lampito*). Therefore, even if we had not *Howascolex* before us, we should have to postulate a form which by its definition would coincide with *Howascolex* as the immediate ancestor of *Octochaetus*, and the intermediary between *Octochaetus* and *Notiodrilus*.[1]

I consider therefore that the solution of the problem of classification is to be found in reckoning the Octochaetinae as beginning with *Howascolex*, and placing *Erythraeodrilus* and *Octochaetus* as independently evolved descendants of *Howascolex*; the line *cd* in the foregoing chart is therefore to be considered as that which delimits the Octochaetinae from the Acanthodrilinae.

Family GLOSSOSCOLECIDAE.

Genus PONTOSCOLEX.

West Haputale Estate, Ceylon, 6200 ft.; dug from earth; Dec., 1913 (*S. W. Kemp*). Four specimens of a species of *Pontoscolex*, probably *P. corethrurus*, but the specimens were not fully mature.

[1] It is no doubt possible to agree with the above (which is indeed almost self-evident), and still, on the principle that the facts of geographical distribution are an essential part of the definition of a group, to hold that two (morphologically) indistinguishable genera are nevertheless to be kept separate. The point is that it seems premature at present to discuss what must, after all, be an extremely rare exception to the general rule, in connection with *Howascolex* and the putative ancestor of *Octochaetus*.

I give a few details of the nephridial system in the anterior part of the body, as far as they can be made out by dissection under the binocular dissecting microscope. The subject has interested previous observers (*cf.* Beddard, 2, pp. 48, 655); the condition which I found differs, however, from that described by Beddard for what is presumably the same species, viz. *P. corethrurus*.

It is necessary first to glance at the septa. The first is attached to the parietes at the level of groove 5/6; the second at 6/7, third at 7/8, and the fourth at the level of 9/10. It appears at first sight as if a septum is missing between 7/8 and 9/10; as will be seen, this is not the case; what has happened is that septum 8/9 has been shifted backwards. All the above septa are thickened.

The next septum is attached at the level of groove 10/11, and is thin; subsequent septa are attached at subsequent grooves,—11/12, 12/13, 13/14, etc., and may be described as very thin. These may be taken as corresponding to the grooves at which they are attached; it follows therefore that septum 9/10 has disappeared; but since, as said above, septum 8/9 has shifted back, the hiatus appears to be situated more anteriorly.

The justification for this view is the disposition of the nephridia. What is apparently segment x contains two pairs of nephridial coils, what is apparently the united segments viii and ix contains one only. The external apertures of the nephridia are near the anterior borders of their respective segments; and though the nephridial coil belonging to segment ix has been pushed backwards by the backward shifting of septum 8/9, the external aperture has remained in its original position; so that the nephridial tube of ix has now, passing forwards, to pierce the (true) septum 8/9 (the last thickened septum) in a forward direction in order to arrive at its external aperture.

The nephridia of segments viii, vii, and vi have their normal disposition. Those of v, lying deeply within the cone-shaped septum 5/6, debouch normally on the surface; but the coils constituting their posterior ends, and lying by the side of the anterior end of the gizzard, are apparently connected with similar coils of the nephridia of iv and iii. I could not separate the posterior ends of these three nephridia; but whether they merely interlace, or whether they communicate, I cannot say. The external openings of the organs belonging to iv and iii have the normal position.

The nephridium of segment ii forms a large and close coil on the side of the oesophagus, behind the pharynx and in front of the gizzard; from this there passes forwards a thick tube which enters the hinder end of the pharynx. This is a much more intimate and direct connection of nephridia and alimentary tube than that described by Beddard for *P. corethrurus*, where a nephridium opens on to the surface in segment ii, but owing to the great retractility of the anterior part of the body, this opening may actually at times come to lie within a temporary buccal cavity.

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EXPLANATION OF PLATE VI.

Figs. 1, 3 and 4 drawn with Zeiss's Abbe's drawing apparatus.

Fig. 1.—*Enchytraeus barkudensis*; longitudinal section of anterior end, showing everted pharynx; × 116.

buc. cav., floor of buccal cavity everted; *c. g.*, cerebral ganglion; *m. ph.*, muscular strands attached to pharyngeal 'sucker'; *oes.*, oesophagus; *ph.*, pharyngeal 'sucker'; *pr.*, prostomium; *sal.*, salivary gland; *v. n. c.*, commencement of ventral nerve cord.

,, 2.—The same; two nephridia, from an entire specimen in cedar oil; *a.*, from segment ix; *b.*, from a postgenital segment.

,, 3.—*Fridericia carmichaeli*, section of anterior end a little to one side of median line; × 116.

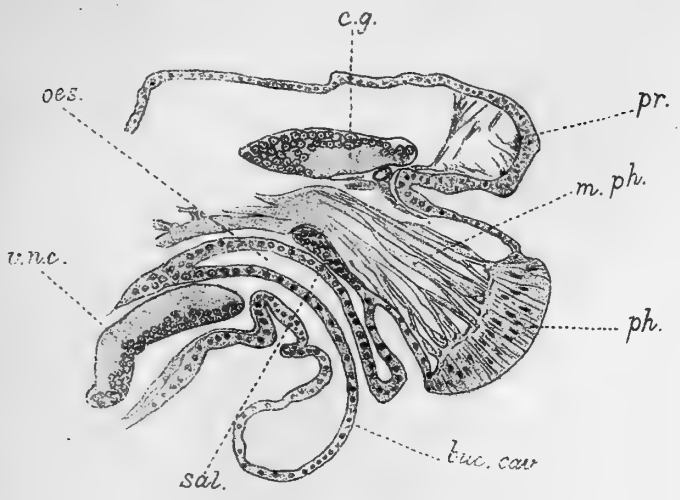
buc. cav., folded epithelium in floor of buccal cavity; *c. g.*, cerebral ganglion; *d. v.*, dorsal vessel (or one of the two branches into which its anterior end divides); *m.*, muscular band passing obliquely downwards from dorsal aspect of pharynx to ventral body-wall; *oes.*, oesophagus; *ph.*, the cup-shaped pharynx; *pr.*, prostomium; *sal.*, salivary gland; *s. o. g.*, suboesophageal ganglion.

,, 4.—The same; horizontal section through dorsal portion of segments vi—xi, showing aggregations of coelomic corpuscles with setae and fragments of setae imbedded. The setae catch the eye much more strikingly in the actual specimen, where they are bright and refractile. The small clear circles, e.g. in segment viii, are setae cut transversely; the nuclei of the corpuscles are shown either black or with dotted interior. Constituents of body-wall not separately shown; × 140.

d. v., dorsal vessel; *sept. gl.*, septal gland of segment vi; *set.*, mass of coelomic corpuscles with setae and setal fragments,—similar masses are seen in viii and ix; *sp.*, sperm morulae and spermatozoa; 10/11, septum 10/11; vi—xi, the corresponding segments.

,, 5.—The same; penial bulb in transverse section; × 210.

b., penial bulb; *p.*, penial lumen; *str.*, strands of muscular or connective tissue attaching bulb and penial tube to lateral body-wall; *v. d.*, termination of vas deferens; ♂, male aperture.



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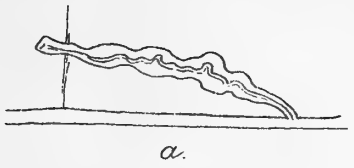

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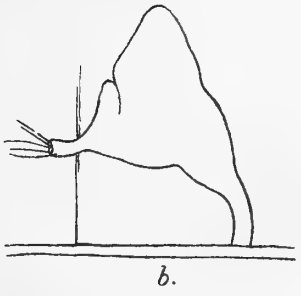

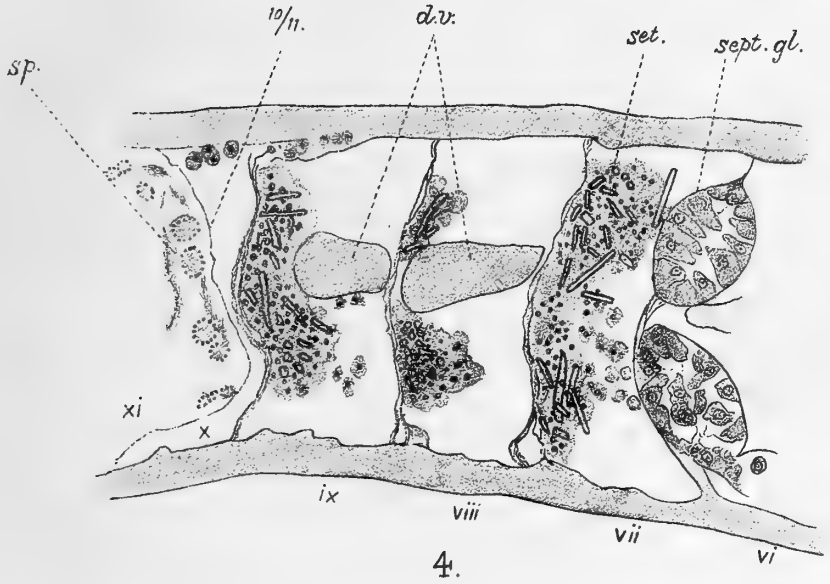

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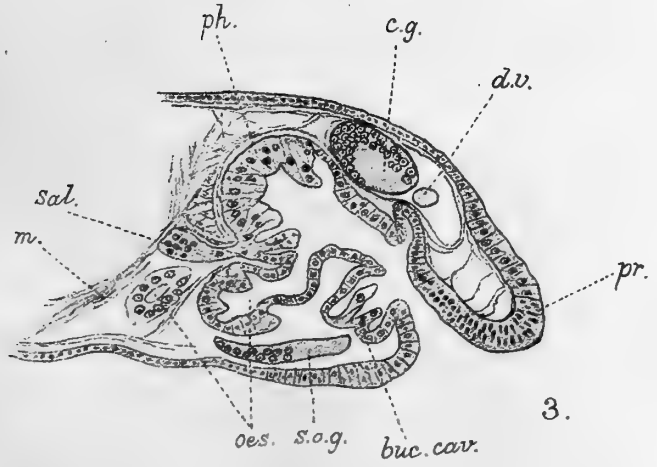

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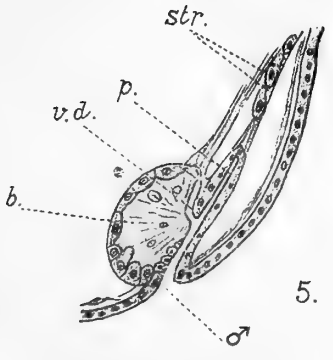

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A.C.Chowdhary, lith.

INDIAN OLIGOCHAETA.

EXPLANATION OF PLATE VII.

Fig. 6.—*Drawida ghatensis*; a seta from segment viii; × 160.

,, 7.—*Drawida chalakudiana*; genital region, diagrammatic. *a*, anterior genital area; *b*, light margin of posterior area; *c*, darker coloured interior of posterior area; *d*, shallow part of groove 10/11; *e*, median tubercle; vii—xi, the corresponding segments.

,, 8.—*Erythraeodrilus kinneari*; spermathecae of one side, with diverticula and accessory spermathecae almost meeting at their outer ends in the body-wall of segment viii. From a dissection.

,, 9.—*Megascolides hastatus*; penial seta. *a*, distal portion, × 90; *b*, extreme end, × about 600.

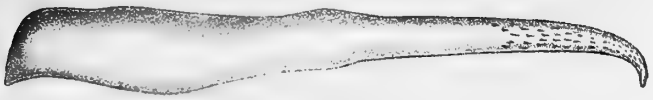
,, 10.—*Megascolides duodecimalis*; spermatheca, the small diverticulum showing at the base.

,, 11.—The same; end of penial seta; × *ca.* 400.

,, 12.—*Megascolides pilatus*; the distal ends of two penial setae, seen from different aspects; × *ca.* 350.

,, 13.—*Comarodrilus gravelyi*; region of male apertures.

,, 14.—*Perionyx bainii*; region of male apertures. ♂, male aperture; *t*, overhanging papilla, or 'tag'.



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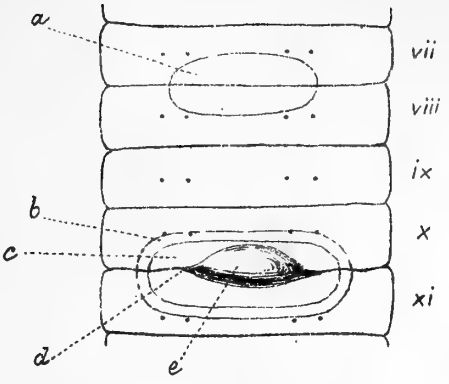

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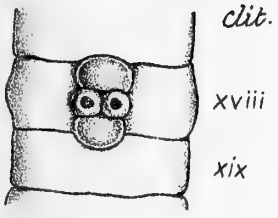

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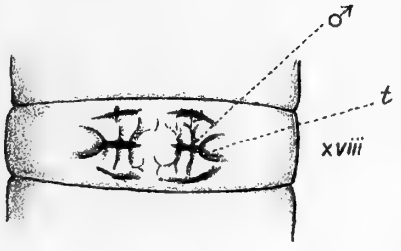

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A.C.Chowdhary, lith.

INDIAN OLIGOCHAETA.

EXPLANATION OF PLATE VIII.

Fig. 15.—*Perionyx bainii*; penial seta; × *ca.* 300.

,, 16.—*Megascolex escherichi* var. *papillifer*; genital field; ♂, male aperture.

,, 17.—*Megascolex campester*; spermatheca. The appendages on the upper swollen part of the duct are micronephridia.

,, 18.—The same; distal end of a penial seta. *a.*, as seen under the microscope, × about 400. *b.*, represents what would probably be seen if the end of the seta could be rotated through a right angle; but this view is not obtained, since the setae, owing to the curve of the shaft, lie on the slide in the position of *a*.

,, 19.—*Megascolex hortonensis*; genital area. *clit.*, clitellum; *g. f.*, the surface of the thickened genital field; *pap.*, flat, slightly raised papillae; *pen.*, penis; *pit.*, depression on segment xviii; xvii—xix, the corresponding segments.

,, 20.—The same; spermatheca.

,, 21.—*Megascolex kempi*; spermatheca.

,, 22.—*Megascolex varians* var. *insolitus*; spermatheca.

,, 23.—The same; distal end of penial seta; ×220. The whole of the portion which is clothed with spines is shown.

,, 24.—*Megascolex sextus*, penial seta, *a.*, showing general shape; *b.*, more highly magnified (× 300) distal extremity.

,, 25.—*Megascolex polytheca*; spermatheca, in glycerin after clearing. *b. v.*, blood-vessel running along its side; *cav.*, portion of cavity containing only granular matter; *ep.*, epithelium lining cavity and duct; *x.*, transparent mass, filling greater part of cavity; × 90.

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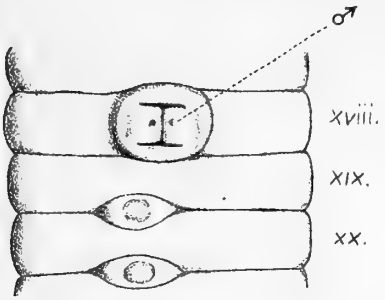

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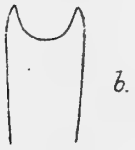

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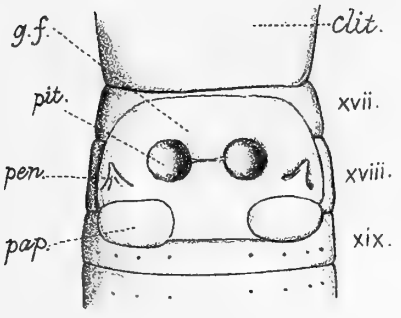

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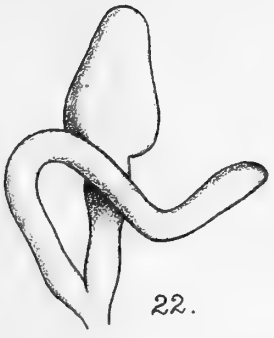

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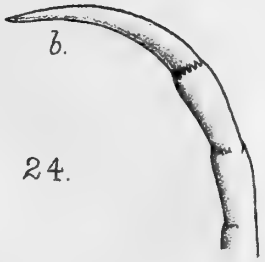

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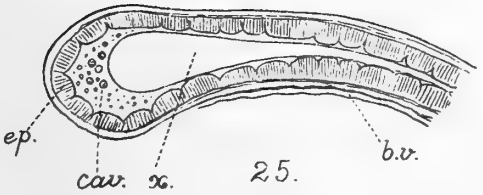

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A.C.Chowdhary, lith.

INDIAN OLIGOCHAETA.

EXPLANATION OF PLATE IX.

FIG. 26.—*Megascolex polytheca* var. *zonatus*; spermatheca.

,, 27.—*Megascolex kavalaianus*; spermatheca.

,, 28.—*Megascolex phaseolus*; male genital region; *b.*, bean-like elevation on xviii; *w.*, the ring-like wall, cleft behind; *p.*, papilla on xix; *clit.*, clitellum; ♂, male pore; xviii, xix, the corresponding segments. Drawn from the only specimen showing the papilla on xix.

,, 29.—The same; spermatheca.

,, 30.—*Megascolex filiciseta*; penial seta. Lateral view of distal end; this seta was free from its sheath, and shows a relatively small number of the pinna-like spines; × about 500.

,, 31.—The same; a young seta in its sheath, with numerous spines, 16 on each side (not 17, as in the lower row); × about 500.

,, 32.—*Megascolex cochinensis*; male genital area. *clit.*, clitellum; *x.*, its posterior border.

,, 33.—The same; spermatheca.

,, 34.—*Megascolex konkanensis* var. *longus*; prostate of right side.

,, 35.—The same; spermatheca.

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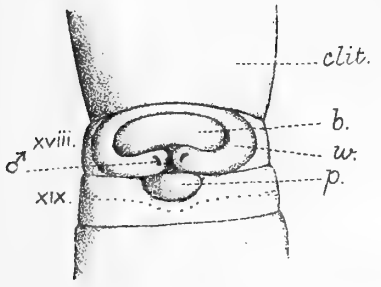

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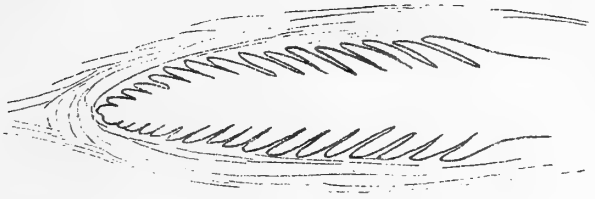

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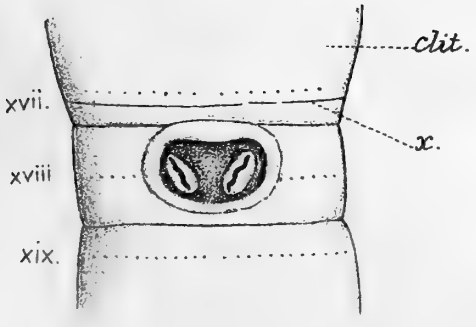

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INDIAN OLIGOCHAETA.

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THE INDIAN VARIETIES AND RACES OF THE GENUS *TURBINELLA*.

By JAMES HORNELL, *Government Marine Biologist, Madras.*

(Plates X—XII).

Like the species represented by mankind, that of the Indian conchs belonging to the genus *Turbinella* is not an ideal one composed of a single predominant variety; on the contrary both are excellent types of the collective species comprising in each instance a number of well-marked forms, whereof the principal are approximately co-equal in taxonomic value and thus constitute strongly characterized varieties or sub-species.

The species was first described by Linnaeus under the name of *Voluta pyrum*, but unfortunately this name was given to a form which, in my opinion, is not the central one, but is a variety probably thrown off by a stock which resembled more closely one of the other existing varieties. However, as it is at present difficult to prove the truth of this hypothesis, and as, after all, names are but labels with which we ticket things and ideas for ease of reference, this is of comparatively small importance.

Including Linnaeus' type as one, I distinguish five well-marked sub-species or varieties, namely:—

(*a*) var. *obtusa*, var. nov.,
(*b*) var. *acuta*, var. nov.,
(*c*) var. *fusus*, Sowerby,
(*d*) var. *globosa*, var. nov., and
(*e*) var. *comorinensis*, var. nov.

The first three I consider equally important and equal in classificatory value; regarding the two last, I am as yet somewhat doubtful as to whether they have sufficient stability of form to be considered more than strongly marked local races of limited permanence; I incline, however, to think both will prove to be good varieties. The names now given to all these are new except that of *fusus*. I had hoped to give Gmelin's name *rapa* to the variety I call *acuta*, but this proved impossible as I find Gmelin's *rapa* to be no more than an inflated and less obtuse form of the variety described by Linnaeus.

I did not arrive at this conclusion of specific identity without difficulty, for if the more emphatic individuals of each form only be compared, unity of species seems impossible. Fortunately I have had the opportunity of comparing thousands of shells from the principal Indian localities where *Turbinella* is found, and from the

results of this study I have found it impossible to draw any hard and fast line separating specifically any of the main assemblages. Finally, I arrived at the conclusion that while the two most important forms, which I term *obtusa* and *acuta* respectively, constitute merely varieties of one species, their varietal characters were at no long distant period in process of such permanent fixation that the establishment of separate species would have been accomplished had not geological changes brought the two varieties into close intermingling before the fixation of specific characters was completed.

Each of the five varieties into which I divide the species, if judged by isolated individuals in which are strongly developed the special characteristics and proportions found in their respective shells, may assuredly be classed without difficulty by the closet naturalist as a distinct and well-marked species. Strangely enough this has not happened, for though a considerable number of species have been erroneously created through the study of individual shells, all such are based upon the forms and local races of the single variety *obtusa*. Thus

Voluta gravis, Dillwyn,
Turbinella clavata, Schub. and Wagn.,
Turbinella napus, Lamarck,

are bad species founded upon specimens of the form *typica* of *T. pirum obtusa*, while Lamarck's *Turbinella rapa* represents form *rapa* of the same variety and probably was based upon a large specimen of this varietal form from the neighbourhood of Madras. Certainly the shell figured by Reeve as *T. rapa* in Vol. IV of his *Conchylogia Iconica* represents precisely such a shell.

The first four of the varieties I now propose to define are inhabitants of the coastal waters of Ceylon and of Continental India; the fifth (*T. pirum fusus*) is found in the Andaman Islands.

The following key to the five varieties defines the principal characteristics of each :—

Spire elongate; shell widely fusiform. Breadth in length, 1·75 to 2.	Shoulder angular, prominent.	(1) var. *fusus*, Sowerby.
	Shoulder rounded, low.	(2) Profile of whorls in spire convex, var. *acuta*, var. nov.
		(3) Profile of whorls in spire nearly straight, var. *comorinensis*, var. nov.
Spire short; shell either globose or top-shaped. Breadth in length under 1·75.	Spire moderately short; shell globose; periostracum rough and thick.	(4) var. *globosa*, var. nov.
	Spire often very short; shell inclined to be top-shaped; very wide at shoulder. Periostracum thin and little sculptured in small and medium-sized shells.	(5) var. *obtusa*, var. nov. With two forms :— (*a*) *typica*, (*b*) *rapa* (Gmelin).

I will now discuss in detail the main characters distinguishing these varieties, together with those of the shells from different localities, the local variations being due in the main to differences in the abundance of food supply, and in the character of the environment, particularly in regard to the degree of exposure to unfavourable

conditions, such as surf action, prolonged spells of turbid, mud-laden water, and scarcity of food.

1. Variety **obtusa**, var. nov.

Judging the importance of the co-varieties of *Turbinella pirum* from the numerical standpoint, this variety is entitled to first place. It is the form which furnishes all but a fraction of the produce of the great fisheries in the north of Ceylon and along the Indian Coast of Palk Bay and thence from Point Calimere to Pulicat Lake. Out of a total annual production in this region of about 15 lakhs of shells, this form contributes 13 lakhs. Its habitat lies entirely northward of a line curving into Palk Bay from a point about the middle of the north coast of Mannar Island to another on the Indian mainland a few miles west of Pamban (Plate XII). The significance of this peculiar line of demarcation will be explained later.

The characters of this variety fluctuate within considerable limits, from a form with a well-marked though short spire to one where it is extremely abbreviated with whorls much telescoped. It was the latter which Linnaeus described and which therefore has to be considered the type of the species. To this form I will therefore apply the term *typica*, while for the other extreme the term *rapa* will be appropriate as it was a shell of this form to which Gmelin (1790) applied the specific name *rapa*.

The length of both forms compared with varieties *acuta*, *fusus*, and *comorinensis* is markedly short in comparison with the breadth, due to (*a*) an emphatic telescoping of the whorls of the spire, and to (*b*) a considerable inflation of the body whorl. The former forces the shoulder high up and imparts to the shell a distinctive top-shape suggesting stunting, which contrasts sharply with the handsome free growth and wide spindle shape of var. *acuta*. The periostracum in small and medium shells is usually thin and weak with a distinct tendency towards smoothness; the spiral rows of prominences or nodes and the lines of low periostracal ridges are poorly developed, very much less than in *acuta*; it is seldom that more than a trace remains of any except the shoulder nodal row. Young shells of this variety are often richly flecked with chestnut spots, but this is a very variable character and many shells otherwise exactly similar to the spotted ones are almost or quite spotless, and a uniform white. With increasing size spotting tends to be suppressed, and full grown shells seldom show the slightest trace of spots.

Between the two extremes of shape seen in this variety a perfect range of gradation can be traced, and, although when the extremes be placed side by side their differences appear so well-marked as to appear to justify separation, I am unable to split it up as these extremes are not localized and intermediate forms are always easily found linking them up.

It is difficult to distinguish any clearly defined local races of this variety; the more important ones are those of (*a*) Tirupalagudi, (*b*) the Coromandel Coast, and (*c*) Nayinativu.

(*a*) *The Tirupalagudi race.*—These shells are found off the villages of Tirupalagudi, Tondi and Mudirampatnam in the south-west angle of Palk Bay, and come from

beds in $2\frac{1}{2}$ to $4\frac{1}{2}$ fathoms where they are subject to the influence of rough seas and muddy water during the greater part of the year. They are distinctly stunted in general appearance and a proportion have the apex so greatly abraded as to be almost flat in the apical region. The apical angle of those living in depths of $2\frac{1}{2}$ fathoms averages 104·64° as against 102·52° for those in $4\frac{1}{2}$ fathoms. The extremes however range between 85° and 134°, between which perfect gradation is always to be seen in every batch of shells (Plate X, fig. 5).

This great range in the angular index of the spire is due largely to the fact that

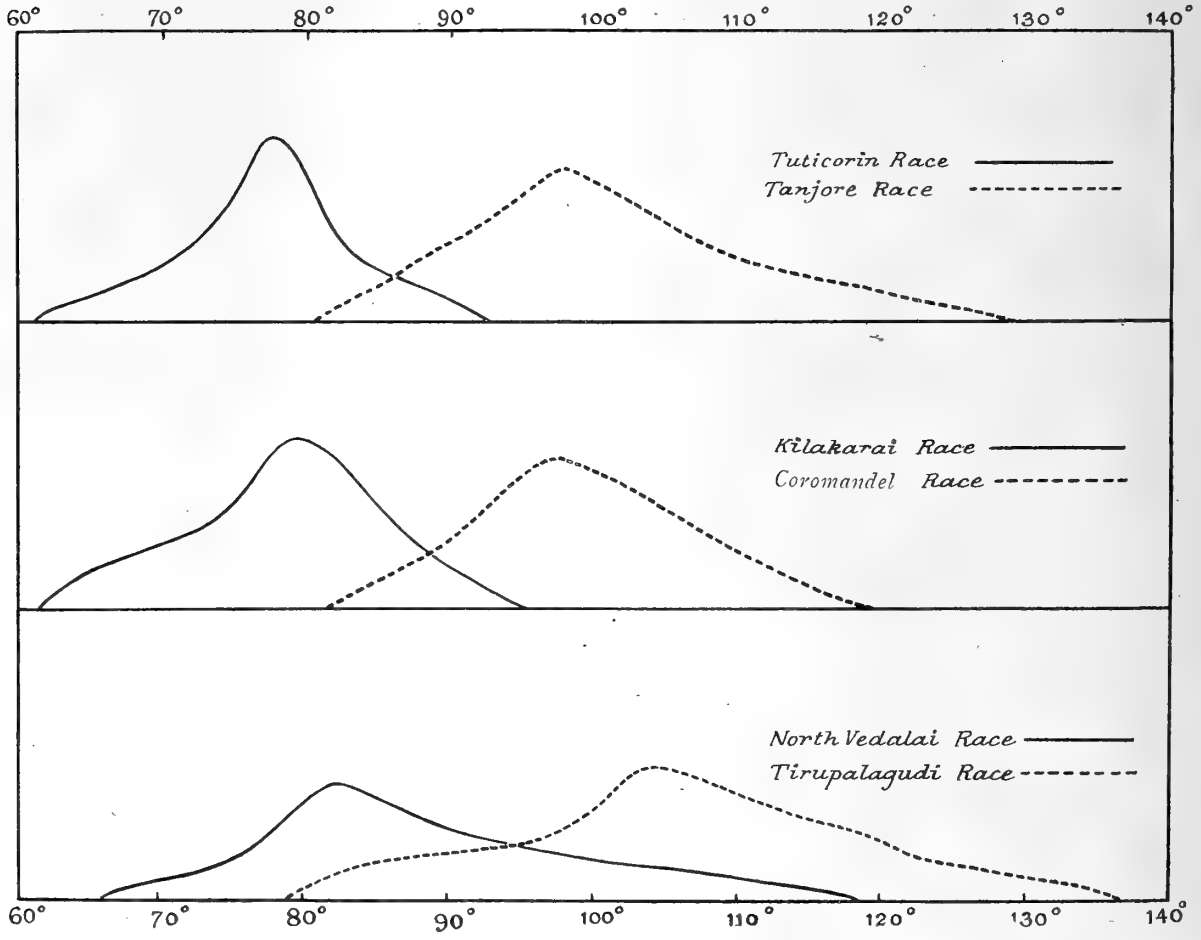


FIG. 1.—Diagram showing by smoothed curves the respective ranges of the apical angle in three local races of *T. pirum acuta*, compared with three of *T. pirum obtusa*.

this *obtusa* race marches with a corresponding border race of variety *acuta*, living south-eastwards, off Pillaimadam and North Vedalai, villages a few miles west of Pamban Pass. The commingling and overlapping of the two varieties that ensues is clearly seen upon reference to the apical angle chart given as text-fig. 1.

(*b*) *The Coromandel race* is found along the length of the Coromandel Coast, from Point Calimere to some distance northward of Madras. It is closely akin to the Tirupalagudi race, but is larger in average size, usually less stunted in apical development and in large specimens often exhibits a strong and vigorous development of

periostracum. Shells here grow to 7 inches in length by 4·5 inches in diameter, giving a ratio of length to breadth of 1·555, whereas I have seldom seen Tirupalagudi shells more than 5 × 3·15 inches—a ratio of 1·587. Typical shells are shown on Plate X, fig. 6, and Pl. XI, fig. 7.

A marked characteristic of many of these shells is a coating of some foreign organic substance upon the periostracum. This extraneous skin gives the shells a dark, blotchy, and dirty appearance. It appears to be due to the presence of a crusting hydroid allied to *Hydractinia*, but as I have not yet examined it in the live condition, I cannot say positively what it is.

This form also crosses to Ceylon, where, among the many islands around Jaffna, conditions are so diverse that merchants distinguish quite a number of trade varieties, separated by differences in weight, size, and shape (Pl. XI, fig. 8). These approximate more or less to races (*a*) and (*b*) but one may be described separately as worthy of remark. This is :—

(*c*) *The Nayinativu race.*—These shells, fished off the island of Nayinativu, are remarkable for the large size and heavy weight attained, ranging up to 6·9 × 4·25 inches (breadth in length, 1·62) with a weight of 2 lb. 2 oz. (Nos. 1 and 7 in fig. 8, Plate XI). The periostracum is thick, the first and the second or shoulder nodal row usually fairly well developed. This form approaches closely to short, stout, aged examples of var. *acuta* and goes far to prove the specific identity of the *obtusa* and *acuta* forms. I should also remark that similar approximation to the *acuta* form is also to be found amongst the largest sizes of the Coromandel race. Among these we get many shells closely similar to those from Nayinativu, with others having the spire greatly telescoped and distinctly top-shaped in form.

Taken generally the larger the shell grows, the less emphasized are the varietal differences, so that when the largest specimens of *obtusa* and *acuta* are ranged alongside one another, it is impossible to draw any definite line of demarcation between them.

On the other hand, the medium sizes, from 3 to 4½ inches in length, show the greatest amount of divergence, and it is never impossible to separate an average group of *obtusa* from one of *acuta*, though selected individuals can usually be found to bridge the interval.

2. Variety **acuta**, var. nov.

Next in numerical and commercial importance to variety *obtusa* comes the elegant form which I distinguish under the above name. Its habitat marches at the head of the Gulf of Mannar with that of the type. It is to be noted particularly that it passes northward out of the Gulf at two points, the first at Pamban Pass beyond which it spreads fan-like east and west, and the second through the channels of Adam's Bridge, whence it passes west along the whole of the N. E. and N. coasts of Rameswaram Island and eastward to the north coast of Mannar Island in the vicinity of Talaimannar. To the south, on the Ceylon side, it spreads over the Pearl Banks in fair numbers as far south at least as Dutch Bay, and then in diminishing

numbers to the neighbourhood of Colombo; on the Indian side it reaches Manapad Point, somewhat south whereof it marches with the varieties *globosa* and *comorinensis*. It again appears on the shores of the Kathiawar Peninsula in considerable numbers.

This variety is found in greatest profusion on sandy beds off Tuticorin at depths generally from 7 to 10½ fathoms. It is also found in shallower water, but there it is not nearly so numerous as in deeper water and the shells are less vigorous and well grown. From these beds from 2 to 3½ lakhs of shells are annually fished, with less than a quarter of a lakh from all the rest of the Gulf of Mannar ground.

The typical var. *acuta* is comparatively narrow and moderately elongate with a well-balanced spiral; the final whorl in mature shells shows no exaggerated inflation as in the *obtusa* type and there is no marked angularity of shoulder, the position of which would be difficult to trace were it not for the presence of a well-marked row (the second) of periostracal nodes. On removal of the periostracum, vestigial inequalities are found, coinciding with the bold periostracal nodal eminences. The angular index of the spire ranges from 62° to 91½°, with a mean of 77·8°. The breadth in the length averages 1·83 in medium-sized specimens of 6 inches length, reduced to 1·75 in the case of the largest and stoutest size (7½ × 4¼ in.). Apart from the Kathiawar habitat, there are three well-marked local races:—(*a*) Tuticorin, (*b*) Kilakarai, and (*c*) Rameswaram.

(*a*) *The Tuticorin race.*—Taking freedom of growth as shown by the well-balanced spiral of the whorls, neither unduly lax nor stunted into a squat coil, the massiveness of the shell, the clean, strong development of the periostracum, the rapidity of growth, the large size attained both individually and on the average, and the great abundance in which they are found in spite of an annual thinning of their numbers that has run to an average of fully 250,000 during the past twenty centuries, the shells fished off Tuticorin and for about 30 miles north and south thereof, appear to represent the most vigorous strain of all. It may be taken as the typical local race of the central type of *Turbinella pirum*.

In representative shells the apical angle is low, averaging 77·8°, while the range in variation in this character, lying between 62° and 91·5°, is notably restricted, bespeaking a compact race living under uniform conditions. Periostracal growth is thick, bright olivaceous yellow in tint and obviously vigorously grown; the surface is normally clean and remarkably free from crusting growths, cleaner and brighter than in any other race I have seen. The development of the rows of periostracal nodes and nodules is correspondingly strongly marked. Usually there are six rows of nodules present, consisting of two shoulder rows, and four body rows. The second or anterior shoulder row is the only one strongly developed. In a five-whorl shell, the number of nodules in this row are usually 3 to the inch; they vary somewhat and I have some shells whereon the nodes are specially large and coarse numbering only 1·75 to the inch. The first shoulder row is usually present and well defined, but the nodules are generally less than half the size of those in the second row. Of the body rows, trace of all four series is nearly always present, but occasionally one is suppressed entirely—usually the fourth. They are not merely raised lines or ridges as

seen normally in var. *obtusa*, but are made up usually of parallel rows of distinct nodular elevations, miniatures of the coarse knobbed nodes of the shoulder row. In many large shells they gradually decrease on the body whorl as they approach the lip. When the periostracum is removed the position of the periostracal nodes in the shoulder rows is indicated by very slight eminences or swellings, which are the vestigial remains of strong shoulder knobs such as are seen in the related genera *Fulgur* and *Cynodonta*. Beneath each of the body rows a continuous obscure narrow band-like ridge, very feebly developed, can usually be traced; only in large individuals with coarse and thick periostracum are there indications of minute vestigial knobs at intervals upon these ridges; in young specimens slight furrows often take the place of these raised lines (Pl. X, fig. 1).

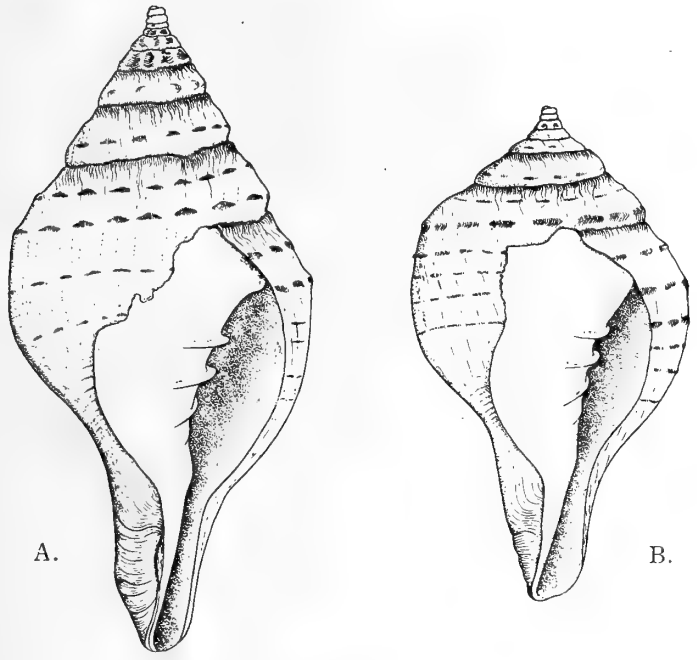


FIG. 2A.—Elongated example of *Turbinella pirum acuta* (Tuticorin race).
FIG. 2B.—Squat example of *T. pirum acuta*, from same region.
Drawn from selected shells to show the extremes in form seen in this race.

In medium-sized shells, say under 6 inches in length, the ratio of axial length to the diameter of the body whorl ranges within narrow limits from 1·75 to 1·85. Hence the shell as compared with the two forms of *obtusa* is relatively narrow. In a few old shells of $7\frac{1}{2}$ in. in length the body whorl is considerably inflated, altering slightly the ratio of width to length, but in ordinary large individuals the more slender form is retained unaltered.

The colour of these shells is usually a pure porcellaneous white, more or less suffused with pale pink interiorly at the oral aperture Small shells sometimes show reddish spots, very variable in number and distribution.

The apex never shows wearing down due to abrasion such as is common in the Tirupalagudi race of *T. pirum obtusa* (*typica*) and in var. *comorinensis* about to be

mentioned. This, together with the freedom from parasitic or symbiotic growths, shows that this race flourishes under very favourable conditions. Its principal and most favourable habitat is the wide stretches of sand interspersed between the rocky pearl banks off the Tinnevelly coast. Here tubicolous polychaets abound and these form the favourite food of the chank. Shells found upon or round the edges of the rocky banks in shallow water are less well-grown and often have symbiotic organisms upon them, chiefly corals, polyzoa, and algae. The columellar plicae in this race are moderate in size, very seldom markedly prominent and scarcely ever swollen or stout except in individuals living close to the littoral.

Sinistral forms are unknown on the Tuticorin banks so far as my information extends.

(*b*) *The Kilakarai race.*—This race inhabits the shallow water (2 to 4 fathoms) lying between the southern shore of Ramnad district from Valinukam Point to Pamban Pass, and the chain of coral islands lying parallel to this coast. In general outward appearance these shells resemble closely the Tuticorin race; the apical angle is much the same, ranging between 62° and 89°, with a mean of 77·9° (Plate X, fig. 2—upper 7 shells). The chief difference is that the resting phase appears to occur much more frequently and in these not only does the lip become thickened, but the columellar plicae frequently attain an abnormal stoutness and prominence, while some little distance from the lip a low blister-like swelling, approximately $\frac{3}{4}$ or 1 inch long by $\frac{1}{2}$ inch wide, is present. The extreme thickening of the sides of the oral aperture which takes place in the resting phase, constricts the opening considerably and distinguishes these shells markedly from the more regularly grown shells from Tuticorin, where a resting stage is comparatively infrequent till considerable age (size) be attained. The explanation appears to be that in the deep water beds off Tuticorin growth proceeds uninterruptedly the whole year round, owing to the protection afforded by a deep water habitat from any interruption in feeding or periodical shortage of food due to bad weather conditions; hence in the Tuticorin shells the resting phase seldom occurs until the individual is far advanced in life. On the Kilakarai coast, the shallow water habitat of the local race exposes them to much disturbance during the prevalence of the south-west monsoon; this entails difficult conditions of life and begets a condition where the forces of the mollusc are necessarily concentrated upon thickening its shell at the mouth. As a consequence a transverse section of a Kilakarai chank of this description shows an alternate series of thick and thin places in the walls of the whorls; this is a peculiarity which renders shells of this race of inferior value for bangle-making although the shell substance is hard and of good colour. These shells are largely employed as blowing conchs.

(*c*) *The Rameswaram race.*—The individuals of this race grow to a smaller average size than either races (*a*) and (*b*), but as this average size is admirably adapted to provide bangles of diameter exactly suited to the requirements of Bengali ladies, and as they suffer much less from the defect of irregular growth due to the frequent occurrence of rest phases, these shells are actually more highly prized by bangle-makers than the larger shells of the Kilakarai race. Shell bangle-makers also state that the

shell substance of the Rameswaram material is harder and takes a better polish than even the regularly grown handsome Tuticorin shells. This is due to the slow rate of growth characterizing these shells; the depth at which they live, $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms, and the large amount of mud in suspension in the water around them, renders their habitat less favourable for growth than the deeper water and clean sands, densely stocked with polychaets, found in the Tuticorin area (Pl. X, fig. 3).

The mean apical angle is 83·3°, as against an average of 77·8° for Tuticorin and 77·9° for Kilakarai. The shells are decidedly shorter in the spire than either of the other two races and as already stated they scarcely ever attain a large size; $5\frac{1}{2} \times 3$ inches diameter is nearly a maximum for those fished in the offshore beds lying in $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms. It is notable that shells from inshore beds, 2 to 3 fathoms, grow to a larger size than those from the deeper beds. Except in the case of shells found in the inshore beds on rocky ground, the columellar plicae are not usually strongly developed, in this agreeing with the Tuticorin shells. Towards the west these shells spread along the shore of the mainland as far as Pillaimadam, a place eight miles west of Pamban Pass, where they begin to mingle with the Tirupalagudi race

FIG. 3.—Spire of var. *comorinensis* (A) seen in profile for comparison with (B) profile of var. *acuta*, Tuticorin race.

of the type form, *T. pirum obtusa*. On the east the former race continues as far as Talaimannar at the N.W. corner of Mannar Island. A few miles east of this they come into contact with the Ceylon form of the type variety. The Kathiawar race appears almost identical with the Rameswaram one and may be included with it. The approximation may be explained by the fact that the conditions of life in these two localities are much the same—the presence of much rocky bottom, and life in a sea muddy during much of the year.

3. Variety **comorinensis**, var. nov.

This variety is restricted to the extreme south of the Indian Peninsula; its range runs northward from Cape Comorin on both the east and the west coast for some 30 to 40 miles. It lives in shallow water exposed to heavy ground swells most of the year. The spire is rather short, with a mean index of 83°. The outline in axial section is an elongated oval, the body whorl being elongated axially to a considerable extent (Pl. XI, fig. 9—upper 6 shells). It has the appearance of a stunted form of the Tuticorin shell and this was doubtless its origin. It has however developed

some special characteristics, one morphological, the other physical. The former lies in the peculiar way in which the uncovered portion of each whorl has a straight profile between the bounding sutures, whereas in var. *acuta* the profile of the exposed part of each whorl is more or less convex. The profile of the two forms may be represented diagrammatically as shown in text-fig. 3.

In *comorinensis* the edge of each succeeding whorl projects slightly beyond the one preceding, thus forming a slight collar; in *acuta* the edge does not so project. The physical difference of this form from others is its brittleness and comparative thinness. This renders it difficult to cut, as even a slight blow suffices to fracture it. The periostracum is inclined to be smooth, with weakly developed nodal lines. The first row is normally absent, as are also the body rows as a rule. The shoulder row alone is usually present, but with nodes very weakly developed. In some it is practically absent. In colour this variety is remarkable for its extreme whiteness, a point in its favour with bangle-makers, but much discounted by its fragility. It grows to a fair size, but is always light and comparatively thin.

Like some of the shells of var. *obtusa* fished in the shallows of the S.W. corner of Palk Bay, a proportion of the present variety show the spire much worn down by attrition.

4. Variety **globosa**, var. nov.

The range of this variety coincides geographically with *comorinensis*, but it lives at a greater depth—*comorinensis* being essentially an inshore form. *Globosa* exhibits extreme inflation of the body whorl, an apex of abbreviated *acuta* form, a dense, coarse periostracum ornamented with more than usually prominent lines and nodal eminences, a heavy and thick shell, and a red tinge within the mouth. Its length compared with the diameter is markedly short, the diameter ranging between 1·5 to 1·7 in the length. Two typical forms measure respectively $6 \times 3\frac{1}{2}$ inches and $5 \times 3\frac{1}{4}$ inches. The apical angle ranges between 80° and 110°, with a mean of 92°. The largest shells show very strong development of all the nodular rows, but whereas in the Turicorin shells of var. *acuta* the second shoulder row is normally conspicuously better defined than the others, in *globosa* the pre-eminence of this particular row tends to disappear and the tendency here is towards equality of the nodes in all the rows. There is usually scarcely any greater prominence of the shoulder nodes over those of the first row or those of the second upper body rows; of the latter there are usually four present (Pl. XI, fig. 9—the lower five shells).

5. Variety **fusus**, Sowerby.

This is confined to the Andaman Islands. In general form it differs from the continental varieties mainly in the shape of the shoulder portion of the whorls. In the Andaman individuals this is strongly marked in medium-sized individuals and distinctively angular; it is further emphasized by the great prominence of the shoulder row of periostracal nodes which are more protuberant than in any of the other

forms (Pl. XI, fig. 11). In fully adult specimens the angularity of the shoulder becomes considerably reduced and obscured and the difference between this form and *T. acuta* is thereby much lessened (Pl. XI, fig. 10). The shell spiral is more lax than in any but a few of the most elongated Indian forms of *T. pirum acuta*; its apical angle varies between 77° and 82° in the specimens I have examined. The second or anterior row of periostracal nodes is also strongly developed, though less than those of the first. Whether these two rows of periostracal nodes are equivalent to the first and second or to the second and third in *T. pirum obtusa* and *T. pirum acuta* I cannot decide. In both the latter the second row is usually the only one conspicuously developed, but in the majority of *T. pirum obtusa* and a considerable proportion of *T. pirum acuta*, the first row is either quite vestigial or actually suppressed; again in some specimens of *T. pirum acuta* and *T. pirum globosa*, the first row is quite strongly developed, only a little less prominent than the second. Besides these two prominent shoulder rows, there are three to four body ridges, low, moderately marked and continuous, not showing any sign of nodulation. The Andaman shell is pure white in colour and rather light in weight. The anterior canal is markedly elongated. In both shells examined the columellar plicae appear as three high, compressed ridges, with a fourth, anterior to the others, obscure and low as is usually the case in this species generally. In the fully mature individual the three large plicae are thick and truncate at the free edge; in the smaller, which has a thin and immature lip, thin and knife-edged.

Very young specimens of this variety show the shoulder angle much less emphatic than in the adult, and thus approach closely to the *acuta* form.

The suture between the last two whorls is characteristically deep, and this is a disadvantage commercially, as it renders bangles cut from these shells easily broken, the deep suture forming an emphatic plane of weakness.

CONCLUSIONS.

Consideration and comparison of the foregoing and other facts lead me to the conclusion that the immediate common ancestor of all these varieties was a shell of the *acuta* form, having a moderate apical index and well developed periostracal sculpture arranged in spiral lines of discontinuous prominences or nodes. The Rameswaram and Kathiawar race seem to me the nearest to this form though both these probably have the periostracal sculpture less well-marked than in the ancestral form. Varieties *fusus*, *globosa* and *comorinensis* are all closely related to this ancient *acuta* form, whereas the typical *obtusa* is the most divergent and most changed form. Var. *fusus* has undoubtedly been long isolated from the rest of the species and under this isolation has developed special features which, being continued, have now become fixed. It is therefore a moot point as to whether it is not entitled to specific rank. It certainly is on the line that divides variety from species, and is an excellent instance of a local assemblage of individuals evolving differences—causes we much perforce ignore—which, becoming permanent, are in course of producing a new species.

Globosa and *comorinensis* are younger varieties and have not become so stabilized as *fusus* owing to non-isolation from the main mass of the *acuta* species.

The peculiar geographical distribution of *obtusa* and *acuta* (including also *globosa* and *comorinensis* under the latter) is again most illuminative on the influence of differences in environment upon separated groups of an originally united race in producing and stabilizing variations from the original stock. The geographical distribution of these two principal varieties as shown in the sketch plan on Plate XII will make this clear.

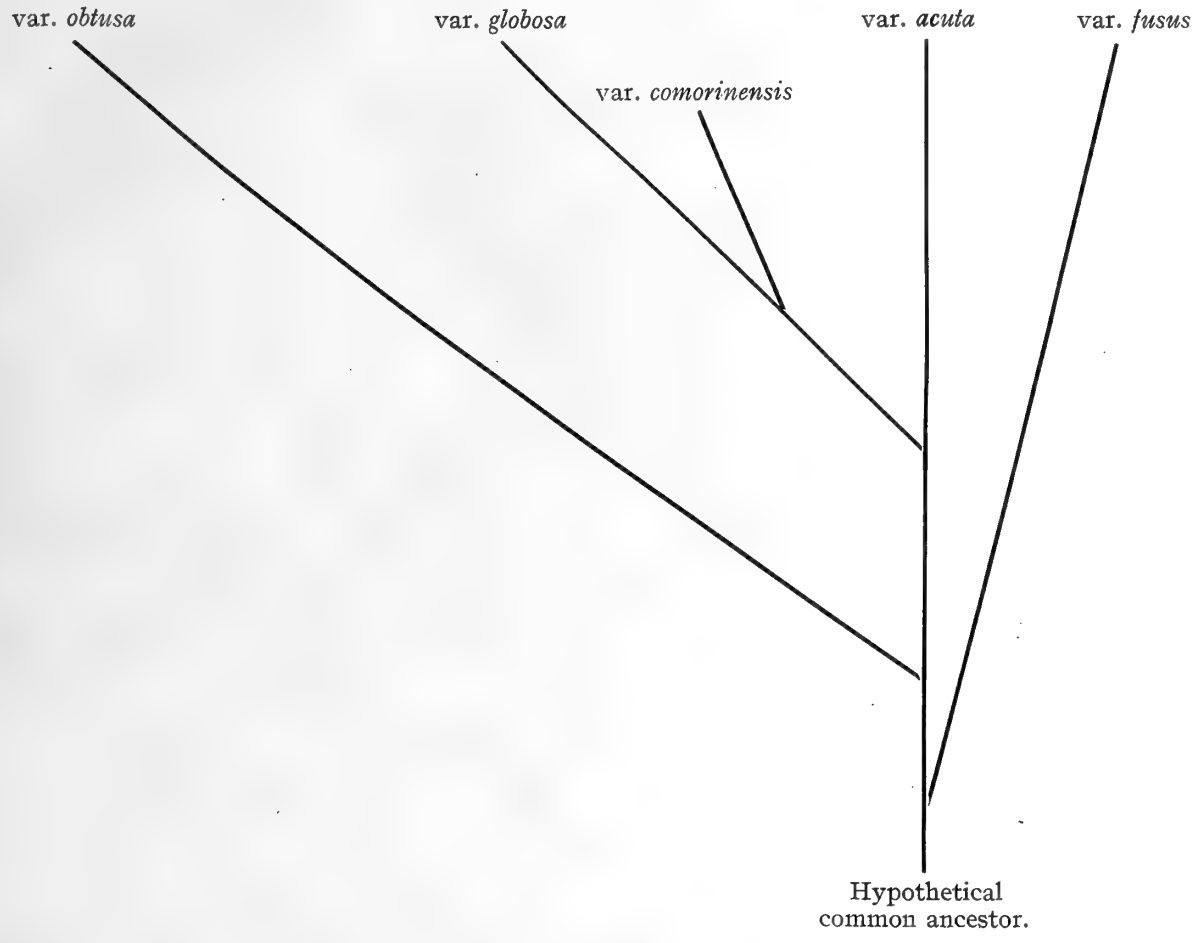
As is shown, the barrier formed by Rameswaram and Mannar Islands and Adam's Bridge very nearly forms the dividing line, *obtusa* being found entirely north of this line while *acuta* monopolizes the whole coastal waters of the Gulf of Mannar. But in addition the latter is seen to pass some distance beyond the barrier named and so to invade the territory of *obtusa*.

The hypothesis I present is this. We have incontestable evidence, chiefly furnished by the existing distribution of certain animals and plants in Ceylon and India, that the geological phase existing in the Gulf of Mannar and Palk Bay region antecedent to the present condition was that of a land barrier stretching continuously from India to Ceylon in the region now known as Adam's Bridge.

Further we have geological evidence that this phase was preceded by one where the level was even lower than it is now and when no land whatever existed between what is now the Gulf of Mannar and Palk Bay. During this phase of absolutely free communication from Cape Comorin to Madras, I think we have reason to believe that a single form of *Turbinella pirum* peopled the whole stretch of these coastal waters. The conditions would, so far as we can see, be little divergent anywhere along such a coastline and there would be no special localized conditions adequate to stimulate the evolution of well-marked varieties. Such uniform conditions disappeared immediately upon the formation of a continuous land barrier between India and Ceylon on the line Pamban—Rameswaram—Adam's Bridge—Mannar. Two isolated groups of the species would then be entailed; even connection by way of the east and south of Ceylon would be ineffective to keep up a connection between the isolated groups, because very deep water comes close to the land on parts of the E. and S.E. of Ceylon, and such deep water is as great a barrier to the dispersal of *Turbinella* as a land barrier, seeing that its larvae do not pass through a free-swimming stage. What we have seen happened in the case of the Andaman *Turbinella* happened again here. The shells in one or may be in both the localities cut off by the Indo-Ceylon barrier diverged from the common ancestor, and to-day we have two forms so strongly marked as to constitute distinct varieties. Had the land barrier not been broken down, these two varieties would assuredly have hardened into distinct species. With the breaking down of the barrier before this was effected, we get a mingling of the two main varieties and the possibility of the eventual suppression of one of them. Of this, I am, however, doubtful; I believe rather that the *obtusa* form has evolved characters fitting it to contend with certain conditions peculiar to Palk Bay and neighbourhood —of which muddy water is one—better than the *acuta* variety, which is more adapted

to deep water undisturbed by surface disturbances. If this be so, then the invasion of the Palk Bay region by *acuta*, by way of Pamban Pass and Adam's Bridge, will not prove successful; the two varieties will continue to crystallize their characteristics and will end, as they were undoubtedly doing up to the time the land barrier broke down, in becoming distinct species.

The phylogenetic relationship between the various varieties as indicated by morphological considerations supported by distributional and geological evidence may be represented as follows:—



The strongly marked periostracal layer in *acuta* may possibly be correlated to either or both of two reasons, the greater need to protect the shell in the Gulf of Mannar from the erosive effects of the coarse gritty sand characteristics of typical chank beds in that region or from the destructive burrowing of the tunnelling sponge *Cliona*. The thinness of the periostracum in the Coromandel race of *T. pirum obtusa* may be correlated to a decrease in the activity of these noxious factors in the Coromandel Sea—a doubtful hypothesis—or it may be related to the accessory assistance rendered against such factors by the very frequent occurrence of a crusting hydroid (?) on the shells from this region; this adventitious coat certainly aids in the protection of the shell from corroding influences whenever it occurs. All these are however mere guesses in the present state of our knowledge of the subject.

The foregoing is an attempt to give a reasoned account of the varieties and races of one of the dominant molluscs of Indian seas and to offer a working hypothesis for the explanation of the origin of some of the varieties which exist; at the same time to define and demarcate the characteristics and limits of the chief varieties, a matter which till now has been in a distinctly chaotic condition.

APPENDIX.

NOTE ON THE GEOLOGICAL HISTORY OF *TURBINELLA* IN INDIA.

By E. VREDENBURG, *B.L., B.Sc., A.R.S.M., A.R.C.Sc., F.G.S., Superintendent, Geological Survey of India (communicated with the kind permission of the Director, Geological Survey of India).*

The genus *Turbinella* first appears in India in oligocene times, when it is represented by a handsome somewhat nodose species with a tall stepped spire, *Turbinella episoma* Michelotti, which was first described from the same geological horizon in northern Italy. As we trace the successors of this fossil into formations of later age, they do not show the slightest indication of any approach towards the " sankh " of India. The oligocene shell is at first succeeded, in miocene times, by *Turbinella affinis*, J. de C. Sowerby, whose main distinction from *Turbinella episoma* consists in the slightly more effaced ornamentation, principally on the body-whorl. The difference in outward appearance is so slight that it would often be difficult to distinguish specimens relatively of both species but for the fact that the miocene form bears five columellar folds instead of three as in the oligocene fossil. During the miocene, *Turbinella affinis* was succeeded by two more forms, first, a hitherto undescribed species which may be named *T. prœovoidea*, very closely related to *T. affinis*, but in which the distinction from *T. episoma* becomes much more clearly accentuated owing to a greater portion of the spire becoming nearly smooth, and lastly, in middle or upper-middle miocene times by a smooth form which corresponds so closely with *T. ovoidea* Kiener, of the coasts of Brazil, that it cannot be separated from it otherwise than as a variety. In *T. prœovoidea*, the columella bears only four spiral folds, of which the most anterior one is apt, in certain specimens, to become indistinct. In the fossil variety of *T. ovoidea*, three folds are especially well developed, a fourth anterior fold being always present, but often feeble. This is the only distinction from the living Brazilian shell in which, judging from the single specimen available in Calcutta, there is no indication of this fourth anterior fold. In their shape and ornamentation, the four Indian fossil forms constitute a connected series the evolution of which consists principally in the gradual obliteration of the sculpture, but the spire always retains its elongate outline which is much steeper even than in the most elongate varieties of the living Indian species.

The age of the Indian fossil specimens of *Turbinella ovoidea* is probably not older than "tortonian," that is middle miocene. The modern " sankh " appears in a fossil condition in beds whose age must be at the limit of pliocene and uppermost miocene, along the Coromandel coast, at Karikal. The only specimen so far available from that formation is in a fragmentary condition and has not been figured, but is sufficiently preserved to have enabled Mr. Cossmann to refer it to one of the particular

varieties recognized by Mr. Hornell, the one corresponding with Gmelin's *Turbinella rapa*. According to Mr. Cossmann, "la spire un peu élevée, avec des nodosités transverses, très obsolètes, ressemble plutôt à celle de *T. rapa*, qu'à la spire tout à fait déprimée de *T. pirum*." (Faune pliocénique de Karikal, *Journ. Conch.*, Vol. L, 1902, p. 130). Mr. Hornell has observed specimens of the modern Indian species in pleistocene or sub-recent formations near Rameswaram and Tuticorin.

It has been above noticed that the oligocene species of India, *Turbinella episoma*, corresponds with a European fossil. The similarity between the oligocene faunas of India and of Europe is most remarkable, the percentage of European species in the case of the oligocene mollusca of north-western India, amounting to as much as 40 per cent, indicating that the seas of India and Europe constituted, at that time, portions of one zoological province. In the case of the lower miocene beds of India with *Turbinella affinis*, and in those with *T. prœovoidea*, the faunistic correspondence with Europe is very feeble, and the points of resemblance between the faunas of both regions finally disappear completely when we reach the horizon of the beds with *Turbinella ovoidea*. The Indian Ocean and Mediterranean regions seem to have been as thoroughly disconnected in middle miocene times as they are at the present day. The presence of the Brazilian species becomes therefore all the more remarkable, and seems to indicate that, while direct communication was closed with the Mediterranean and eastern Atlantic, an easy interchange of species could nevertheless take place between the Indian Ocean and the regions now constituting the *western* Atlantic, or at least with the Caribbean Sea. It is worth noticing that *Turbinella ovoidea* occurs in a fossil condition in the Miocene of San Domingo, and it is highly interesting to recall, in this same connection, the observation made years ago by Duncan as to the extraordinary similarity between the lower miocene coral fauna of India and that of the West Indies. Naturally enough, Duncan was under the impression that the connection between India and the West Indies took place, in lower miocene times, across the Mediterranean and Atlantic. We find now, however, from a study of the mollusca, that the directness of the marine connection between India and Europe had been much impaired in lower miocene times, while in middle miocene times, when the communication was certainly completely cut off, we find a remarkable instance of specific identity with Brazil and the West Indies in the case of one of the commonest and most conspicuous mollusca. It should also be kept in mind that, in miocene times, the climatic conditions, throughout the Mediterranean region, had already become unfavourable to the growth of reef-building corals, and therefore, even had a free communication subsisted, the spread of these organisms through that region would no longer have been possible.

It may very well be therefore that, already in lower miocene times, we should look to the east of India for the free communication that allowed the intermingling of the coral faunas of India and of the West Indies.

In conclusion, the oligocene *Turbinella episoma* of India and Europe is not the ancestor of the Indian "sankh," or, if at all connected genealogically, the line of

descendance did not take place through its Indian miocene mutations. The genus did not survive into the miocene of Europe.[1] In the miocene of India, *Turbinella episoma* was succeeded by three related "mutations," *Turbinella affinis*, *Turbinella præovoidea*, and finally *Turbinella ovoidea*, which latter spread eastwards as far as the West Indies. The latter species has survived to the present day along the coasts of Brazil, while, in India, at the end of the Miocene or beginning of the Pliocene, it was superseded by the totally different *Turbinella pirum*.

[1] As noticed by Bellardi (*Moll. terr. terz. Piem. e Lig.*, IV, p. 53) the attribution of a fragment of *Turbinella* to the Pliocene of Asti is probably due to an error of labelling.

EXPLANATION OF PLATE X.

Varieties of **Turbinella pirum** (Linn.).

Variety *acuta*.

FIG. 1.—Tuticorin race. Seven specimens showing range in form. × $\frac{1}{5}$.

,, 2.—Kilakarai and Ceylon Pearl Banks race. The seven upper figures are from Kalikarai, the three at bottom are from the Ceylon Pearl Banks off Marichchikadde and Dutch Bay. × $\frac{1}{5}$.

,, 3.—Rameswaram race. Six specimens. × $\frac{1}{5}$.

,, 4.—North Vedalai race. Eleven specimens. × $\frac{1}{5}$.

Variety *obtusa*.

FIG. 5.—Tirupalagudi race, showing range in form. Compare with the shells from North Vedalai (fig. 4) which march with this race of *obtusa*. × $\frac{1}{5}$.

,, 6.—Coromandel race. Specimens from off the coast of the Tanjore District. × $\frac{1}{5}$.

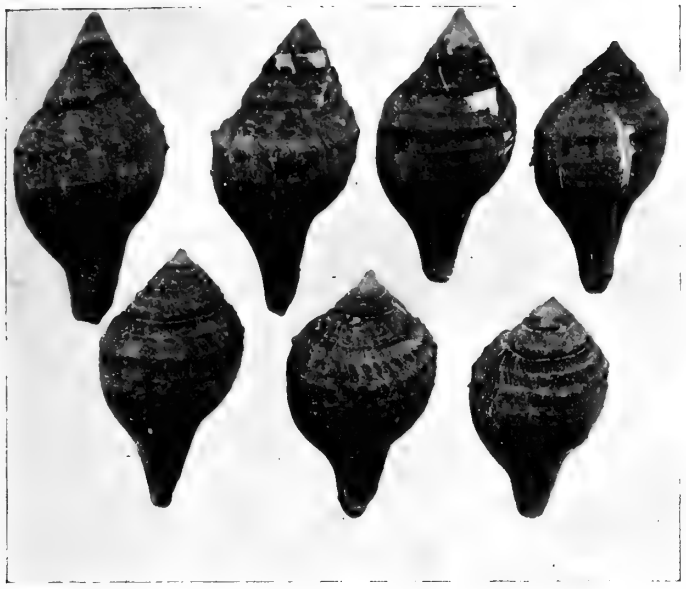


Fig. 1.

Fig. 3.

Fig. 5.

Fig. 6.

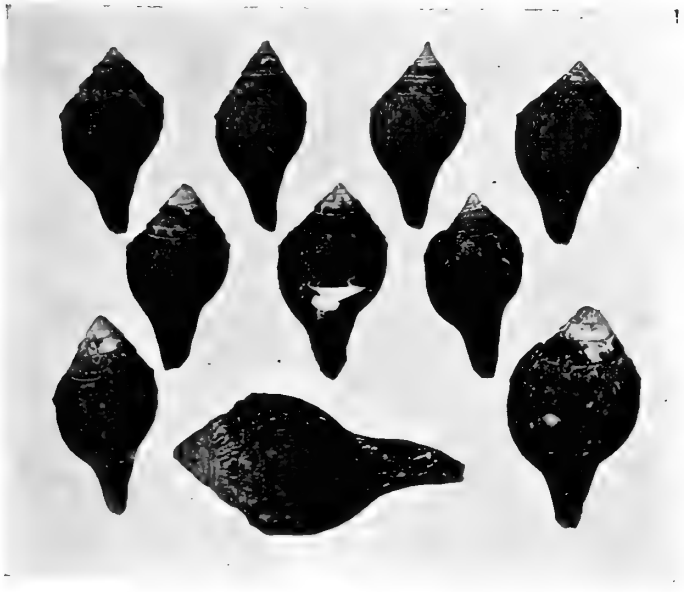


Fig. 2.

Fig. 4.

EXPLANATION OF PLATE XI.

Varieties of **Turbinella pirum** (Linn.).

Variety *obtusa*.

FIG. 7.—Coromandel race. Specimens from Chingleput and South Arcot Districts. $\times \frac{1}{5}$.

,, 8.—Examples from the Jaffna Islands and north-east coast of Ceylon. These also may be classed as of the Coromandel race. $\times \frac{1}{5}$.

Varieties *comorinensis* and *globosa*.

FIG. 9.—Var. *comorinensis*, represented by the upper six (smaller) examples. $\times \frac{1}{5}$. Var. *globosa*, by the five larger ones in middle and bottom row. $\times \frac{1}{5}$.

Variety *fusus*, Sowerby.

FIG. 10.—A fully adult individual showing very strong plicae and stout oral lips. $\times \frac{3}{5}$.

,, 11.—Back view of a younger specimen to show periostracal sculpturing and angular shoulder, the latter more marked here than in fully adult individuals. $\times \frac{3}{5}$.

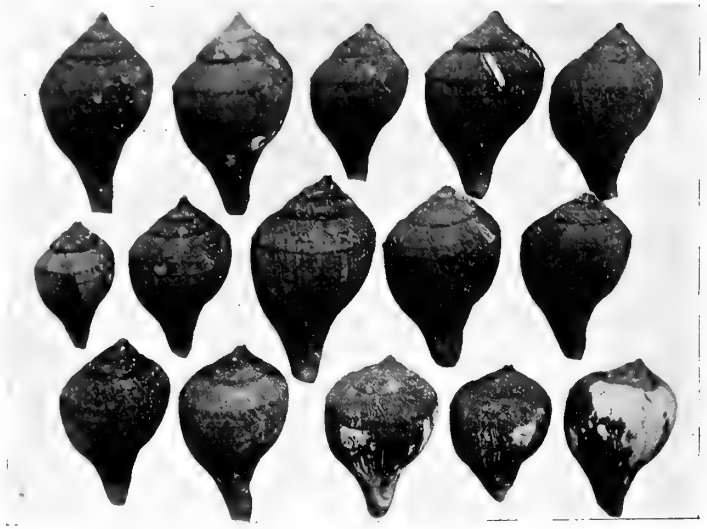


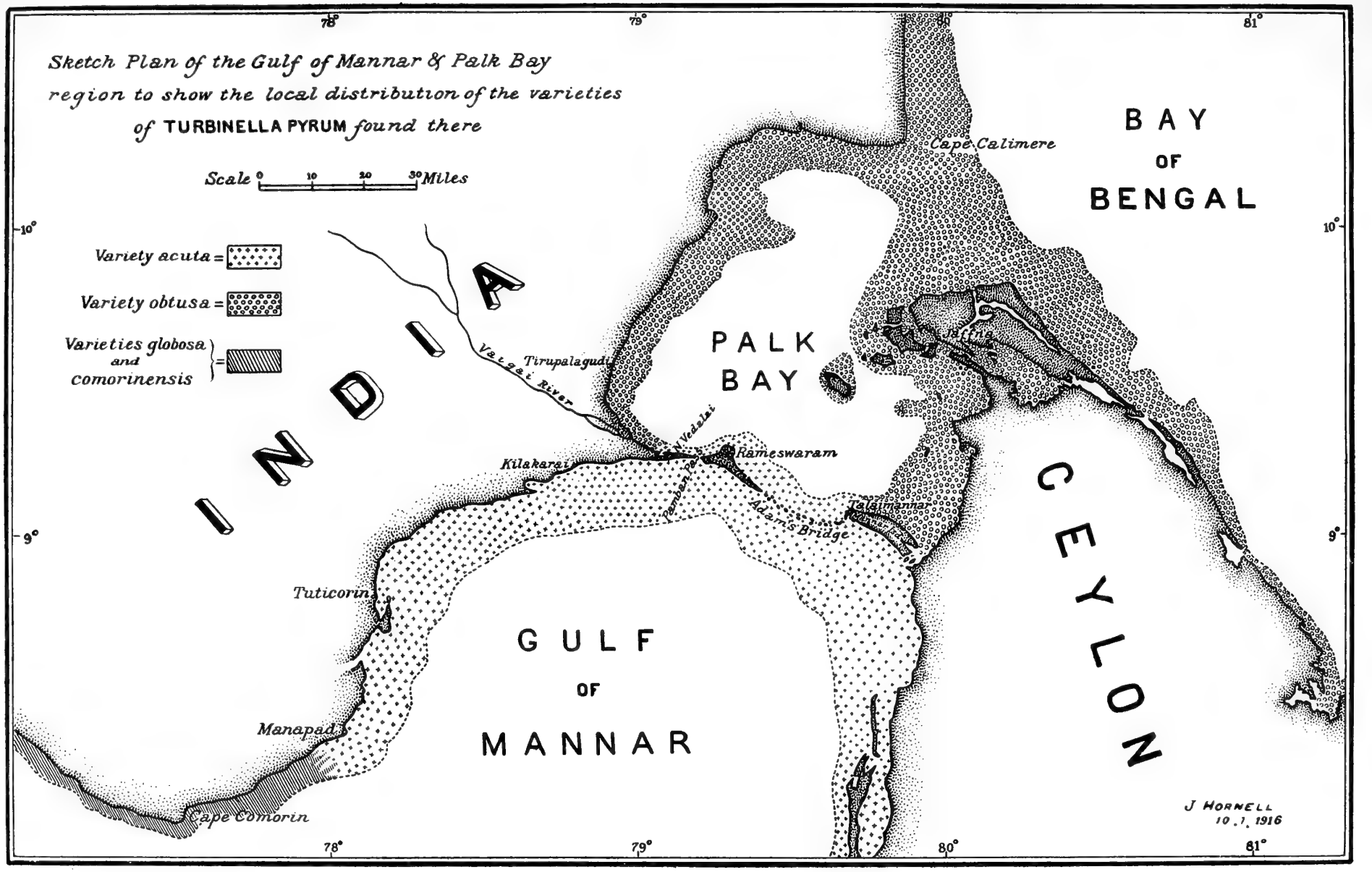
Fig. 7.

Fig. 8.

Fig 10.

Fig. 9.

Fig. 11.



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THREE PLATES TO ILLUSTRATE THE SCALPELLIDAE AND IBLIDAE OF INDIAN SEAS, WITH SYNONYMY AND NOTES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

The three plates now published were prepared about five years ago, to be issued with an account of the Scalpellidae and Iblidae of Indian seas, which was to be arranged on the same lines as my account of the Lepadidae published in these *Memoirs*.[1] As soon, however, as the Surgeon Naturalist on the 'Investigator' began to dredge in shallow water off the coast of Burma,[2] it became clear that our knowledge of these barnacles was still very incomplete so far as the eastern side of the Bay of Bengal was concerned, and it seemed best to defer the publication of the monograph until further material could be obtained.

It had been arranged by the Government of India that the 'Investigator' should be entirely devoted to zoological work for one month in every year, and that a considerably enhanced grant should be made to the Surgeon Naturalist for apparatus and books, but war broke out and the scheme has had to be postponed indefinitely.

In these circumstances I think it best not to defer the publication of the three plates any longer, seeing that all the species figured in them have now been described and that in the case of two[3] of these species no figures have hitherto been issued.

The plates are numbered VI, VII and VIII because they are to be regarded as a continuation and final instalment of the "*Illustrations of the Zoology of the R.I.M.S. Investigator*", in which five previous plates have already been devoted to the Cirripedia. These were published in two series in 1907 and 1908 respectively.

A preliminary account of the Indian species of *Scalpellum* (*s.l.*) has already been issued in Vols. V and IX of the *Records of the Indian Museum*.[4]

The figures have been drawn by Babu A. C. Chowdhary, S. C. Mondul and D. N. Bagchi, who have devoted their usual skill to their preparation.

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[1] "An account of the Indian Cirripedia Pedunculata. Part I.—Family Lepadidae (*sensu stricto*)." *Mem. Ind. Mus.*, II, pp. 61-137, pls. vi, vii (1909).

[2] See Annandale, *Rec. Ind. Mus.*, X, p. 273 (1914).

[3] The names of these species are marked with an asterisk in the lists that follow.

[4] "The Indian Barnacles of the subgenus *Smilium*, with remarks on the classification of the genus *Scalpellum*": *Rec. Ind. Mus.*, V, pp. 145-155 (1910); and "The Indian Barnacles of the subgenus *Scalpellum*": *Rec. Ind. Mus.*, IX, pp. 227-236 (1913).

The following is a list of the species figured here:—

Mitella mitella (Linn.)
Scalpellum (Smilium) squamuliferum, Weltner.
,, ,, *bengalense*, Annandale.
,, ,, *acutum*, Hoek.
,, *alcockianum*, Annandale.
,, *velutinum*, Hoek.
Scalpellum pacificum, Pilsbry.
,, *albatrossianum*, Pilsbry.
,, *curiosum*, Hoek.
,, *laccadivicum*, Annandale.
,, *lambda**, Annandale.
,, *longius**, Annandale.
Lithotrya nicobarica, Reinhart.
Ibla cumingi, Darwin.

All the specimens figured, except the *Mitella* (which is from the Gulf of Siam) and one example of *Ibla cumingi* from the Persian Gulf, are from the seas of British India.

Family SCALPELLIDAE.

Mitella mitella (Linn.).

(Plate VII, fig. 1.)

1758. *Lepas mitella*, Linné, *Syst. Nat.* (10th ed.), p. 668.
1851. *Pollicipes mitella*, Darwin, *Mon. Cirr., Lepadidae*, p. 316, pl. vii, fig. 3.
1905. *Pollicipes mitella*, Gruvel, *Mon. Cirrh.*, p. 19, fig. 22.
1907. *Pollicipes mitella*, Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), p. 121.
1907. *Mitella mitella*, Pilsbry, *Bull. U.S. Nat. Mus.*, No. 60, p. 6.
1910. *Pollicipes mitella*, Annandale, *Vid. Med. nat. Foren. Kjøbenhavn*, p. 181.
1912. *Mitella mitella*, Krüger, *Abh. d. II. Kl. Kong. Akad. Wiss. München*, II Suppl.-Bd., 6 Abh., p. 8, taf. ii, figs. 10, 11.
1913. *Pollicipes mitella*, Hoek, *op. cit.*, Introduction, p. xv.
1916. *Mitella mitella*, Joleaud, *Ann. Mus. Hist. Nat. Marseille*, XV, p. 25, pl. v, figs. 17-21.

Curiously enough this common species, which is abundant at some places in the Gulf of Siam and also occurs in the Malay Archipelago and in the western part of the Indian Ocean, has not been found in the seas of British India. The specimen figured is from the Gulf of Siam.

Scalpellum (Smilium) squamuliferum, Weltner.

(Plate VI, figs. 1, 2.)

1894. *Scalpellum squamuliferum*, Weltner, *Sitz.-Ber, naturf. Freunde*, p. 80, figs. 1-5.
1905. *Scalpellum squamuliferum*, Gruvel, *Mon. Cirrh.*, p. 56, fig. 59.
1907. *Scalpellum squamuliferum*, Annandale, *Illustr. Zool. 'Investigator,' Crust.* (*Entom.*), pl. ii, fig. 4.
1908. *Scalpellum squamuliferum*, *id.*, *ibid.*, pl. iii, figs. 4-6.
1908. *Euscalpellum* (*?*) *squamuliferum*, Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, p. 108.
1910. *Scalpellum* (*Smilium*) *squamuliferum*, Annandale, *Rec. Ind. Mus.*, V, pp. 147, 151, fig. 2.
1911. *Scalpellum squamuliferum*, Stewart, *Mem. Ind. Mus.*, III, p. 37, pl. iv, figs. 1-6; pl. v: pl. vi, figs. 1-6 and 9.
1913. *Scalpellum squamuliferum*, Hoek, *Siboga-Exp.*, mon. XXXI*a*, Introduction, p. xv.
1916. *Scalpellum* (*Protoscalpellum*) *squamuliferum*, Joleaud, *Ann. Mus. Hist. Nat. Marseille*, XV, p. 41.

Scalpellum (Smilium) bengalense, Annandale.

(Plate VI, figs. 3, 4; pl. VII, fig. 3; pl. VIII, figs. 1-5.)

1906. *Scalpellum bengalense,* Annandale, *Ann. Mag. Nat. Hist.*, (7), XVII, p. 395.
1907. *Scalpellum bengalense, id., Illustr. Zool. 'Investigator,' Crust.* (*Entom.*), pl. i, fig. 5 (young).
1908. *Euscalpellum bengalense,* Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia,* p. 108.
1910. *Scalpellum* (*Smilium*) *bengalense,* Annandale, *Rec. Ind. Mus.*, V, pp. 146, 153, fig. 1.
1911. *Scalpellum bengalense,* Stewart, *Mem. Ind. Mus.*, III, p. 44, pl. vi, figs. 7, 10.
1913. *Scalpellum bengalense,* Hoek, *Siboga-Exp.*, mon. XXXI*a*, Introduction, p. xiv.

Scalpellum (Smilium) acutum, Hoek.

(Plate VII, fig. 4.)

1883. *Scalpellum acutum,* Hoek, '*Challenger*' *Zool. Rep.*, VIII (*Cirripedia*), p. 80, pl. iii, fig. 19, pl. viii, fig. 12.
1902. *Scalpellum longirostrum,* Gruvel, *Cirrh. du 'Travailleur' et du 'Talisman'*, p. 70.
1907. *Scalpellum* (*Smilium*) *acutum,* Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), p. 64, pl. vii, fig. 1.
1908. *Smilium acutum,* Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia,* p. 107.
1910. *Scalpellum* (*Smilium*) *acutum,* Annandale, *Rec. Ind. Mus.*, V, p. 154.
1913. *Scalpellum acutum,* Hoek, *op. cit.*, Introduction, p. xiv.

Scalpellum alcockianum, Annandale.

(Plate VI, fig. 5.)

1906. *Scalpellum alcockianum,* Annandale, *Ann. Mag. Nat. Hist.*, (7), XVII, p. 392.
1907. *Scalpellum alcockianum, id., Illustr. Zool. 'Investigator', Crust.* (*Entom.*), pl. i, fig. 2; pl. ii, figs. 2, 2*a*, 2*b*.
1907. *Scalpellum alcockianum,* Pilsbry, *Bull. U.S. Nat. Mus.*, No. 60, p. 25.
1913. *Scalpellum alcockianum,* Hoek, *Siboga-Exp.*, mon. XXXI*a*, Introduction, p. xiv.

I am describing shortly in the *Journal of the Straits Branch of the Royal Asiatic Society* a form from the western part of the Malay Archipelago closely allied to this peculiar species, which seems to be related also to *S. giganteum*, Gruvel, from the Atlantic. The Indian species is distinguished from all other members of the genus by the great length of its anal appendages.

Scalpellum velutinum, Hoek.

(Plate VI, figs. 6, 7.)

1883. *Scalpellum velutinum,* Hoek, '*Challenger*' *Zool. Rep.*, VIII (*Cirripedia*), p. 96, pl. iv, figs. 10, 11; pl. ix, figs. 7-9.
1883. *Scalpellum eximium, id., op. cit.*, p. 100, pl. iv, figs. 6, 7; pl. ix, figs. 10, 10*.
1898. *Scalpellum sordidum,* Aurivillius, *Bull. Soc. zool. France,* XXIII, p. 190.
1902. *Scalpellum alatum,* Gruvel, *Cirrh. du 'Travailleur' et du 'Talisman'*, p. 57.
1907. *Scalpellum velutinum,* Pilsbry, *Bull. U.S. Nat. Mus.*, No. 60, p. 26, pl. iii, figs. 2, 3.
1908. *Scalpellum* (*Arcoscalpellum*) *velutinum, id., Proc. Acad. Nat. Sci. Philadelphia,* p. 109.
1908. *Scalpellum velutinum,* Annandale, *Illustr. Zool. 'Investigator', Crust.* (*Entom.*), pl. iv, fig. 7.
1911. *Scalpellum velutinum, id., Ann. Mag. Nat. Hist.*, (8), VII, p. 588.
1913. *Scalpellum velutinum, id., Rec. Ind. Mus.*, IX, p. 229.

Scalpellum pacificum, Pilsbry.

(Plate VII, fig. 7; pl. VIII, fig. 11.)

1906. *Scalpellum tenue*, Annandale (*nec* Hoek), *Herdman's Rep. Pearl Oyster Fisheries*, V, p. 142.
1907. *Scalpellum pacificum*, Pilsbry, *Bull. Bur. Fish. U.S.A.*, No. 617, p. 182, pl. iv, figs. 3, 4.
1913. *Scalpellum pacificum*, Annandale, *Rec. Ind. Mus.*, IX, p. 230.

Scalpellum albatrossianum, Pilsbry.

(Plate VI, fig. 9.)

1907. *Scalpellum albatrossianum*, Pilsbry, *Bull. U.S. Nat. Mus.*, No. 60, p. 54, fig. 19.
1908. *Scalpellum albatrossianum*, Annandale, *Illustr. Zool. 'Investigator', Crust.* (*Entom.*), pl. iii, fig. 10.
1913. *Scalpellum albatrossianum, id., Rec. Ind. Mus.*, IX, p. 232.

Scalpellum curiosum, Hoek.

(Plate VIII, figs. 8-10.)

1906. *Scalpellum japonicum*, Annandale (*nec* Hoek), *Herdman's Rep. Pearl Oyster Fisheries*, V, p. 141.
1907. *Scalpellum curiosum*, Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), p. 79, pl. vii, figs. 8, 8*a*, 8*b*.
1908. *Scalpellum curiosum*, Annandale, *Illustr. Zool. 'Investigator', Crust.* (*Entom.*), pl. iv, fig. 8.
1913. *Scalpellum curiosum, id., Rec. Ind. Mus.*, IX, p. 233.
1913. *Scalpellum curiosum*, Hoek, *op. cit.*, Introduction, p. xiv.

Scalpellum laccadivicum, Annandale.

(Plate VI, fig. 8; pl. VIII, figs. 6, 7.)

1906. *Scalpellum laccadivicum* and var. *investigatoris*, Annandale, *Ann. Mag. Nat. Hist.*, (7), XVII, pp. 393-395.
1906. *Scalpellum subflavum, id., ibid.*, p. 397.
1907. *Scalpellum laccadivicum* and var. *investigatoris, id., Illustr. Zool. 'Investigator', Crust.* (*Entom.*), pl. i, figs. 3, 4.
1907. *Scalpellum subflavum, id., ibid.*, pl. i, fig. 6.
1907. *Scalpellum polymorphum*, Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), p. 80, pl. vii, figs. 9-11.
1908. *Scalpellum* (*Arcoscalpellum*) *laccadivicum*, Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, p. 110.
1913. *Scalpellum laccadivicum*, Annandale, *Rec. Ind. Mus.*, IX, p. 235.
1913. *Scalpellum laccadivicum*, Hoek, *op. cit.*, Introduction, p. xiv.

Scalpellum lambda,* Annandale.

(Plate VII, figs. 6, 6*a*; pl. VIII, figs. 12-15.)

1910. *Scalpellum lambda*, Annandale, *Rec., Ind. Mus.*, V, p. 115.
1913. *Scalpellum lambda, id., ibid.*, IX, p. 234.

Scalpellum longius,* Annandale.

(Plate VII, figs. 5, 5*a*.)

1913. *Scalpellum longius*, Annandale, *Rec. Ind. Mus.*, IX, p. 234.

Lithotrya nicobarica, Rhdt.

(Plate VII, fig. 2.)

1851. *Lithotrya nicobarica*, Darwin, *Mon. Cirr., Lepadidae*, p. 359, pl. viii, fig. 2.
1905. *Lithotrya nicobarica*, Gruvel, *Mon. Cirrh.*, p. 99.
1907. *Lithotrya nicobarica*, Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), p. 122.
1913. *Lithotrya nicobarica*, *id.*, *op. cit.*, Introduction, p. xv.

I figure a specimen received in exchange from the Copenhagen Museum and labelled as being a co-type of Reinhardt's species. I have not seen the original description.

Family IBLIDAE.

Ibla cumingi, Darwin.

(Plate VII, figs. 8, 9.)

1851. *Ibla cumingii*, Darwin, *Mon. Cirr., Lepadidae*, p. 183, pl. iv, fig. 8; pl. v, figs. 1-8.
1902. *Ibla quadrivalvis*, Lanchester (*nec.* Cuvier), *Proc. Zool. Soc. London*, I, p. 372.
1905. *Ibla cumingi*, Gruvel, *Mon. Cirrh.*, p. 147.
1907. *Ibla cumingi* and *I. sibogae*, Hoek, *Siboga-Exp.*, mon. XXXI*a* (*Cirr. Ped.*), pp. 47, 48, pl. iv, figs. 20-22; pl. v, figs. 1-8.
1911. *Ibla cumingii*, Stewart, *Mem. Ind. Mus.*, III, p. 47, pl. iv, fig. 7.
1911. *Ibla cumingi*, Annandale, *Rec. Ind. Mus.*, VI, p. 229.
1913. *Ibla cumingi* and *I. sibogae*, Hoek, *op. cit.*, Introduction, p. xiv.

EXPLANATION OF PLATE VI.

Scalpellum (Smilium) squamuliferum, Weltner.

FIG. 1.—Part of peduncle (magnified).

,, 2.—Anal appendage in lateral view (stained and magnified).

Scalpellum (Smilium) bengalense, Annandale.

FIG. 3.—Part of peduncle (magnified).

,, 4.—Male in lateral view (stained and magnified). The specimen figured was completely devoid of calcareous valves.

Scalpellum alcockianum, Annandale.

FIG. 5.—Outline of capitulum, of capitular valves and of first row of peduncular plates. A. Rostrum and rostral latera as seen from inside the capitulum. B. Carina and carinal latera as seen from inside the capitulum. All × 2.

Scalpellum velutinum, Hoek.

FIG. 6.—The two mandibles of an Indian individual (highly magnified).

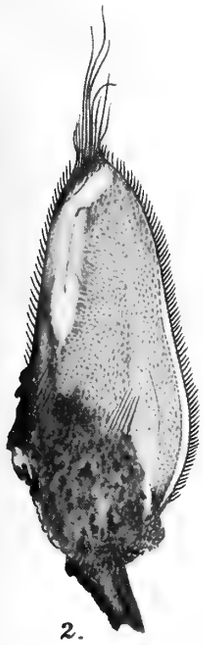
,, 7.—Male (highly magnified), with the spines from different regions still further enlarged.

Scalpellum laccadivicum, Annandale.

FIG. 8.—Dorsal view of capitulum and upper part of peduncle (magnified).

Scalpellum albatrossianum, Pilsbry.

FIG. 9.—Dorsal view of base of carina and adjacent parts in an Indian specimen (magnified).



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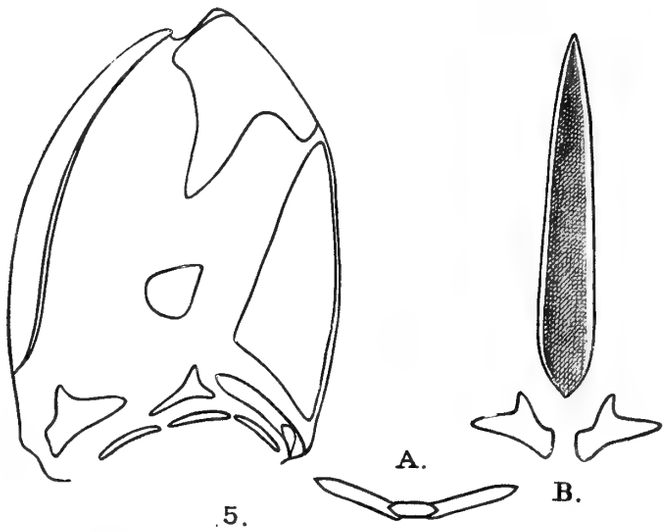
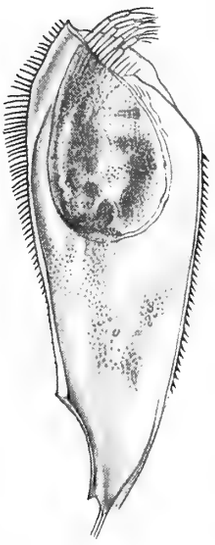


A. B.

5.



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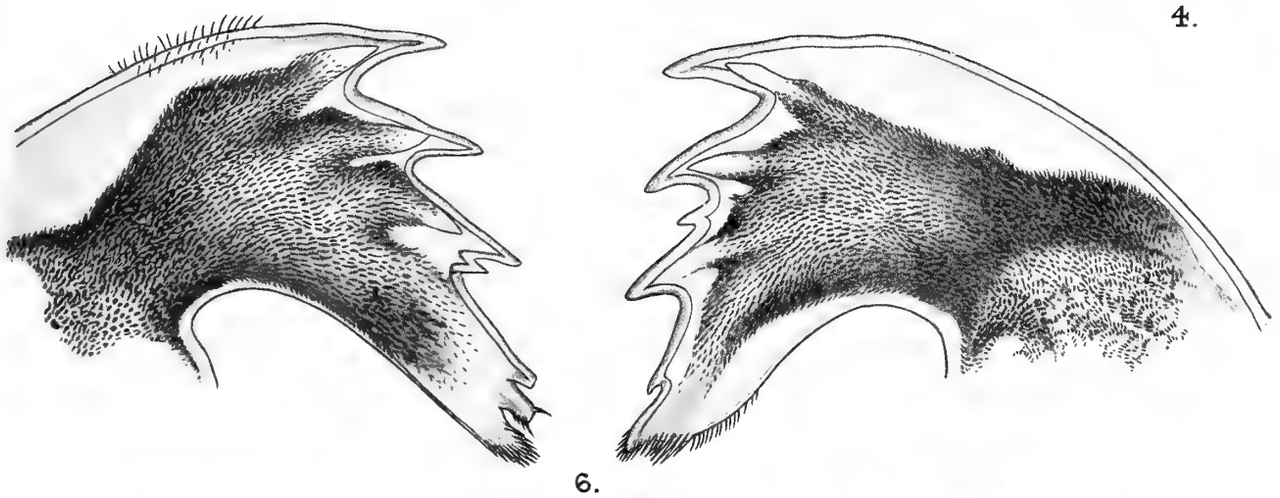
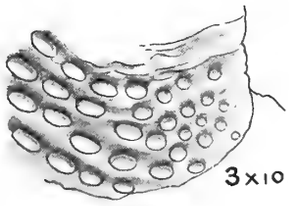
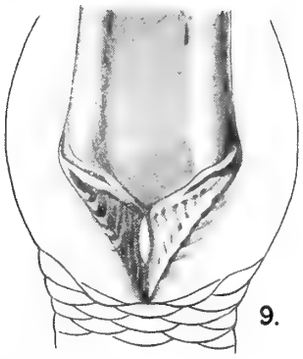


6.

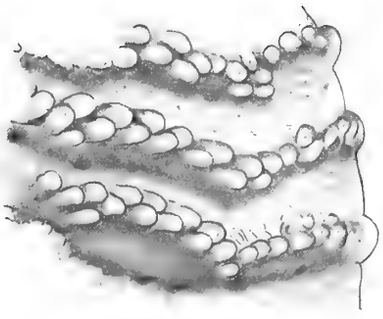


3×10.



9.

7.



1×10.

8×4.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1912.

EXPLANATION OF PLATE VII.

Mitella mitella (Linn.).

FIG. 1.—Specimen from the Gulf of Siam. × 2.

Lithotrya nicobarica, Reinhart.

FIG. 2.—Co-type from the Nicobars.

Scalpellum (Smilium) bengalense, Annandale.

FIG. 3.—Mature specimen from the Bay of Bengal in lateral view (magnified).

Scalpellum (Smilium) acutum, Hoek.

FIG. 4.—Specimen on the root-spicules of *Hyalonema* from the Andaman Sea in lateral view (magnified). 4*a*. Dorsal view of the same specimen.

Scalpellum longius, Annandale.

FIG. 5.—One of the type-specimens in lateral view (magnified). 5*a*. Dorsal view of the same specimen.

Scalpellum lambda, Annandale.

FIG. 6.—Type-specimen in lateral view (magnified). 6*a*. Base of carina and carinal latera in dorsal view.

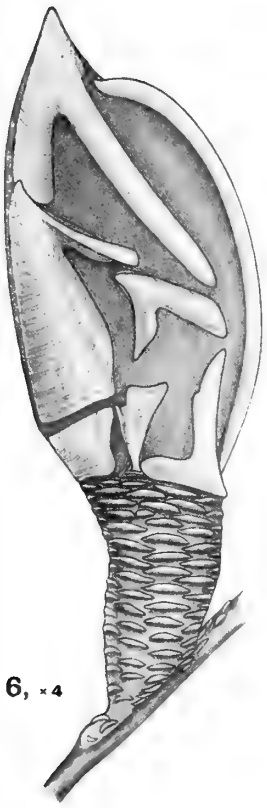
Scalpellum pacificum, Pilsbry.

FIG. 7.—Indian specimen in lateral view (magnified). 7*a*. Base of carina and carinal latera in dorsal view.

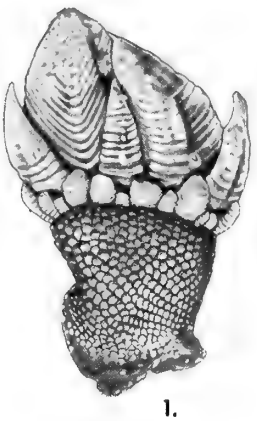
Ibla cumingi, Darwin.

FIG. 8.—Specimen of the form *sibogae*, Hoek, from the coast of Burma (magnified).

,, 9.—Old and shrivelled specimen of the typical form from the Persian Gulf (magnified).



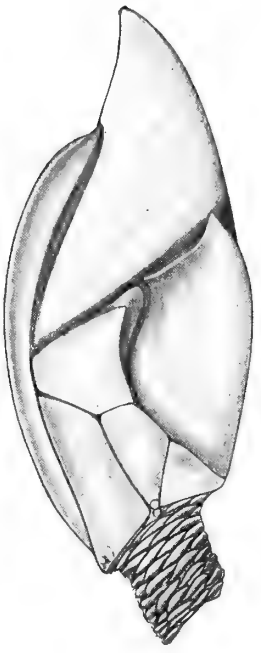
6, ×4



1.

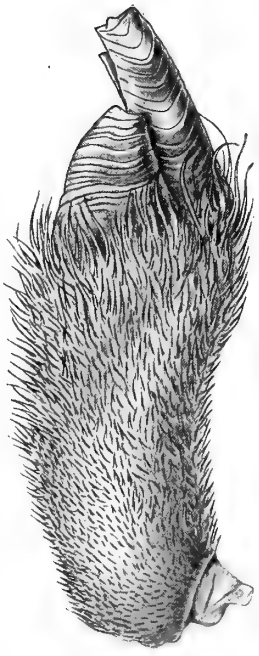
×8

5a, ×8.



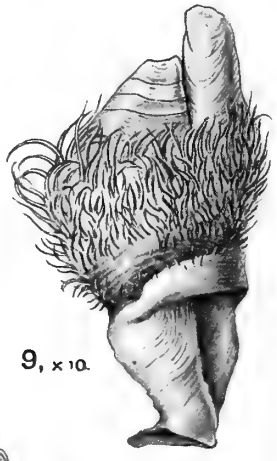
5, ×8.

6a, ×4

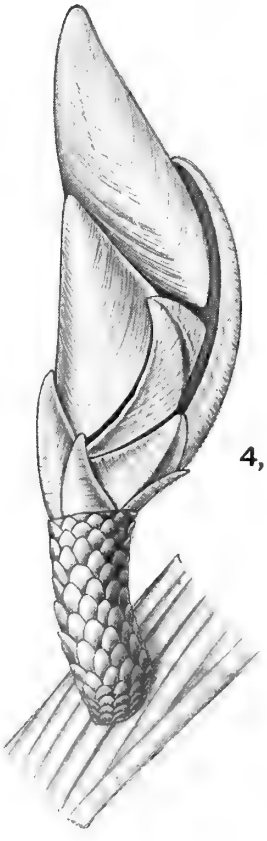


8, ×10.

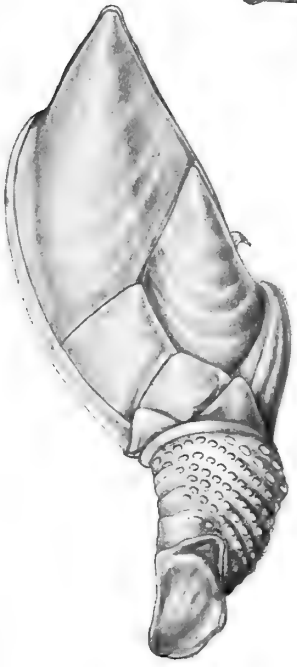
2.



9, ×10.

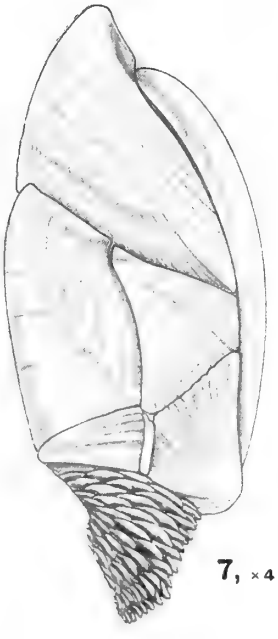


4, ×10.



3, ×4.

4a, ×10.



7, ×4

7a, ×4.

Photo-Engraved & printed at the Offices of the Survey of India, Calcutta, 1912.

Indian Cirripedia (*Pollicipes, Lithotrya, Scalpellum, Ibla*).

EXPLANATION OF PLATE VIII.

Scalpellum (Smilium) bengalense, Annandale.

FIG. 1.—A pair of maxillae, showing variation. × 75.
,, 2.—Penis. × 30.
,, 3.—Tip of anal appendage. × 75.
,, 4.—Mandible. × 30.
,, 5.—Maxilla. × 75.

Scalpellum laccadivicum, Annandale.

FIG. 6.—Anal appendage. × 30.
,, 7.—First cirrus. × 16.

Scalpellum curiosum, Hoek.

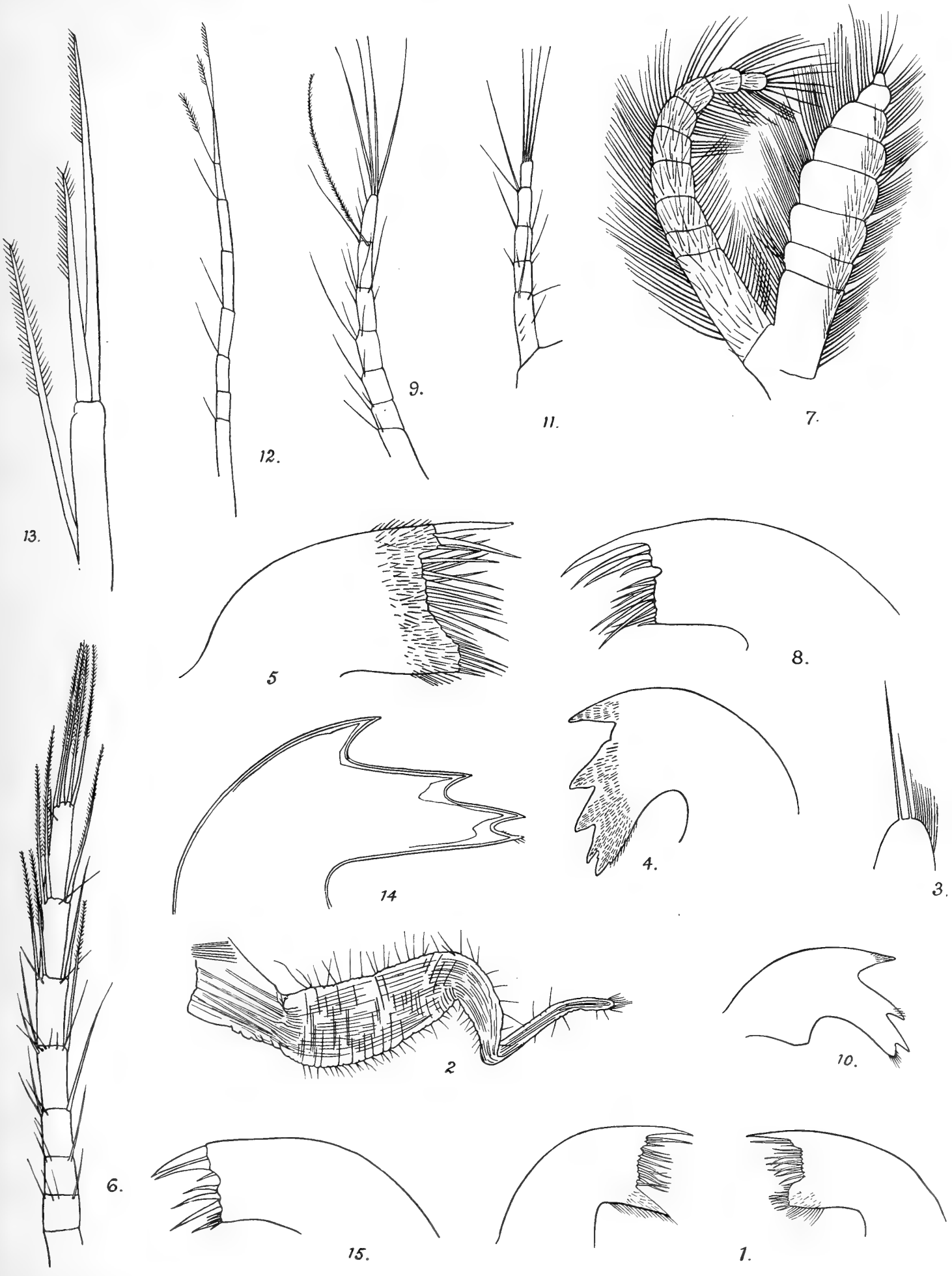
FIG. 8.—Maxilla. × 75.
,, 9.—Anal appendage. × 30.
,, 10.—Mandible. × 30.

Scalpellum pacificum, Hoek.

FIG. 11.—Anal appendage. × 30.

Scalpellum lambda, Annandale.

FIG. 12.—Annal appendage in lateral view. × 35. The last segment is possibly distorted.
,, 13.—Terminal segment of same appendage viewed somewhat obliquely. × 157.
,, 14.—Mandible. × 190.
,, 15.—Maxilla. × 190.



D. N. Bagchi, *del.*

INDIAN SPECIES OF SCALPELLUM.

MEMOIRS OF THE INDIAN MUSEUM

Vol. VI, No. 4.

THE APHIDIDAE OF LAHORE.

By the late Bashambar Das, *M.Sc.*

Edited, with Notes and an Introduction.

By P. van der Goot.

(Text)

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NOTE.

The plates with their respective explanations will be issued later.

THE APHIDIDAE OF LAHORE.

By the late BASHAMBAR DAS, *M.Sc.*

EDITED, WITH NOTES AND AN INTRODUCTION.

By P. VAN DER GOOT (*Salatiga, Java*).

(Plates XIII—XXX.)

INTRODUCTION.

By P. VAN DER GOOT.

The following pages contain a somewhat shortened account of a very thorough and interesting study on the Aphididae of Lahore by the late Mr. Das, which study originally was submitted as a thesis for his Doctorate in the Punjab University. Mr. Das' sudden death unfortunately prevented the publication in full of his valuable paper. Financial reasons making it impossible to publish the study as a whole in the "*Memoirs of the Indian Museum*," the writer was consulted by Dr. Annandale, now Director of the Zoological Survey of India, as to the possibility of publishing those parts of Mr. Das' paper that might contain any information either new or interesting to science.

After having looked through the manuscript of the late Mr. Das' paper, it was thought advisable to omit from the original paper all descriptions of recorded species that had already been sufficiently dealt with by other authors. Of the different well-known species all particulars available as to their biology in India have however been retained in full. The descriptions of different new species are published here in the original form as Mr. Das has put them down, although in the writer's opinion they are sometimes a little too lengthy.

The writer has had the pleasure of being in correspondence with the late Mr. Das on different points of systematical questions concerning Aphididae, and, through his courtesy, has received specimens of some of the new species, treated in this paper. Being therefore in the position of comparing my own notes on these species with the descriptions of Mr. Das, I have sometimes thought it necessary to add in short a few corrections or additions. In some cases I have thought it advisable to add in a separate note my own opinion on some questions of nomenclature or systematics. The original descriptions themselves have, however, been left untouched as much as possible.

In my opinion Mr. Das' paper will prove of great value to our knowledge of tropical and subtropical Aphididae, a subject which until very recently has been practically left untouched. His pioneer-work undoubtedly will give his fellow-workers many a good addition to their knowledge of this interesting group of little insects.

Salatiga, November 10th, 1916.

Lt.-Col. J. Stephenson, I.M.S., Principal and Professor of Zoology, Government College, Lahore, has kindly supplied the following biographical note:—

"Bashambar Das was born in 1884 at Nainakot, Gurdaspur district, where his father was a teacher in the local school. He received his early education at Rahon

in Jullunder district, and matriculated from the Doaba High School at Jullunder. After studying for two years at the Forman Christian College, Lahore, he passed the Intermediate Examination in Science of the Punjab University. He then joined the Lahore Medical College; but after two years, owing to a serious illness, he had to give up his studies just as he had passed the Preliminary Scientific examination. These two years served however to give him a good foundation for his biological studies later on.

"His educational career as a medical student having been thus unexpectedly cut short, he joined the Government College, Lahore, and obtained the degree of B.Sc. in 1908, taking as his subjects Botany and Zoology. He was the first to join the regular M.Sc. class in Zoology, which was started in the same year; and while thus engaged in his further studies he was appointed to a demonstratorship in the department. In 1910 he obtained a good second class in the examination for the degree of M.Sc. in the Punjab University.

"By this time his inclination for outdoor observation and aptitude as a naturalist had become fully established; he was a keen collector and student of insect life; and before taking up the study of a special group he had equipped himself as an entomologist by paying several visits to the Imperial Agricultural College at Pusa and the Indian Museum at Calcutta, where he carefully examined the collections and identified his own specimens. In 1912 he was appointed to the Provincial Educational Service as Assistant Professor of Biology in the Government College, Lahore, and now began to examine and collect plants with the same keenness and care which he had hitherto bestowed on animal life. He selected the Aphids for special investigation, since this group gave him the opportunity of studying the plant hosts as well as the insects themselves.

"He resolutely declined marriage till he should have done a sufficient amount of research work to submit a thesis for the degree of Doctor of Science. The thesis, now published in the present form, was presented in 1914; and both the examiners having expressed their approval of it as a sufficient qualification for the degree, its author would in the ordinary course have been invested with the degree in 1915, and would thus have been the first person to receive the Doctorate (except *honoris causae*) in the Punjab University. Unfortunately for Biological teaching in the Punjab, Bashambar Das died of an attack of cholera in May 1915, contracted while attending on two students suffering from the disease in the College Hostel."

FOREWORD.

The studies on plant-lice embodied in this paper were chiefly carried out at Lahore, in the Government College Biological Laboratory, under the direction of Lt.-Col. J. Stephenson, D.Sc., Principal and Professor of Biology.

In order to consult reference literature and to examine any previous Aphid material, opportunities were taken for spending some time in the Entomological sections of the Agricultural Research Institute at Pusa (Behar) and the Indian Museum in Calcutta (Bengal). Shorter visits were paid to similar institutions at Lyallpore (Punjab), Dehra Dun (United Provinces) and Poona (Bombay).

Descriptive accounts and life-histories, so far as known, of forty species, new and old, belonging to eighteen different genera, have been dealt with. Plates and Camera lucida drawings accompany all, as well as the characters of genera and identification tables where necessary. A host-plant index has also been prepared and is given at the end.

With the object of facilitating further work on Aphids in India, an attempt is herein made to present in one place all information of this nature that exists concerning these insects in this country. Lines for additional investigations, therefore, and special points requiring more extended observation are indicated throughout.

Most of the theoretical considerations, as well as the measures for controlling such as are pests, have not been touched upon at all.

The relation of plant-lice to their environment, and in particular to their insect friends and enemies in India, could merely be given in some cases; their detailed account has been reserved for an independent treatment.

For the rest, taking into account the very scanty earlier knowledge on Oriental Aphids, it may be hoped that what is contained in the following pages would be of interest either as new, or recorded for the first time from India.

It would be of use to note, in this connection, that Lahore is situated in 31° 35′ N. and 74° 20″ E.; its height above sea level is 732 feet. The hottest months are May and June with a mean maximum temperature of about 106°; the actual highest may go up to 120°. The mean minimum for the cold months of December and January is nearly 40°; the actual lowest has never gone below 29°. The amount of rainfall ranges between eight and twenty-five inches, but is chiefly confined to the "rainy season" in July and August.

The time for shedding leaves differs in most of the deciduous plants, so that in the plains we do not have a "winter" preceded by an "autumn" or "Fall," when all the plants are devoid of foliage. Wheat and several other cereals are "winter crops"; when harvested in April no "volunteer wheat" remains in the fields.

INTRODUCTION.

Aphididae or plant-lice are soft-bodied, usually small insects belonging to the same large group popularly known as "bugs." Like them constituted to live upon liquid food only, they draw out their nutriment by puncturing the living parts of plants, by means of their suctorial beaks. It is due to their sedentary habits and quick multiplication that they are generally found in smaller or larger droves, most frequently upon the leaves and the tender shoots of their hosts. If the drain upon the juices is excessive, the plants are very much weakened, and even succumb to the injury. Those therefore that attack the cultivated plants often assume an economic importance for the gardener and the farmer, necessitating vigorous, and in cases even elaborate, measures to be taken in hand to stop or stem the losses due to these pests.

Aphids.

Economic importance.

Their biological interest and importance is no less great. They present several unusual and remarkable peculiarities in their structure and life-histories. Their study has attracted numerous workers, but still the group requires a thorough investigation from several aspects.

Biological interest.

The popular English names for these insects are "green-fly blight" or "plant-lice." The German "Pflanzenlause" is an exact equivalent of the latter, though equally often they are referred to as "Blattlause" or "leaf-lice."

There is hardly any word in use in the Punjab to definitely designate a "*plant-louse.*" Ordinarily the farmer speaks of it as "Tela" from "tel," meaning oil, which has a reference rather to the effect of its presence upon the attacked plant. When clustering in large numbers on the young branches and constantly sucking the juice, the insects void out thin and clear saccharine excreta, known as "honey-dew," which falls in fine drops over the lower parts of the plant. These come together and smear the leaves, or flow down the branches. On drying up a little, this liquid takes the appearance and consistency of a syrup or a non-volatile oil with which the plant seems to be sprinkled over Moreover, the branches thus wetted, and the smothered vegetation below these, when dried and ignited, burn as if they had been soaked in some inflammable material. Hence the propriety of naming it "Tela." But the indefiniteness about this name is that a similar effect may be caused by insects other than Aphids, and in that case the other insects are also termed "Tela." For instance we have "Mango Tela," which is a Psyllid; "Sugarcane Tela," that is an *Aleurodes*; or "Banyan (*Ficus bengalensis*) Tela," that may be a Coccid (*Monophlebus*).

Vernacular name "Tela."

In the United Provinces an individual Aphid is called by the agriculturists

"Maun" or "Mahun," which is not an unfamiliar name in the Punjab either; but I suspect it would about as commonly be applied to any small-sized, quiet-looking insect. Still, if either of these names is settled upon to signify a "plant-louse" in the restricted sense, it would, in my opinion, be almost as good as any to be newly coined for general use.

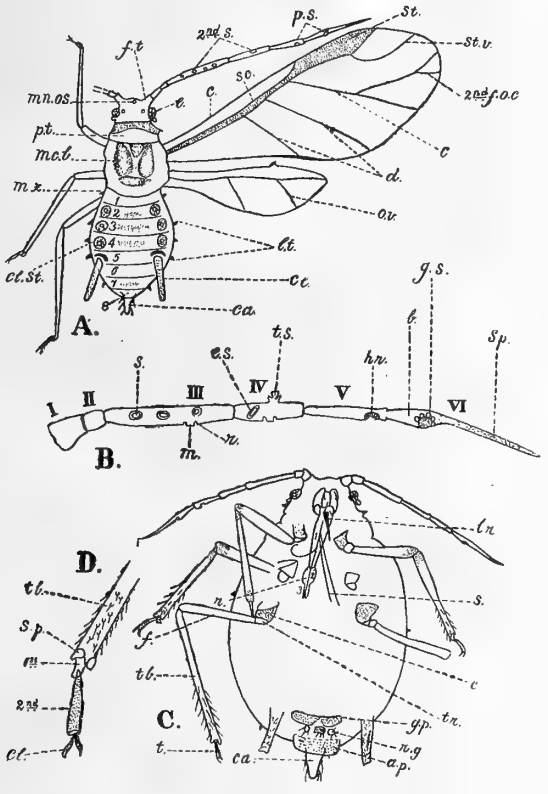

Fig. 1.—The Anatomy of an Aphid (diagrammatic).

A. Alate viviparous female. C. Apterous viviparous female.
B. Antenna. D. Tarsus.

e. = eye; f.t. = frontal tubercles; 2nd s. = secondary sensoria; p.s. = primary sensoria; mn.os. = medium ocellus; pt. = prothorax; mc.b. = mesothoracic bosses; mx. = metathorax; cl.st. = carinal spot; ca. = cauda; ce. = cornicle; l.t. = lateral tubercles; o.v. = oblique vein; c. = costa; sc. = subcosta; d. = discoidals; cb. = cubitus; 2nd f.o.c. = 2nd fork of cubitus; st.v. = stigmal vein; st. = stigma.

s. = sensorium; m. = membrane; r. = rim; e.s. = ellipse sensorium; t.s.—tuberculate sensorium; h.r. = hair rim; b. = base; g.s. = group of small sensoria; sp. = spur.

lr. = labrum; s. = setae; r. = rostrum; f. = femur; tb. = tibia; t. = tarsus; ca. = cauda; a.p. = anal plate; r.g. = rudimentary gonapophyses; g.p. = genital plate; tr. = trocanter; c. = coxa.

tb. = tibia; s.p. = sole pustule; 1st. = 1st joint; 2nd. = 2nd joint; cl. = claws.

Though aphids are normally present during the main part of the year, yet a casual observer often overlooks them on account of their small size and lack of bright colouration. Their presence is indicated, and may at least be inferred from some of the following circumstances:—

General conditions of Aphid attack.

(1) The leaves of an infested plant may be deformed in some way, either twisted, contorted, arrested in growth or changed into true pseudo-galls.

(2) Its general appearance may be sickly and the lower foliage smeared with an oily liquid over which a deposit of fine dust renders it still more unsightly.

(3) This liquid serves as an excellent culture medium for the growth of the sooty fungus *Capnodium*, sometimes only in its "Fumago" stage. The latter forms black smoky incrustations over the leaves, blocks their light, and on drying up scales off in thin flakes. The more abundant the excreta or "honey-dew" of the aphids, the greater is the growth of the fungus. Whole fields may thus be blackened and smothered in some cases.

(4) Predaceous insects such as Coccinellids (ladybird-beetles) may be noticed in the vicinity, and these insects always possess conspicuous, warning colours. Their shape, like half a pea, is also characteristic. Syrphid flies, too, hover about the infested plants in order to deposit their white eggs, and can be recognised by their bright banded abdomens.

(5) A very sure sign again is the presence of ants coursing up and down the plant. Even when there are just a few aphids hiding themselves under a leaf, ants would discover them much quicker than any trained collector of insects. Ants are too notoriously fond of sweet things, and seek out the plant-lice for the "honey-dew" they discharge. To this fondness may be ascribed those extraordinary relations existing between ants and aphids into which at present we need not go. Lubbock, Büsgen, Forbes, Mordwilko, Wheeler and Webster have written on the subject.

Metamorphosis and Life-cycle.

Like the majority of other Hemipterous insects plant-lice do not undergo any true metamorphosis. The normal course of their life-history in Lahore, with slight variations, is about the same as in other countries, and may be briefly told as follows:—

Eggs.—The eggs are deposited during winter from any time in December to late February. They are long oval in form, varying in length from 0·5 mm. to 1·5 mm., and are generally laid scattered near or upon the host buds, but in some forms as clusters also. The light colour of the freshly laid egg soon changes into shining jet black, a characteristic of the aphids.

The hatching period extends from late February to about June in some species. The insects that emerge are wingless, and remain so till maturity, that is fifteen or twenty days later, when they begin to reproduce parthenogenetically. Several broods of similar "asexual" or "agamous" females, all giving birth to live young, may follow, and are spoken of as "apterous viviparous females."

Stem-mothers.—The original females from which the later generations spring are called "stem-mothers" or "Fundatrix."

Ecdyses.—The time taken by each female, from its birth to the age when reproduction begins, differs according to season and species from four or five days to twenty or more. During this interval there are usually four or five "ecdyses" or skin-moults.

Pupae.—After one or more broods of apterous females the young that are born soon develop stumpy elevations on either side of the two hind thoracic segments, known as "wing-pads," such individuals are somewhat incorrectly referred to as "pupae." Their backs in many cases are ornamented with spots of white pulverulence.

Alate viviparous females.—At the final moult the pupae change into winged insects, which for all practical purposes are considered equal to the imagines of other insects. They are not equivalent to them, however, because they also reproduce asexually, and are termed "winged" or "alate viviparous females." They fly off or migrate to other plants of the same species, thus assisting in the dispersal of the colonies, or to a different or "alternate host" which may form a necessary part of the life-cycle. Lichtenstein employed the word "Pseudogyna" for all apterous or alate viviparous females.

In Lahore plant-lice that hatch early in March multiply very actively till about June and then disappear. Their disappearance is partly due to enemies and the heat, and partly to the diminished flow of sap in the plants during the hot summer. Some go to other hosts, others migrate to cool moist places, still others probably lay eggs before the setting of summer. After the rains in September they are again found on their hosts; those that come back from different plants are called "return migrants."

Sexuales.—From September onwards, during October and November, there is again a period of very active increase in their numbers. Late in November or early in December the true sexes develop. The offspring of the last generation of viviparous females either become males or egg-bearing females, and are referred to as "sexuales."

Males.—The males may be winged or wingless; a third stumpy kind was also discovered in one species. One, two, or all the three kinds may be found in the same species. They are readily recognised by their anal end having a well-developed "genital armature," consisting of a curved central penis and two triangular lateral pieces (see below under *Shivaphis*). Their bodies are more slender, darker than ordinary agamic individuals; sometimes they are dark pinkish in colour; all the antennal joints are characteristically full of secondary sensoria, their number being much in excess of those on the antennae of alate viviparous females.

Females.—The oviparous females are somewhat fusiform, and contain eggs instead of embryos. They are very often pinkish, yellowish, or otherwise differently coloured to the apterous females, which in other respects they resemble. The chief distinguishing character is the smaller size of their hind legs, which are also swollen and covered over by numerous small irregular sensoria. Unlike the males no additional sensoria are developed on the antennae. The hind legs are known to be employed for oviposition in suitable situations.

In a few forms sexuales are said to possess no functional mouth parts, that is the beaks are atrophied.

After pairing the eggs are deposited to start the life-cycle again. Most of the

eggs are sterile and never hatch; this is due to the males often being produced much in advance of the females, which thus do not get a chance of mating and deposit unfertilised ova.

[A summary of the systematic position of the Aphididae and an account of their general anatomy has been withheld from this paper, in order to diminish its size. The names for the different parts of the aphid-body, as used in this paper, are sufficiently indicated in the drawing (fig. 1) at the beginning of this introduction. The student of Aphididae may find more elaborate particulars on aphid-anatomy, etc. in several recent publications of European and American writers (Tullgren, Mordwilko, Börner, etc.). P. v. d. G.].

Previous work on Aphids in India.

All the knowledge we possess of Indian plant-lice is confined to a few stray notices in the *Indian Museum Notes* published up to 1903. A summary of these, with some additions, is given by Lefroy in *Indian Insect Life*, p. 747 (1910), with a list of twenty-one definitely recorded Indian species, including even those that occur outside the plains. Besides these eleven more are listed for the tropics by van der Goot in a paper on two undescribed Javanese Aphids, published in Holland in 1912. Otherwise there is rarely ever a reference to Indian forms in European or American literature.

Value of Buckton's notes.

The identifications in the *Indian Museum Notes* in almost all cases are by Buckton, who appears to have been, at the time the specimens were submitted to him from Calcutta, either preoccupied by other work, or to have given up doing the Aphids.

Though later methods of description have necessitated a thorough rewriting (being undertaken at present by Prof. Theobald) of even his monumental work on British Aphids—the latest complete monograph of the family—yet the accounts he furnished of Indian insects are too summary to be of much value, and are accompanied in most cases by indefinite and incorrect illustrations. An overhastiness is apparent in proposing new genera and species, and against their too brief characterisation a protest was entered at that time by W. W. Frogatt in the *Indian Museum Notes*, vol. V, no. 3, p. 111. His *Ceylonia theaecola*, new genus and new species, (*Indian Museum Notes*, II, p. 34) for instance is the same as *Toxoptera aurantii*, Koch 1847, reviewed by Buckton himself in *British Aphids*, vol. IV. *Chaitophorus maculatus* (Buckton) is identical with *Callipterus trifolii* (Monell); *Lachnus fuliginosus*, Buckton, is created out of mixed material of *Lachnus viminalis* (Boyer) and *Dryobius persicae* (Cholod.), and so on.

The list by Lefroy.

The additional species listed by Lefroy are determinations by H. Schouteden, whose correspondence I was kindly permitted to examine at the Agricultural Research Institute at Pusa. Unfortunately all duplicates of the specimens sent to Schouteden were altogether lost, as they could be found nowhere in the collections. Therefore a verification of the names of these aphids is practically impossible except indirectly. *Aphis adusta* (Zehnt.), for example, we now know to be a synonym of *A. maidis* (Fitch). *A. cardui*, L. on *Vicia* sp. and *A. rumicis* on *Vigna catjang* are probably both *A. medicaginis* (Koch).

Thistles of the genus *Carduus* are foreign to the Indian plains, their place being taken by species of *Cnicus*, which are only infested by *A. rumicis*, L. *A. cardui*, L. I have never so far collected from any part of India, nor have I come across *A. rumicis* on any Leguminous plant. *A. medicaginis* (Koch) possesses certain characters in common with both these species, but is quite distinct, papilionaceous herbs and shrubs forming its most favourite hosts.

Schouteden has described no new species from India, but had placed query marks against several as doubtful.

Thus, useful as it is, the list given by Lefroy can only be accepted as accurate with a certain amount of reserve.

Very few collections of Aphididae have been made in this country, and most of those in the possession of the Indian Museum, Calcutta, are at present said to have been sent away for identification. But formerly there was hardly a single entomological collection or museum, known to me in India, where one could go and find even half a dozen species of properly-determined aphids. Such a state of affairs, though not undesirable from certain points of view, acts as a serious initial difficulty in the way of a student.

Another almost insurmountable obstacle that a student in India encounters is the deplorable lack of up-to-date literature on this family. Ordinary libraries do not pretend to supply it, and in the best libraries expected to possess literature, *i.e.* those at Pusa and Calcutta, it was not so well represented as it ought to be, and perhaps could not be unless specially ordered. The literature is widely scattered in numerous journals and in many different languages, and often being out of print is unobtainable through the book-sellers. This want we have in part met by procuring for the libraries of the Punjab University and Government College most of the recent works on these insects, either through the research grant from the Government or through the courtesy of Western Aphidologists.

In Lahore one is handicapped by the lack of even a convenient local flora for ready reference to the names of plants, which is quite an essential factor in the study of plant-lice.

Besides these extraneous difficulties the systematic study of this family has some peculiar disabilities of its own. In spite of the partiality shown towards these insects by distinguished workers for a long time, the sad reproach in the words of a well-known entomologist (Lefroy) "that the classification of Aphids is a disgrace to Entomology" is perhaps too true: pains are no doubt being taken by some modern authors to remove this reproach.

Difficulties in the group itself.

With a full knowledge of the difficulties mentioned above, an attempt has been made to start a preliminary study of the Indian species of this important group of insects. A part of the result, with whatever shortcomings it may inevitably have, is presented in the form of this paper.

A list of the Lahore Aphids, dealt with in this paper, is given below; a host index for these will be found at the end of the paper.

I.	*Pemphigus.*	(1) *aedificator* (Buck.).
	,,	(2) *cynodonti*, n. sp. (on *Cynodon*).
II.	(a)—*Macrosiphum.*	(3) *rosaeiformis*, n. sp.
	(b)—*M.*	(4) *solidaginis*, Fabr.
	(c)—*M.*	(5) *sanborni* (Gil.).
	(d)—*M.*	(6) *granarium* (Kirby).
	(e)—*M.*	(7) *pisi* (Kalt.).
III.	*Rhopalosiphum.*	(8) *lactucae* (Kalt.).
IV.	*Myzus.*	(9) *persicae* (Sulzer).
V.	*Phorodon.*	(10) *cannabis*, Pass.
VI.	(a)—*Siphocoryne.*	(11) *avenae* (Fabr.).
	(b)—*S.*	(12) *indobrassicae*, n. sp.
	(c)—*S.* (= *Siphonaphis*, v.d. Goot).	(13) *nymphaeae* (Linn.).
VII.	(a)—*Brevicoryne* (n.g.).	(14) *brassicae* (Linn.).
	(b)—*B.*	(15) *coriandri*, n. sp.
	(c)—*B.*	(16) *chenopodii* (Schrank).
VIII.	*Stephensonia* (n.g.).	(17) *lahorensis*, n. sp.
IX.	(a)—*Toxoptera.*	(18) *graminum* (Rond.).
	(b)—*T.*	(19) *cyperi* (v.d. Goot).
	(c)—*T.*	(20) *punjabipyri*, n. sp.
X.	(a)—*Aphis.*	(21) *rumicis*, Linn.
	(b)—*A.*	(22) *medicaginis*, Koch.
	(c)—*A.*	(23) *sacchari* (Zehnt.).
	(d)—*A.*	(24) *maidis* (Fitch).
	(e)—*A.*	(25) *gossypii* (Glover).
	(f)—*A.*	(26) *malvae* (Koch).
	(g)—*A.*	(27) *malvoides*, n. sp.
	(h)—*A.*	(28) *durranti*, n. sp.
	(i)—*A.*	(29) *nasturtii* (Kalt.).
	(j)—*A.*	(30) *nerii* (Boyer).
XI.	*Brachycaudus.*	(31) *pruni* (Koch) or *helichrysi* (Kalt.).
XII.	*Hyalopterus.*	(32) *pruni* (Fabr.).
XIII.	(a)—*Brachyunguis* (n.g.).	(33) *letsoniae*, n. sp.
	(b)—*B.*	(34) *harmalae*, n. sp.
	(c)—*B.*	(35) *carthami*, n. sp.
XIV.	*Eichochaitophorus.*	(36) *himalayensis*, n. sp.
XV.	*Callipterus.*	(37) *trifolii* (Monell).
XVI.	*Shivaphis* (n.g.).	(38) *celti*, n. sp.
XVII.	*Tuberolachnus.*	(39) *viminalis* (Boyer).
XVIII.	*Tuberodryobius* (n.g.).	(40) *persicae* (Cholodk.).

Pemphigus (?) aedificator (Buck.).

Host.—Pistacia integerrima.

Vern. " Kakkar " ; the gall is known as " Kakkar Singi."

The insect may be readily recognised by the characteristic horn-like galls into which it converts the leaflets of the abovenamed species of *Pistacia*. From May to October they may be observed as straight or curved pod-like structures, generally at the terminations of branches. They are either wholly green or partly pinkish and contain

innumerable yellow plant-lice, covered over by a white flocculence secreted by six rows of wax-glands on their back. The galls ripen in November; the tips of the galls are generally narrow and imperforate and their curved shape, in most cases, makes them look like miniature horns, hence the vernacular name "Singi" from sing (= horn). From a crack or a slit on one side of a ripe gall the insects, that have in the meantime developed wings, emerge in swarms at this time. The empty galls turn brown and woody. They may remain hanging on the tree for more than a year, and are conspicuous objects in winter when the tree is devoid of green foliage.

These galls are supposed to form a valuable drug which is officinal in the Indian Pharmacopea; it is sold in the bazaar at one anna per ounce and is prescribed in pulmonary and intestinal disorders of children. Reference to this commercial article may be found, besides many Indian works, in Watt's *Dictionary of Economic Products*, vol. VI, p. 268 and Stewart's *Punjab Plants* of 1869, page 47. Both these writers express their ignorance about the insect concerned in its manufacture.

In 1891, C. F. Elliot first observed swarms of flies leaving the galls in November at a place called Harnai (Baluchistan), about 3,000 feet above sea level. The tree on which he noticed them was, according to him, *Pistacia terebinthus*, but that probably is a mistake as "Kakkar Singi" galls are only formed on *P. integerrima*.

The specimens were sent to the Indian Museum in Calcutta and thence forwarded to Buckton, who, as usual, gave a new name to the insect, but supplied an altogether too brief description of it, and even that in several points quite wrong. The faint and obscure illustration that accompanies the description conveys little more than that the insect figured is an "Aphidine" one. The antenna is shown as made up of eight or nine joints whose relative lengths cannot be discerned. It is stated that no sensoria are present! (*Ind. Mus. Notes*, vol. III, no. i, pp. 71-73).

The apterous viviparous female has not been mentioned at all.

Though we find that Buckton gives a fairly accurate account of the form, size, texture, contents, etc., of a dry gall, it was neither known to him nor was it suspected by the authorities at the Indian Museum that it was identical with the well-known "Kakkar Singi."

Except for a passing observation in Tullgren's systematic work on *Pemphigina* (1909) there is no record of the Aphid in current literature. It is probably for the first time here that the true insect and the drug have been connected. The problem was being investigated independently on a few *Pistacia* trees in the Botanical Gardens, where the development of the gall was thoroughly followed. On comparison it was later discovered that the insects were in every respect the same as those originally collected by Elliot and preserved in the Indian Museum in Calcutta.

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body oval or ovate; posterior end frequently tucked in telescopically.

Colour bright yellow to yellowish-orange; in old individuals even deep orange. Legs and antennae hyaline.

The insects are clothed with white powder, large quantities of which collect at one end of the gall. It is secreted by rounded dot-like glands, situated along the dorsum in rows, two of which are medial and two on either side lateral. There are only four glands on the head and a conspicuous one in the centre of the anal plate. None are to be found ventrally.

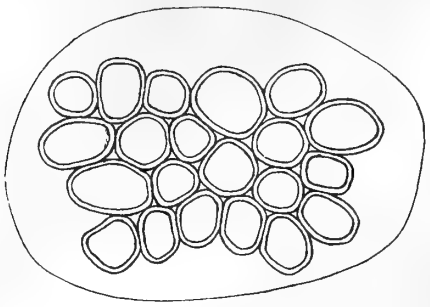

Fig. 2.—*Pemphigus aedificator* (Buck.). Wax-plate with facets of apterons female, × 890.

Head small, concolorous with body, or slightly darker, without frontal tubercles. Eyes very small and black. Antennae short and stout, about one quarter the length of the body, composed of five joints only.[1] Article I is gibbous, subequal to II but much thicker. Spur blunt, thickened at apex which ends in a few short stiff hairs; if the sensorium be counted with it, the spur is almost half as long as the base.[2]

Length proportions :—

	I.	II.	III.	IV.	V.
	30	28	43	40	60+27
Lengths ..	0·050;	0·049;	0·067;	0·065;	0·100+0·048 mm.

The primary sensoria on articles IV and V have distinct hair-rims.

Lateral tubercles are conspicuous as black dots on carinae; in macerated glycerine mounts they come out like big sensoria.[3]

The glands consist of a larger or smaller number of polygonal or circular plates with a few dots on each. The plates have no definite arrangement in their grouping and sometimes appear as if depressed below the general surface. They secrete thready white flocculence which later turns powdery.[4]

The cornicles and cauda are absent.

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[1] [*Stem-mothers* have only 4 joints to their antennae; the body is darkish (after note by Mr. Das). P. v. d. G.].

[2] [In giving measurements of the spur most writers agree in counting the sensorium as belonging to the base of the last antennal joint. P. v. d. G.].

[3] [In specimens of apterous females, which I received from Mr. Das, I could not find any trace of "lateral tubercles," which by the way would be a unique fact if occurring in this genus. Perhaps Mr. Das may have mistaken the stigmata for "tubercles?" P. v. d. G.].

[4] [To this description of the wax-glands of *P. aedificator* a few corrections ought to be added.

The different technical terms, as given by Mr. Das, are not quite correct. In accordance with Börner, who furnished a very complete description of the wax-glands of the Chermesinae, the wax-glands of Aphididae are cylindrical hypodermic cells. In slides these glands show like circular or polygonal figures with a chitinous outlining, called *facets*. These facets are mostly grouped together on more or less distinct and chitinous plates, called the *wax-gland plates*. The waxy flocculence is secreted through very small pores in the membrane of the facet, the so-called *wax-pores*.

In the apterous female of *P. aedificator* the wax-plates are not chitinized, but still are quite distinct from the rest of the integument because of their surface being quite smooth, not striate like the rest. The facets are circular or semicircular, lying quite close together, their number varying from 20 to 60 on each plate. A "*plate-hair*" is always wanting. P. v. d. G.].

The "anal end" is characteristic on account of a large rectangular almost vertical anal-plate, outlined with dark stiff hairs; its centre is occupied with a prominent wax-gland [1], the secretion from which flows like a tail behind the insect. The anus is raised upwards and is placed almost on the dorsal surface, forming a semicircular opening. Ventrally there is a black crescentic genital plate with its concave end facing backwards.

The rudimentary gonapophyses are conspicuous as two rounded dots, beset with a few hairs to each.

Legs very small; tarsi long, about half the size of tibiae.

Rostrum short and stout; it reaches up to about the third coxae, because all the legs are situated close together. Its three segments are subequal; the last one black-tipped and triangular.

Measurements (average) :—

Length	1·50 mm.
Breadth	0·82 ,,
Antennae	0·38 ,,
Tarsus	0·06 ,,

The pupae, which develop about October, are very similar in appearance to apterous viviparous females. They are quite yellow and tassellated with glands as usual; they only change colour when approaching their final moult in November. Slowly the dirty greenish tinge invades the thorax and abdomen. The shoulders are whitish.

Alate viviparous female.—Body elongate oval; dull black or very dark green. Head, antennae, prothorax, legs and rostrum black; mesothoracic bosses large and shining black. The white powder forms only a thin layer over the surface.

Head broad, without frontal tubercles, with two or three depressions on vertex; front bilobed with a median groove. Eyes and ocelli well developed, black. Antennae short but relatively a little longer than those of the apterous female. Unlike the latter the number of articles here is six. All the joints are narrow at the base and gradually widen towards their distal ends. The spur is about half the base of VI.[2]

Length proportions :—

	III.	IV.	V.	VI.
	16	11	13	21
Lengths ..	1·33	0·95	1·01	1·70 mm.

Sensoria rather large, without hair-rims, except the primary ones; the form is various, from somewhat broad or long oval to irregular circular or even dumbell-shaped in some. They are not tuberculate; the membrane is almost flush with the

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[1] [I have been unable to discover any "wax-glands" (= group of facets) on the anal plate. P. v. d. G.].

[2] [The measurement of the spur as given by Mr. Das is not quite correct; its length is only $\frac{1}{4}$ of the base of joint VI. P. v. d. G.].

surface of the antenna. There are occasionally one or two hairs arising from it, whose bases may be seen as white dots.[1] As they are crowded at the apex of the joint that part looks swollen. Their number is from four to six (4-6) on article III; from two to three (2-3) on IV and only one or none besides the primary on V.

Prothorax sharply defined from the head, broad rectangular in outline; it carries a blacker stripe on its anterior edge.

Mesothoracic bosses large, flattish, of the usual form; so is the metathorax with its one semilunar median, and two triangular lateral black spots.[2]

Wings ample, much longer than body; grayish-white with thin brown veins.

Stigmal flattening large and inflated, rhomboid; its posterior border continues along the subcosta as a thick black band, the centre is occupied again by a black elongated spot. A thin false vein passes behind the stigma right up to the insertions as illustrated. The stigmal takes its origin from the latter and reaches the margin almost straight with a very slight curve. Cubitus simple and obsolete at base.

First and second discoidal veins arise in most cases as a result of the forking of a common trunk, springing from the basal third of the subcosta, which is rather unusual. The hind wing also is relatively large with two normal oblique veins.[3]

Abdomen ovalish, strongly arched and distended, due to the presence within of a large number of young ones. Lateral grooves and carinae come quite near each other, but at the sides the segments are separated by shallow grooves which impart to the edges a wavy or festooned appearance.

Colour very dark dirty greenish; glands similar to those of the apterous viviparous female; cauda and cornicles absent.

Anus dorsal; anal and genital plates as in the apterous female. Rudimentary gonapophyses as two very conspicuous, rounded, spiny processes between the plates.

Legs longer and blacker.

Rostrum similar, but reaches only very little beyond the first coxae.

Measurements :—

Length	..	..	..	2·20 mm.
Breadth	..	..	..	0·50—0·60 mm.
Antennae	..	..	..	0·60 mm.
Wing expanse	..	..	..	6·50 ,,
Wing	..	..	..	3·0 × 0·60 mm.

Natural History.—The winged females issue forth in large swarms from cracks or holes in the pod-like galls. In Lahore this begins about the third week of October and continues throughout November. The colonies inside the galls, which were kept

[1] [The small hairs mentioned by Mr. Das do not arise from the membrane of the sensorium, but from the integument itself on the opposite side of the joint. P. v. d. G.].

[2] [The mesothoracic bosses are indistinctly separated; the mesothorax, therefore, is simple, not three-lobate.

Mr. Das does not mention a marginal group of facets on each side of the prothorax and two spinal groups on the middle of the metathorax. P. v. d. G.].

[3] [Unfortunately Mr. Das does not mention in what way the wings are carried under normal conditions. P. v. d. G.].

somewhat protected inside muslin bags, ripened in some cases as late as the middle of December, but the majority of the galls are quite empty long before this time. Occasionally some yellow apterous viviparous females are also seen reproducing at the time, but the last generation all change into pupae and ultimately fly out, the apterous females dying a natural death.

These winged females are very impatient to discharge their load of young and even on a slide they would expel a few of them by strong peristaltic movements of the abdomen. Inside the muslin bags the tiny young crawl about for a day or two, and may even moult once, but they soon die, as they absolutely refuse to take nourishment either from the gall or from the *Pistacia* leaves. Evidently it is some other plant to which the winged females migrate and on which the young can thrive. During the little spare time I had outside official duties, I made several attempts to determine this alternate host. It is recorded of the European species of *Pemphigus* (on *Pistacia*) that they spend a part of their life history on graminous plants. Taking a hint from this, several grasses and similar weeds were enclosed in cages containing alate migrants issuing from galls, but in no case was the artificial colonisation successful, and the young plant-lice died after their first moult.

From certain anatomical resemblances it was strongly suspected that the insect provisionally described below as *Pemph. cynodonti*, n. sp. may be the alternate form. Its time of appearance in early October more or less coincided with the ripening of the galls. But as colonising experiments gave negative evidence no definite proof can be adduced to maintain this hypothesis. It may be expected that with increased vigilance and better opportunities for conducting field and indoor observations the alternate host of this important insect will soon be ascertained. Till then our knowledge of its life-history must remain incomplete. As at present known it is as follows:—

Life-cycle.—The foliage buds of *Pistacia* open about the latter half of February, some fifteen days after those that contain shoots of inflorescene. Almost simultaneous with the appearance of the tender pinkish leaves tiny protuberances—the future galls —are visible at the bases of the leaflets. These all enclose one darkish aphid each, hatched from the egg, laid some time previously upon the bud. As the leaves mature the galls grow and the aphids within (stem-mothers) multiply; yellow apterous females are born that reproduce again parthenogentically. This continues from March to October when the galls ripen and the last generation of plant-lice change into pupae, ultimately becoming the winged insect in November which migrate to some other plant.

The points requiring elucidation are:—

(*a*) What is the plant or plants to which the insects go.

(*b*) When are the sexuales developed.

(*c*) What time do the "return migrants" come back to *Pistacia*.

It must be these latter that deposit the eggs, which hatch out again in early March to start fresh colonies in the galls.

Possible connection with Pemphigus cynodonti.—From *Pemphigus cynodonti*, n. sp.

it differs in several important respects both in the apterous and the alate form. The colour, size, number of antennal joints of the apterous female and the sensoria and wings of the alate form are dissimilar in the two.

The *Pemphigus* on *Cynodon* is apterous throughout winter and spring, forming winged individuals only in late April or early May. Their further history is obscure. They were never observed on grass from May to October, nor were they ever noticed on *Pistacia*. If in spite of these differences any connection between these two species is established later on, a complete life-cycle might be expected to be somewhat like this:—

The eggs hatch into stem-mothers in March and found new colonies within the galls containing apterous females till October; in November the aphids leave the galls as winged viviparous females. From November to April or May of the following year the generations are all wingless; in May they would go to *Pistacia* as alate females but viviparous again; the progeny of these would, at some time from May to November or December, develop the sexual individuals that would lay eggs in the buds. These wintering over must hatch again in March. Thus the life-cycle would extend over at least two years, but this remains to be established.

Formation of the galls.—The leaves of *Pistacia integerrima* are compound ones as shown in the accompanying reduced drawing (pl. xiii). Each possesses a long peduncle, having five or six pairs of nearly sessile leaflets. Almost invariably it is the topmost leaf of a branch on which the galls develop, and therefore are always terminal. At a time when the leaflets are very young and the peduncles hardly elongated at all, the stem-mothers hatch from the eggs and fix themselves near the bases of the leaflets on their upper surface. In a manner very similar to what is seen in some Psyllids, they make a depression which bulges as a conical projection ventrally. This pit, by constant irritation, grows larger and its top slowly closes up, so that there is now a closed finger-like process on the underside of the leaflet, in which the stem-mother is enclosed. These are the future galls, and there may be as many as six or eight on one compound leaf: ordinarily their number is limited from one to four, the commonest number being two as shown in the figures. The leaflet on which the gall develops soon atrophies; other leaflets may grow even to their normal size, but generally remain stunted.

The first effect of gall-formation on a leaf is the arrested growth in length of its peduncle which usually becomes thickened and curved downwards, so that the leaflets and the growing galls are situated quite close to each other. If the leaflets drop off early the galls become terminal.

Growth.—The galls grow very slowly at first, but in about two months' time they attain a length of two or three inches; in breadth they vary from $\frac{1}{6}$ to $\frac{1}{4}$ of an inch. In the shade the colour remains green, but the portions that are exposed to the sun turn partly pinkish. The inside is perfectly smooth, pink, and dusted with white powder from the backs of the insects. This powder when abundant collects in the lower end of the gall, and protects the insects from becoming wet with their own liquid excreta, which trickles in white drops.

Large resin ducts enter the walls, and the substance readily exudes if they are injured; it moreover often congeals on the outside and possesses a characteristic odour.

The number of plant-lice inside at this time is about twenty, but later the number increases excessively. The gall shows a steady growth during the rainy months of July and August. In late September it is mature.

Form.—At this time it has quite the appearance of a straight or curved leguminous fruit, and is popularly referred to as a "Phali," the vernacular for a pod. This "pod-gall" is either uniform in thickness or partly swollen and partly very thin; distally it usually narrows into a hard imperforate beak. The galls, which have become bent at an early stage, maintain their curvature even when dry, and are not unlike small horns: this resemblance has earned for them the vernacular name "Kakkar Singi" as already alluded to above.

Size.—The galls vary in length from five or six inches to about a foot; some of the largest galls are more or less straight and may measure up to an inch across. The usual thickness is about half an inch. The wall itself is from $\frac{1}{12}$ to $\frac{1}{10}$ of an inch thick in fresh specimens, and is soft and yielding as long as the insects are inside. The interior is always pink in colour, and is full of teeming aphids in countless thousands.

Opening of the galls.—Birds, squirrels as well as other animals at this time nibble at the fruit-like galls and cut holes into them. These holes are utilised by the winged insects as an exit. But even when such holes are absent the alate insects, by mechanical pressure of their beaks, can cause the galls to crack in places. This happens invariably in cases when the galls are protected in muslin bags.

Dry galls.—The empty galls on drying turn brown and woody, often getting twisted and contorted into various shapes, with cracks and slits on the sides. They remain hanging on the tree sometimes for considerable periods, and are packed with the white flocculent secretion of the aphids intermixed with the exuviae, wings and dead bodies of the insects. Some galls retain their pink colour.

They serve as excellent places for the hibernation of spiders and insects like Coccinellids, which are usually found inside them.

Enemies.—This aphid, well-protected inside the galls, is singularly free from the attacks of predaceous and parasitic insects. Late in the season when the holes and cracks are formed occasionally a Coccinellid gets entrance, and once or twice a *Chrysopa* has also been reared from them. No parasites were ever obtained.

Sometimes from a riddled gall the ants carry off the aphids as food, and it would not be surprising if it is found that at least some of the holes are due to the agency of ants. They can be easily seen cutting similar round holes in the large and persistent calyx of the fruit of *Withania somniferum* inside which *Aphis malvoides* sometimes resides.

Systematic.—The name *Pemphigus aedificator* we owe to Buckton, but as already remarked his descriptive account of the insect is extremely inadequate and defective. Evidently little pains were taken to ascertain the proper generic position.

From typical *Pemphigus* this aphid differs in several important respects.

(1) The antennae of the alate females have article VI longer than III; the reverse is true for *Pemphigus* (Oestlund, *Aphid. of Minn.*, 1887).[1]

(2) The sensoria are more rounded than transverse.[2]

(3) In the wings the first and second discoidals are formed by the forking of a common trunk.

(4) The rudimentary gonapophyses are only two in number. The usual number in Pemphiginae is three (after Tullgren and van der Goot).

(5) The apterous females have the antennae made up of five joints only.[3]

Such important and distinctive features perhaps require a generic separation from *Pemphigus* as defined at the present day. But as I have not had an opportunity of a detailed examination of this genus, I have refrained from proposing a new name, and left the insect under *Pemphigus*. The change may later on be introduced by better authorities on the subject, if considered necessary.

[The different characters of "*Pemphigus*" *aedificator* show that it is distinctly different not only from the genus *Pemphigus* but as well from the tribe Pemphigina, to which it has hitherto been considered to belong. With most characters in common with the Pemphiginae, this species principally differs in the number of rudimentary gonapophysae and the form of the mesothorax, both very important characters. As to my personal opinion, *P. aedificator* might perhaps be considered the "missing-link" between the tribe Pemphigina and some representatives of the tribe Hormaphidina, as for instance the species of the genus *Schizoneuraphis*, v. d. G.

The characters of *P. aedificator* necessitate not only the erecting of a new genus but even of a new tribe. In remembrance of the late Mr. Das, my esteemed co-worker, I have the honour to propose the name *Dasia* for the new genus, Dasiina for the new tribe, with characters as follows:—

Tribe Dasiina, nov.

Only genus: *Dasia*, nov. gen.

Characters: those of the genus *Dasia*.

Genus *Dasia*, van der Goot, gen. nov.

(Type: *Pemphigus aedificator*, Buckt.).

Morphological characters:—

Body with distinct groups of wax-glands in the apterous as well as in the alate form. Facets of wax-glands circular or polygonal, lying close together; no central-facet present.

Mesothorax simple, without distinct bosses.

Eyes of the apterous female consisting of 3 stemmata only.

Antennae six-jointed, in the apterous form often 4- or 5-jointed. Processus terminalis distinct, but always shorter than half the length of the basal part of the ultimate joint. Primary sensoriae rounded, small, with distinct hair-rims. Secondary sensoriae oblong-ovate, broad, not longer than half the circumference of the antennal joint; hair-rim always absent.

Cornicles entirely wanting. Cauda obsolete. Anal-plate simple. Rudimentary gonapophysae 2 in number, distinctly separate, spiny.

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[1] [The relative lengths of the antennal joints have no generic value. P. v. d. G.].

[2] [The sensoriae of *P. aedificator* does not differ much from those of other true *Pemphigus* species, such as *P. bursarius*, L., *P. spirothaecae*, Pass., etc. P. v. d. G.].

[3] [In the genus *Pemphigus* only the fundatrices have 4-jointed antennae, exactly as is the case too with *P. aedificator*, according to Mr. Das. The virgogeniae of *Pemphigus* always have their antennae 5-jointed! P. v. d. G.].

Fore-wings with the media I[1] simple; media II and cubitus with a short common trunk. Hind-wings with 2 transverse veins.

Legs well developed; trochanter not separated from the femur. P. v. d. G.].

It may be mentioned here that the insect under review has several structural characters in common with *Pemphigus (?) cynodonti* described below.

There is another similar *Pemphigus* infesting the leaves of the same *Pistacia* in the Punjab Hills near Kasauli. It forms only pseudo-galls by reflecting a part of the leaf over the rest of its surface. The alate females develop in July. The sensoriae on the antennae are more rounded and tuberculate; the wings, glands, etc., are alike, but rudimentary gonapophyses are entirely wanting.

All three species seem to fall in the same category though an entire lack of gonapophyses in one is rather a remarkable feature.

Pemphigus (?) cynodonti, sp. nov.

Host.—Cynodon dactylon.

Vern. Dub grass.

Locality.—River bank near railway bridge; canal bank in the Botanical Gardens.

Distinguishing marks.—In moist places, from November to March, one often notices some of the lowest suckers of *Cynodon* very much stunted in growth, pale yellowish, and in places pink-coloured. All the leaves are much smaller than normal ones and hypertrophied breadthways, while they appear to arise in a bunch, due to arrest in the growth of internodes. Such pseudo-galls contain numerous dull green insects covered over with long threads of iridescent gray flocculence issuing from rows of glands on their backs. One such branch is shown in the accompanying sketch (pl. xiv, fig. 10) besides a normal healthy shoot. The ground below is sprinkled over with white pulverescence.

Only apterous viviparous females are generally met with. Six rows of glands on the body, those on the head having chitinous rings encircling them; absence of cornicles and visible cauda, very small rostrum and two rudimentary gonapophyses are further characters to distinguish this aphid. In winged females the cubitus is simple and the sensoria irregular.

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body ovate to oval, stout, from light greenish to dull dirty green: in March individuals lose most of this green tinge and look almost whitish, even after removal of the ordinary clothing of white meal.

Long white threads are particularly abundant on the head and the anal end, where they flow into a thick tail. Each of these larger threads is made up of smaller ones that issue from cells below the chitinous layer of the body, see pl. xiv, figures 1 and 2.

A white powder is secreted, at least it is found over the whole body.

The posterior end is often tuckled in.

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[1] [I follow the nomenclature of veins as used by Tullgren and others; in this description *media* I = *cubitus*, *media* II = *first discoidal* and *cubitus* = *second discoidal* of Mr. Das' descriptions. P. v. d. G.]

Head flat, black, except the hinder edge touching the prothorax; three pairs of clear glands are situated above; the first almost on the front, and the third at the level of the eyes. The latter is the largest and lies on the line terminating the black portion of the head.

The glands have a chitinous ring surrounding them.

Antennae resting directly on the head, black, sparingly hairy; the spur is thick and large, about half the base of VI; first joint longer than second.

Length proportions :—

	III.	IV.	V.	VI.
	12	6	10	11+5 (16)
Lengths ..	0·20	0·10	0·16	0·19+0·08 mm.

There is one sensorium at the extremity of V. On article VI there is another associated with a group of smaller ones. Both sensoria are strongly ciliated.

Prothorax of the body colour; lateral sides dusky, the duskiness invading the dorsal parts as well. There are two glands about the middle and two depressions a little on their outside.

Meso- and metathorax similar to the abdominal segments, only their lateral glands are larger and they themselves are narrower.

The abdominal pattern consists of six longitudinal rows of greenish to darkish glands; two are median, two latero-dorsal and two lateral. These dot-like glands are largest on the sides. On the ultimate segments there are only four; a pair on either side becomes confluent. A little below the carinae is a prominent row of black lateral tubercles, a pair for each segment.[1]

Anus semicircular and raised to the dorsal surface.

The cauda is only a dark line, otherwise obsolete.

Anal plate very conspicuous, rectangular, standing vertical; spiny along the margins which are black. The central part, directed backwards, is occupied by a large gland which secrets the threads of flocculence, running into a tail.

Genital plate thick, crescentic, black.

The rudimentary gonapophyses are small and two in number.

The cornicles are entirely wanting.

Legs stout, black, including coxae; tibiae only about a quarter as long as femora; tarsi only slightly smaller than third antennal joint.

Rostrum short and stout, hardly reaches a little beyond the first coxae; all the three joints are subequal and black.

Measurements :—

Length	1·75—2·00 mm.
Breadth	0·95—1·15 ,,
Antennae	0·80—0·95 ,,

Alate viviparous female.—Winged insects are very rare; during two years that they were kept under observation it was possible only to secure a few in the last week

[1] [Very likely the presence of lateral tubercles, as stated by Mr. Das, is only an error. P. v. d. G.].

of April, 1914. That they were viviparous females was made out by dissecting young embryos from their bodies.

Body ovalish, with a much less covering of meal; colour dark green, almost black.

Head, antennae, thoracic bosses, sternum, legs and rostrum all black.

The antennae arise from pits on either side of the medially grooved front.

The antennal spur is large, its terminal part a little thicker and beset with a few spines.

Article III thickest and longest, unlike the apterous viviparous female.

Length proportions :—

	III.	IV.	V.	VI.
	15	6	$8\frac{1}{2}$	9+4 (13)
Lengths ..	0·25	0·10	0·14	0·15+0·06 mm.

Sensoria: 10-13 irregular sensoria are borne in a line on III and 2-3 on IV; their membrane is dotted and often two are united together.

The prothoracic edge anteriorly is black and flattens on either side into larger dots; there is also another smaller band on the middle.

The metathoracic bosses are shining black, rather flattish and broad.[1]

Wings voluminous, hyaline, having brown veins; costa and subcosta including insertions black. The posterior edge of the stigmal flattening is dark gray and swollen uniformly. The stigmal vein exhibits a slight curve. The first and second discoidal arise from a common point; the cubitus is simple and obsolete in its basal part. The posterior wings have two oblique veins.

The abdomen bears the same pattern of glands, but they are small; the lateral sides are wavy due to the well marked segmentation.

Lateral tubercles are present as in the apterous female.

Anus dorsal; the narrow ridge-like cauda and black vertical anal plate are all similar to those of the apterous viviparous female described above.

Legs a little larger, otherwise similar.

Rostrum short and thick, just reaches to the middle of first and second coxae.

Measurements :—

Length	..	..	1·70—1·80 mm.
Breadth	..	..	0·70—0·80 ,,
Antennae	..	..	0·85—0·95 ,,
Wing expanse	..	..	7·50 ,,
Wing	..	..	3·10 × 1·85 ,,

Glands —These are in most cases circular or flattened oval in form; in young females about to moult they assume a dark colour and are very clearly marked on the cast-off skin. Each consists of a smaller or larger number of rounded or somewhat angular facets, on which the hypodermal glands open and pour their secretion in the

[1] [Mr. Das does not mention if there are any wax-glands present on the thorax, which is very likely to be the case here. P. v. d. G.].

form of very fine threads. These unite to make thicker threads which may grow as long or longer than the body of the insect. The largest amount of secretion occurs near the head and the anus. The glands in surface and profile views, along with the secreted threads, are shown in the accompanying figures (pl. xiv). They do not possess any central large facet as found in *Schizoneura*, nor is the group of facets comprising a plate surrounded by any chitinous ring as is said to be the case in the type for the genus *Pemphigus*.

Three pairs of glands on the head of the apterous female are composed of a smaller number of facets and encircled by clearly marked rings. On the background of the dusky head they appear like ocelli.

Life-history.—Malformations on grass (*Cynodon*) shoots are first noticeable about October or November.

The woolly plant-lice are all apterous and reproduce very quickly; if fresh growing shoots are provided to them in pots or glass vessels, they arrest the growth of these shoots at once and convert a normal branch into a sickly cluster of small leaves.

Throughout winter reproduction continues, slackening a little in January and early February. In March again the grass in most localities is covered over by thin flakes of waxy material, looking like cotton wool, and the insects are abundant. In April the apterous females have a much lighter colour, almost whitish; the progeny of these develop into pupae and some of them ultimately succeed in becoming winged adults. The winged females are parthenogenetic as evidenced by the presence of young embryos in their bodies, but they were not observed to reproduce on grass. Apparently they fly off to some other host that is at present unknown.

Natural enemies like *Scymnus* spp. and *Brumus suturalis*, Aphis-lion and some Syrphid larvae are very active amongst them on warm days. The aphids are present in shaded places and preferably on branches that are covered over by a debris of dry leaves. The predaceous insects, however, hunt them out very actively, so that it is only during a week or two when they may be collected. After the first week of May none at all is visible. How and where the life-cycle is spent from May to October I have been unable to find out.

This species resembles in many important features the one found on *Pistacia integerrima* and described above as *Pemph. aedificator*, Buck. As both are present in the same locality, it was suspected that it might prove to be the migratory form of *Pemph. aedificator*, and experiments were undertaken to discover the relation. Twice from November to April the species were kept under observation both in the field and the laboratory, and several attempts made to transfer the winged forms of the one to the other, but they all failed.

The alate migratory females from *Pistacia* galls did not reproduce young on *Cynodon* under glass chimneys. Alate forms from *Cynodon* could not be colonised on *Pistacia* leaves. So very probably the two forms have nothing to do with each other, though some further and more accurate observations would be required to establish this point.

Systematic.—The two insects, otherwise from their structural anatomy, are quite distinct from each other. The colour, antennae, sensoria and stigma of wing, etc., are different in the two species.

As no species of *Pemphigus* is recorded from *Cynodon* (*vide* Patch, *Host Index of World's Aphidae*, 1913) I have provisionally named it *Pemphigus cynodonti*.

The generic position has been discussed above in connection with *Pemphigus aedificator*.

Genus **MACROSIPHUM** (Pass.).

(= *Siphonophora*, Koch).

This genus, and as a matter of fact the entire family, has its home in temperate regions where it is numerically best developed. In the tropical and subtropical plains of India it is rather sparsely represented although the Himalayas harbour a very large number.

Leaving out of account the hill forms a short identification table for the few species from the plains is given below:—

A. Colour (including body) green.			B. Colour red brown or chestnut.	
I. Cornicles green.	II. Cornicles black.		(i) Body surface dull. Cornicles very long, twice the length of cauda. Hosts *Sonchus* spp.	(ii) Body very shining. Cornicles short and conical, subequal with cauda. Hosts Garden Chrysanthemums.
	(i) Apterous female ovate or oval; short and conical. Hosts Graminous plants.	(ii) Apterous female long oval, almost linear. Cornicles long and cylindrical. Hosts *Rosa* spp.		
Cornicles somewhat curved. Antennae black at joints. Hosts mostly Leguminous plants.				
(1) *Macros. pisi* (Kalt.)	(2) *Macros. granarium* (Kirby).	(3) *Macros. roseiformis*, n. sp.	(4) *Macros. solidaginis*, Fabr.	(5) *Macros. sanborni* (Gillette).

With the possible exception of No. 4 (see below) all of them are pests of economic importance; short accounts of them have been prepared separately in the following pages.

Macrosiphum pisi (Kalt.).

"Green dolphin" (English).

"Green Pea Louse" (American).

Syn.—*Siphonophora pisi* (Koch. Buck.).

Nectarophora destructor (Johnston).

Plenty of literature exists on this notorious insect. Several papers by Messrs. Johnston, Sanderson and Chittenden have appeared on the control and remedial measures against this destructive pest of peas in America (*Circulars and Bulletins of U.S. Dept. of Agr.*, 1908-1909).

Gillette has figured the antennae and cornicles in the *Jour. Econ. Entom.*, vol. IV, p. 384; 1911.

Theobald gives figures, description and a fairly complete bibliography with a list of synonyms (*Jour. Econ. Biol.*, Sept. 1913, p. 134).

Mr. J. J. Davis, of the Bureau of Entomology, U.S.A., states that he is about to publish a complete account of the morphology and natural history, etc. of this insect.

I find that the Indian insect is identical in all respects with the European and the American form, and as the descriptions of these are easily accesssible no further morphological account is needed here.

Life-history.—This insect would often be attracted by white clothes and settles on them if on the wing. Its ravages to pea crops have been said to be very serious in the United States of America, but so far I have not noticed it here in any large numbers upon them. Possibly it is controlled and kept in check by natural enemies, but there is no doubt that it is a standing menace and might become a bad pest in any year favourable for its reproduction. So far it has been sparingly infesting the following plants in Lahore and some of them are those not recorded as its hosts in other countries:—

(1) *Alhagi maurorum*	22nd February, 1913.
(2) *Melilotus alba*	April, 1913.
(3) *Medicago sativa* (Lucerne)	27th March, 1913.
(4) *Medicago falcatum* (*Vern.* Methe)	13th April, 1913.
(5) *Clianthus dampieri* (Glory flower or Parrot beak)	12th April, 1913.
(6) *Lathyrus adoratum* (Sweet Peas)	February and March.
(7) *Dolichos lablab* (Sem)	28th August, 1913.
(8) *Peganum harmala*	3rd March, 1913.

Natural enemies.—Besides the usual enemies, this species is liable to the attacks of the fungus "Entomophthora aphidi" which destroys it in large numbers. Mr. G. R. Dutt of the Research Institute at Pusa once sent me specimens from sweet peas where the fungus had done particularly good work in reducing it. The infected insect first swells up a little, then getting stupefied fixes itself to one side of the twig or leaf not favourable for feeding, turns yellow and later on shrivels up to a scaly form.

Another *Macrosiphum* sp. is occasionally collected on sweet peas in May. It is about the same size as *Mac. pisi* and resembles it closely in colour, etc. Further, it has cornicles which are smooth throughout without any area occupied by polygonal markings. But its cornicles are much smaller, conical and hardly reaching to the base of the cauda. The description of this form is omitted in this paper.

Macrosiphum rosaeiformis, n. sp.

"The Punjab Rose Aphis."

Hosts.—Several species of cultivated roses in gardens (*Rosa centifolia*, *R. damascaus*, *R. moschata* and varieties.)

Distinguishing characters.—A large green aphid with brilliant red eyes, clustering head downwards, in lines, over the tender shoots or flowerbuds. The size of the shoot often appears twice as thick as it actually is, because of their overcrowding

numbers. Body elongated, cornicles black; large yellowish-green cauda and long black antennae on frontal tubercles; the pattern on the back of the alate female, as shown in the figure, and about sixteen sensoria on the third antennal article are distinctive.

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Form of the body much elongated oval or elliptical, from three to four times longer than broad; the body has short rows of hairs on well marked segments; without any mealy covering.

Colour yellowish-green, dark green in places; appears mottled because of the red eyes of the young embryos seen through the skin.

Head and post-cornicular part yellowish.

No pattern except the two rows of brown depressions in line with the lateral grooves and running internal to the cornicles. The segment immediately behind the cornicles is oily and elevated above the general surface.

Head yellowish, almost as broad as long, distinct but not large; frontal tubercles about half the size of the first antennal joint, front rather shallow with a median convexity and a few short hairs.

Eyes large and red, with well developed occular tubercles.

Antennae either wholly black, except for the lighter basal two joints, or light greenish ringed with black at the articulations; distal third always black; hairs short and sparce, arising from small tubercles. Length about that of body or slightly longer, not reaching beyond the body.

Length proportions :—

	III.	IV.	V.	VI.
	49	35	30	8+41
Lengths ..	0·79	0·57	0·50	0·13+0·70 mm.

The third article bears only two or three sensoria.

The prothorax bears a small lateral tubercle, which is rather unique as we do not find them in this genus.

Cornicles black, conical, long and projecting backwards and outwards, slightly curving also; bases swollen and light in colour; the proximal four-fifths granulated finely, the distal one-fifth narrowed, always darker and bearing polygonal markings over its surface.

Cauda light yellowish, thick, constricted near its basal third part and afterwards gradually narrowing; sharp tooth-like tubercles and curved hairs are present as usual. In life the cauda is carried like a sabre with a gentle curve; it is about half the length of the cornicles.

Anal and genital plates distinct; the latter concave anteriorly.

Legs long and light greenish; a little duskiness at the knees, while the tarsi are black.

Rostrum short, yellowish; last two joints subequal, reaching to the level of second coxae.

Measurements :—

Body	2·6—3·0 × 0·95 mm.
Antennae	3·1 mm.
Cornicle	1·1 ,,
Cauda	0·55 ,,

Alate viviparous female.—Body long oval, with a very slight bloom on the undersurface of the thorax.

The colour of the head and thorax appears dusky ochraceous yellow; abdomen a darker green than the apterous female; antennae, legs and cornicles much blacker.

The pattern on the abdomen consists of three large circular spots on the carina of the pre-cornicular portion. One small spot on the first abdominal and another faint one just outside the cornicles; a row of large transversely flattened spots in the lateral grooves. At least two round spots in front and in line with the cornicles; about two transverse stripes on the mid-dorsum of the first two abdominal segments. There is no spot around the bases of the cornicles or on the hinder segments which are said to be present in true *Macrosiphum rosae*.

Head dusky or black, concolorous, with small frontal tubercles; front rather shallow, not deeply channelled as in other species.

Eyes red; with stemmata and the usual three ocelli.

Antennae wholly black, longer than body.

Length proportions exactly the same as in apterous females.

	II.	IV.	V.	VI.
Lengths ..	0·80	0·57	0·48	0·11+0·81 mm.

Sensoria (secondary) on article III from 14 to 16, placed ventrally almost in one line; all of them circular and having a double contour.

The prothorax bears a broad dusky band on its anterior margin and a distinct lateral tubercle on either side; concolorous with mesothorax.

Mesothorax ochraceous yellow in colour; on its dorsum four black muscle-bosses and prominent stigmal spots on lateral sides; meso-sternal bosses also occupy a small area on the ventral side, while on their sides, a little laterally placed, are two conspicuous but small dots.

The metathorax has a transverse band in front of which is to be seen another semilunar mark.

The wings are large with normal venation; occasionally the second furcal is wanting.

Stigmal flattening dark brown; a camera lucida drawing shows the arrrangement of the veins.

Cornicles quite black, similar to the apterous female, only smaller in size.

Cauda long, with a slight constriction above the broad basal third part; it is about half the length of the cornicles.

The legs are much blacker, specially the distal femora and tarsi, which are of the same colour as the cornicles; tibiae dusky, coxae of body colour.

The ventral surface is lighter in colour.

The rostrum reaches up to the second coxae.

Measurements :—

Body	2·50 × 0·85 mm.
Antennae	3·00 mm.
Cornicle	0·70 ,,
Cauda	0·39 ,,
Wing expanse	8·50 ,,
Wing	4·0 × 1·45 mm.

The "Punjab Rose Aphis" has a very strong superficial resemblance to the famous "Rose Aphis," *Macrosiphum rosae*, Linn., said to be very common and often destructive in orchards and gardens in Europe and America. Apparently the same insect is met with in the East as well, as I have received specimens from Mr. van der Goot, who collected them on rose bushes in Java. They are in no way different to the insects I received from Europe and America.

Lefroy mentions *Macrosiphum rosae* (Linn. or Reaum.) as occurring in India (*Indian Insect Life*, p. 747). I believe that this is based on Buckton's identification, who had received some specimens from the North-Western Provinces and who considered them as identical with the English Rose Aphid, vide *Monog. Brit. Aphid.*, Vol. IV, p. 181.

I do not find Buckton's identifications very reliable so far as Indian plant-lice are concerned. In several instances in the case of insects sent him from the Indian Museum, Calcutta, even the genera are incorrect. About the species under review I can only say this much, that it is quite likely that India may be the habitat of true *Macrosiphum rosae*, Linn., but so far it has never been collected by me on rose bushes in the Indian plains. As there is a chance of this species being easily mistaken for the European Rose Aphis, I tabulate below the chief morphological characters in which the two insects differ from each other.

I am calling this species *Macrosiphum rosaeiformis*, n. sp., as there does not appear to me any other species of this genus to which it would be so nearly related as *M. rosae*, Linn., from the literature available.

DIFFERENCES IN THE TWO FORMS.

Macrosiphum rosae (Linn. or Reaum.).	*Macrosiphum rosaeiformis*, sp. nov.
Apterous viviparous female.	*Apterous viviparous female.*
(1) Body about twice as long as broad.	(1) Body much longer, sometimes over three times longer.
(2) Sensoria on 3rd antennal article from 8 to 10 (Essig); from 3—5 large and 3—5 small (Theobald).	(2) Sensoria never more than three, often only two.

Alate viviparous female.

(1) Body broader.

(2) Antennae 3·55 mm. to 4·2 mm.

(3) Sensoria very many (Essig); from 42—48 (Theobald); over entire length.

(4) Pattern on abdomen: three spots on sides; a black patch at bases of cornicles; a crescentic one in front and two dark patches behind on either side; last segments with a black stripe.

Alate viviparous female.

(1) Body narrower.

(2) Antennae 3·0 mm., quite similar to that of the apterous female.

(3) Sensoria on 3rd article never more than 16; from 14—16 ventral and in one line.

(4) Pattern on abdomen: three lateral spots large and two smaller; patches at bases in front and behind absent; also the dark band on the last segment.

Two rows of spots in last grooves; two spots in front of and in line with cornicles; transverse marks on the middle of first two abdominal segments present.

There are also some other minor discrepancies which can be explained as individual variations, but in view of the above account it forms a very good species.

Twice a year roses in Lahore produce new shoots, once in March and again about October or November. At both these periods the "Rose Aphis" can be collected. My dates from the City Circular Gardens and the Botanical Garden have been early December and March–April. As there are always a few young shoots present throughout the winter it is true that the species remains actively viviparous during this period, but after April or early May no trace of it is to be found in the plains. Whether it migrates or deposits eggs after producing sexual forms on the approach of summer is still undetermined.

Natural enemies :—

(1) *Lysiphlebus* sp. which extensively parasitises it.

(2) Syrphids, several species.

(3) Coccinellids, chiefly *Chilomeles sexmaculata*, often clearing twig after twig.

Unlike the European Rose Aphis there is no pink variety in the case of this insect.

Macrosiphum granarium (Kirby; Pergande).

"Wheat Grain-Louse."

Literature :—

Buckton, *Brit. Aph.*, vol. I, p. 114.

Pergande, *U.S. Dept. of Agric. Div. Ent. Bull.* 44, 1904.

Theobald, *Jour. Econ. Biol.*, vol. VIII, 1913 (gives description and figures; a part of the acccompanying illustration is copied from Theobald's figure).

The large wheat plant-louse is easily recognisable in the field from the brief diagnostic characters already given above (p. 157). It infests several graminous crops grown in winter, more especially wheat, barley and avena.

M. granarium can be collected from wheat or avena blades as early as November, when the avena or wheat seedlings are hardly a few inches high. It continues throughout the winter, till the wheat is removed from the fields in early April.

At this time it clusters round a common graminous weed, a species of *Agrostis*; even parasitised females flock to this grass, but what occurs to them later has not been followed out.

Parasitisation of this species is very extensive.

Macrosiphum sanborni (Gillette).

Host.—Cultivated Chrysanthemums.

Literature :—

Sanborn, *Kans. Univ. Sc. Bull.*, vol. III, 1 (under *Siphonophora chrysanthemi*).
Gillette, *Can. Entom.*, vol. L, 2, p. 65, 1908.
„ *Jour. Econ. Entom.*, vol. IV, p. 385, 1911 (antennae and cornicles figured).

This Aphid as found in the Punjab is identical with the American species, only our early winter specimens are larger.

Biology and life-history.—This species first appears on Chrysanthemums in late September or early October. It appears certain that these are the "stem-mothers" hatched from eggs, laid at some previous time upon these plants. They are very large and are all apterous. One or more isolated specimens may be found on each plant with a small brood of a few young that are vermillion red. Soon after this the numbers increase and after the second generation alate females develop which spread the species. This process continues till December.

The shining red-brown insects cluster on the tops of young shoots and only when very numerous attack the veins of the leaves as shown in the plate.

They sit in rows upon the angles of the twigs with their heads directed downwards. The slender beak can be readily withdrawn and the insects drop to the ground even at the suspicion of alarm.

They have a curious habit of swinging or jerking their bodies from side to side with the long hind legs dangling in the air. This is done almost rhythmically; all the members of the colony take part in it and keep time with a regular swing; all the time the beaks remain inserted. This habit probably keeps them safe from parasites.

The species becomes scarce in December when the sap in the plants is diminished after the flowering period is over. The few survivors are stunted in size.

In January again a few shoots begin to sprout, but are abundant only in February and March. In the latter months the insects are again active on the new leafy branches. After April they entirely disappear leaving no visible trace behind.

A few attempts were made to secure the sexuales but were unsuccessful.

Its enemies are chiefly *Chilomeles sexmacalata*, the young of a Mantid and small species of Syrphids.

Systematic.—In the structure of its cornicles and cauda it differs materially from typical species of the genus *Macrosiphum*. The following points may be specially noted :—

(1) The cornicles are unusually small and stout; reticulation extends over more than two-thirds of its distal surface, while in other species it occupies only a small apical portion.

(2) The cauda is very large and thick, irregularly cylindrical, with a rounded tip, not sabre-like and pointed.

(3) The cauda is longer than the cornicles, while in typical species it is considerably smaller.

It would perhaps be appropriate to separate it into a different genus or subgenus.

A *Macrosiphoniella* has been described from chrysanthemums by Del Guercio recently in the Italian Journal "*Redia*," with which at present I am unacquainted. It may be this species.[1]

Macrosiphum solidaginis, Fabr.[2]

Hosts.—*Sonchus oleracea*, *Sonchus arvensis*, *Sonchus* sp.

Biology.—This insect is of no economic interest as it infests only the wild species of *Sonchus*. The earliest date of its appearance in Lahore is the first week of January; it soon thickly covers over the stalks of inflorescence and later attacks the leaves. About this time it is usually destroyed wholesale by the Fungus *Entomophthora* sp.; from January onwards up to May it is found on its host only occasionally.

A few observations were conducted on some colonies kept in the laboratory, relative to the effect upon them of the diurnal heat. As the maximum temperature for each day began rising and reached about 95° F. in third week of March all the insects deserted the plant. After two weeks or so there was a shower of rain and during two cloudy days that followed several apterous females were seen on the same plant. In the middle of April when the maximum reached 104° F. again not a single insect was to be observed above-ground; early in the last week, however, another slight rainfall with threatening weather brought out the Aphid on the same plants. They seemed to come up after every slight rainfall.

These observations were not carried forward into the season, neither was the further life-history followed as to what time the sexuales, etc. are produced.

The three species of *Sonchus* are the only hosts known at present in Lahore, though in Java many other species of Compositae are said to be its food-plant.

Systematic.—The "Eastern Sonchus Aphid" is quite different from the insect familiarly known by the same name in the West, *i.e. Macrosiphum sonchi*, Linn.

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[1] [*Macrosiphum sanborni*, Gill. very clearly belongs to the genus *Macrosiphoniella*, Del Guercio, which genus seems to differ principally from *Macrosiphum*, Pass. in having the cornicles shorter than the cauda. This same chrysanthemum-aphid has been described by Mr. Theobald as *Macrosiphoniella bedfordi*, Theob. (*Bull. Ent. Research*, vol. IV, 1914, p. 318), a name later on corrected by this author to *Macr. chrysanthemi*, Del. Guercio (*Bull. Ent. Res.*, V, 1915, p. 112), which again must fall as a synonym to *Macr. sanborni*, Gill., the latter name being of an earlier date (1908). P. v. d. G.].

[2] [Literature on *Macr. solidaginis*, Fabr.:—

a. Kaltenbach, *Die Pflanzenläuse*, 1843, p. 32.

b. Koch, *Die Pflanzenläuse*, 1857, p. 197.

c. v. d. Goot, *Beitr. z. Kenntniss der holländischen Blattläuse*, 1915, p. 90. P. v. d. G.].

The latter is listed by Lefroy in *Ind. Insect Life*, p. 747, from safflower (*Carthamus tinctorius*), but I have never collected it from anywhere in India nor have I so far seen any Indian specimens of the same.

M. sonchi is easily recognised by the tufts of hair on the abdominal segments besides other structural features. The colour and food-plant, however, being the same, confusion between the two is quite likely to occur.

I have not been able to compare *M. solidaginis* with the American insect *Macrosiphum sonchella* (Monell), but in correspondence with Mr. P. van der Goot I have learnt that the Indian *Sonchus* Aphid is identical with the Javanese one, which he considers to be identical with the European *Macr. solidaginis*, Fabr. I have therefore accepted the name as given by van der Goot.

Rhopalosiphum lactucae (Kalt.).

Syn.—*Aphis lactucae* (Kaltenbach).
Rhopal. ribis (Koch), according to Buckton.

Literature :—

(1) Kaltenbach, *Mon. d. Pflazenlause*, 1843.
(2) Buckton, *Mon. Brit. Aphid.*, II, pp. 9, 10.
(3) *Jour. Econ. Entom.*, III, p. 378.
(4) Sanderson, *Canad. Ent.*, XXXIII, p. 70 (1901).
(5) Theobald, *Journ. Econ. Biol.*, III, 3, p. 105 (1912).
(6) Schouteden, *Aphids de Belg.*, p. 236 (1906).

Food-plants.—In Europe and America this insect has been recorded on the following plants:—

(1) *Sonchus oleraceus.*
(2) *S. asper.*
(3) *S. arvensis.*
(4) *Cichorium endiva.*
(5) *Ribes rubrum* } Currants and Gooseberries.
(6) *R. grossularia* }
(7) *Lapsana vulgaris.*
(8) *Picris heiracoides.*

In the neighbourhood of Lahore it has been observed rather sparingly only on the three species of *Sonchus* mentioned above; especially on *S. asper* growing in shady places or along the edges of water-courses in Gol-bagh and the Ravi forests.

The time of appearance is always from May to June, clustering round young flowerheads.

Distinguishing marks.—A rather large Aphid, from yellowish-green to green in colour; long greenish antennae, legs and cauda; cornicles very much swollen in their distal halves; alate females with a black irregular blotch and smaller spots on the back; the apterous females are provided with a few sensoria on article III of the antennae; it appears in May on *Sonchus* spp.

The species can easily be identified from the above diagnosis, and as fairly accu-

rate descriptions are available in the literature cited above no further characterisation is given here. My figures sufficiently indicate the morphological characters.

Systematic.—The genus *Rhopalosiphum*, Koch, has several characters in common with *Macrosiphum*, but is distinguished at once by the clavate cornicles. According to the latest definition *Rhopalosiphum* ought to have a few secondary sensoria on the 3rd antennal article of the apterous viviparous female. The cauda is said to be about $\frac{1}{2}$—$\frac{1}{3}$ the length of the cornicle. The Punjab species differs somewhat in having a longer cauda. Moreover, in an otherwise excellent description with plates by Theobald (*Jour. Econ. Biology*, III, 3, 1912) no sensoria are shown on the apterous antennae of *R. lactucae* on *Ribis* sp., while their number on article IV of the antennae of the alate female is from 17-20; in the Lahore specimens I have never found them to be more than from 10-13. Measurements are not given by Theobald but the Lahore specimens agree fairly well with those of Buckton although the latter mentions the apterous female antennae as smaller than the body but figures it longer, which, as a matter of fact, it is.

In spite of these minor apparent differences I believe that the Indian insect is identical with the European and the American form.

So far it has not been observed to infest any plant of economic value, as it does gooseberries in the West; nor is anything known of its further life-history after its disappearance in June. Its appearance also in the beginning of May is equally sudden, and it has been met with at no other time of the year. Of course there is no record of its existence in India before this.

Myzus persicae (Sulz.)

Syn.—*Rhopalosiphum dianthi* (Schr.)

Synonyms and Literature.—There is plenty of literature current both in Europe and America concerning this notorious and cosmopolitan plant-louse. It has either been described as *Rhopalosiphum dianthi* or as *Myzus persicae*, although these are by no means its only synonyms. Some of them, along with an accurate colour description, will be found in Buckton's *Monog. Brit. Aphides*, II, p. 15. But perhaps the latest with an excellent account of its morphology and life-history, as well as some of the more important literature, will be found in two papers, one by Prof. Gillette in the *Jour. Econ. Ent.*, vol. I, p. 359, 1908, and another in the same volume on page 83 by Taylor. The latter author has discussed and conducted some remedial measures also. A very useful summary of their work is given conjointly with fine illustrations in Bulletin Nos. 133 and 134, Colorado Exp. Station, 1908.

Indian references.—Indian notices of this Aphid may be seen in *Ind. Mus. Notes*, vol. IV, no. 1, p. 23, 1896, where the description is copied from Buckton, and vol. IV, no. 4, p. 197, 1899, which contains a list of European host-plants as given by Walker. An indifferent plate accompanies the former reference, which is evidently a poor reproduction of Buckton's. The same has been figured by Lefroy in *Ind. Ins. Life*, p. 744, 1909.

It has been reported from Calcutta on rape and brinjal (*Solanum melongena*).

The actual specimens in the Indian Museum labelled as *Rhop. dianthi*, upon Brinjal, that I had occasion to examine, proved mostly to be *Aphis malvae*, Koch; so the latter reference in the *Ind. Mus. Notes* is probably an error.

The Aphid may be found almost at any time wherever there is any kind of *Brassica* crop growing and then mostly in company with *Siphocoryne indo-brassicae*, n. sp. But its hosts are numerous and I have given below a list of plants on which it has been actually collected.

The life-history appears to be much the same as in America, but details have not been properly followed out yet.

This species is extremely abundant after August and September. Numerous plants serve as hosts as will be seen from the list. During October and November *Brassica* crops are their special favourites and they feed on these usually in company with *Siphocoryne indo-brassicae*. About the last week of November, from various herbaceous plants, large autumn migrants and alate males begin returning to young peaches and settle on the under side of the leaves. Throughout December this continues. The colonies from whence they come themselves retain their parthenogenetic reproduction as usual, and there is hardly any perceptible diminution in numbers by their migration.

The "return migrants" are much larger and give birth to young which develop into deep pink.

Oviparous females.—Egg-laying does not start before January, unlike what obtains in the west, where it is reported to commence as early as the first week of November.

Winter is in no way detrimental to their life and viviparous females remain fairly active after sunrise even on the coldest days. They pass into spring in this manner; when food is more abundant the colonies multiply quickly.

As is the case with many other plant-lice in Lahore, this species also disappears about the beginning of May, and the earliest date for collecting it again is the last week of August as apterous viviparous females on cruciferous plants.

It may be that some eggs hatch at this time, but then they do not hatch upon the peach.

The ordinary predaceous and parasitic insects feed upon them.

Systematic.—According to the investigations of Gillette and Cholodkovsky, the correct name for this species is *Myzus persicae* (Sulzer). It has been frequently referred to as *Rhopalosiphum dianthi* (Koch) in the literature on these insects.

The explanation offered by Gillette for the mistake about the genus is that the "spring migrants" in this case possess cylindrical cornicles, while the "autumn migrants" have them clearly clavate in their distal halves.

In Lahore so far we have not secured any specimens with straight cornicles, they are always more or less swollen.

Recently the species has been separated into a new genus (*Myzoides*) by van der Goot, 1913, along with two more similar Aphids. As this name has not been generally accepted yet I have retained the old one of *Myzus persicae* (Sulzer).

Food-plants.—*Myzus persicae* (Sulz.) [= *Rhopalosiphum dianthi* (Schrank)] has

been notorious for its extremely polyphagous habit. Its distribution also is more or less cosmopolitan and one often finds lists of food-plants on which it is usually seen feeding published separately for each country. I give below a list of hosts from which the insect has been collected by myself in Lahore and the neighbourhood. The most favourable hosts and those upon which it may be observed feeding almost any day throughout the winter, in company with *Siphocoryne indo-brassicae*, are the plants belonging to the Natural Order Cruciferae and more particularly to the various species and sub-species of the Genus *Brassica*. But it can live and reproduce on almost any green and succulent plant. The list includes several plants which this insect has not been reported to infest in other countries; and, though a fairly large one, does not pretend to be at all exhaustive.

(1) *Althea rosea* (*Vern.* Khatmi).
(2) *Ageretum conyzoides*. In March.
(3) *Brassica juncea*. Rape and Mustard (*Vern.* Sarson). November to March.
(4) *Brassica oleracea*. Cabbages and Cauliflowers (*Vern.* band-, gand- and phulgobhi).
(5) *B. campestris*.
(6) *B. rapa*. Turnip.
(7) *Erruca sativa*.
(8) *Raphanus sativa*.
(9) *Sisymbrium iro*.
(10) *Capsella bursa pastoris*.
(11) *Coronopus dydimus*.
(12) *Convolvulus major*. January-February.
(13) *Ipomea guttata*. }
,, *I. crispa*. } Morning and Evening Glory.
,, *I. mexicana*. }
(14) *Withania somniferum*.
(15) *Nicotiana tobaccum*.
(16) *Datura stramonium*. (The pupae here are often pink coloured).
(17) *Linaria*, several species. Toad-flax. February–March.
(18) *Antirhinum* sp. Snapdragon.
(19) *Euphorbia helioscopiae*.
(20) *Mazus* sp. River side in April.
(21) *Malva sylvestris*.
(22) *Prunus persicae*. (Often pinkish in colour, in company with *Aphis pruni*, after March).
(23) *Dianthus caryaphyllus*.
(24) *Pyrus communis*.
(25) *Dalbergia sissu*.
(26) *Solanum tuberosum*.
(27) *S. lycopersicum*.
(28) *Stellaria media*. In February.

(29) *Rumex dentata.*
(30) *Chenopodium* sp.
(31) *Tropoeolum* sp. Nasturtium.
(32) *Viola tricolor.*
(33) *Gallium* sp.
(34) *Cinanaria.*
(35) *Echinops echinata.*

Phorodon cannabis, Pass.

(Bhang Aphid. *Vern.* Bhang Tela).

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body rather long elliptic, tapering towards ends; more than twice as long as broad, provided with distinct knobbed hairs mostly directed backwards.

Prevailing colour deep green; sometimes very light coloured individuals are met with, especially in March and April. Three broad longitudinal stripes run down the back from the head to the apex of the abdomen. The lateral stripes have dark spots to indicate the abdominal segments, well seen in fixed specimens. The thoracic segments are marked off by green transverse grooves.

Head green; front very narrow with a few capitate hairs; frontal tubercles large and each produced into a well-marked tooth directed forwards and inwards, carrying a few hairs.

Antennae above the tubercles green proximally, while the distal half is black; the whole surface furnished with scattered and similarly knobbed hairs.

The first joint is drawn forward into a tooth on the inner side, with hairs on its end.

Antennae slightly shorter than the body.

Length proportions of the joints from the third segment onward as follows:—

	III.	IV.	V.	VI.
	20	14	12	5+21
Lengths ..	·33	·23	·2	·08+·42 mm.

Prothorax green like the rest of the thoracic segments, the lateral depressions being well marked as usual. The sides are well rounded; there is just the appearance of a short tubercle near the posterior edge.

The skin on the abdomen is marked off into very irregular areas whose boundaries rise clearly above the general surface. It gives a strange corrugated but a distinctive appearance to the species under the microscope.

Cornicles long, thin, cylindrical, occasionally slightly clavate; green throughout in young and smaller individuals, but smoky on the distal quarter in the adult and old specimens. They lie in a sickle-like curved manner (see figure), at first directed backwards and towards the middle line, then slightly diverging. They project beyond the cauda and often are full of oil globules, forming a row within the cornicle.

Cauda green, long conical, with sharp tubercles and a few strong hairs.

Legs green with knobbed hairs; only the tarsi are black with short first segment.

The rostrum just reaches up to about the middle of the second and third coxae. Colour greenish with a smoky tip.

Measurements of large specimens on an average are:—

Body	1·70 × ·75 mm.
Antennae	1·5 mm.
Cornicle	·66 to ·75 mm.
Cauda	0·166 mm.

Alate viviparous female.—Body long oval; prevailing colour green or slightly yellowish-green; devoid of hairs.

Head black, triangular, with a narrow front carrying the median ocellus in the centre.

Frontal tubercles distinct, strongly porrected (as in the apterous female) into a pointed tooth without capitate hairs.

Antennae black, about equal to the body length; a long spur to the sixth joint, third joint strongly tuberculate.

Sensoria, 16–19 on III; 5–7 on IV. The primary sensoria on V and VI have a strong "hair-rim."

Length proportions:—

	III.	IV.	V.	VI.
	24	16	15	6+29
Lengths ..	·40	·26	·25	·10+·49 mm.

The prothorax is sharp-edged and broad posteriorly and has a black band near the front margin, two black dorsal dots on the sides and a green transverse stripe behind.

Mesothorax large, yellowish, with four shining black muscle-lobes on the top; on the sides a large stigmal spot, black in colour.

The metathorax is narrow and has two lateral spots and a crescentic band near the posterior edge.

Abdomen ovate with a wavy margin; the colour is green; darker green central and two lateral stripes are indistinctly apparent.

The pattern of black dots and stripes, as shown in the figure, is made up of:—

(i) Three large black spots on the carina.

(ii) Four (plus an indistinct fifth) broad black stripes on the posterior half of the abdomen. The one just in front of the cornicles is crescentic.

(iii) A double row of fairly large spots on the lateral grooves, of which the first three segments have both the spots confluent with each other, making the spot appear a very broad one. The fourth segment has them separated, one spot just in front of the cornicles and almost in line with the three larger carinal ones, the other touching the second broad ab-

dominal band. On the fifth the inner spot just meets the third band, while the outer one just lies behind the cornicles. The segment behind has only two lateral spots.

Wings large and broad; slightly smoky in appearance; slightly dusky flattenings at apices. Veins very dark; cubitus with a double fork and obsolete at base. Stigma dark brown at the flattening with yellow insertions; the stigma has a gentle curve as shown in the camera lucida drawing.

Cornicles black, long and cylindrical, with a distinct rim reaching to the tip of the extended cauda.

Cauda long, with one or two indentations; dusky green.

Anal plate semicircular. Genital plate brownish and made up of two darkish halves.

Ventral surface segmented and of a light greenish or yellow colour.

Legs like the apterous female, slightly more dusky, without knobbed hairs.

The rostrum just reaches the second coxae beyond the black sternal muscle-bosses.

The lateral tubercles are absent.

Measurements :—

Body	1·60 × ·65 mm.
Antennae	1·60 mm.
Wing expanse	5·80 ,,
Wing	2·6 × 1·1 mm.
Cornicle	0·45 mm.
Cauda	0·166 ,,

Life-history.—The species makes its appearance in October on old sickly-looking plants of *Cannabis*. The specimens from which the description has been prepared were collected in November near the bridge on the Ravi adjoining reserved forests. They multiply freely till some time in December when sexuales are produced. Only on one occasion, below a mango groove along the opposite bank of the Chhota Ravi, a few young oviparous females were secured. They resembled the apterous viviparous female, except that the colour was pink and the hind tibiae stout and swollen on account of the presence of many small circular sensoria.

No males were captured; probably they are alate and form a little earlier. Neither was it possible to collect the eggs.

In the absence of any definite data, which further observations might furnish, it can only be surmised that alate males and some migratory females fly off to some other host where, after the oviparous females have developed, the eggs are deposited to tide over the winter.

Such an alternate host is probably one or more compositous plants, besides *Cannabis* itself, on which the winter may be passed even in the parthenogenetic condition.

In March and April the species is sparingly present on *Cannabis indica*, in the angles between the ventral veins of the leaves. But it thickly infests the under sides of the leaves of *Cnicus arvensis*. It may be collected on the latter throughout May,

but in June this plant is entirely deserted and the Aphid either dies or migrates to some unknown place.

In this connection it is interesting to note that I have collected the identical species in Simla and the neighbouring hills in July and August. The hosts there are *Cannabis indica*, *Cnicus* sp. (a long-leaved and very spiny kind) and *Artemesia* sp.

The life-cycle would, therefore, be completed somewhat as follows:—

In March and April the eggs laid in the previous winter (December) hatch into stem-mothers, on some compositous weed and possibly also on *Cannabis*. They give birth to spring generations that stay in the plains up to about June. They are in evidence again during October and November. The hot summer months are in all likelihood passed in some cool shady places out of sight, or in the hills.

Late spring individuals on *Cannabis* are smaller in size than the autumn ones.

An *Aphidius* and a *Lysiphlebus* extensively parasitise this Aphid changing it into shining inflated skins with a circular hole on one side. The parasites are most abundant in April, issuing in large numbers from the bodies of wheat Aphids.

The insect is apparently of no economic importance, unlike the famous Hop-louse, *Phorodon humuli*, of Europe and America.

Systematic.—The *Cannabis* Aphid is a near relation to the famous Hop-louse of Europe and America and is in some respects very similar to it, infesting a plant of the same order. But Hops (*Humulus lupulus*) are never grown here nor has *Phorodon humuli*, its pest, been so far observed in India.

The generic characters of *Phorodon*, Pass. (lit.=tooth carrier), as given by Passerini, *loc. cit.* and quoted below, are quite apparent.

Antennae tuberculo frontali suffultae, articulo primo intus dente valido adaucto. Frons inter antennas plana; nectaria longissima, cylindrica vel leviter clavata; caeterum ut *Siphononphora* (*Macrosiphum*).

The latest and emended characters given for this genus (van der Goot, *Zur Systematik der Aphiden*, 1913) are chiefly as set down by Passerini with additions, etc. as follows:—

Body almost hairless or with extremely short hairs, not scattered in groups or knobbed.

Lateral tubercles absent.

Antennae not longer than body, in the apterous female distinctly shorter; first segment with a strong tooth on the inner side. Frontal tubercles well developed, having a similar tooth but more marked. The absence of sensoria on the third antennal article distinguishes it further from the genus *Macrosiphum*, which it resembles in other respects.

The Indian species is rather peculiar in having capitate hairs scattered all over the body in rows, mostly directed backwards. The antennae and the characteristic teeth also carry a number of similar hairs. A slight clavation of the cornicles is also observable in the large apterous female. The pattern on the skin, *i.e.* the peculiar corrugations described above, seems to be absent in all the species described so far. Both the capitate hairs and the skin-pattern are absent in the alate female. The

presence of capitate hairs is rather a deviation from the generic characters, but they are confined to the apterous forms only.

Passerini has described a species of *Phorodon* on *Cannabis*, but the accounts of these insects by older writers was confined chiefly to the superficial characters which are often not very reliable. As even these earlier accounts are not available in English, I have prepared the description of the insect as found in the Punjab.

It is likely that the Italian and the Indian insects are identical, so I have adopted Passerini's name for the present instead of proposing a new one.

CLUB-CORNICLED APHIDS.

A short notice of the history of the genera *Rhopalosiphum* (Koch) and *Siphocoryne* (Pass.) might well precede the accounts to be given in the following pages of some Indian Aphids that are related to them in a way, though differing in several important respects.

The genus *Rhopalosiphum* of Koch was first split up by Passerini into two groups. One set of species had antennae placed directly on the head, and the other carried them on frontal tubercles. Koch's name was retained for the latter, while *Siphocoryne* (Pass.) was proposed for the former (*Aphidae Italicae*, 1863). "Rhopolos" and "Coryne" both mean a "club" and refer to the swollen or clavate character of the cornicles or "siphunculi."

The indistinct presence or absence of frontal tubercles is often confused, and it becomes a matter of individual opinion whether a particular species should be put in one or the other genus.

Monell suggested an amalgamation of the two genera which was not accepted, and Lichtenstein (1885) who followed Passerini defined the genus *Siphocoryne* thus:—

(1) Antennae implanted directly on head, non-hairy, with seventh joint distinctly longer than sixth.

(2) Nectaries long and clubbed.

Buckton (*Brit. Aphid.* 1887) held similar views and remarked that the genus partook the characters of *Aphis* and *Rhopalosiphum*. Oestlund (*Aphid. Minnesota*, 1887) further added that these characters were accompanied by the third antennal article being very "tuberculate" and the species attacking unbelliferous plants. This is not true for all species.

Van der Goot (*Zur Systematik der Aphiden*, 1913) has furnished a definition on morphological grounds and separates the two genera thus:—

Frontal tubercles well defined; a few sensoria on article III always present, in case even of the apterous female. *Rhopalosiphum.*

Frontal tubercles indistinct or absent; sensoria in case of the apterous female always absent. Cornicles clubbed in both. *Siphocoryne.*

Evidently here no notice is taken of the relative lengths of the antennae, body, cornicles and cauda, etc.

It is of interest that Walker very early pointed out and erected a new genus

Liosomaphis with *Rhop. berberidis* (Kalt.) as its type, and described it in the *Zoologist*, 1860, p. 1119. The distinctive characters were:—

(1) Antennae shorter than body.

(2) Seventh joint smaller than third.

(3) Cornicles clavate on one side and about one quarter the body length.

The genus was never accorded any acceptance and Buckton brought back "*Lios. berberidis*" under *Rhopalosiphum*.

Wilson has attempted to revive it in his "Key to the genera of Aphidinae" (*Ann. Entom. Soc. America*, 1910), but apparently not with much success.

If we accept van der Goot's latest definition we should place *Lios. berberidis* under *Siphocoryne*, and after examining the insect I am of opinion that in spite of its very small frontal tubercles its natural affinities are with *Siphocoryne*. We may then for the present score off the genus *Liosomaphis*.

But *Siphocoryne* when thus defined forms quite a heterogeneous group including a large number of species. These have been proposed to be broken up into more natural subdivisions of generic importance by van der Goot and Theobald. The discovery of some new forms in the Punjab has necessitated the addition of two more genera. The whole view of the present situation can be summed up by giving the characters of the various genera proposed in tabular form.

Aphidine Genera with Clavate Cornicles.

I. Antennae of apterous female provided with secondary sensoria. *Rhopalosiphum*, Koch.

II. Antennae of apterous female without sensoria (A).

(A). (i) Capitate hairs over the body, cornicles clavate only on one side, frontal tubercles absent. *Stephensonia*, gen. nov.

(ii) Capitate hairs absent; cornicles clavate on both sides; frontal tubercles indistinct or absent (B).

(B). (i) Cornicles smaller than or subequal to cauda. *Brevicoryne*, gen. nov.

(ii) Cornicles longer than cauda; frontal tubercles absent or inconspicuous (C).

(C). (i) A large precaudal tubercle present on the dorsum. *Tuberculaphis*, Theobald.

(ii) Large precaudal tubercle absent (D).

(D). (i) Lateral tubercles on first and seventh abdominal segment present. *Siphonaphis*, van der Goot.

(ii) Lateral tubercles on first and seventh segment wanting. *Siphocoryne*, Pass.

I am not quite sure whether we should differentiate genera by the presence or absence of lateral tubercles on the first and seventh segments, as van der Goot has done in creating a new genus *Siphonaphis* with *S. nymphae* as type. In this paper, therefore, the species has been retained in the old genus *Siphocoryne*.

It is also worth noting here that Schouteden had adopted the name *Hyadaphis* of Kirkaldy in place of *Siphocoryne*, Pass. on the grounds of priority (*Catal. des Aphides de Belgique*, 1906, p. 40). This name, in part, was taken by some American authorities, but its claim to priority has been discovered to be not very well founded; hence we again consider *Siphocoryne*, Pass. as the true and appropriate name.

The species met with in the Punjab have been dealt with separately in the following pages.

Stephensonia, gen. nov.

Type *S. lahorensis*, sp. nov. On Chrysanthemums.

Characters.—Body ovalish; green; clothed with capitate hairs.

Head with broad front and no trace of frontal tubercles.

Antennae smaller than body; spur of article VI smaller than III but larger than the base; sensoriae present on all antennal articles of alate females.

Wings rather long and slender; veins clouded with dusky pigment; membrane also somewhat smoky; venation normal Aphidine.

Abdomen with rows of knobbed hairs, and hardly any lateral tubercles.

Cornicles long, about one-fifth the body length, clavate only on the inner side.

Cauda conical, about two-thirds as long as cornicle.

Rostrum long, up to second coxae; very sharp pointed and readily withdrawn at the slightest alarm; third joint longer and much narrower than second.

Stephensonia lahorensis, sp. nov.

Host —Cultivated Chrysanthemums (*C. sinense*).
(*Vern.* Gul Daudi or Guldhudi).

Morphological Description.

Apterous viviparous female.—A small-sized species, hardly visible when only a few are sitting in the indented margin of a leaf; rounded or broad oval in form; widest just in front of the cornicles and gradually narrowing towards the head.

Colour shining green, without mealy powder, very much resembling the leaves of the host.

Eyes brilliant red, without distinct stemmata.

Head yellowish-green, as long as broad; front large and convex, with bases of antennae quite wide apart, without any trace of frontal tubercles; some capitate hairs project anteriorly.

The absence of ocular tubercles is rather rare in Aphidinae.[1]

Antennae short, about half the body length, proximal half of the colour of the head, the rest black; the joints are distinctly marked.

Spur of article VI slightly shorter than that of III; IV, V and base of VI subequal. The length of the basal part of VI is noticeable.

	III.	IV.	V.	VI.
Lengths ..	0·168	0·085	0·085	0·085+0·150 mm.

Thoracic segments of body colour, without lateral tubercle on prothorax and with a few capitate hairs.

Abdomen ovate, shining green; short hairs on body segments, placed in transverse rows and all knobbed distally, more prominent on the anal end as shown in the drawing.

[1] [Ocular tubercles, although small and little prominent, are distinctly present in the apterous form too! P. v. d. G.].

Pattern none, except yellowish patches surrounding the cornicular base and two faint stripes on the segments in front of the cauda.

Cornicles long and slender, of the colour of the body, but nearer the tip black; only slightly swollen in their distal one-third and on one side towards the middle line of the body; they reach to about the termination of the cauda. Scaly throughout.

Cauda broad conical, often reflected over the base; distal half beset with teeth, dusky; base broader, edged with black but greenish transparent and without teeth; one or two indentations laterally placed; it is about three-fourths of the cornicles.

Anal plate rounded posteriorly, dark brown; it lies on a swollen penultimate segment.

Genital plate much larger and concave anteriorly; it seems to be made up of two halves; less dark in colour.

Legs short and stout, enabling the insect to run rapidly, which it does on the slightest disturbance to the leaf on which it rests. Light green all over, including coxae; tarsi black.

Rostrum reaches half way between second and third coxae; very narrow and black in front; the ultimate segment is slightly longer than the one before it and about half as broad; bifid at the tip.

Measurements (average) :—

Body	..	..	.. 1·12 × 0·52 mm.
Antennae	..	..	.. 0·65 mm.
Cornicle	..	..	.. 0·23 ,,
Cauda	..	..	.. 0·15 ,,

Alate viviparous female.—They are never numerous, unless kept well protected under artificial conditions in the laboratory.

Small and active; with wings folded in the usual aphid way, over which the smoky veins are deeply marked.

Colour shining, light or deep green, oval in outline.

The pattern consists of three very faint carinal spots, hardly visible in some; two post-cornicular stripes; a row of black spots running along the lateral grooves, double on two or three segments just in front of the cornicles, as shown in the figure.

Head black, triangular, convex in front, bearing prominent red eyes.

Antennae almost wholly black, the segments distinctly marked off from each other. Spur of article VI smaller than III; base of VI subequal with V and a little smaller than IV :—

	III.	IV.	V.	VI.
Lengths ..	0·24	0·125	0·11	0·110+0·192 mm. (=·303 mm.)

The whole length is about 0·94 mm.

Sensoria scattered over the whole surface of the articles as follows :—

III. 13-15;
IV. 7-8;
V. 2-3.

The prothorax bears a transverse band on its anterior half, concolorous with the head.

Mesothorax yellowish green with shining black muscle elevations as usual over the dorsum, occupying about the half of its middle surface. Lateral black spots present.

Metathorax with a black stripe and another triangular elevation in front, narrower than the mesothorax.

Wings longer than usual, somewhat narrowed towards the tip; about three times as long as broad. Stigmal flattening dusky, the rest, including insertions, yellowish. All the veins are clouded with a blackish pigment; membrane also somewhat smoky. There is a prominent bend at the first forking of the cubitus.

Abnormalities are numerous; sometimes the first and second furcal are very close to each other, in others the stigmal is forked. One very strange freak is shown in the camera drawing of two pairs of wings; all the veins are branching even in the hind-wing.

Cornicles much like that of the apterous female, but more clearly incrassate towards their inner side and darker in colour. They narrow into a sort of neck just below the flanged tip; scaly.

Cauda, anal and genital plate very similar in both forms.

The capitate hairs are more marked on the posterior extremity on account of the small size of the segments.

Lateral tubercles not apparent.

Legs black at the coxae, distal femora and tarsi; tibiae brown. A dark band between hind coxae, narrow in the middle.

Rostrum brown-black, tipped and sharp-pointed; it can be readily withdrawn from the leaf; it reaches up to the second coxae.

Measurements :—

Body	..	..	1·16 × 0·50 mm.
Antennae	..	..	0·94 mm.
Cornicle	..	..	0·22 ,,
Cauda	..	..	0·14 ,,
Wing	..	..	2·0 × 0·70 mm.
Wing expanse	..	..	4·35 mm.

The pupae are also stout in build, with yellowish thorax and black wing-pads; head blackish with a median white line; abdomen green as usual.

Natural history.—This pretty species is one of the smallest to be found in Lahore and has a curious habit of sitting in notches on the margins of leaves. It also crowds among very young and tender leaves and only when abundant attacks the lower veins and flower stalks. In the latter situation it is frequently to be noticed feeding in company with two other aphid pests of Chrysanthemums, *i.e.*, *Aphis malvoides*, sp. nov., and *Macrosiphum sanborni* (Gill.), about late December in the Gol Bag or gardens outside Bhati Gate.

Its small size and entirely cryptic colour, which quite matches with that of the leaves of its host, necessitated a careful examination to make sure of its presence.

The apterous viviparous females begin to come out about the middle of September when the rains are quite over and the young plants are "repotted" and "dressed up" with supporting sticks and kept in the sun. Soon after this the alate generation is produced, which migrate, flying off in the afternoon, to disperse the species.

Throughout the following months of October, November and December alate and apterous females are born promiscuously. The flowering period of Chrysanthemums is over and a few fresh shoots sprout before January. The plants generally about this time are either pulled out and kept in a heap or allowed to stand in the pots for the sake of shoots, which are ultimately removed by cutting them off from the parent plant. The Aphids also leave the old leaves with diminished nutriment for these growing shoots. They continue reproducing up to March, and in shady moist places or if kept protected in the laboratory even up to April.

They entirely disappear later, many of them being devoured by predaceous insects. How they tide over the hot summer months from April to September has not been yet found out, but the matter is under investigation.

So far no other alternate host has been discovered, and it is probable that the whole life-cycle is passed on Chrysanthemums. It is quite possible that at some period during winter the true sexes are produced which deposit the usual kind of eggs, but no definite information exists so far.

Insect enemies.—Three species of small ladybird beetles of the genus *Scymnus* keep an efficient control over its undue multiplication, and equally serviceable in this connection are the small "Pseudo Syrphids," whose blind larvae are seldom absent where the Aphid is to be found.

The only internal parasite bred from this Aphid is the small Chalcid, *Aphelinus* sp., which turns it jet-black.

Systematic.—The insect is evidently new to Science and possesses such distinctive characters of its own that it is very difficult to connect it, even remotely, with any of the existing Aphidine genera. Maculation of the wing veins is seldom met with in this tribe and capitate hairs are only present in some species of *Myzus* and *Phorodon*, but entirely absent in what may be called "*Siphocoryne*-like genera." Slight clavation of the cornicles is known to occur occasionally in *Myzus*, but the total absence of well-defined frontal tubercles at once separates this Chrysanthemum Aphid from *Myzus*.

In the structure and relative length of the antennae, along with the form of the cornicles, this Aphid has a considerable resemblance to *Rhopalosiphun berberidis* (Kalt). For the latter Walker once proposed a new genus *Liosomaphis* (1868) and Wilson (1910) has recently attempted to revive it. But the *Berberis* Aphid is now rightly considered to be a good *Siphocoryne* because it lacks secondary sensoria on the antennae of the apterous female.

It was at first very tentatively suggested by me to group these two insects together, but after examination of specimens from Europe there is little doubt that they are widely separated from each other.

In view of the combination of many unusual characters possessed by this Lahore

Aphid I consider it necessary to establish a new genus for it. The systematic position it would occupy would be somewhat intermediate between *Myzus* and the old genus *Rhopalosiphum* on one side and *Siphocoryne*, Pass. on the other.[1]

It is a great pleasure to me to dedicate this interesting insect of Lahore to Professor J. Stephenson, D.Sc., I.M.S., as a token of the highest esteem in which he is held by his pupils and colleagues. A distinguished biologist himself, it is he to whom we owe practically all we have of Biology in the Punjab, and but for his active encouragement throughout and allowing me every possible facility in its study, this little work on Aphids could hardly have been undertaken, far less carried out to any completion.

The specific name, it is expected, would help to permanently associate his name with the city where he has carried out his many researches.

Brevicoryne, gen. nov.

Body elongated oval, stout, flattish; strongly mealy; two posterior segments arching over cauda.

Antennae much smaller than body, particularly of the apterous viviparous female; the spur is smaller than III.

Lateral tubercles usually wanting except in *Brev. brassicae*, Linn., where they are small, but distinct.

Cornicles very small in size; clavate on the distal half, narrowed into a neck below the vasiform tip; in apterous females they are more or less cylindrical, much thinner near the apex.

Cauda prominent, larger than the cornicles and long conical in form.

Other characters much as in *Siphocoryne*.

Three species are included under this genus:—

(1) *Brevicoryne coriandri*, sp. nov.
(2) *Br. chenopodii* (Schrank).
(3) *Br.* (=*Aphis*) *brassicae* (Linn.).

They together constitute a fairly homogeneous group or subgroup; otherwise all three would form very aberrant species of *Siphocoryne*.

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[1] [I am in doubt, whether the morphological characters of *Stephensonia lahorensis*, Das, really necessitate the erecting of a new genus, separate from *Siphocoryne* (Pass.), v. d. G.

The clavateness of the cornicles in *Stephensonia* is small, indeed much smaller than in true *Siphocoryne* species such as *S. berberidis*, *S. xylostei* and *S. ligustri*. But we find the same kind of slightly swollen cornicles in *Aphis padi*, L. (=*A. avenae*, Fabr.), and this species has now by nearly all authors been put under *Siphocoryne*!

The very short capitate hairs of *St. lahorensis* are a little more aberrant, since all true *Siphocoryne* species are nearly naked; however, this character alone is not sufficient to establish a new genus. Other separate characters, as mentioned by Mr. Das, such as the dark colour of the veins, are in my opinion of no generic value. It therefore seems advisable to me to sink the genus *Stephensonia* and place the species *Stephensonia lahorensis*, Das, back in the genus *Siphocoryne* (Pass.), v. d. G. P. v. d. G.].

Brevicoryne coriandri, sp. nov.

Host.—On Coriander (*Coriandrum sativa*); *Vern.* Dhania.

Distinguishing characters.—A rather stout Aphid, clustering on the umbels of Coriander flowers and young fruits; body mottled or irregularly spotted greenish. Rusty red patches around the bases of the short brown cornicles, which are swollen in the alate female; cauda longer than cornicles; numerous sensoria on the 3rd and 4th articles of antennae; pupae generally with a reddish-brown intercornicular band.

Morphological Description.

Apterous viviparous female.—Body very mealy, thickset, resembling that of *Siphocoryne* (=*Aphis*) *brassicae*; egg-round, appearing a little flattish on account of the short stout legs.

Colour dirty greenish, the portion behind the cornicles and on the edges yellowish or lighter greenish; on the dorsum are conspicuous a number of irregularly scattered dark green spots; mottling is also noticeable in fresh specimens after removal of the white powder. Some (3-4) of the spots are between the cornicles, others on either side of the mid-dorsum, two or three are on the thoracic segments also.

A large, more or less circular spot, rusty-red in colour, around the base of each cornicle is never absent; a faint stripe on the penultimate segment and another smaller and darker line on the last segment.

Head brownish, broad, with black eyes and without frontal tubercles.

Front rounded or convex.

Antennae light greenish, distal part consisting of the 5th and 6th joint black; small, about one half or less than the body length.

Proportions from 3rd joint onward:—

	III.	IV.	V.	VI.
	13	7	6	5+11
Actual lengths	·21	·11	·10	·85+·19 mm.

Prothoracic segment without lateral tubercles and generally with a single greenish spot.

Meso- and metathorax with a blackish spot on the lateral edge above the insertion of each leg.

Abdomen without lateral tubercles; the last two segments arch over the cauda; the skin is marked out into clear polygonal areas.

Cornicles dark brown, similar or slightly deeper in colour than the patch around their bases; short, more or less cylindrical, not distinctly clavate, but constricted below the distal rim, which is black. They are here smaller than the cauda.

Cauda conspicuously long, light greenish, conical, the apical part above the waist almost cylindrical; base broad, hyaline, edged with black.

Genital plate blacker and apparently larger than the anal plate, the latter rectangular, the former somewhat crescentic or semicircular, concave anteriorly.

Ventral surface lighter in colour, with two or three blackish blotches about the level of the lateral grooves.

Legs comparatively short and stout; tarsi black, the rest light yellowish-green or slightly brownish, darker in individuals about to moult. Between the second coxae a short but clear transverse groove.

Rostrum arising from a dark face, greenish-brown, with the last joint dusky, reaches up to the second coxae.

Measurements :—

Body	..	..	.. 1·70 × ·86 mm. (average).
Antennae	..	..	.. 0·81 mm.
Cornicle	..	..	.. 0·13—0·20 mm.
Cauda	..	..	.. 0·24 mm.

Alate viviparous female.—Body smaller; colour similar to the apterous female; dirty light green, deep anteriorly and light behind, with about six irregular dark spots; also a rusty area in the mid-dorsum.

There is no pattern on the abdomen except the reddish-brown patches around the cornicular bases, and three darkish spots on the carinae in front of the cornicles.

Head broad, pitch black, with similar antennae and eyes.

Antennae large, black, except for a very small basal part of the third article which is lighter, narrower and devoid of sensoria. The rest of this joint and the fourth are strongly tubercled and studded all round with sensoria. The spur and the third joint about equal in length or the 3rd a little longer.

Sensoria very many on the third, upwards of thirty-five (35); the fourth has about a dozen (12); often one or two on the fifth and sixth in addition to the two primary sensoria which have a distinct hair-rim.

All the secondary sensoria on III and IV have a double contour.

Length proportions :—

	III.	IV.	V.	VI.
	20	10	8	5+17 (Ratio)
Actual lengths ..	0·33	0·16	0·13	·08+0·29 mm.

Prothorax green, with a black broad band near the anterior edge.

Meso- and metathorax of the usual form with black shining muscle bosses; a black stigmal spot on the lateral sides below the origin of the wings.

Wings large, with normal venation; stigmal flattening dark brown; veins light brown, well marked; insertions yellow. Cubitus faint near its base; its second fork arising about midway between its origin and the margin of the wing; tips of veins flattened slightly.

The absence of lateral tubercles on the sides is noticeable.

Cornicles dark coloured, rather small, of about the same size as the cauda; narrow below and gradually enlarging and becoming distinctly clavate or swollen, ending in a vasiform tip.

Cauda broad at base and proximal half; then narrowing and remaining of the same thickness up to the tip as shown in the illustration; crenulations extend right up to the base.

The anal and genital plates as well as the ventral surface is similar to that of the apterous female.

Rudimentary gonapophyses large, three in number.

Legs much darker, specially at the coxae, distal femora, tibiae and tarsi. There is a black band stretching between the third coxae.

Mesosternal bosses black, shining and four-lobed.

Rostrum reaches to the second coxae.

Measurements :—

Body	.. .. ..	1·50 × ·62 mm.
Antennae	.. .. ..	1·15 mm.
Wing expanse	.. 5·50—6·4 mm. ; wing	2·95 × 1·19 mm.
Cornicle	.. .. ..	0·15 mm.
Cauda	.. .. ..	0·17 ,,

Alate male.—Remarkably similar to the alate female in its structural characters, but it can be readily made out by its *yellow* colour and somewhat slender body. The genitalia of course is the chief distinguishing character.

Head, antennae, band on prothorax, mesothorax, legs, cornicles and genital armature all black.

The antennae in one of the larger specimens has the following proportions :—

	III.	IV.	V.	VI.
	22	11	10	6+22
Lengths ..	0·35	0·19	0·16	0·10+0·35 mm.

The spur and the 3rd joint are equal; relatively to the body the antennae are longer than those of the alate female.

The sensoria are exactly of the same form and number on the 3rd and 4th articles as the alate females; in this character they differ from the males of other plant-lice, in which the males always possess many more sensoria. The additional sensoria (probably for want of room, as these joints are already crowded) are placed about 6-10 on the 5th, and about 3 on the 6th.

Wings smaller and narrower than those of the alate female; the membrane has a little dusky hue; relatively to the body they are fairly ample, but not voluminous.

Cornicles of the same type, only much smaller.

The cauda, raised upwards by the reduced anal plate becoming vertical, is very small and appears about the same size as the conical penis in the centre of the usual kind of genital armature.

The males vary a good deal in size; some are very small, others fairly large and nearly equal to the alate females.

The measurements below are from a large specimen.

Body	.. .. ..	1·50 × 0·55 mm.
Antennae	.. .. ..	1·25 mm.
Wing expanse	.. 5·5 mm. ; wing	2·5 × 1·10 mm.
Cornicle	.. .. ..	0·10 mm.
Cauda	.. .. ..	0·11 ,,

The males appear on Coriander in January, and quit the plants along with other migrant females soon afterwards; they probably have some alternate host which so far is unknown. It is also possible that they go to other Coriander plants, although no oviparous females have been collected at any time during the year. During March and April Coriander plants are again badly attacked. It remains to be determined whether these hatch from eggs laid on the plants or migrate from another host. The summer history after April to October is also obscure.

Hosts.—The chief host is *Coriandrum sativa*; occasionally a few stray specimens were captured on *Foeniculum* (Fennel) and *Carum capticum*, but they do not infest these plants. Coriander is often so much weakened that in bad attacks whole beds are killed. At the same time also a fungus (*Urophlyctis coriandri*) is seen on these plants, which causes smaller or larger blister-like swellings and a good deal of hypertrophy of the stems, leaves and fruits.

The aphids may be the cause of rendering the plants less strong and so less resisting to the spores of the fungus, thus causing a double injury, one direct and the other indirect.

The larger Coccinellids and Syrphids act as natural checks, but they are particularly liable to the attacks of a species of the fungus *Empusa*. Such specimens become reddish before death, instead of yellowish-brown as is the case when killed by *Entomopthora*.

The Coriander Aphid of the Punjab is evidently a different insect from a similar one in the West (*Siphocoryne foeniculi*, Pass.) known to infest several umbelliferous plants. The Western insect was originally described by Passerini (*Gli Aphidi*, 1860) from Italy, and Buckton published an account of the European insect with a coloured plate in *Brit. Aphidae*. There is little doubt that the Punjab insect, though having as its host a member of the same group of plants, is not identical with it

Siphocoryne conii, Davidson, on hemlock, seems to resemble it in certain respects, but is differentiated at once by the lengths of the antennal articles and the relative size of the cauda and cornicles. The former, as given in the *Journ. Econ. Entom.*, II, p. 304, 1909, is much smaller than the latter in the ratio of 3 to 4.

There is no other *Siphocoryne* known to me that may be even remotely similar to it, and taking it to be an undescribed species I have named it after its host.

Moreover, from the typical genus *Siphocoryne* it departs in certain important structural features, especially in the form, size and relative lengths of the cornicle and cauda, as well as the general characters of the body, antennae and lateral tubercles.

In view of this it has been separated along with two other species into a small group comprising the new genus *Brevicoryne*. Diagnostic characters are given above and also in the table of genera under "Club-Cornicled Aphids."

Brevicoryne chenopodii (Schrank).

Host.—Species of *Chenopodium*, specially *Ch. alba*.

Distinguishing marks.—The insect is often conspicuous by the pod-like galls—rather pseudogalls—into which it changes the leaves of the herbaceous weed men-

tioned above. Either the leaf is conduplicated by uniting its edges, or a part of its surface near one side is folded over the rest of the leaf and kept in that position. A kind of pouch is formed, open on one or both ends. This grows bigger and even hypertrophies, and when exposed to the sun turns pinkish-red, like true galls. Being swollen outwards it is quite roomy inside and contains bead-like drops of honey-dew, whitened by the copious powdery meal. Frequently it is quite full of teeming Aphids.

The illustration shows the galls of almost natural size on the branches; the one split open to show the interior is one and a half times natural size.

Morphological Description.

Apterous viviparous female.—Body thickly covered over with white powder, stout, thick-built and short-legged; elongated oval, often a little flat and drawn out posteriorly into a conspicuous cauda.

Colour greenish over the whole body, including cauda, which is lighter; distal half of antennae, eyes, coxae, tarsi and the anal and genital plates black. Cornicles and legs and a patch below the bases of the former brown.

Head about as long as broad, convex anteriorly, the centre slightly elevated; antennal pits far apart, their inner edges a little projecting towards the front; colour greenish-brown.

Antennae short; first three joints concolorous with the head, the rest black.

Articles III and VI (including spur) subequal; IV and V also subequal.

Lengths (average) from third joint onwards:—

III.	IV.	V.	VI.
0·220	0·085	0·085	0·066+0·160 mm.

The thoracic segments are distinctly marked off from each other and their dorso-lateral sides are somewhat raised above the general surface; lateral depressions large. The prothorax bears very ill-developed lateral tubercles.

Abdomen not much arched, generally similar to that of *Siphocoryne* (=*Aphis*) *brassicae*, L. and *B. coriandri*, sp. nov.; no pattern, except a circular patch below the bases of the cornicles.

Lateral tubercles hardly visible, absent on the seventh abdominal segment and a very small one if at all on the segment in front of the cornicles.

Cornicles brownish, small, almost cylindrical or only slightly incrassate about the middle, narrowing towards the flanged tip; the size is from one half to two-thirds that of the cauda.

There is no intercornicular band.

Cauda prominently long, light green, hairy as usual; it is almost cylindrical with a rounded tip; a constriction or narrowing above the broader base, then the breadth is uniform; turned upwards; the base is dark edged.

Anal plate large, rectangular, with distinct black borders.

Genital plate lighter in colour and slightly concave anteriorly.

Legs brownish and comparatively small; tibia greenish-brown; coxae dark.

Rostrum reaches a little beyond second coxae, brown in colour; the last segment

is narrow and pointed, quite black, and longer than the preceding one in the ratio of four to six.

Measurements :—

	Average.
Body	1·50 × ·65 mm.
Antennae	0·75—0·90 mm.
Cornicle	0·11 mm.
Cauda	0·19 mm.

Alate viviparous female.—Prevailing colour of body green, with preponderance of black as usual; mealy.

Head black; front broad, antennal pits wide apart with their inner edges projecting anteriorly almost to the level of the median ocellus.

Eyes with large occular tubercles; black.

Antennae almost throughout black, just the basal part lighter; much longer proportionately than the apterous female. Articles III and VI, and IV and V are subequal; scaly from 3rd joint onward.

Length proportions :—

	III.	IV.	V.	VI.
	22	9	9	5+17
Lengths ..	0·36	0·15	0·15	0·08+0·29 mm.

Secondary sensoria circular, only ten or eleven present on the 3rd joint, almost equal in size and situated along one line on the ventral side.

The prothorax has a broad band concolorous with the head; no visible lateral tubercle.

Mesothorax as usual with shining black dorsal and ventral bosses formed of muscles below, divided into four pieces, occupying about the middle half of the dorsum and three-fourths of the mesosternum respectively.

The metathorax bears a transverse band, not reaching the edges, and in front of it another semilunar black elevation.

Abdomen ovate, wholly green; the black eyes of the embryos can be seen through the skin; three spots on carina, one short transverse band on the first and another on the last abdominal segment.

No lateral tubercles on the sides or small flat ones in front of the cornicles.

Cornicles brown, small, narrow at base, almost appearing to arise from pits; they gradually become swollen and end in a distinctly vasiform tip and are about one half the size of the cauda.

Cauda long, greenish, broad at base and with rounded tip, much like that of the apterous female.

Anal and genital plates also similar.

The rudimentary gonapophyses are three in number in both this form and the apterous female.

Legs much darker and longer.

Coxae black; in front of the hind coxae there are two black triangular spots, one on either side.

Rostrum up to about second coxae.

Wings long and rather slender, not very broad; veins black and distinctly marked. Stigma dark brownish; its basal parts and the insertions greenish-yellow. Cubitus reaches up to the sub-costa. Stigmal vein with a gradual curve throughout.

Measurements :—

Body	..	..	.. 1·50 × ·060 mm.
Antennae	..	..	.. 1·16 mm.
Wing expanse	..	5·10 mm.;	wing 2·20 × 0·76 mm.
Cornicle	..	..	.. 0·10 mm.
Cauda	..	..	.. 0·19 ,,

Natural History.—The insect seems to appear some time about the middle of December, the earliest date in my collection being 19th December. At this time one notices a few leaves, nearer the base than the top of the plants, either wholly or in part changed into galls. As explained above, there is always an opening to them, either at one or at both ends. Through this opening the Aphids can creep out. It is not usual to find alate females inside, but they are often found sitting more or less isolated on the under sides of the leaves. It was easy to find out the reason for this from plants kept under observation in the laboratory.

Up to the pupa stage, *i.e.* up to the time when the active nymph has to cast its final moult, it stays inside the gall, but as the space inside is very limited and the gall is often crammed with young aphids, the pupa almost instinctively understands that it would be unable to expand its wings when it casts its skin and the crumpled new wings are to be inflated with air. Creeping out of the gall it sits quietly on the sheltered side of the leaf where it can, for some time, obtain food as well, though it does not appear to take much before ecydysis. After moulting and fully expanding its wings the females stay on the plant for considerable periods before flying off to new ones.

Very young leaves are always attacked and if they have not had time to unfold or grow the whole leaf is conduplicated and inflated; otherwise only a part of the leaf forms the pseudogall and the rest remains normal. In bad attacks almost all the upper leaves of the branches and more particularly of those which terminate in the inflorescence turn into small pods as is shown in the illustrations.

If the food supply of the species is interfered with, by injuring the branch which bears the galls, all the insects come out and travel to other parts of the plant.

Owing perhaps to the fact that *Chenopodium* is more or less in leaf throughout the year, it has not been possible yet to secure the males and the true females that lay eggs. The most active reproduction takes place during March and April when it may be found in almost any shady place, along water-courses, in the fruit orchards and gardens on all sides of Lahore. But it seems to be fairly active also in the summer months; along the banks of the river Jumna at Delhi it was flourishing well in the latter part of July (23rd July 1913).

Myrmecine ants regularly attend this Aphid to remove the honey-dew, which

often collects in very large globules inside the galls; the mealy coat of the insect protects it from becoming soiled with-honey-dew.

Natural enemies.—The openings in the galls serve as passages for the exit and entrance of parasites and predaceous insects as well.

A species of *Lysiphlebus* is extremely active in reducing its numbers, and there is always a large percentage of "mummified" and inflated dead or dying plant-lice, fastened to the surface of the leaves by the parasitic grub inside. Any number of the *Lysiphlebus* can be secured by placing pot plants or twigs under a bell jar; they copulate freely in captivity and parasitise other aphids by entering through the holes in the galls.

Small Coccinellids of the genus *Scymnus* act as useful checks, and the flocculent larvae of the one-spotted *Scymnus* are always quite abundant.

Systematic.—It has been suggested to me by an American correspondent that probably this *Chenopodium* Aphid is the same as *Aphis chenopodii*, Schrank.[1] But both Schouteden (*Cat. Belgian Aphids*, 1906) and Buckton (*l.c.* III, p. 37, pl. xlv) consider the latter a synonym of *A. atriplicis*, Linn., and the description of *atriplicis* as given by Buckton (*Monog. Brit. Aphids*, 1887) certainly differs very much from that of the Punjab insect. Provisionally, therefore, I have retained it as Schrank's species. Furthermore, it does not belong to the genus *Aphis* but to my new genus *Brevicoryne*.

It is also possible that a new genus of Del Guercio, *Uraphis-Hayhurshtia* (Patch, *Host Index of World's Aphididae*, 1913) of which the type is *A. atriplicis*, might turn out to be the same as *Brevicoryne*. In that case Del Guercio's name should have priority. The Italian work is at present inaccessible to me in India.

Brevicoryne (Aphis) brassicae (Linn.)

(European Brassica plant-louse).

Literature :—

Buckton, *Brit. Aphids*, II, p. 33 (1875); accurate colour description and plate.
Essig, *Pom Coll. Jour. Entom.*, III, 3, p. 323 (1911); illustrated detailed account.
Herrick, *Jour. Econ. Entom.*, IV, pp. 219-224 (1911); life-history and methods of control.
Ind. Mus. Notes, II, 6, p. 167.
Lefroy, *Ind. Ins. Life*, p. 747 (1910).
The Agricultural Department of India have also issued a coloured plate for popular purposes.

There are numerous other references to this well-known and cosmopolitan species of plant-lice since Linné first gave it a name in *Syst. Nat.*

The insect in Lahore has been found rather sparingly on a few occasions either

[1] [It is nearly certain that the species described above by Mr. Das is identical with *Aphis chenopodii*, Schrk., of which species we have a fairly good description by Kaltenbach (*Die Pflanzenläuse*, 1843, p. 107). Kaltenbach mentions as a synonym *Aphis atriplicis*, L., and this name being older must have priority. The *Aphis atriplicis* of Fabricius is only one of the numerous synonyms of *Aphis rumicis*, L.

I have received specimen of *Brevicoryne* (*Aphis*) *atriplicis*, L. from Mr. J. J. Davis of Lafayette (Ill. U. S. A.), which entirely agree with the descriptions furnished by Mr. Das. P. v. d. G.].

on cabbages or on turnips. It is never so bad as reported from other countries, and hardly deserves the name of "Mustard Aphis" in India, where it is replaced almost entirely by a much worse Aphid, described below as *Siphocoryne indobrassicae*, sp. nov. The difference between the "European Brassica louse" and "Indian Brassica louse" is that the latter is never so mealy, and has a pattern of hyaline non-pruinose spots instead of deep black ones; the cornicles in the latter again are much larger; the sensoria on the antennae of the alate female are present on both joints III and IV and never so numerous as in the former. Moreover, the black bands on the abdomen of the Western insect are quite absent here. For other differences see the descriptions and figures.

The systematic position is of interest. Traditionally from Linnaeus downwards all the writers have given it a prominent place among the species of the genus *Aphis*. This genus, as at present defined and comprising species such as *A. gossypii*, *A. malvae*, *A. nerii*, etc., cannot, through any stretch of definition, be made to include a form like this species. The shape, structure of antennae, cornicles and cauda, taken in conjunction with the relative lengths of the two latter, are widely different from typical species of *Aphis* (Mordwilko and van der Goot).

Van der Goot, to my knowledge, was the first to remove the species from the genus *Aphis* and transfer it to *Siphocoryne*, Pass., with which indeed it has a much greater affinity than with *Aphis* (*Zur Systematik der Aphiden*, p. 93, 1913). But even he had pointed out, at the time, that the species was somewhat aberrant. In fact it deviates considerably from the types of that genus, in several essential characters. The cornicles, for instance, though clavate, are smaller than the cauda; the reverse is true for *Siphocoryne*. The case is similar with some other features mentioned above.

In view of this I have tentatively suggested, in consultation with Mr. van der Goot, to place this old Linnean species under a separate genus, *Brevicoryne*, along with two more similar plant-lice on *Chenopodium* and Coriander.

Siphocoryne indobrassicae, sp. nov.[1]

(The Indian Mustard Aphid).

Vern.—Sarson ka tela.

This aphid is more or less a serious pest of all the *Brassica* crops and particularly of mustard and rape, on which in certain seasons, as in 1913, it becomes uncommonly bad. Almost all the flowering shoots are thickly covered with plant-lice, and the

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[1] [This species, called by Mr. Das *Siphocoryne indobrassicae*, is apparently identical with *Aphis pseudobrassicae*, Davis, of which a very accurate description has been published by Mr. J. J. Davis (*Canad. Entomologist*, vol. 46, 1914, p. 231); the descriptions of the apterous and alate female, as furnished by Mr. Das, have therefore been omitted here.

The same species is known to occur in Java; in the U.S. of America it is recorded from the States of New York, Indiana and Texas. An American specimen, received through the courtesy of Mr. J. J. Davis, agrees with the descriptions of Mr. Das and myself. Of course the species distinctly belongs to the genus *Siphocoryne* (*Pass.*) v. d. G. P. v. d. G.].

sickly plants present the appearance of being oiled over, on account of the profuse honey-dew that is excreted and which falls on the lower parts.

Myzus persicae is frequently found along with it in varying proportions, but it can easily be made out even with the naked eye.

It is also quite distinct from the European *Aphis brassicae* (Linn.), but apparently has been confused with it, and it is in all probability this species that has been referred to as such in Lefroy's books "*Indian Insect Life*" and "*Indian Insect Pests*," as well as in the list of vernacular names for common pests. A plate has also been issued by the Imperial Entomological Department at Pusa, which is quite good from an artistic, but of little value from a scientific, point of view.

It is quite likely that the *Aphis brassicae*, Linn. as mentioned in *Indian Museum Notes* is also more often this Indian Aphid than the European insect. The latter is also met with in India, and in this paper an account of it is given under *Brevicoryne brassicae* (Linn.). It is not at all so abundant and common, and when present it chiefly attacks cabbages or turnips, at least this is the case in the plains and hills in the Punjab.

The distinguishing features of this Aphid are the following :—

(1) A very slight meal on the body (abundant in *A. brassicae*, Linn.).
(2) Two median rows of squarish spots and two more on the lateral sides. These spots appear bright and shining in contrast with the dull greenish-white of the body. At these spots meal is entirely absent, so that they become easily wet with water.
(3) Posterior abdominal segments banded.
(4) Black clavate cornicles which are longer than the cauda ; a very prominent genital plate and many sensoria on the 3rd and 4th antennal article of the alate female.
(5) The oviparous females have from twelve to eighteen eggs.

Apterous oviparous female.—This form appears in November and December on turnips (*Brassica rapa*) and mustard (*B. juicea*) and is quite similar to the apterous viviparous female in form and colour.

Antennae black, except the basal part of the 3rd joint.

Cornicles slightly smaller, not so clavate and narrowed at the tip.

Cauda broadly conical without the middle constriction.

Posterior legs characteristically swollen and smaller.

The hind tibiae in the oviparous female are about (5/6) five-sixths of those in the apterous viviparous female (45 : 56). Its proximal two-thirds is beset with numerous small, rather irregular sensoria, often in groups of two or three ; their rims are not so well defined as of those of the antennal ones in the alate female.

The body, if the eggs have not been laid, is distended. The number of eggs is quite unusual ; from twelve to eighteen may be dissected out from a single individual. This is even more than the number that are to be found in much larger Aphids of the Lachnine tribe.

Among Aphidinae the number of eggs normally does not exceed a few and very often it is only one. The European *Aphis brassicae*, Linn. (according to Harrick in the *Jour. Econ. Entomology*, vol. IV, p. 219, 1911) lays on an average about four eggs.

When freshly laid the colour of the eggs is yellowish, mottled on the surface with greenish dots. The micropylar side is narrower than the other and constricted into a greenish cap. As usual the eggs in a few days turn jet black and remain so till ready for hatching some time in the spring.

The males are likely to be alate, but none have been secured. They may be emerging a little earlier in the season, about the beginning of November.

Life-history.—This is by far the commonest Aphid in the plains during the winter and spring months. It makes its appearance soon after the mustard plants have put forth their stems and are a few inches high, about October. Active reproduction goes on in November and December on various cruciferous plants like the cabbage, cauliflower, radish, turnip, etc., which are all winter crops in India.

Severe loss is inflicted on these at this time. Young mustard shoots form a favourite vegetable (*Sarson ká ság*) in the villages; the attack in 1913 was so bad that very little of it was available in places where it used to be plentiful in former years, and there was a widespread complaint against this destructive pest.

On warm evenings the winged females in large numbers form a conspicuous part of the aerial insect fauna of the season. They are not unlike swarms of may-flies and frequently fall into the eyes of those walking briskly or riding a bicycle. At these times large numbers may be collected by hand without the aid of a net.

The sexes are produced in December; only oviparous females were secured, laying eggs freely on turnip and mustard plants. Probably the alate (?) males are produced earlier.

The eggs on cabbages seem to have little chance of hatching as there is a succession of two or three crops in the season. There are abundant colonies of parthenogenetic females, which reproduce actively after the eggs have been laid. They continue to do so during January and February, when again there are large swarms in early March which is the flowering time of mustard. The fields look like vast sheets of beautiful yellow with a delicate tinge of green and the occasion is celebrated as a fair (*Basant*), on which the people wear yellow turbans. Numerous Aphids are particularly attracted towards this coloured head-dress, though some of them settle on white clothes as well.

Sexual individuals have not been found to be produced, neither is it known with certainty whether the winter eggs hatch at this time or not. If they do, the stem-mothers must be mixing their generations with those of the viviparous females from winter. When the mustard crop is changed for radish and cabbage they breed on the latter up to early June, but in diminishing numbers and even become scarce in May.

The summer history is not definitely known; probably they are present on stray plants in cold moist places. They are abundant in the hills and from there migrate to mustard plants again in September or October. It is also likely that later it may be found that they pass the summer and rainy seasons in the egg stage.

It appears that the species originated in some colder regions in the hills. The life-history would be quite adapted to the conditions there. In autumn (about November) in such places the eggs are deposited and in this state the species tides over the severity of the cold winter. In spring these hatch and the insects reproduce throughout the summer and rainy season till the sexes arise again.

In the plains, probably on account of heredity, egg-forming females are seen about the same time, though the species has to suffer no inconvenience from the winter. Whether, as a provision against the summer, eggs are laid a second time is still to be discovered.

The species falls a prey to numerous predaceous and parasitic insects that keep it in check in normal years.

As the bodies of most of these Aphids touch each other when feeding, it makes them particularly liable to the attack of the Fungus "*Entomophthora aphidae*," which destroys them in large numbers. Fungus-killed Aphids turn yellow and soon shrivel to a brownish scale.

Siphocoryne nymphaeae (Linn.).

Synonym.—Rhophalosiphum nymphaeae, Koch.

Hosts (in Lahore):—

(1) *Lemna* sp. (in Chhota Ravi).

(2) *Melumbium speciosum* (Shalimar and Botanical gardens).

(3) *Scirpus lacustris* (Shahdara).

Numerous other aquatic plants have been reported as hosts of this very widely distributed species.

Literature.—Since Linnaeus' time (1767) numerous writers on Aphids have figured, described or listed this semiaquatic insect. The monographs of Koch (pp. 26, 44) and of Buckton (VI, p. 12) give accurate illustrated accounts. Essig (*Pom. Coll. Jour. Entom.*, IV, 3, pp. 793-797, 1912) has lately furnished a morphological description with a fair summary of the previous literature. Patch (*Maine Agric. Exp. Station Bull.* 202, 1912) figures the antennae. Davis (*Entom. News*, p. 245, 1910) and Cockerell (*Science*, p. 764, 1905) give useful accounts. The insect has been listed in Lefroy's *Indian Insect Life*, p. 747.

Distinguishing characters.—A rather large insect of a dark olive-green or reddish-brown colour (on *Scirpus*), often shining; sitting singly or in pairs on floating *Lemna* fronds, or in large numbers on water-lily leaves, or in rows along the ventral surface of marshy *Scirpus*. A distinctive feature under the microscope is the clearly-marked polygonal areas on the skin, formed by the pores of wax-secreting glands; also the long, distally clavate cornicles; the spur is longer than III; about 17 sensoria on the alate antennae.

The size, antennal lengths, sensoria and measurements of the cornicles and cauda of the Indian species agrees very well with the description of the insect by E. O. Essig from California.

Miss Patch has published a figure of the antennae and cornicle, with notes on the size and antennal lengths, from Maine (Orono), which is different. The specimens

that we found of this species on the peaches as "return migrants" are almost exactly similar however. It is possible, therefore, that at the time Miss Patch collected her specimens, those generations were being developed which later fly off to other hosts in company with the males.

The antennal proportions of such a return migrant collected in December are as follows :—

	III.	IV.	V.	VI.
	25	18	16	9+33
Lengths ..	0·40	0·30	0·26	0·15+0·55 mm.

The size is also larger as seen from the body measurements given below :—

Body	2·1 × 1·05 mm.
Antennae	1·80 mm.
Wing expanse	7·50 ,,
Cornicle	0·26 ,,
Cauda	0·14 ,,

The number of sensoria, instead of being 13 or 14, is from 17 to 24 on article III and 3 to 4 on IV.

The males that were collected on the peach at the same time are much smaller. As I am not aware if any description of these males has ever been published I give a detailed one below. The oviparous females were not to be found in December; probably they form in January, but observations were not carried on into that month.

The *alate male* is much smaller and narrower proportionally to the alate viviparous female, along with which it migrates to the peach plant in December.

Head pitch black, shining; about twice as broad as long and broader than the prothorax, which has a conspicuous black band on its anterior margin and two spots latero-dorsally behind.

Antennae about as long as body, black; 3rd article very stout, about half or three-fourths of the 6th, with numerous sensoria.

Length proportions :—

	III.	IV.	V.	VI.
	21	14	12	6+28
Lengths ..	0·35	0·23	0·20	·10+0·46 mm.

The sensoria are scattered all round; their numbers are 25 on III, 19 on IV and 8 on V.

Thorax and wings similar to alate viviparous female, only smaller in size.

Abdomen, colour light yellow at margins outside the lateral grooves, in the middle dark green; strongly segmented so that the shining abdominal rings appear green-banded. Post-cornicular segments concolorous with the edges.

The pattern consists only of 3 very faint lateral spots and faint rusty areas behind the cornicles.

The end of the abdomen appears truncated on account of the swollen penultimate segment bearing the genital armature.

Cornicles clavate only on their distal halves which are dark brown; the narrow proximal part is of the body colour; the vasiform tip is black and reaches to the base of the cauda.

Cauda edged with black, raised upwards; anal plate black and narrow.

The genital armature is of the usual form, consisting of two black "claspers" bounded by hoop-like ridges behind and laterally; a light yellow penis projects conically from between their posterior ends medially.

On the ventral surface there is a row of depressions along the lateral grooves.

Legs, rostrum, etc. like the alate female.

Measurements :—

Body	..	..	1·50 × 0·50 mm.
Antennae	..	..	1·49 mm.
Cornicle	..	..	0·25 ,,
Wing expanse	..	..	6·0 ,,

The specimens were collected from the ventral surface of peach leaves (*Prunus persica*) on young plants near Chhota Ravi on 28th December, 1913, along with migrant alate females depositing young ones.

Life-history.—This species therefore appears to have the same life-history as most other plant-lice, parthenogenetic reproduction continuing during the year; in December alate migrants and males return to the peach and in all likelihood lay eggs there which ought to hatch in the spring. After one or two generations on peaches the alate females must again probably return to aquatic plants.

Enemies.—Besides the usual predaceous insects and spiders we have reared the parasite *Triox* from this species. The dead Aphid is raised upon a tent-like cocoon formed by the larva inside; the imago emerges from one side of the cocoon and not through a hole cut into the body of its victim, as do other Braconid and Chalcid parasites.

Systematic.—The water-lily Aphid possesses small frontal tubercles, well seen in the apterous viviparous female, but not so distinct in the alate female. The presence or absence of these tubercles was taken as the chief character for separating the club-cornicled genera *Rhopalosiphum* and *Siphocoryne*. As this very character here is a contestable point, some writers place it under one genus and others under the other. In most of the earlier works the species is described under *Rhopalosiphum*. But if we accept van der Goot's emended definition of *Siphocoryne*, in which he includes only those species that lack sensoria on the antennal articles of the apterous viviparous female, then this Aphid very rightly belongs to *Siphocoryne*. On other grounds also the trend of opinion is to regard it as belonging to this genus. However, some authorities, like Prof. Theobald, still hold to the old view of grouping it under *Rhopalosiphum*. Van der Goot has further thought it desirable to bring it under a new genus altogether, on account of the presence of lateral tubercles on the abdominal segments, which are absent in the type-species *S. xylostei*, *S. foeniculi*, etc. He proposes to call this new genus *Siphonaphis*. It is still a point to be settled whether we

can attach generic importance to these tubercles. I have therefore, not finding myself in entire agreement with him in this, retained it under *Siphocoryne*.

Siphocoryne avenae (Fabr.).

(European Grain louse).

Synonyms.—*Aphis avenae* (Fabr.); *A. padi* (Kalt.).

Literature and synonymy.—This species is up to the present known in Europe as *Aphis avenae*, the original name given by Fabricius in *Entomologia Systematica*, vol. IV, p. 214, 1794.[1] American authors almost unanimously describe it under *Siphocoryne* since Pergande's excellent memoir on "Aphids affecting grains and grasses of the United States" (*U. S. Department of Agric. Bull.* No. 44). He gives a complete account of its life-history and a description of the various forms with a bibliography and a synonymic list. References to it are to be met with in many Reports and Bulletins issued by Experiment Stations mostly under the name of "Grain and Apple Aphis," by Thomas, Gillette and Taylor, Patch, Wilson and others. An accurate and detailed description, though differing in certain respects from the insect as found in India, has been given by Essig (*Pomona Coll. Journ. Ent.*, IV, p. 791, 1912), apparently under the wrong name *Aphis maidis*, which is altogether a different species and is dealt with elsewhere in this work.

In India, in the plains, one is apt to find mostly the winged forms only and I have so far never discovered the apterous individuals unless I have specially hunted for them or reared them under glass vessels in the laboratory.

From late October onwards throughout winter one finds isolated winged Aphids on the blades of young plants of wheat, barley or avena. There are seldom more than two or three individuals on one plant. They are either *Aphis maidis* or *Siphocoryne* (*Aphis*) *avenae*. The latter can be at once recognised from the former by its large ample wings, deeply marked veins, very black antenna in which the spur of the sixth joint is more than four times the length of the base, and brown cornicles with a concolorous band between them. The apterous forms remain underground and are seldom met with unless one digs them up.

The apterous female is to be found with her brood of a few young on the white stalk of the cotyledon, between the permanent position of the wheat or avena-seedling and the seed, as shown in the rough diagram. The colour is often dull greenish or darkish but never black as noted by Western writers, and one invariably notices a russet intercornicular band. The largest specimens are very often wholly russet brown, thick built, with arched backs and quite plump.

When noticed for the first time by digging up a few rather weak-looking seedlings in the wheat and avena fields in November, they were attended by the brown and black ant (*Meranophus bicolor*). The antennae were invariably five-jointed,

[1] [Since the name *Aphis padi*, L. has older rights than that of *Aphis avenae*, Fabr., the correct name of the species mentioned here must be *Siphocoryne padi*, L., or better still *Siphonaphis padi*, L., as I have pointed out elsewhere (v. d. Goot, *Beitr. z. Kenntn. der holl. Blattläuse*, p. 241). P. v. d. G.].

and the description very similar to that given by Pergande for the "stem-mothers," which hatch out from the eggs in early spring in the United States, but not having read an account of them then it was difficult to guess that the root-feeding apterous form, so different in size and colour from the winged insects on the plants, could be the same. Seedling experiments in the laboratory were started to establish their identity.

Alate females were brought in from the fields and fed on young seedlings which were constantly changed, the young being carefully removed with a camel hair brush. The greenish young, with their reddish intercornicular band, changed in colour as they grew in size after each moult. The russet colour gradually spread ultimately over the whole body.

A second series of experiments were at the same time continued with apterous females and a few pupae from the underground parts of the seedlings. The winged females produced from these were similar to those found on the plants, and the apterous females that developed in the tubes were in no way different to those usually met with underground.

Conclusion.—The conclusion that I arrived at is that this form has developed a habit of feeding on the parts of the seedlings below the surface. The winged forms creep out and spread the species to different plants and fields. In March and April they may again be secured on the rhizomes of the common *Cynodon dactylon*, in moist places.

Loss.—The species has been, in my opinion, the cause of very considerable loss to wheat fields, although its existence has been so far altogether unnoticed.

Natural check.—The only check that nature has provided is a small blackish *Scymnus* (*sordidus* ?) that feeds on it in the larval and imago stages. Below ground it is singularly free from the attacks of internal parasites as well as from Syrphid larvae.

Genus **Toxoptera** (Koch).

Toxoptera is an easily recognisable genus, on account of its possessing structural features which combine a peculiar wing venation with the rest of the characters belonging to the subfamily Aphidineae. The cubitus in the fore-wing is only once forked, while in other genera it is forked twice. This is the normal condition in *Toxoptera*, while in others only abnormal individuals of this type are met with occasionally.

In other respects it very much resembles either a *Myzus* or an *Aphis*.

The species definitely recorded from India so far appears to be only one; the cosmopolitan *Tox. aurantii* (Fonsc.), which is known from Europe, America and Asia. It has been reported from Bengal, Southern India and the tea-growing hill stations. But the orange plant, its chief host in the neighbourhood of Lahore at least, seems to be quite immune as I have never collected it here on the orange.

Tox. aurantii is the same as the insect named for the Indian Museum by Buckton as *Ceylonia theaeicola*, upon tea bushes (vide *Ind. Mus. Notes*, vol. II, no. i, p. 40, and *Ind. Ins. Life*, p. 748). It has been referred to again in *Indian Museum Notes*,

vol. III, no. i, p. 40, from tea gardens in India. I am not giving a detailed account of this insect as it is not indigenous to Lahore.

Leaving out *Tox. aurantii* therefore, so far unnoticed in the vicinity of Lahore, one collects usually three different species, recognisable with comparative ease from their colour and the host-plants.

(1) *Toxoptera graminum* (Rond.)

Light green in colour with similar black-tipped cornicles; it infests graminous crops such as wheat, avena, etc.

(2) *Toxoptera cyperi* (v. d. Goot).

Dark green in colour, more or less variegated, with black cornicles; it attacks mainly *Cyperus rotundus*, "Motha" or "Dila" grass.

(3) *Toxoptera punjabipyri*, sp. nov.

Body colour black, but appears slate-grey on account of whitish meal; its host is pear and plum the young leaves of which it conduplicates.

Separate accounts of these are given below.

Toxoptera graminum (Rond.).

This insect was first described from Italy by Rondani, who noticed it in huge swarms during 1852. It has come into great prominence by becoming a serious wheat-pest in U. S. of America, where it is known as the "Green bug" or the "Spring grain aphis."

Passerini has given the description of the Italian insect in *Aphidide Italicae*, p. 28, 1863. Numerous notices are contained in the Bulletins and Circulars of the U. S. Department of Agriculture and the Reports issued by various experiment stations, written mostly by Pergande, Washburn, Webster, Sanborn, Hunter and others.

The most complete and very profusely illustrated work, with elaborate experiments on its parasitisation and consumption by natural enemies, as well as the influence of environmental condition on the "Green bug" and its parasites, is to be found in the *Bulletin of the Kansas University*, vol. IX, pt. 2, 1909, by S. J. Hunter and P. A. Glenn; a very valuable publication indeed. Bulletin 38 (1902) and Circulars 85 and 93 (1907 and 1909) of the U. S. Department of Agriculture, Bureau of Entomology, are also useful. As the Indian insect is identical, no further description of it is given here.

In the Punjab this *Toxoptera* has been most commonly collected from wheat, avena, barley and on *Cyperus rotundus* and *Cyperus niveus*.[1] A number of individuals may be found feeding on *Cynodon dactylon*, the common Dhoob grass in April or early May.

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[1] [It is a little doubtful whether the statement of Mr. Das as to *Cyperus* being a food-plant of *Toxoptera graminum* is quite correct, since this Aphid has so far been known only to attack Gramineae. Perhaps Mr. Das may have mistaken for *T. graminum* a light-greenish *Toxoptera*-species on Cyperaceae, not uncommon in Java too and described by me as *Toxoptera minuta*, sp. nov. (v. d. Goot. *Zur Kenntniss der Blattläuse Java's*, p. 86). P. v. d. G.].

Life-history.—In its essential details the life-history of this so-called "Green bug" does not materially differ from those of other Aphids. It has been more or less thoroughly worked out in America, and its course in India appears to be very nearly the same. The details, however, have not as yet been worked out in India, and I am not aware if the Agricultural Department of India have taken any notice of this pest. So far there is no mention of its occurrence in any of their Bulletins or Memoirs issued from the Research Institute at Pusa.

Natural enemies.—In normal years it is kept in check by the various predaceous insects and their larvae, and is also extensively parasitised by *Lysephlebus* sp. The Fungus *Entomophthora aphidi* was observed killing numbers of them in wheat fields along the Ravi in March.

Possible source of danger.—As it has been shown by its past history in Europe and America that its outbreak in any year might become extremely serious, it would be worth while to look upon it as a possible dangerous insect. In the words of Prof. Sanborn of America, "Whenever the natural conditions permit this aphis to flourish, it can devastate all the wheat and oats that may be planted on its latitude of infestation. The financial losses are almost inconceivable" (*Bull. U. S. Dept. Agric.*, no. 60, 1906).

Toxoptera cyperi (van der Goot).

Host.—*Cyperus rotundus.*

Vern. "Motha" or "Dila."

Distinguishing features.—Twice a year, in September and November, and March and April, this Aphid is often seen abundantly, on the lower surface of the common *Cyperus* ("Motha" or "Dila" grass) sitting in rows one behind the other.

In colour it is dark green, almost black with variegated or mottled abdomen ; jet black, long antennae and cornicles, with a brownish intercornicular band ; the deeply marked veins of the wing and the cubitus which is forked only once are characteristic.

Almost all the species of the genus *Toxoptera* are of a destructive nature. *Cyperus* would often be found quite weakened and ultimately killed by the incessant drain caused by individuals of this species.

Hunter, in his "Studies of Parasitism," has demonstrated that *Toxoptera graminum* (Rond.), though much smaller in size than the common grain louse *Macrosiphum granarum*, inflicts much severer injury on wheat than the larger Aphid. Nineteen *Tox. graminum* adults would kill a healthy plant of wheat in about eleven days, while twenty *Mac. granarum* adults, after the same number of days, would do a similar plant comparatively little harm (Hunter, *Kansas Univ. Bull.*, vol. IX, no. 2, 1909).

Injury to plant.—We have found here the case with *Tox. cyperi* to be more or less similar. Two adult apterous viviparous females were placed on a healthy vigorous *Cyperus*. The plants and Aphids were protected under a lamp chimney in the usual way, in November. It was observed that after twenty days the plants turned yellow and died. Of the insects most of the young changed into pupae and later developed into alate females.

This perhaps is the only way of securing specimens of the winged insect, as ordinarily in the field very few of them are to be noticed on the plants, where one usually sees only apterous females and young.

Time of appearance.—The Aphid is in evidence about March, and continues to be so during April and even May. After this it either hides itself or migrates to cooler places. It has not been possible up to now to follow up its summer history and to determine the summer hosts. We meet it again in September in Lahore. Near the base of the Siwaliks and the Himalayas in Saharanpur and Dehra Dun districts I have collected it in July and August. From September onwards it continues breeding till its disappearance in November. Sexual forms have not been collected, but in all likelihood they are produced at this period, the species wintering in the eggs which hatch in March. No plant of any economic importance is its host at present.

Distribution.—It seems to have a wide distribution in India. I have collected it from various localities throughout the Punjab, United Provinces, Bihar, Bengal and most of Central India. Probably it is present in other provinces as well, and possibly extends towards Java and the countries around.

Name.—The insect appears to be undescribed, at least no description is available yet. We have been calling it after its host provisionally. Recently mention has been made in a footnote by van der Goot ("*Zur Systematik der Aphiden*," 1913) of a Javanese species that he calls *Tox. cyperi*, n. sp. It is very probable that the Indian insect is identical with the one found in Java. Specimens have been asked for in exchange.

The insect has, since writing the above, been found to be quite similar to the Java one.

Toxoptera punjabipyri, sp. nov.

Hosts.—*Pyrus communis* (Pear).

Pyrus sp. (Wild variety of Pear).

Distinguishing characters.—A medium-sized blackish Aphid, with a darker streak on the abdomen; young slate-coloured; cornicles and cauda black; usually apterous females only, having the spur smaller than article III. Cubitus in alate female forked once; sensoria on both articles III and IV; the colonies remain inside the pseudogalls formed by conduplicating young *Pyrus* leaves.

Description.

Apterous viviparous female.—Body ovalish, tapering towards both ends from the cornicular region; pruinose, owing to the white meal; the latero-dorsal parts of the abdomen dark greyish; a dark line runs lengthwise in the middle; last antennal joints, head, cornicles, cauda, anal plate, coxae, distal femora, tarsi, all black; basal antennae, proximal femora and tibiae whitish, or yellowish; eyes dark red.

Head much broader than long; frontal tubercles distinct, small, on the same level as the convexity of the front.

Antennae a little smaller than body; the size varies; article III is longer than the spur.

Proportions of articles :—

	III.	IV.	V.	VI.
	27	17	12½	6+22
Lengths ..	0·45	0·28	0·20	0·10+0·36 mm.

Thoracic segments in stout individuals ill-defined, lateral tubercles present on prothorax.

Abdomen uniform; rows of spots in lateral grooves; posterior two segments banded across; last one with a darker stripe; lateral tubercles on all the segments.[1]

Cornicles long, cylindrical, imbricate, slightly broader at base; they reach to the base of the cauda and are directed backwards and inwards.

Cauda ensiform, apical part dark, oval with a few hairs; basal part broad, hyaline, black on edges, less than half the length of the cornicles.

Anal plate rectangular, when seen from below situated a little lower than the genital plate and overlapped by it. The latter appears as if made up of two rounded halves.

Rudimentary gonapophyses three.

Rostrum reaches almost to the second coxae.

Measurements on an average :—

Body	..	..	1·90 × 0·95 mm.
Antennae	..	..	1·50 mm.
Cornicle	..	..	0·33 ,,
Cauda	..	..	0·15 ,,

Alate viviparous female.—Colour dark grey or black; very little meal on body. Head black, without frontal tubercles. Eyes dark red. Antennae long.

Proportions :—

	III.	IV.	V.	VI.
	22	13	12	6+30
Lengths ..	0·36	0·21	0·20	0·10+0·50 mm.

Prothorax with a black band anteriorly, in the middle of which on either side is a lateral tubercle; near the posterior angles again another pair which is larger but not so black.

Mesothorax usual shining black.

Wings broad; veins and stigma brown; posterior border of latter darker; cubitus only forked once; anterior limb of the fork longer.

Abdomen pyriform; the pattern consists only of large carinal spots on the second, third and fourth segments; those on the first and fifth are smaller. Immediately behind the cornicles a large rectangular blotch; the seventh and eighth segments are black-banded; transverse, almost linear spots in latero-dorsal grooves.

Lateral tubercles alternate with the carinal spots.

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[1] [Very likely this statement is incorrect. As far as I know all *Toxoptera* species only show lateral tubercles on the first and on the seventh abdominal segments. P. v. d. G.].

Cornicles cylindrical, imbricated for the most part.

Cauda small, constricted a little about the middle, ensiform.

Anal and genital plates distinct, the latter elliptic.

Legs normal, black, excepting bases of femora and tibiae.

Rostrum short, extending half way between first and second coxae.

Size of individuals variable; autumn migrants are larger than the alate females of the summer.

Measurements on an average :—

Body	.. ..	1·60 to 1·75 × 0·65 to 0·75 mm.
Antennae	.. ..	1·50 mm.
Wing expanse	..	5·85—6·20 mm.
Cornicle	.. ..	0·26 mm.
Cauda	.. ..	0·10 ,,

Alate male.—The alate male is essentially quite similar to the alate female described above; the colour alone is darker; the size smaller or larger; the pattern exactly the same.

Antennae longer with a very large number of sensoria.

Antennal proportions :—

	III.	IV.	V.	VI.
	22	17	16	6+32
Lengths ..	0·36	0·28	0·26	0·10+0·53 mm.

Sensoria scattered all round the articles, 32–40 on III, about 20 on IV and about 15 on V.

Cauda raised upwards owing to the presence of the large genital armature; it is slightly smaller than that of the alate female.

Anal plate narrow; genitalia of usual form.

Measurements :—

Body	.. .. ..	1·55 × 0·70 mm.
Antennae	.. .. ..	1·65 mm.
Wing expanse	.. .. ..	5·75 ,,
Cornicle	.. .. ..	0·25 ,,
Cauda	.. .. ..	0·09 ,,

Oviparous female.—Specimens reared on plums are dirty reddish-brown in colour; body oval, with short legs; they move with an awkward gait. The antennae, cornicles and cauda are all smaller than those of the apterous viviparous female.

The frontal tubercles on the head are hardly present.

Antennal joints indistinct; spur much longer than article III.

Proportions :—

	III.	IV.	V.	VI.
	13	9	$8\frac{1}{2}$	5+20
Lengths ..	0·21	0·15	0·14	0·08+0·34 mm.

Cornicles very small, cylindrical, black.

Cauda round, on which the usual constriction is faintly marked; more than half the length of the cornicles.

Genital plate much in advance of the anal.

Legs short; tarsi, "ankles" and "knees" black, the rest brownish.

Hind tibiae stunted and swollen in the middle, both ends narrow; there is a comparatively small number of indistinct sensoria scattered over the central dark portion; the ratio of its length to the hind tibiae of an apterous viviparous female is about 7 to 11, as shown in the diagram. The sensoria mostly have a single contour, they number about fifty.

Rostrum reaches beyond second coxae.

Measurements :—

Body	.. .. ..	1·20 × 0·70 mm.
Antennae	.. .. ..	1·05 mm.
Cornicle	.. .. ..	0·14 ,,
Cauda	.. .. ..	0·09 ,,

Eggs shining black, lighter when first laid; about ·5 mm. or less in length. They can just be made out as dark specks with the naked eye.

Life-history.—The leafy 'spurs' of the pear begin to unfold after the second week of February; the flowers are out a little earlier. The foliage period runs into March. The eggs of this Aphid hatch about this time and begin to attack the young developing leaves. As the leaves are expanding, the presence of one or more of the "stem-mothers" so modifies the process that the two edges of the leaf remain adhering to each other, and do not separate even when it is quite mature. Thus an inflated kind of pod results inside of which the Aphids multiply quickly. Such pseudogalls are generally open near the ends, and one often sees sometimes every leaf on a young branch affected in this manner.

Many generations of purely apterous females are produced, and it is very difficult in the following months of March and April to secure the alate females. Even for dispersing the colonies it is the apterous ones that move out for considerable distances.

In May the last generation become winged, if they are not already destroyed by numerous predaceous and parasitic insects. Every individual on getting wings flies off and does not breed any more on the pear. It has not been possible so far to trace to what host the winged females migrate; by the middle of May the leaves of the pear not yielding any nutrient sap the insects desert them altogether. Empty pseudogalls contain only their exuviae and serve as hiding places for spiders and Coccinellids.

The females ("spring migrants") that have flown off are rather delicate insects, smaller in size than the apterous viviparous females.

From May to December their history is obscure. In early December, or even before, alate females ("return migrants") accompanied by alate males return to the pear or plum. The lower branches of the larger trees and the tops of open nursery plants are chosen for alighting.

The "return migrants" possess powerful wings and larger bodies than the spring migrants. The number of sensoria on the antennae is also greater.

The progeny of these develop into oviparous females, while the males wait till they are ripe. After fertilisation, or if no males are available even without it, one or two eggs are laid by each egg-bearing female. This takes place in the latter part of December or in January. These are the eggs that hatch in February and March to start fresh colonies.

Although sometimes rather badly attacked the pear being a large tree with plenty of foliage does not suffer much by the attacks of this *Toxoptera*. In some cases, moreover, if the Aphids leave off a little early the leaves straighten out again, but generally they remain more or less conduplicated till they fall.

Toxoptera is a small genus, comprising about half a dozen known species from different parts of the world. None has been recorded so far as affecting pears and plums in this way. I believe the species to be new and have named it *punjabipyri* after its chief host in the Punjab.

Genus **Aphis** (Linn.; Mordw.; van der Goot).

In the plains I have come across only about ten species belonging to this genus.

A.—General colour yellow.

(1) Body deep rich yellow; eyes, cornicles, cauda and anal plate conspicuous black. 9–12 sensoria in a line on article III.
Host *Calotropis* and other Asclepidaceae. *A. nerii* (Boyer).

(2) Lemon yellow to greenish-yellow intermingled, others quite green; cornicles and cauda black; 4 or 5 to 7 or 8 sensoria on article III.
Hosts numerous, chiefly Malvaceae, Cucurbitaceae, Solanaceae or any other plants. Malviform group.

(3) Light or almond yellow; cornicles small and dusky. Sensoria 9–12, scattered all round; wings with deeply-marked veins.
Host *Sorghum* or *Panicum* sp. *A. sacchari* (Zehnt.).

B.—General colour dark pink.
Host *Sorghum* and *Panicum*. *A. sacchari* (Zehnt.). Pink variety.

C.—General colour green.

(4) Bluish green to light greenish. Body elongated; small, black cornicles surrounded by dark areas at base. Sensoria 15–18 on article III, 4–5 on IV. Infests rolled-up leaves of Graminous plants like wheat, maize, sorghum, etc. *A maidis* (Fitch).

(5) Body dark or dull greenish; may be mottled, intermingled with yellow. Hosts numerous. Malviform group.

(6) Body of apterous female oval, uniform, livid green with concolorous cornicles and cauda; 7–10 sensoria on article III, 0–4 on IV.
Host *Nasturtii* sp. (a cruciferous weed near water-courses). *A. nasturtii* (Kalt.) ?

D.—General colour black.

(7) Body dull black to dark greenish; post-cornicular segments striped; 15–18 sensoria on article III; forms pseudo-galls on leaves, etc.
Host *Solanum nigrum*, *Rumex* and *Cnicus*. *A. rumicis*, Linn.

(8) Body in adult apterous female with a large shining black spot on back; 5–6 sensoria on article III.
Host mostly Leguminous plants. *A. medicaginis*, Koch.

A table for the "Malviform Group" of *Aphis* spp. and short accounts of those mentioned above are given below separately. A list of the plants on which they have been collected is incorporated with the general host index at the end of the paper.

Aphis rumicis, L.

Aphis rumicis is a cosmopolitan species and said to be a very general feeder in the West. Numerous writers have mentioned it from a host of plants since Linnaeus first described it in *Syst. Nat.* p. 734. Schouteden gives a list of eleven synonyms (*Cat. Aphids de Belgique*, p. 277, 1906). Buckton has furnished a very good colour description with a plate (*Brit. Aph.*, vol. II, pl. lxiv). Oestlund gives the antennal structure and measurements (*Aphid. Minn.*, p. 61, 1887). Gillette has figured the cornicle and antennae of the alate female (*Jour. Econ. Entom.*, vol. III, p. 407, 1910). Patch illustrates the antennae of a variant specimen with a few notes (*Maine Agric. Expt. Station Bull.* No. 202, 1912).

There is little difficulty in recognising this insect as it infests only a few plants in the Indian plains, and on almost all of them the leaves are turned into pseudo-galls. The most favourite host is *Solanum nigrum*, on which it is shown in the accompanying plate; others are *Cnicus arvensis*, *Rumex dentata*, *Chenopodium* (rarely), *Pyrus communis*.

The species is present almost throughout the year, but is most abundant in the winter months; when it is scarce in the plains, during May and June, it can be collected from the sub-hilly districts.

This plant-louse is very extensively parasitised by one of the Proctropidae; small *Scymnus* beetles also search them out from their shelters; ants invariably attend them.

Aphis medicaginis, Koch.

Literature :—

Koch, *Pflanzenlause*, p 94, figs. 125, 126 (1857):
Gillete, *Journ. Econ. Entom.*, vol. I, pp. 177–178 (1908).
Essig, *Pom. Coll. Jour. Entom.*, vol. III, no. 3, p. 527, 1911 (gives description and bibliography).

Hosts.—Mostly Leguminous plants, rarely other plants.

Distinguishing characters.—Colour of apterous female warm reddish-brown; the adults shine like glass beads among the droves of dull-coloured young and immature specimens; the basal antennae and tibiae and proximal femora are white and contrast noticeably with the other black parts of these organs. The shining part on the back of the adult wingless female is constituted by a huge irregular black blotch that covers practically the whole of the abdomen, excepting the anterior one or two segments. The alate female has intersegmental black stripes as shown in the figure; there are only five or six sensoria on the 3rd article; cornicles and cauda black.

The insect, though readily recognisable from the above description, has on several occasions been confused with *A. rumicis*, L. and *A. cardui*, L. These two plant-lice, as listed in Lefroy's *Indian Insect Life*, p. 747, from Leguminous plants, are in all likelihood *A. medicaginis*. The "Indigo Aphis" referred to in *Indian Museum Notes*, vol. VI, p. 45, is also evidently this insect.

The size is very variable; ill-fed specimens from Indigo or *Cajanus* may be half the size of others fed on the juicy creepers of *Dolichos*.

The species may be noticed sparingly practically all the year round. Numerous Leguminous plants serve as its host; the names of the plants with dates are given in the host-index at the end of the paper. Those most common are the species of *Cajanus*, *Indigofera*, *Dolichos*, *Dalbergia*, *Medicago*, *Vicia*, *Sesbania*, *Cassia*, etc.

The adult apterous females have the curious habit of falling from the twig or leaf at the slightest alarm. Nothing is known about the life-history or whether the sexes are ever formed or not.

Systematic.—The original description by Koch (*loc. cit.* p. 94) is not very clear; neither does his plate (fig. 126) give a satisfactory picture of the apterous insect; it rather shows two rows of dorso-lateral black spots alternating with white ones, and two or three dark bands on the hind body-segments. Koch evidently did not notice any large polished black blotch on the dorsum, as he was always particular to illustrate such a character, and has done so in several other instances.

There may therefore be some justification for the suspicion in the minds of certain writers that Koch probably was only redescribing *A. rumicis*, L., from a Leguminous plant, under a new name. *A. rumicis*, L. does infest such plants in Europe, but not to my knowlege in India. It is possible, therefore, that *A. medicaginis* (Koch) may turn out to be a synonym of *A. rumicis* (Linn.). But in America all the aphidologists have taken *A. medicaginis* (Koch) to represent the species described above, which is clearly distinct from *A. rumicis*.

If, in reality, Koch's name is proved to be a synonym, then this Aphid (left without a name) will have to be renamed, and *A. papilionacearum* as proposed by van der Goot is very appropriate indeed.

Aphis nerii (Boyer de Fonscolombe).

Synonym.—*Myzus nerii* (Boyer).

Literature :—

(1) Fonscolombe, *Ann. Soc. Ent. Fr.*, X, p. 157.
(2) Essig, *Pom. Coll. Jour. Ent.*, III, 3, p. 530.
(3) Lefroy, *Ind. Ins. Life*, p. 748.

Distinguishing marks.—This species is known in the country as "Ak ka tela," and can be recognised very readily by the deep rich yellow colour of its body, on which stand out conspicuously the beautiful large black cornicles. It is often seen clustering along the veins of leaves of *Calotropis gigantea* (*Vern.* Ak). The branches and lower leaves get smeared with the sweet oily-looking excreta which attracts numerous ants, flies and wasps. In bad attacks the plants look very sickly, and the leaves are smutted with a sooty fungus, *Capnodium*.

As the species has been fairly well described in the first two references above, no further account of it is given here. The Punjab insect is apparently exactly the same as the European and the American forms, only it never infests *Nerium odorum*, from which host it takes its specific name. This plant, though abundant, is practically immune from Aphid attack of any kind.

Distribution.—The species is practically cosmopolitan as I have heard of its occurrence in Java, while from the plains as well as the hills of India, specially from the North, the East and the West, it has been collected by myself.

The food-plants are the following :—

(1) *Calotropis gigantea.*
(2) *C. procera.*
(3) *Hoya longifolia.*
(4) *Cryptostegia grandiflora.*
(5) *Asclepias* sp.
(6) *Cynanchum dalhousie.*
(7) *Dragea volubilis.*

All the plants belong to the Natural Order Asclepiadaceae.

It has been found practically throughout the year on all the plants mentioned above.

Dragea, in May, sometimes has all its flower-stalks thickly covered over with the insect. It is present again on *Hoya* in September and October, and December to February, and in summer on *Calotropis gigantea.*

Systematic.—In Europe the species has been often referred to as *Myzus nerii* (Boyer), but as it has none of the characters of *Myzus* as the genus is at present understood, it should be, and now is, rightly called *Aphis nerii.* The name *Myzus nerii* has been published in *Indian Insect Life* on the identification of Schouteden. *A. asclepiadis* of Passerini is the same insect, but the name *nerii* is older, and a correspondent has suggested that it might better go under that name, as *Aphis nerii* (Kalt.) is still older and a distinct species. But there is some confusion here in the synonymy, and the American authors give the description of *A. asclepiadis*, which is certainly a distinct species.

A. lutescens, Monell, attacks *Calotropis* and the Asclepiads, but this again, in spite of the name referring to the yellow colour, is entirely a distinct insect. Essig has given a description of this insect from California in *Pom. Coll. Journ. Ent.*, vol. III, p. 402.

I think it is best to call it *A. nerii* (Fonsc).[1]

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[1] [Some doubt has recently been cast on the correctness of calling our Aphid an Asclepiadaceae : *Aphis nerii*, Boyer. The question may briefly be put as follows :—

Passerini (1863) has described a yellow Asclepiad aphis, calling it *Myzus asclepiadis.* Schouteden considered this species to be identical with the yellow Oleander Aphis "*Myzus*" *nerii*, Boyer, and other authors have accepted this opinion. But recently Mr. Theobald has pointed out (*Bull. Ent. Res.*, vol. vi, 1915, p. 129) that in his opinion the Oleander Aphis and the Asclepiad Aphis are two quite distinct species. As the principal point of difference this latter author mentions, that in *Aphis asclepiadis* the 5th antennal joint is shorter than the 4th, while in *Aphis nerii* the 5th joint is said to be as long as the 4th.

This statement, however, is not quite in accordance with the investigations of other authors. Mr. Essig, who furnished a very extensive and apparently correct description of the Oleander Aphis from California (*Journ. Pom. Coll.*, vol. 3, p. 530), mentions that in the apterous female the lengths of the

Natural enemies.—*Chilomeles sexmaculata* and *Coccinella septempunctata* in the larval and imago stage destroy large numbers of this Aphid. All the common Syrphids actively deposit their white eggs among them, and their blind larvae were noticed sucking hundreds of them dry every day. An *Aphidius* is sometimes bred from among colonies of this Aphid but is never abundant.

A curious disease attacks them, possibly of a Fungoid nature, which kills almost all of them at once. The attack seems to be rather sudden, and one might almost unexpectedly find at any time the under sides of leaves full of reddish-brown or later darkish-brown shrivelled-up skins in place of living yellow Aphids. It has often been noticed to appear specially after a very hot day. The heat may have something to do with it, as the outward appearance of the dead specimens is not very different to that of a scorched insect. The Aphids remain attached to the leaves for a long time.

Life-history.—This Aphid can live through the winter in the parthenogenetic state, but probably the sexes are produced before the winter, though none were collected. Every year in February, March and April the leaves and flowers of *Hoya viridis* are covered over with this Aphid in thousands. In September again the case is the same. Any of the above mentioned hosts may be similarly attacked.

Aphis sacchari (Zehntner).

Name and host.—This plant-louse was first noticed on sugar-cane in Java and named after its host (*Arch. Jav. Suiker-industrie*, Dl. IX, p. 674, 1901). The original description is in Dutch.

In India the insect has never so far been collected from *Saccharum officinarum* (sugar-cane), but is here certainly a *Sorghum* Aphis. The only other plant known as its host in this country is *Panicum colore*.

Distinguishing characters.—It is found on the under side of leaves of *Sorghum vulgare* (juar or chari) in thick patches, and excretes "honey-dew" so profusely as to blacken all the leaves. The fungus that forms sooty layers, scales off in thin flakes from the dry leaves.

The insect is almond-yellow or pink in colour with a thick, stout body with small black cornicles; there is a pattern on the abdomen of the alate female, and from ten

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antennal articles are : I 0·1 mm., II 0·08 mm., III 0·36 mm., IV 0·28 mm., V 0·25 mm., VI 0·1 mm., VII 0·47 mm. Thus the 5th joint is distinctly shorter than the 4th, exactly as in our Asclepiad Aphis! The difference between *A. nerii* and *A. asclepiadis*, as mentioned by Mr. Theobald, can therefore hardly be correct.

As has already been pointed out by Mr. Das the description of the Oleander Aphis, as given by Essig, agrees fairly well with that of our Asclepiad insect. It remains, however, a very astonishing fact that in tropical regions this aphis should only show a partiality towards Asclepiadae and leave the oleander uninfested. Still more curious is the fact that, after Mr. Theobald, *Aphis asclepiadis* should attack *Salix* too. Only biological experiments will be able to definitively settle whether the Aphids on Asclepiads, oleander and willow are to be regarded as one species or not. Until this question is solved, I think it best to follow Schouteden and call our Asclepiad Aphis *Aphis nerii*, Boyer. P. v. d. G.].

to twelve somewhat tuberculate sensoria on the 3rd article; cauda subequal or longer than cornicles; the thick smoky veins on the wings are distinctive.

Life-history.—*Sorghum* in Lahore is sown about the latter part of April, and one crop under a system of forced cultivation is ready in July. A second sowing is started about this time. The Aphid makes its appearance on a few low plants, near the margin of the field, early in July. Only small droves of them are visible after a good search. In August and September the attack is in full force. They decrease in numbers soon after this, and some of them shift to *Panicum* spp. Till December the Aphid is in evidence on the latter host. The further life-history remains to be determined.

Biology —This tiny insect possesses extraordinary powers of rapid multiplication. On seedling plants under glass chimneys the new-born young reached the reproductive age after five days, and had moulted four times during this period. At first they bring forth from 3 to 4 young a day, but later the rate slowly decreases. The alate females quickly spread the species to neighbouring plants and frequently considerable portions of large fields are seriously attacked. Such an increase in numbers is correlated with an equally excessive amount of excreta, the "honey-dew" that is voided, falling in small drops over the lower leaves, dries up to a syrupy consistency and offers an excellent medium for the sooty fungus *Capnodium* to grow on.

Blackened and smothered leaves of *Sorghum* are unmistakable signs of the presence of this *Aphis*.

These plant-lice are constantly attended by smaller as well as larger ants. Wasps and flies also hover round the plants.

Enemies.—Besides the usual Coccinellids and a *Lysiphlebus*, there is a tiny Chalcid (*Aphelinus* sp.) that does useful work in reducing its numbers. Aphids stung by *Aphelinus* turn jet black, but do not swell up and are easily recognisable; the parasite on emergence either cuts a circular hole or ruptures the back. Its mode of attack is also unique. The female parasite at first flits from insect to insect examining each with her quivering antennae. On finding one that has not already been stung she retreats a few millimetres, turns round facing away from the victim, and measuring her distance quickly darts out her long ovipositor and thrusts it into the abdomen and deposits an egg. The *Aphis* smarts for a moment and is quiet again. The parasite departs to repeat the process on another specimen. After the second day the *Aphis* changes in colour; at first it is greyish, then darker, and later jet black. The insect adheres fast to the leaf before it dies.

Pink variety.—A dark pink variety of *Aphis sacchari* also exists among the droves, or may be noticed feeding and breeding separately. Excepting in colour there is not the least structural difference between it and the almond-yellow form. A parallel case of this kind is known from Europe in *Macrosiphum rosae*, Linn. The two varieties have an entirely independent life; they breed perfectly true, and the progeny of one is never noticed to develop into adults of the other kind.

The pink variety is never so numerous as the yellow, but in Lahore it is the first to appear on *Sorghum*.

Systematic.—The species doubtfully belongs to the genus *Aphis*, at least it is a very aberrant one. The points of difference are noted below:—

(1) The antennae in the alate female are about as long as the body, not smaller.

(2) The cornicles are small, hardly three times as long as broad, not four times or more.

(3) The cauda is subequal or even longer than the cornicle, not distinctly smaller.

(4) The wings are clouded with pigment, not hyaline as is usual in *Aphis*.[1]

Aphis maidis (Fitch).

Synonyms.—*A. adusta* (Zehnt.)
A. sorghi (Theobald).

Literature:—

(1) Fitch, *Second Report on the Insects of New York by State Entomologist*, 1856 (original description).

(2) Oestlund, *Synop. Aphid. Minn.*, 1887, p. 56 (alate insect described).

(3) Webster, The Corn-leaf Aphis. *U. S. Dept. Agri. Circ.* No. 86, 1907.

(4) Davis, *U. S. Dept. Agri. Bur. Ent. Tech. series*, No. 12 (account of biological studies on this and two more Aphids; mentions full bibliography; a description without figures is also added).

(5) *Agri. Dept. of India, Pusa, Behar.* A plate under the name of "wheat aphis" has been issued, but is more of popular interest than of any scientific value.

(6) *Ind. Ins. Life*, p. 747 (identified by Schouteden as *A. adusta* on "juar", *Sorghum valgare*).

I have not seen good figures of this Aphis and therefore have given some, showing morphological details.

Distinguishing characters.—The Wheat Aphis or the Corn-leaf Aphis invariably takes up its position in the half rolled-up young leaves of various graminous crops. It is only on maize and *Panicum colore* (a grass) that it attacks the inflorescence.

The blue-green colour and long oval body, with two black spots surrounding the bases of the short black cornicles, always conspicuous in the light-coloured individuals, are unmistakable marks of its identity.

The alate form is never abundant and is often entirely absent; the structure of the antennae only separates it from another similar species (*Siphocoryne avenae*) on the same crop. The spur of the 6th article is a little over twice the base.

The alate female would often be mistaken in the field for *Siphocoryne avenae*; more so because both migrate to wheat and Avena seedlings in November, and are seen as isolated specimens. The black body and head with similar antennae and very short second fork of the cubitus are characters common to both. The number of sensoria on the joints differ, and the spur of the 6th article in *Siphocoryne avenae*

[1] [The writer has placed *Aphis sacchari*, Zehnt. in a new genus called *Longiunguis*, v. d. G.; to this genus belongs another species, *Longiunguis odinae*, v. d. G., which is common in Java and has been collected too in Ceylon by the late Mr. Rutherford. P. v. d. G.]

is about five times that of the base, while in *A. maidis* it is hardly more than double.

Systematic.—The species described as *A. maidis* (Fitch) by Essig (*Pom. Coll. Jour. Ent.*, vol. IV, No. 3, p. 791, 1912) is evidently *Siphocoryne avenae*; hence it is not included in the literature above.

I have also included *A. sorghi* (Theobald) as a synonym of this species. It was reported to attack the leaves and heads of Dura (*Sorghum vulgare* in the Soudan), and an account of the insect appeared in the *First Rep. Wellcome Res. Lab. Khartoum*, 1904. Unfortunately the account is incomplete in certain respects, and the details of structure, on an otherwise excellent plate, are somewhat inaccurate. The total absence of secondary sensoria, as shown on the antennae of the alate female, would be remarkable if it is so. From the colour, form, and the relative lengths of the antennal articles it appears to be identical with *A. maidis* (Fitch), though Prof. Theobald thinks otherwise.

A. adusta of Zehntner, described in 1901, is undoubtedly *A. maidis*, according to van der Goot.[1]

Food plants and times of appearance.—In India this Aphid feeds on the following plants:—

(1) Wheat	(*Triticum sativum*)	December–March.
(2) Oats	(Avena)	November–April.
(3) Barley	(*Hordeum vulgare*)	January and February.
(4) Maize	(*Zea mays*)	August-November.
(5) Sorghum	(*Sorghum vulgare*)	June-October.
(6) Bajra	(*Pannisetum typoideum*)	September.
(7) ,,	(*Panicum colorenum*)	September–November and April.
(8) ,,	(*Panicum crus-gali*)	March.
(9) Dub grass	(*Cynodon dactylon*)	December.

In the above months collections have actually been made of this species in the plains, and it is also apparent that it infests both the Rabi and the Kharif crops in the Punjab, and that there is hardly any time of the year when it is not to be met with.

Life-history.—Elaborate experiments were undertaken by Dr. Forbes (*Report of the State Entomologist of Illinois*, 1905, p. 123) to determine the life-cycle in winter at Chicago, and similar experiments were made by Davis (*loc. cit.*) at Urbana, Ill. No sexual forms could be obtained. It appears that in that country it has not been definitely ascertained how the species passes the winter, as its food-plants are not available then. In India there is no difficulty on this account, since some crop is always available, and the insect can pass from one plant to another very easily. Owing to an abundant food supply here one meets with very few winged forms at all

[1] [*Aphis maidis*, Fitch, has been put by the writer into the genus *Siphonaphis*, v. d. G., for the reason that it has distinctly swollen cornicles, together with the presence of lateral tubercles on the first and seventh abdominal segments (see v. d. Goot, *Zur Kenntniss der Blattläuse Java's*, p. 67). P. v. d. G.].

under natural conditions. The few individuals that mature at once fly off to more succulent plants when the ones on which they have been feeding show signs of a decreasing flow of sap. To obtain alate specimens one has often to artificially weaken the plants in confinement, in order to accelerate the production of pupae. Taking two typical plants of summer and winter crops, as wheat and maize, the life-history would ordinarily be alternating on them. Avena, I believe, suffers most from its attack, for in the rolled-up young leaves thousands would frequently be found weakening and disfiguring the plants. This position, referred to already above, is very characteristic, and the insect must be responsible for a considerable amount of loss, by retarding growth and not allowing the leaves to open for a long time.

On maize it attacks the male inflorescence from September to November, when it migrates to Avena and wheat, which are just sprouting.

Experiments.—In order to determine the course of its life-history in the Punjab, a number of individuals were colonised on *Cynodon dactylon* (common dub-grass) grown in small flower pots, under muslin-topped lamp chimneys. They were kept in the laboratory, the pots being irrigated from below. Some colonies were left in the Botanical Gardens under field conditions, at the place where they were first noticed. The experiments were started early in October, 1913. Throughout the winter, that is up to the middle of January, viviparous reproduction went on, and alate or apterous individuals were formed more or less promiscuously.

The details as to the number of moults, the age at which reproduction commenced and stopped, the days an individual lived, etc., were much the same as those given by J. J. Davis, and need not be repeated here.

White-banded apterous viviparous female.—Early in February a few apterous viviparous females were observed that were conspicuous among the colonies in the laboratory as well as in the field. Each carried several thick white bands or stripes of mealy powder, one to each body segment. Sometimes the band was discontinuous in the middle, and one or two elliptic spots were in some cases noticed situated laterodorsally on the immature females, but the full number developed only on adult specimens. These were slightly larger and much darker than ordinary females; the cornicles were distinctly narrowed at the tip.

Measurements of one are given below :—

Antennal proportions :—

	III.	IV.	V.	VI.
	12	9	$8\frac{1}{2}$	5+15
Lengths ..	0·20	0·15	0·14	0·01+0·25 mm.

Body	..	2·50 × 1·15 mm.
Antennae	..	0·90 mm.
Cornicle	..	0·20 ,,
Cauda	..	0·15 ,,

We are not in a position to say positively what is the significance of this "banding"; it has been noticed in *A. rumicis*, and I have also noted it in "malviform"

Aphids in December. Neither was it discovered what kind of individuals the progeny develop into, but with them or a little later, about the third week of February, several winged males were secured in the chimneys, and on *Cynodon* in the garden. As males of this species have never been collected before a short description is given here.

Alate male.—The alate male is a slender, attenuated, shining, dark-reddish, almost black insect; the usual type of genital armature is conspicuous at the anal end.

Head rather broad, quite black, with dark red eyes.

Antennae about the same size as those of the alate viviparous female, but the joints appear thicker, more rounded, and separated from each other by hyaline arthrodial membranes.

Length proportions :—

	III.	IV.	V.	VI.
	22	12	10	6+19
Lengths ..	0·37	0·20	0·16	0·11+0·31 mm.

The spur is only slightly smaller than the base.

Sensoria as is usual in the males; the joints are studded over on all sides by sensoria of various sizes; the 3rd bears about 45, the 4th about 18 and the 5th about 13. None are present on the sixth, except the primary sensorium with its group of smaller ones.

Prothorax distinctly marked by a broad line anteriorly and provided with lateral tubercles.

Mesothorax large, shining black.

Wings normal, on account of the narrow body they appear relatively voluminous; otherwise their actual size is even smaller than those found on larger alate viviparous females. The membrane appears more smoky as a whole; the stigma and veins are brown.

Abdomen long-oval, thin, the breadth here being much smaller than at the thorax. Four large circular spots in front of the cornicles at the carinae, with two or three black stripes on the segments in front of the cauda.

Cornicles cylindrical, with vasiform tip, somewhat incrassate about their middle; the size is smaller than those of the alate female.

Cauda thick, rounded, very much elevated towards the dorsal side, small and stumpy looking; its length is slightly less than the cornicles.

Anal plate narrow, directed backwards.

The genital armature consists of a central conical penis; two spiny lateral somewhat triangular lobes on the sides, meeting in a deep black cresentic line in front. Postero-laterally run two blackish hoops; their hind ends curve to touch the sides of the penis.

Legs long and black.

Rostrum small, reaches half way between first and second coxae.

Measurements :—

Body length	..	..	1·55—1·65 mm.
Abdominal breadth	..	..	0·38—0·42 ,,
Thoracic breadth	..	..	0·50—0·54 ,,
Antennae	..	..	1·32 mm.
Cornicle	..	..	0·11 ,,
Cauda	..	..	0·09 ,,

The alate viviparous females, produced at the same time when these males form, are unusually large; the dimensions of their wings, body and antennae are all greater than the males. The number of sensoria on article III may be as many as 24; on IV 6-7; some individuals were found with about 5 or 6 sensoria on their 5th article as well.

No oviparous females were collected and are probably never developed on *Cynodon*. Later the size of the apterous and alate females, that were still present on the grass in March, grew extremely small; their colour also was very light greenish.

Life-cycle.—The life-cycle, therefore, after the migration of winged males and females from *Cynodon* in February, is not known. The insect is not noticeable after March. We have again seen apterous viviparous females multiplying actively on *Panicum* sp. in June, in the Botanical Gardens not far from the place where the original colonies existed. These looked remarkably like "stem-mothers" of other Aphids, and in all likelihood had hatched from eggs laid upon these plants some time previously. Therefore, though we have not been able to actually collect either the oviparous females or the eggs, inferentially it seems correct to conclude that after March eggs are laid on species of *Panicum* growing along water-courses. These hibernate in the hot summer months of April and May, hatching in June if there is an early shower of rain.

The point that needs clearing up is, whether the migrant females and males do return to *Panicum*, and whether the progeny of the former develop into oviparous females. From June to March the food-plants are abundant on which the species can conveniently subsist.

Enemies.—Larvae of the smaller kinds of Syrphids destroy whole colonies of this species; several Coccinellids also abound among them.

MALVIFORM GROUP OF *APHIS* SPECIES.

The characters common to the species of this group, besides their extremely polyphagous nature, are:—

(1) Body more or less oval, from dull or mottled green to lemon-yellow; usually a row of oil globules, coloured yellowish or greenish, between the cornicles.

(2) Cornicles tapering, black.

(3) Cauda ensiform, black,[1] bearing very nearly the same ratio in length to the cornicles; that is a little more than its half.

(4) Pupae in all the species have rows of white spots and develop yellow or orange pigment upon the anterior abdominal segments.

(5) In alate females the pattern consists of similar lines and spots.

Not only can these species subsist on a great variety of different plants, but their size and colour is also subject to many variations. This is responsible for the considerable amount of confusion that prevails in their synonymy in the West. No satisfactory diagnoses are available, and the same insect has been described by different authors under several names because of the once current idea that each plant had its own peculiar Aphid.

After making extensive collections of these insects in many parts of India I have exchanged them for other Asian, American and European specimens, and have also carried out a number of "pure culture" experiments by isolating single individuals on plants in chimney pots and watching their progeny. As a result of this I am able to distinguish four distinct species recognised by their structure under the microscope, and I believe them to be as follows:—

(A) Sensoria present on both III and IV antennal articles .. (1) *A. durranti*, sp. nov.
(Isolated on *Durranta* and *Colocasia*).
Sensoria present only on III. (B).

(B) Spur of VI much longer than III, roughly in the ratio of 3 to 2 .. .. (2) *A. malvae* (Koch).
(Isolated on Cucurbitaceae).
Spur of VI slightly longer or subequal to III. (C).

(C) Sensoria on III, 6–8, not quite in one line; a large species; antenna more than 1 mm.; cornicles about ·20 mm. .. (3) *A. gossypii* (Glover).
(Isolated on Balsam; *Capsella*; *Cryptostegia*, etc.).

(D) Sensoria on III, 4–6, all in one line; a small insect; antenna less than 1 mm.; cornicles about ·15 mm. or less .. (4) *A. malvoides*, sp. nov.
(Isolated on *Malvestrum*, Chrysanthemum, etc.).

Aphis malvae (Koch).

Synonym.—A. cucurbiti (Buck.) ? (*Brit. Aph.*, vol. II).

This Aphid we have found chiefly on Cucurbitaceae, but it attacks an extremely large number of other plants as well. The same is said of it in other parts of the world also.

Apterous viviparous female.—They vary in colour from green to lemon-yellow. For some time the progeny of the yellow form remain yellow, but when the colony increases the young often develop into green. The offspring of the green form may similarly be quite yellow.

The green colour begins to invade the abdomen from the cornicular region and

[1] [The cauda is not black in all the species belonging to the malviform group. In *Aphis malvae*, for instance, the colour of the cauda varies from light yellowish to dark green or dusky green, but is never blackish. P. v. d. G.].

extends backwards and forwards; it is due to the internal juices, the skin itself being quite hyaline.

General form of body, cornicles, cauda, etc. are shown in the figures.

The antennae reach to about the base of the cornicles.

Length proportions :—

	III.	IV.	V.	VI.
	17	10	9	6+18
Lengths ..	0·28	0·16	0·15	0·10+0·30 mm.

Measurements :—

Body	..	..	1·50 × 0·75 mm.
Antennae	..	..	1·12 mm.
Cornicle	..	..	0·26 ,,
Cauda	..	..	0·14 ,,

The pupa have a green intercornicular band and rows of white spots on the back.

Alate viviparous female.—It is slightly smaller than the apterous female; the cornicles also are comparatively smaller. The pattern on the abdomen is indistinctly marked; on the mid-dorsum of the abdomen three faint spots can be observed on the first three segments, also two bigger stripes on the two posterior segments.

The structure of the antennae is characteristic, although its length varies according to the size of the individual; smaller specimens may be even less than three-fourths of the larger ones.

The antennal articles are long and well marked; all are imbricate.

Length proportions :—

	III.	IV.	V.	VI.
	14	10	9	6+20
Lengths ..	0·25	0·16	0·15	0·10+0·34 mm.

Article III is roughly about two-thirds the length of the spur.

Sensoria circular and rather large, almost in one line; their number usually is six, but varies from five to seven.

Cornicles quite black and smaller than those of the apterous female.

Cauda more than half the cornicle length, as shown in the drawing.

The rostrum reaches to the second pair of coxae.

Lateral tubercles on first and seventh segments well developed, as usual.

Measurements (on an average) :—

Body	..	..	1·50 × 0·65 mm.
Antennae	..	..	1·10 mm.
Cornicle	..	..	0·20 ,,
Cauda	..	..	0·11 ,,
Wing expanse	..	..	4·85 ,,

The season when it is most abundant is May and June; it badly attacks melons, cucumbers, squashes, gourds and Lagenaria, etc.

It is extensively parasitised and preyed upon by numerous predaceous Aphid-enemies.

Systematic.—I have not been able to procure the real *A. cucurbiti* of Buckton from England ; the original description is faulty in several respects, but the coloured figures that he has given seem remarkably like the insect described above. I have therefore kept it as a doubtful synonym of *A. malvae* (Koch). European specimens agree in essential features with it, but Buckton has given in the same volume figures and an account of what he considered as *A. malvae* (Koch). It is likely, therefore, that his *A. cucurbiti* might be different, but only an actual examination of his specimens can settle the point.[1]

Aphis malvoides, sp. nov.

Hosts.—Numerous, e.g. *Malva* spp. ; *Malvestrum* spp. ; Chrysanthemum ; pear ; pansy ; *Solanum* spp., etc.

Apterous viviparous female.—A comparatively small insect, but very abundant.

Body oval, lemon-yellow without mottling ; between the cornicles usually a row of oil globules that possess a greenish tinge ; this tinge in some individuals spreads in front and behind also.

Head well-rounded, greenish-brown with inconspicuous frontal tubercles.

The antennae reach half way down the back ; black distally. The spur and article III are almost equal ; sometimes III is even slightly longer.

Proportions :—

	III.	IV.	V.	VI.
	12	7	7	5+12.
Lengths ..	0·20	0·13	0·13	0·08+0·20 mm.

Prothorax concolorous with head.

All the thoracic segments have a pair of black dots, one on each side just above the coxal joints. A dark brown band, which lies to the front and outside each coxa, often invades the lateral sides and thus small smoky patches are visible on the carina even from the dorsal side. The band is largest on the metathorax.

Abdomen pyriform ; all the segments bear lateral tubercles, the largest ones are on the first and seventh ; white meal is scanty on the dorsal surface.

Cornicles small, jet-black and conical, truncate at tip.

Cauda ensiform, tip dusky ; the broader base below the constriction very light-coloured and hyaline ; about half the length of the cornicles.

Anal plate rectangular, much blacker than the genital plate, which is more or less rounded.

Legs yellowish, tibial points and tarsi black ; in front of third coxae a conspicuous black mark extending outwards.

The rostrum reaches almost to the 3rd pair of legs.

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[1] [In my opinion *Aphis cucurbiti*, Buckt., is without doubt identical with *Aphis malvae*, Koch. The species is common in Holland on cucumbers in greenhouses. P. v. d. G.].

Measurements :—

Body	..	..	.. 1·20 × 0·50 mm.
Antennae	..	..	.. 0·90 mm.
Cornicle	..	..	.. 0·25 ,,
Cauda	..	..	.. 0·12 ,,

Alate viviparous female.—Body-colour yellow; portions behind the cornicles and at their level full of greenish globules; the posterior part of the abdomen may be quite dark greenish: the usual pattern of three carinal spots; one cornicular and two bands on the last two segments are present.

Head, antennae, thorax, legs, cornicles and caudal tip black.

Antennal proportions :—

	III.	IV.	V.	VI.
	12	9	7	$5\frac{1}{2}+14$.
Lengths ..	0·20	0·15	0·13	0·08+0·23 mm.

Sensoria large, circular; they are seldom more than five but may be six or as few as three, generally placed in a line.

Cornicle smaller than that of the apterous female, conical and imbricate; it does not reach to the base of the cauda.

The cauda has the constriction between the base and tip rather ill-defined; it is a little longer than half the cornicle.

Genital plate larger than that of the apterous female, less dark than the anal plate.

The rostrum reaches up to the edge of the mesosternal bosses.

Wings rather small, well-rounded, with brown veins and greenish stigma.

Measurements :—

Body	..	..	.. 1·20 × ·45 mm.
Antennae	..	..	.. 0·90 mm. or less.
Wing expanse	..	..	.. 4·20 ,,
Cornicle	..	..	.. 0·16 ,,
Cauda	..	..	.. 0·10 ,,

The pupae are characteristic, appearing as if constricted between the thorax and abdomen. Anterior half of abdomen bright yellow or even orange; posterior half dark greenish. The head bears two blackish lengthwise marks, between these the skin splits in moulting. Thorax greenish with light green, almost white, shoulders, tipped with jet black. Two median rows of white spots, a pair to each segment, extend from the head to the caudal base; on the abdomen they widen out a little. Parallel to these are placed four similar spots on either lateral edge.

This small Aphid is extremely polyphagous and infests plants of widely different orders. It is not infrequently found feeding in company with other malviform Aphids, and can only be recognized from *A. malvae* or *A. durranti* by the structure of its antennae.

It can be collected almost throughout the year except in the summer.

It is likely that this insect occurs in other parts of the world also, and has been

confused there with *A. malvae* (Koch). But as no account of it appears to exist anywhere I consider it to be an undescribed species. There is a very close affinity between these two plant-lice, and I have consequently named it *Aphis malvoides*, sp. nov.[1]

Aphis durranti, sp. nov.

Hosts.—Durranta sp.; *Vitex nirgundo*; *Colocasia*, etc.

Apterous viviparous female.—Body of small size, about the same as *A. malvoides*.

Colour yellowish-brown, without any mottling; in fully developed specimens the thorax, edges of the abdomen and the post-cornicular segment are dark green.

Head dark brown, concolorours with the basal antennal joints; front convex.

Eyes dark red.

Antennae on inconspicuous frontal tubercles. The spur is more or less subequal to the 3rd article; sometimes it is smaller and sometimes a little longer.

Proportions :—

	III.	IV.	V.	VI.
	14	9	8	5+14.
Lengths ..	0·24	0·15	0·14	0·08+0·24 mm.

The prothorax bears lateral tubercles and a black stripe.

The mesothorax and metathorax are large; on their lateral sides both are marked by rounded elevations of black pigmentation. This is quite a characteristic feature, and under a high power of the microscope the fine irregular meshwork of lines over the body assumes here the form of more or less circular facets, like those of the wax-glands in some other genera. Each mass of these circular facets looks like a huge gland. Similar but very much smaller facet-groups are to be seen on the abdominal segments as well. Below these groups and in front of the attachment of the leg is situated a strongly developed tubercle.

Abdomen sparingly pruinose; lateral tubercles of first and seventh segments rather small; on others they are absent.

Cornicles long and stout; cylindro-conical, black; they reach to the base of the cauda.

Cauda ensiform, black at apex; there is a slight constriction between the narrow base and oval apex; it is two-thirds the length of the cornicle.

Anal plate black, elliptic.

Genital plate dusky.

Legs normal, with tibial points, tarsi and coxae black; the rest brownish.

Rostrum long; it reaches almost to the third coxae; last joint over one and a half times the one before it.

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[1] [The name *Aphis malvoides* is already preoccupied for a greenish Aphid, occurring chiefly on Compositae in Java (see v. d. Goot, *Zur Kenntnis der Blattläuse Java's* p. 96). I would therefore propose changing the name of this little Aphid into *Aphis malvacearum*, nov. nom. I have some doubt that this species may only be a small variety of the polyphagous *Aphis gossypii*, Glov. P. v. d. G.].

Measurements :—

Body	..	..	.. 1·50 × 0·65 mm.
Antennae	..	..	.. 0·90 mm.
Cornicles	..	..	.. 0·26 ,,
Cauda	..	..	.. 0·16 ,,

Pupae dirty dark green; the thorax, anterior and posterior parts of the abdomen and also the margins are dark green; the central dorsum is greenish-brown, much lighter, in some distinctly yellowish; shoulders dark-tipped.

There are four rows of white tassellations as is usual in other malviform Aphids.

Alate viviparous female.—Prevailing colour of body dark green; thorax, antennae, legs, cornicles and cauda black.

Head about as long as broad, without any trace of frontal tubercles.

The antennae have the following lengths :—

Proportions :—

	III.	IV.	V.	VI.
	15	10	9	5+16.
Lengths ..	0·25	0·16	0·15	0·08+0·26 mm.

The spur is more or less subequal to the third article.

The articles are well segmented, unlike those of the apterous viviparous female, in which the 3rd and 4th are often confluent.

Sensoria rather small, but usually present on both the 3rd and 4th on one side. They number 6-9 on III and 0 or 1-4 on IV. Only rarely the 4th has one or no sensorium; two or three are the normal number, with seven or eight on III.

Prothorax banded across anteriorly; lateral tubercles present.

Muscle bosses of thorax of the usual shining black, with yellowish insertions.

Wings with normal venation; the brown veins are well marked; stigma greenish-brown.

Abdomen pyriform, compact; four black spots on the carina are clearly visible; the blotch behind the cornicles and the stripes on one or two of the anterior segments and three on the hinder ones are well seen.

Cornicles small, truncate, conical, with a broader base.

Cauda comparatively larger than that of the apterous female; it is about two-thirds the cornicle or more; the waist between the base and the apex is obsolete.

Rudimentary gonapophyses three.

The rostrum reaches to about the second pair of coxae.

Measurements (on an average) :—

Body	..	..	.. 1·35 × 0·50 mm.
Antennae	..	..	.. 1·00 mm.
Wing expanse	..	..	.. 4·15 ,,
Cornicle	..	..	.. 0·15 ,,
Cauda	..	..	.. 0·10 ,,

Aphis durranti can be distinguished with comparative ease from other malviform Aphids, but the differences seen with the naked eye are small, and the size and colour being variable, one cannot readily make it out from *A. malvoides*, sp nov. or even *A. malvae* (Koch) when the two are feeding together.

As it seems to be an unnamed species, it has been called after its chief host, *Durranta*.

The time of appearance is late in September or October, and it continues on till January or February.

Late in December some females were observed to be banded with a white powdery substance of the same nature as that forming the tassels of the pupae. These white bands have been noticed in the case of other species of *Aphis* as well, but little explanation has been offered in regard to them.

No sexuales were secured, though it is probable that they do form at this season, and in all likelihood the progeny of the white banded females may later be found to have some connection with their production.

Winged males in species of this genus are not very different from alate females, and only a careful examination of the genitalia and antennae reveal the differences. The same is true of the apterous oviparous females whose hind legs are not so much swollen as in the other genera; they develop only a few secondary sensoria which ordinarily would escape observation. This perhaps accounts for the scarcity of true sexes so far obtained in this genus.

The chief parasite of this species is a *Lysiphlebus*; it is sometimes so extraordinarily numerous that about midday one can catch hundreds of them by hand.

Aphis gossypii (Glover).

Synonym.—(1) *A. citruli* (Ashmead), 1882.
(2) *A. cucumeris* (Forbes), 1883.

Hosts.—Cotton; *Capsella*; *Impatiens* sp.; *Cryptostegia grandiflora*, etc.

Literature:—

Glover, *Pat. Off. Report*, p. 62; 1854 (contains original description; reproduced again by Ashmead, *Can. Entom.*, XIV, p. 91, 1882).

Gillette, *Jour. Econ. Entom.*, I, 3, p. 176; 1908 (*A. gossypii* and allies); *id., ibid.*, III, 5, p. 404 (1910).

Essig, *Pom. Coll. Journ. Entom.*, III, 4, p. 590; 1911 (a complete description).

Lefroy, *Ind. Ins. Life*, 1910 (mentioned on cotton).

There are slight differences in the measurements of the Indian form as compared with those given by E. O. Essig for the American insect on *Citrus* species.

This Aphid shows more distinct mottling than others; the pattern on the abdomen of the alate female is made up of larger and clearer black spots and dashes, that is of two or three lines on the anterior abdominal and three stripes on the posterior abdominal segments, besides three precornicular carinal spots and another immediately internal to the cornicles.

Antennae long, black, with slender articles.

Proportions :—

	III.	IV.	V.	VI.
	17	10	10½	6+18
Lengths ..	0·28	0·16	0·17	0·10+0·30 mm.

The spur and the 3rd article are subequal.

The sensoria are often placed in pairs, some larger and some smaller, from 6—8 in number, usually 7.

Wings large, with the usual venation; stigma greenish.

Cornicles black, cylindro-conical, imbricate.

Cauda with a slight constriction about its middle; base broad, hyaline; tip dusky.

Measurements :—

Body length	1·50—1·75 mm.
Breadth	0·65—0·75 ,,
Antennae	1·12 mm.
Cornicle	0·20 ,,
Cauda	0·12 ,,
Wing expanse	5·40 ,,

In the apterous female the spur is always smaller than the third article; the cornicles about twice the cauda; sometimes less than that. The cornicles and cauda are much longer than those of the alate female.

Date of collection.—From October to December, also in March and April.

Systematic.—Some doubt has recently been cast in Europe and America as to the distinctiveness of this species. It is supposed that Glovers' *A. gossypii* is only a synonym of *A. malvae* (Koch), but the supposition has never been so far definitely established, and in American literature *A. gossypii* (Glov.) stands as a well-defined species.

There are numerous references to it and Pergande has listed upwards of thirty plants as its host (Riley's *Insect Life*, vol. III, pp. 309-314). It would not be surprising at all if some of these references at least refer to species other than *A. gossypii*, and this may have been the origin for the doubt entertained by some writers.

That the species is, however, a perfectly distinct one can be shown by its morphological characters as is clear also from the table given above (p. 213).[1]

Aphis nasturtii (Kalt. ?).

Host.—*Nasturtium* sp. (*N. indicum ?*), found in moist places along the margins of ditches and water-courses.

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[1] [M. Das has in a clear and distinct way succeeded in separating *Aphis gossypii*, Glov., from allied forms, such as *A. malvae*, Koch. His work will definitively extinguish the confusion, which until now has reigned on this subject P. v. d. G.].

Literature :—

Kaltenbach, *Pflanzenl.*, 1843, p. 76.
Koch, *Pflanzenl.*, 1857, p. 136, fig. 125.
Schouteden, *Cat. Aph. Belg.*, 1906, p. 224.

Distinguishing characters.—The apterous female is wholly grass-green, including the legs and cauda as well as the proximal halves of the antennae and cornicles. The alate female is green with thick-veined wings and sensoria on articles III and IV. It is found on *Nasturtium* sp., a cruciferous weed, in March and April.

I believe that the Punjab insect is identical with the European one which is known to me only from published descriptions. The structural details of the latter are not available, but those noticed in the former are given below :—

Apterous viviparous female.—Body of medium size, scantily pruinose, rather stout, ovalish in form.

Colour grass-green, bright ; legs, rostrum, antennae except the sixth article, main part of cornicle, cauda, ventral surface similar in colour ; tarsi black ; eyes blackish-red.

Head twice as broad as long ; small frontal tubercles present ; prominently knobbed in front.

Antennae about two-thirds of the body-length ; the articles indistinctly separated, sparingly hairy.

Proportions :—

	III.	IV.	V.	VI.
	16	11	$9\frac{1}{2}$	6+18
Lengths ..	0·26	0·19	0·17	0·10+0·30 mm.

There are lateral tubercles on the prothorax and first and seventh abdominal segments.

Abdomen smooth, with rows of very fine hairs on the segments.

Cornicles for the most part greenish, specially near the base ; distally smoky, in old specimens they may be altogether dusky ; cylindro-conical, truncate, smooth without any imbrications, curved outwards.

Cauda somewhat conical ; apex thick and rounded, two-thirds as broad as the base.

Anal plate rectangular ; genital lighter in colour and band-like.

Rudimentary gonapophyses three.

Legs short ; tarsi black ; sole pustules well marked on the tibial points.

Rostrum long, black tipped ; it reaches almost to the third coxae.

Measurements :—

Body length	1·60—1·70 mm.
Breadth	0·95—1·00 ,,
Antennae	1·10 mm.
Cornicle	0·30 ,,
Cauda	0·19 ,,

Alate viviparous female.—Body more compact, oval in form.

Colour leaf-green; head, a band on prothorax and mesothorax, cornicles and caudal apex black; coxae, distal parts of femora and tibiae, anal and genital plates dark brown; the rest of the legs greenish-yellow; eyes dark red.

Head a little broader than long.

Antennal articles imbricate, separated by hyaline constrictions.

Proportions :—

	III.	IV.	V.	VI.
	18	12	10	6+19
Lengths ..	0·30	0·20	0·17	0·10+0·31 mm.

The spur is slightly longer than article III and may be even only as long as ·26 mm.

The prothorax has two latero-dorsal pits and tubercles on the sides.

Mesothorax with strong muscle-bosses and greenish insertions.

Wings ample, with deeply marked veins; stigmal flattening yellowish, its posterior border and the rest up to the base greenish; venation normal.

Abdomen pyriform, with lateral tubercles; the pattern consists only of three spots on carinae in front of the cornicles and one more just behind and internal to them; the rest is uniformly green.

The cornicles and cauda are smaller than those of the apterous female; cornicles imbricate and longer than the cauda in the ratio of 10 to 8; base of cauda greenish, bordered with black.

The rostrum reaches to the second coxae.

Measurements :—

Length	1·50—1·70 mm.
Breadth	0·70—0·85 ,,
Antennae	1·00—1·20 ,,
Wing expanse	4·60—6·00 ,,
Cornicle	0·16—0·21 ,,
Cauda	0·11—0·15 ,,

The insect has been collected only during the months of March and April and even then it is not very abundant. Its appearance is somewhat capricious and its disappearance is equally sudden.

Nothing is known as to its history during the rest of the year.

Brachycaudus pruni (Koch) (van der Goot).

(=*Aphis pruni*, Koch.).

"Peach-curl Aphis."

Hosts (in the plains) :—

(1) Peach (*Prunus persicae*).

(2) *Ageratum conyroides*.

Literature :—

Koch, *Die Pflanzenläuse.*
Buckton, *Monogr. Brit. Aph.*, II, p. 64.
van der Goot, *Zur Systematik der Aphiden*, pp. 96-97.
Stebbing, *Ind. Mus. Notes*, VI, 1913, p. 70 (only referred to as *Aphis* sp. from Dehra Dun).

Distinguishing marks.—This Aphid, so destructive to peaches in Northern India, may be at once recognised by its mode of attack in badly twisting and curling the leaves, in the folds of which it lies well protected and reproduces extensively. It exudes large quantities of sticky "honey-dew," which dries up in the form of a thin pallicle on the inside of the leaf ("pseudogalls") and scales off when the leaf is broken open.

The species is a small yellowish-green insect with one or more darker green stripes on the back; the cornicles are black, specially near the tip; the cauda is hardly visible from above, where there are prominent hairs; the winged females have a large black blotch on the back, accompanied by three or four large black spots on the lateral sides.

The camera lucida drawings show the morphological characters fairly well; the colour and accounts of the size of this insect will be found, given quite correctly, by several European authors.

Brachycaudus pruni resembles in several particulars another peach-infesting Aphid, known in America as the "Green Peach-Aphis" *Myzus persicae*, Schrank (=*Rhopalosiphum dianthi*, Sulz.).

Both are of a similar colour in the body and have a tendency to turn pink; the pupae have three dorsal stripes on the back and the alate females in both are furnished with a big blotch on the abdomen. As the two are frequently found together on the same plant one might easily confuse one with the other.

The following points would differentiate the two with readiness :—

Myzus persicae have larger bodies and longer antennae and legs; the antennae are placed on frontal tubercles which are large and produced into a rounded process towards the inside; the prominent cauda and clavate cornicles are besides further characters not found in the "Peach-curl Aphis," in which the antennae are implanted directly over the head without any frontal tubercles between them.

Appearance.—This Aphid is one of the worst insect-pests that the peach-growers have to contend against throughout Northern India. The leaves are so badly twisted and contorted into pseudogalls and the trees rendered so sickly and unsightly, that they can be recognised at a glance even from a distance. The leaves appear closely crowded and never expand fully; they turn whitish and in some cases pinkish in colour.

Pseudogalls.—The insects sit on the under sides of the leaves along the veins, with their beaks inserted into the growing cells of the vascular tissue. They appropriate all the nourishment that comes to the leaf and thus arrest its growth, particularly in the length. The portions of the membrane or lamina that are free to grow are those enclosed between the veins, so that in their growth they arch outwards and

form pouched convexities, under the shelter of which the insects multiply rapidly. There is an increased flow of plant juices towards the points of irritation caused by the presence of the beaks of the insects, and often later there is a good deal of hypertrophy in these parts which retain their original direction of growth. This results in the formation of the noticeable pseudogalls which are sometimes almost quite closed.

Loss of fruit.—The drain on the plant is very excessive and the normal functions of the foliage are much interfered with; naturally, therefore, the other parts of the plant and in particular the growing fruit are not supplied with sufficient quantities of nutrient fluids. They either are what the gardeners term "thin," that is dwarfish and sickly, or fall off after attaining a small size.

Sometimes whole orchards are affected and the annual loss to peaches must be very considerable. As any further consideration on this head would perhaps be foreign to the scope of this paper, the nature and extent of the loss or its prevention is not touched upon here. For information of this kind one can refer to some excellent Reports and Bulletins issued from the Agricultural Experiment Stations in various parts of the United States of America. Some of the most recent are:—

Monthly Bulletins, State Commission of Horticulture (California), 1913, by Essig.

Biennial Report of Crop and Horticultural Pests 1913: On Aphid Control by Wilson.

Bulletins of Maine Exp. Station by Patch.

Natural enemies.—In spite of its sheltered position this Aphid is extensively parasitised by a *Lysiphlebus* sp. It has often happened that if a twig has been brought from outside enclosed in a handkerchief and kept a few days under cover, one finds at the end of this period hardly any Aphids but plenty of swarming parasites. Several species of Syrphids, chiefly the smaller kinds, lay their eggs near them and the larvae from these suck the Aphids dry. Of the Coccinellids the most useful are three species of *Scymnus*, their small size giving them an easy entrance into the pseudogalls; *Chilomeles sexmaculata* and *Adonia variegata* as well as *Coccinella 2-punctata* are often noticeable, while *Brumus suturalis* is as good as any *Scymnus*.

Besides the above Stebbing has mentioned *Collophora sauzreti* on Peach Aphis (*Ind. Mus. Notes*, VI, p. 45).

Life-history.—The leafy spurs of peaches begin to sprout in the latter part of February or in early March. The Aphid also makes its appearance about this time and begins to curl them up. It is probable that in India, as in other countries, the stem-mothers hatch from eggs laid on peaches some time previously, and it is these that start future colonies; the winged generations soon appear and disperse the species to other plants. Throughout April and some part of May, and in moist shady places even up to June, the Aphids are numerous on peaches.

At this time they may also be noticed on a compositous weed, growing along ditches and water-courses (sometimes cultivated also), causing similar curls on the

leaves. On this plant (*Ageratum conyroides*) they remain throughout the rains and may be collected even up to August.

The case is the same in the hills where they are present up to August on several species of *Prunus*, particularly *P. padus*.

It is on record for the European form that alate males and oviparous females are produced in November. The latter after mating deposit eggs which remain dormant throughout the winter and hatch again in the spring. Such a course is probably taken by this Aphid in the hills in India but not in the plains. I have never observed it on any species of *Prunus* or *Ageratum* after September. It is very likely that the males and females are produced before the end of summer and these lay eggs which hatch again in March, but nothing can be definitely said until further investigation.

The alternate host *Ageratum* might possibly send back the "return migrants" to peaches, which may give birth to males and females in autumn, but in the absence of definite data nothing can be concluded. There is scope here for further work that would amply repay the labour involved as the insect is of very great economic importance. Any methods of control would entirely depend upon a fuller knowledge of its life-history.

Early application, before the leaves are fully out, of some good spray of kerosine emulsion or tobacco decoction is what seems to be practised in America for such pests.

Systematic.—So far the insect has been referred to in current literature as "*Aphis pruni*," but it seems anomalous to group this species along with *A. rumicis* or *A. gossypii*, etc., in the same genus. Several important characters, among others the peculiar form of the cauda and the anal end as well as the absence of lateral tubercles on the seventh abdominal segment, differentiate this species from the true genus *Aphis*. Mr. van der Goot, in his proposed revision of the subfamily Aphidinae, includes this species along with a few more in his new genus *Brachycaudus*. I am in entire agreement with him on this point and have accordingly adopted his name. According to him we should further consider *A. helichrysi* (Kalt.) as a synonym of this species, and as the former was employed at an earlier date the name *Brach. helichrysi* should have priority.

Since writing the above, I have secured males and true females of this Aphid in December on peaches, along with the males of *Myzus persicae*. So the life-history here is practically the same as in the West. The males are very similar to the alate females except that the antennae have sensoria on all the joints and the anal end is provided with the genital armature.

Hyalopterus pruni (Fabr.).

(Mealy Aphis of Peach and Reed).

Synonym.—*H. arundinis* (Fabr.).

Hosts.—*Arundo donax* (*Vern.* Nara).

Phragmites kirki.

Prunus persicae (Peach).

Literature :—

Buckton, *Brit. Aph.*, II, p. 110.
Riley, *Insect Life*, V, p. 236.
Gillette, *Bull. Color. Exp. Station*, No. 133, 1908.
Fabricius, Koch, Mordwilko, van der Goot and others.

Distinguishing characters.—Body somewhat linear, green; four rows of white powdery spots on back; very small cornicles; long cauda; spur and 3rd article subequal; the insect crowds closely in an overlapping manner on the leaves, plentifully surrounded by white mealy secretion and much appressed to the leaf surface, on peaches and *Arundo*, etc.

Systematic.—As noted above this insect has for its host two plants of entirely different orders, peach in gardens and *Arundo* or *Phragmites* near the water's edge. *Arundo* is pretty commonly grown as a hedge in Lahore, but the Aphid attacks it only on the river-side or along the banks of the Chhota Ravi.

The specimens developed on peaches occasionally differ in some minor details from those on *Arundo*, but in essential structure they are exactly similar. Fabricius, the author of the species, believed them to be distinct from each other, and accordingly named one *Hyalopterus pruni* and the other *H. arundinis*. Koch, Buckton and many others held similar views, but it has been definitely established by Riley and Mordwilko that the two are the same species with two distinct hosts. When the two plants occur in the same locality this fact can be easily observed.

The specific name *pruni*, as referring to the more important of the two hosts, is more commonly employed than *arundinis*, though the latter is also in use.

Life-cycle.—The course of its life-history has been followed in Lahore for more than two years and is, in the main, very much the same as what obtains in Europe and America.

Peaches, specially the young plants, put forth new leaves twice a year, once in March and again in September. At both these times thick clusters of the insect may be found crowding chiefly on the under side of the leaves. These hatch from eggs and from March to early in May several generations of apterous females are produced. After this peaches are entirely deserted, although the winged forms that are produced even earlier migrate to *Arundo* or *Phragmites*. They do not remain even on these plants for any length of time. In the summer months they are exceedingly scarce, but are in evidence again in September.

Throughout October alate females come to *Arundo* and start new colonies. The female first makes a white circle of meal, shed from its body, and spreads it evenly on the upper surface of the leaf. As long as the brood consists of only a few young, the circular form of the white patch is maintained by the mother spinning round upon its beak. The waxy secretion adheres tenaciously to the leaf long after all the insects have left. If a drop of water or honey-dew happens to fall on the Aphids it at once becomes a white globule and rolls off without wetting their bodies. During October, November and even December apterous and alate females are produced that attack *both surfaces* of the leaves. About the middle of December the alate males and

the alate females return to young peaches that still have succulent leaves. These specimens either come from other peach trees or from *Arundo*, but mostly from the latter.

The alate females known as "return migrants" are considerably larger than the ordinary winged ones, and more so than those found on peaches early in the season. The wing expanse may be as much as 7·35 mm. The sensoria on the long antennae also number more. After once settling on the leaf the insects are not inclined to move. Below and on the lateral sides of their abdomen thick masses of waxy secretion accumulate and have a silky appearance. The mass seems to be composed of acicular crystals. The quiescent insect, with a white mass below and on either side of the anal end, looks as if attacked by a fungus. The progeny of these are yellowish and soon develop into oviparous females.

These egg-bearing females begin to lay eggs near the buds about the end of December and continue doing so into January or even into February. The males usually die in December. The eggs normally hatch in March.

It would be of interest to know if some of the eggs laid in December or later remain dormant till September; the insects that cluster on peaches at this time look very much like "stem-mothers" in their form and rate of reproduction.

The parthenogenetic reproduction continues throughout winter and even up to March, on *Phragmites*; so that it is only a few of them that give birth to "males" and "return migrants" that go back to peaches, the others remain behind. Sexual individuals have been collected so far only in December and January.

Excretion of honey-dew is extremely abundant in this species; numerous ants, bees, wasps, flies, etc., flock to such infested plants. Predaceous insects and parasites are also numerous. The leaves of peaches, usually on the topmost branches, when attacked by this Aphid do not attain their normal size and colour, but remain small and greenish-yellow in colour.

Brachyunguis, gen. nov.

Characters of the genus.—Body oval, small to medium sized, clothed with mealy pulverescence.

Head totally devoid of frontal tubercles.

Antennae short, third article the longest; the spur or "unguis" of the sixth joint very small, about half as long as the base. (The generic name refers to this character).

Lateral tubercles present on the first and seventh abdominal segments.

Cornicles small, almost cylindrical, half as wide as long.

Cauda well developed, broad-based and long conical; about twice the length of the cornicles.

Rudimentary gonapophyses three.

Three species are found in Lahore belonging to this genus. All are apparently new to science, and accounts of them are given below. Among foreign Aphids none seem to have been recorded as possessing these characters.

Brachyunguis harmalae, sp. nov.

Vern. "Harmal ka Tela."

Host.—Harmal (*Peganum harmala*).

Morphological Description.

Apterous viviparous female.—Body medium sized, about a millimetre and a half in length, oval or egg-round; fairly thickly covered with white powder.

Colour green, like that of the leaves of its host; deep green from the prothorax to the first two or three abdominal segments; afterwards it becomes gradually lighter, and about the cornicles and behind them it is almost yellowish, with a very slight tinge of green on the last abdominal rings. There is frequently a light yellow coloured band stretching across the abdomen at the cornicular area. Beginning at the level of the cornicles eight conspicuous green spots on either side in the lateral grooves extend up to the head; on the thoracic segments the spots are larger and look like depressions.

Head brown, well rounded, about as long as broad with a median longitudinal line on the top, without any trace of frontal tubercles.

Eyes shining red, rather well developed, with ocular tubercles.

Antennae small, light green; distal part of fifth and whole of sixth joint black; hardly reaching up to the second abdominal spot; spur of the sixth much shorter than the base, an important feature of its anatomy.

Length proportions :—

	III.	IV.	V.	VI.
	12	7	7	$6+3\frac{1}{2}$
Lengths ..	0·20	0·11	0·11	0·10+·051 mm.

The thoracic segments are well marked off; the prothorax bears the lateral tubercles. Just below the carina or lateral edges there is a row of dark dots, seen when the insect is examined under a strong binocular lens.

Cornicles very small, greenish, cylindrical, but with a clearly noticeable rim, much shorter than the cauda.

Cauda somewhat long conical, with one or two indentations on either side from which bristles originate; a little less than double the cornicles. Colour greenish, but the edge is black reaching up to the broad base.

Anal plate brown, in front of it is the somewhat crescentic, brown genital plate.

Legs green up to the coxae, only the tarsi and a small part of the knee black; the tibiae in old specimens show a fuscous line on the outer surface.

Ventral surface well segmented, with two lateral rows of green dots and very fine hairs across the rings; deeper green on the sternum.

Rostrum rather long, greenish, last two joints dusky, reaching up to the third coxae.

Face brownish, from where the rostrum arises outlined with black.

Measurements.—The average of early-season specimens is given below; late in the season, about the middle of November, they are smaller in size.

Body (up to)	..	..	.. 1·50 × ·75 mm.
Antennae	..	..	.. 0·80 mm.
Cornicle	..	..	.. ·066 ,,
Cauda	..	..	.. ·12 ,,

Alate viviparous female.—Rather small in size; prevailing colour dark green, covered over by whitish bloom.

Head somewhat conical, about two-thirds as long as broad; black, without frontal tubercles.

Eyes dark red; in young specimens bright red.

Antennae black, but light coloured on the articulation, about half the length of the body and provided with a very small spur.

The basal one-third of the 3rd joint is narrower and lighter in colour than the rest of the joint which bears the sensoria.

Length proportions :—

	III.	IV.	V.	VI.
	14	10	10	7+4
Actual lengths ..	0·23	0·166	0·116	·11+·06 mm.

Sensoria well defined, circular, varying in number from 4 to 6; usually five on the 3rd joint; the rest of the antennae crenulated.

Prothorax banded and laterally tuberculate.

Mesothorax normal, with shining black dorsal and ventral bosses.

Wings slender, hyaline; they look almost white and smooth; the veins are very faintly marked; second fork of the cubitus small, as shown in the figure.

Stigma greenish.

Posterior wings with two transverse veins.

Abdomen pyriform, with its anterior half darker green; a stripe in the middle and the edges similar in colour. The central part is lighter. The dots on the joint of the 7th abdominal segment and three on the edges are on carinae in front of the cornicles; the dots in the lateral grooves are always clearly defined.

Cornicles and cauda like those of the apterous viviparous female, light green in colour.

Lateral tubercles present on the first and seventh segments; small flattish ones may be seen even on the other segments.

Anal plate rounded posteriorly; genital crescentic, concave in front.

Rudimentary gonapophyses three, the central one the longest.

The rostrum reaches beyond the second coxae; its last joint is longer than the one before it, and carries a small bristle with a pit on either side just below the tip.

Measurements :—

Body	..	..	.. 1·30 × 0·70 mm.
Antennae	..	..	.. 0 60 mm.
Cornicle	..	..	.. 0·06 ,,

Cauda	..	..	.. 0·11 mm.
Wing expanse	..	..	.. 8·00 ,,
Wing	..	..	.. 3·70 × 0·75 mm.

The pupae have the anterior part of the abdomen much darker than the posterior. The head generally shows two brown bands placed lengthwise; the split for the final ecdysis takes place between them. The mesothorax and shoulders are greenish-white; the wing pads are tipped with a dusky colour. The rostrum reaches up to the third coxae.

Apterous oviparous female.—The apterous oviparous female is very similar to the apterous viviparous female in the salient features of its anatomy. The body is a little longer, somewhat fusiform, specially towards the cauda. The colour is greenish, with an olive or red-brown tinge. The cauda is broadly conical and blunt. A noteworthy feature is the presence of the swollen hind tibiae, which are slightly smaller than those of the apterous viviparous female in the ratio of 8 to 9. The surface is covered with small sensoria, placed mostly on the upper three-fourths of the length. They are readily recognised as they walk with an awkard gait.

Eggs.—The body contains only one egg, which occupies about three quarters of the whole abdomen. It is either laid in some convenient place or the body of the Aphid shrivels over it, serving as an additional protective covering. Probably in such cases it is too big to be passed and the mother dies in the attempt. The egg is of the usual elongate oval type, brown in colour; after three days or so it changes to shining black. These females are produced in late December and may even be secured in January or February.

Males.—This species is remarkable for the production of numerous different kinds of males. In November the apterous viviparous females begin to bring forth dull orange coloured young. These after their usual four moults become adults. The colour remains the same or gets slightly darker, the legs and antennae being proportionately longer and blacker than other forms. There is a very strongly developed genital armature consisting of a protrusible penis, contained within the lateral conical lobes, and the whole bounded within the elliptic black ring.

The antennal joints are distinct, quite black, and studded with numerous small secondary sensoria on all the joints; they are for that reason thicker also.

Length proportions :—

III.	IV.	V.	VI.
16	11	10	$7\frac{1}{2}+3\frac{1}{2}$

Sensoria small and scattered all round; the numbers are on an average about 11–12 on III; 8–10 on IV; 12–13 on V and 1–3 on VI, besides the primary sensoria.

Cauda raised upwards, so that the genitalia comes into view even from the dorsum.

There are the following three different kinds of males, which normally form in the field as well as in the laboratory, and all the three kinds may be found on a plant at the same time:—

(1) The commonest and the most abundant type is the "apterous male." It is rather long oval, much narrower than the apterous viviparous female. Black and orange pigment are well developed on the body. The rows of dots in the lateral grooves on the dorsum are very prominent. The other characters are as detailed above. The mesothorax is small and normal and the rostrum long and reaching beyond the third pair of coxae.

(2) The second form is the "alate male." It is exactly like the apterous male in the possession of pigment, antennae and genitalia, but the mesothorax and metathorax resemble those of the alate viviparous female. It has wings which are in no way different either in size or form from those of the latter. The anterior wing of one is shown in the figure drawn to the same scale as the female wing. The body being slender they only appear large, otherwise there is no justification for calling them "voluminous" as seems to have been done in the case of other winged Aphid males.

(3) The third kind seems only a modification of the second. Here, as shown in the figure, the individual possesses well developed thoracic bosses, containing muscles for flight, but there are no wings formed. At the last moult from the pupal stage wing pads emerge, but they are only small stumps instead of the normal wings. The other organs are similar. This may be designated as the "stumpy male."

Winged and wingless males in the same species are known to occur in other foreign species also, but I have come across no mention of this third type in the literature available in India. As specimens were collected in the field as well as in the laboratory it appears to be of regular occurrence.

Perhaps it may be possible to explain it on the hypothesis of scanty nutriment, as it has been customary to do in the case of parthenogenetic females, where alate and apterous forms can be produced almost at will. *Brachyunguis harmalae* seems to indicate that the constitution of the males also is similarly and even more susceptible to some sort of variation. In all probability, however, the main factor in the case of males is the necessity for "cross fertilisation" in the species. As noted above the *Peganum* Aphid is "protandrous," that is the males form much in advance of the females. The majority of them die in a vain search for the females, which might appear even a month later. But there are always a few males present when they mature.

The apterous males attempt to creep out of the colony in which they were born; the alate forms at once fly off and must effect cross-fertilisation, if they succeed at all. A failure in the attempt to form a winged male results in a "stumpy male," which functionally at least is as good as any other male.

In this connection may be mentioned another well-known fact about Aphids recorded by several workers in Europe and America, that a very large proportion of the eggs never succeed in hatching. This is not simply due to adverse conditions

like rain, frost, etc., because after these conditions have disappeared there still remain a large percentage which do not hatch. Some facts were observed while studying this species that seem to offer an explanation. For conclusive proof of course a special set of experiments with a definite aim would have to be carried out.

One or two insects to each branch were isolated on several branches of a *Peganum* plant in the laboratory in October 1913, and the twigs were enclosed in loose muslin bags, with the idea of watching their growth and collecting sexual forms. In the bags males were formed some days earlier than the females, the latter after the middle of November. Most of the males died soon after this, while the oviparous females remained wandering about, each carrying its large egg. By the end of December all the females had laid their eggs and only some viviparous females with young and pupae were left. None of the eggs hatched, probably because none were fertilised.

It is a somewhat parallel case with what is well known in Protozoa, like *Paramaecium*. From the original "stem-mother" insect that hatches from the egg, we get in succession a large number of parthenogenetic generations, ending in the last one by the formation of true sexual individuals. The descendants of this common ancestor seem very much averse to mating among themselves. It would therefore appear that unless other males are introduced from a different stock an isolated colony however large its numbers would die a natural death, without being able to lay fertilised eggs to carry on the species into the next season. For this reason it very often happens that from single plants in the field as well as in the laboratory we seldom secure eggs that hatch, the clustering thousands being the descendants of only a single Aphid. Davis, Gillette and others have also noted that most of the eggs gathered in the insectaries shrivel up, while some of those laid and left unprotected outside do hatch. These in all likelihood must have been cross fecundated and fertile.

Peganum harmala, vernacular "Harmal" or "Aspand," is a bushy Xerophytic herb with white flowers and much-divided leaves. By some it is placed among the Rutaceae as an aberrant genus of that order, while others consider it to belong more properly to Zygophyllaceae. The plant grows abundantly in the neighbourhood of Lahore as well as in other similarly dry districts in India.

An active principle has been extracted from this plant, called "harmalin," which is supposed to be a specific against malaria. This substance permeates the whole plant and imparts to it a peculiarly offensive odour, which has earned for it the name of "devil's bush." It is probably this property which insures, in a great measure, an immunity to the plant from the attacks of animals. It is believed that even a camel would not eat it (*Lahore Gazetteer*, 1894).

The only serious pest that the plant has to contend against in nature, excepting one or two occasional visitors, is its own peculiar Aphid, which often completely smothers the growing shoots.

Systematic.—Among the Aphididae, up to very recent times, there were only two genera, *Hyalopterus* (Koch) with *H. pruni* as the type and *Brachycolus* (Buckton) the type of which is *B. stellariae*, distinguished by the cauda being longer than the cornicles. A number of other Aphids, with similar characters, have now been sorted by van der

Goot (1913) into three more new genera with differences of rather minor importance, such as the partial or total absence of lateral tubercles. These he has named *Semiaphis* for *A. carotae* (Koch), *Brachysiphum* for *A. thalictri* (Koch), and *Longicaudus* for *Hyalopetrus trirhodus* (Walker), etc.

The *Peganum* Aphid departs materially from the definitions furnished for these genera, particularly in the structure of the antennae. What is now regarded by modern writers as the sixth joint consists of two parts, the proximal known as the "base" and the distal, which is often filamentous, as the "spur," "unguis" or "processus terminalis." The latter when longer than the former was counted by the earlier authors as the seventh joint and two main divisions were recognised, one with six-jointed and the other with seven-jointed antennae. *Lachnus* and *Aphis* were representatives of these groups according to Passerini, Buckton, Lichtenstein and others. This has been shown to be an incorrect view, and the family Aphididae was split up into a larger number of more natural groups by Mordwilko (1908), who has been mainly followed by van der Goot (1913).

The "harmal" Aphid evidently belongs to their "Aphidina" tribe, but none of the genera comprised in it possess an antennal spur shorter than the base of the sixth article. I have thought it advisable, therefore, to place it in a new genus, *Brachyunguis*. Other distinctive features, besides, are the small cornicles, much longer cauda and the presence of lateral tubercles on the abdomen. Two more species belonging to this genus have been collected in Lahore.

Life-history.—The harmal plant usually perennates by means of an underground root-stock, when the portion above the soil dies out after the flowering period is over. This takes place twice a year. New shoots arise about February and, after flowering in March and April, die off in May or June. The same rhizome sprouts again after the rains, beginning from September and continuing up to about December, when again only dry branches are to be seen. So the periods of growth during the year are roughly in spring and autumn.

The *Peganum* Aphid has adapted itself remarkably to this periodicity in the growth of its host. The eggs laid in December hatch in February or March. The stem-mothers vigorously carry on parthenogenetic reproduction and one finds whole branches lined from top to bottom with rows of concolorous individuals. Alate and apterous forms are given birth to promiscuously until about the middle of April or early May, when some sexual individuals are formed. These are not very common, as only a few were observed in the colony. After the fruiting period is over there is very little sap left in the branches and the heat too becomes intolerable. The parasites of this Aphid also breed very quickly, the Coccinellids and Syrphids completing their life-histories in shorter intervals of time.

Almost all the Aphids are therefore destroyed, except those that have crept underground to take shelter in moist cool places. None are to be observed above the soil. Some eggs are at this time deposited on the plants by oviparous females. These eggs must hatch in September, when the hottest part of the year is over and the plants are reviving. It is also possible that some individuals creep out as apterous

females from places where they have been secreting themselves. Viviparous reproduction is again started with a fresh impetus and the tender shoots of the plants are crowded over by the small green pests.

In November rusty-red young are born which later turn into some kind of males, either apterous, alate or stumpy. The winged ones migrate to other colonies. In December the true females make their appearance and soon begin laying. If they get a chance of mating fertile eggs are laid, otherwise the sterile eggs are passed out which shrivel up later. Each female contains in her body a single big egg.

When active multiplication goes on, the young take only four or five days to become adult moulting four times, once a day.

The ants of the Myrmecine tribe build their nests in dry open places, and it is in similar places that the *Peganum* plant also grows abundantly. A close relation, therefore, seems to have sprung up between the Aphid and the ant. The craters of ant colonies often open below the infested bushes and their workers are incessantly coursing up and down the branches and gorging themselves with "honey-dew," which is freely exuded by the Aphids. It is not at all an uncommon sight to find the ants lifting up fallen plant-lice and depositing them again on the juicy twigs.

For observing them at close quarters some plants were brought into the laboratory in pots. After a few days it was noticed that, through the hole at the bottom of the pot, some workers of *Monomorium indica* (kindly identified by Mr. G. R. Dutt of Pusa) had entered the pots and established their galleries in the soil about the smaller roots. A large hole opened at the base of the plant, while a heap of small pellets was laid to one side as a result of this excavation. A week or so later a part of this colony, that dwelt at a little distance from the pots, had shifted itself into the new galleries bringing all their larvae and pupae with them. The latter were often aerated in the sun below the branches. This ant is so diligent that in October and November it "milked" the plant-lice at all hours of the day and night. At no time during the night were the plants found to be entirely free from ants. Some of them were always present.

The ants often took the Aphids into their galleries also. This could easily be observed when any kind of plant-lice were brought into the laboratory. As soon as the ants discover that the plant-twigs are not yielding any sap to the punctures made by the Aphids and that therefore no honey was forthcoming, they bodily removed the Aphids into their nests, where very likely they served as food for their larvae.

It is also possible that the eggs of this species are stored by the ants in their nests, and taken care of till the fresh shoots arise in early autumn and spring. This fact was first observed by Lord Avebury in regard to an English ant (*Ants, Bees and Wasps*), and is recorded by Forbes and others from America, where *Aphis maidisradicis* is entirely dependent upon *Lasius niger* for its existence and distribution.

Such relations, I have reason to suspect, exist in Lahore also, though the question has not been thoroughly investigated yet.

Very few eggs were observed to be laid on portions of the plant above the soil, as is the case with so many other Aphids.

In June as noted above most of the plants die, but some of them even at this time put forth fresh shoots which remain green throughout the rainy season. On such twigs early in June some eggs were observed to have hatched into stem-mothers and the first generation were yellow; afterwards their progeny acquired the normal green.

Brachyunguis letsoniae, sp. nov.

Host.—Letsonia scandens.

Distinguishing characters.—A fairly large, strongly pruinose, green species; cornicles small; cauda conical and larger than cornicles, both light green, the latter with a brown intercornicular band; antennae short; spur of 6th article smaller than its base; about seven sensoria on the 3rd segment; the insects cluster in the inflorescence of shiny-leaved *Letsonia*.

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body rather large, long, oval and strongly arched; covered with white meal.

Colour green, lighter on cornicles, legs and antennae; a prominent row of mostly double spots on the lateral grooves, one pair on each body segment; between the cornicular bases stretching up to the carinae is a brownish-red band.

Head brown, with pits far apart for the antennae; front well rounded and convex.

Eyes blackish-red or light red in the young.

Antennae short, light greenish; distal joint smoky; they do not reach more than half way over the back. Article VI equal to V and much smaller than III.

Length proportions :—

	III.	IV.	V.	VI.
	17	11	10	$6\frac{1}{2}+4\frac{1}{2}$
Actual lengths ..	0·29	0·19	·17	·12+·08 mm.

Thoracic segments well marked off, showing lateral depressions prominent on prothorax, which bears distinct lateral tubercles on the sides. Additional small lateral tubercles on the first and seventh abdominal segments.

Cornicles greenish in colour, small, cylindrical, very slightly incrassate at base, a little more than twice as long as broad, smaller than cauda.

Cauda greenish, conical, very broad at base; the distal part beset with pointed teeth, basal part smooth; about one-third as long again as the cornicle.

Anal and genital plates somewhat rounded and distinct.

Rudimentary gonapophyses three in number.

Legs rather stout, with black tarsi.

Rostrum greenish; tip blunt; last segment dark, of equal length to the one in front.

Measurements :—

Body	..	..	1·85 × ·80 mm.
Antennae	..	..	1·05 mm.
Cornicle	..	..	0·11 ,,
Cauda	..	..	0·18 ,,

Alate viviparous female.—Body slightly smaller than in the apterous female.

Colour similar, with dusky preponderance over antennae, legs and thorax.

The pattern on the abdomen, as shown in the figure, consists of rows of blackish spots, two on the lateral grooves and two on either side of the mid-dorsal line; three large round spots on carinae in front of the cornicles; the post-cornicular segments show three bands across them, the first one the largest.

Head dark, somewhat pointed; antennae directly implanted in the frontal pits, situated somewhat laterally, ringed with black, otherwise greenish-yellow, about half the body length; half of 3rd article narrow basally, swollen and black distally.

Length proportions :—

	III.	IV.	V.	VI.
	18	12	11	8+5 (average).
Lengths ..	·30	·20	·19	·13+·08 mm.

From 6 to 8 fairly large secondary sensoriae grouped only on the distal black half of the 3rd article; 1 or 2 of these are smaller in size than the other 6.

The primary sensoria on V and VI possess a hair-rim. From the fourth joint onward the antennae are scaly.

Eyes red.

Prothorax brownish-green, with lateral tubercles and a black transverse band.

Mesothorax with usual black shining muscle bosses.

The metathorax has two black dots placed laterally, almost in line with the lateral grooves of the abdomen.

Lateral tubercles on the 7th abdominal segment pointed and concial; there are flat ones on the other segments.

Cornicles green, similar to the apterous female, tips vasiform.

Cauda greenish, larger than cornicles; conical, with a broad base.

Genital plate crescentic, concave anteriorly; anal plate large and rectangular.

Legs with tarsi and distal femora blackish, otherwise brownish-green.

The rostrum reaches to the second coxae; between the third coxa there is a conspicuous black depression.

The wings have the normal "Aphidine" venation; veins thin and brownish; stigma throughout greenish in colour. Stigmal vein, as shown in the camera drawing, uniformly curved, while the second fork of the cubitus is much nearer the apex of the wing than the cubitus itself.

Measurements (on an average) :—

Body	..	..	.. 1·65 × 0·73 mm.
Antennae	..	..	.. 1·1 mm.
Wing expanse	..	..	.. 6·1 ,,
Wing	..	..	.. 2·80 × 1·2 mm.
Cornicle	..	..	.. 0·12 × 0·05 mm.
Cauda	..	..	.. ·16 mm.

This insect has been collected only from *Letsonia scandens* in the Botanical Garden during the month of October, 1913. Soon after this it disappeared and was never found afterwards even during March and April. *Letsonia* is neither a common nor perhaps an indigenous plant in Lahore. For the sake of its beautiful silvery leaves it is cultivated in gardens as an ornamental creeper.

The Aphid infests the tender young branches and the inflorescences of the plants.

Nothing is known about its further history and probably some alternate host may be found later.

The species is named after the host-plant and evidently belongs to the new genus *Brachyunguis*.

Brachyunguis (?) carthami, sp. nov.

Host.—"Wild safflower" *Carthamus oxycarpi.*

Distinguishing characters.—Body oblong; ashy-gray on account of the thick mealy coat; two large rectangular blotches internal to the cornicles and rows of other black spots on either side with one in the middle; cornicles black, smaller than cauda; lateral tubercles large and antennae short with sensoria even on the joints of the apterous viviparous female; it appears in the hot months of May and June.

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body oblong to ovate, rather depressed, thickest in the cornicular region; showing distinct carinae in most specimens.

Colour ashy-gray or whitish, in life almost cryptic on its host; but this is due to a very thick layer of pulverescence which conceals the real reddish-brown colour of the insect.

The pattern on the body becomes visible on removal of the meal with a drop of alcohol. It consists of two prominent irregularly-rectangular spots, internal to and slightly in front of the cornicles. A median row of dots extends from behind the head right up to the cauda; on the thoracic segments the spots are largest and faintest on the anterior abdominal segments; a double row is noticeable near the lateral grooves and still another is formed by the black and conspicuous lateral tubercles. The skin bears a mosaic of anastomosing lines.

Head rounded in front, black, about as long as broad.

Eyes black.

Antennae black, arising from depressions; they are very short, hardly reaching beyond the anterior third of the body; the joints are well marked and intricate.

The spur is only slightly smaller than the base.

Length proportions :—

	III.	IV.	V.	VI.
	12	6	6	$6\frac{1}{2}+5\frac{1}{2}$
Actual lengths ..	0·20	0·10	0·10	·11+·09 mm.

Sensoria are present on articles III and IV, from 3 to 5 and 1 to 2 respectively.

The prothorax has a large lateral tubercle and three spots on the dorsum.

The mesothorax and metathorax have their median and lateral spots particularly large; they almost form one continuous blotch in some individuals.

The abdominal segments possess lateral tubercles the largest of which are situated on the first and seventh segments. The others are small but black and in macerated mounts come out exactly like sensoria. Each black tubercle appears to be associated with a small sensorium.

The posterior segment frequently overlaps the cauda.

Cornicles black, imbricate, somewhat truncate conical, not quite cylindrical as in the type of this genus. The base is about two-thirds the length and the apex less than half. It is about one-tenth of a millimetre long.

Cauda broad-based, somewhat conical; apical portion black, basal hyaline except the edges. It is about as long as its breadth at base; a little longer than the cornicles in the ratio of 3 to 2.

Anal plate conspicuous black, rounded posteriorly.

Genital plate somewhat overlapping; a little larger and concave anteriorly.

Rudimentary gonapophyses three in number; the central one the largest and beset with a few spines.

Legs rather short and stout, dark brown; tarsi and precoxal areas black.

The rostrum reaches up to the middle of the 2nd and 3rd coxae.

Measurements (in large individuals) :—

Body	2·0 × 0·95 mm.
Antennae	0·70 mm.
Cornicles	0·10 ,,
Cauda	0·15 ,,

Alate viviparous female.—Body ovate, mealy.

Colour similar to the apterous viviparous female.

Antennae, head, prothoracic band, mesothorax, legs, cauda and cornicles all black.

The pattern on abdomen is also similar to the apterous viviparous female, except that on carinae in front of the cornicles there are three large circular spots and a small one near the base of the cornicles. The rectangular blotch is absent, but on the margins there is just another row of tiny dots in addition to the median and lateral ones.

Head broad, with prominent eyes and ocelli.

Antennae very much like that of the apterous viviparous female; the spur is small.

Proportions (on an average) :—

	III.	IV.	V.	VI.
	14	6	6	$6\frac{1}{2}+5\frac{1}{2}$
Lengths ..	0·23	0·10	0·10	0·11+0·09 mm.

The whole length about three-fourths of a millimetre.

Sensoriae from 5 to 7 on article III and from 2 to 3 on article IV.

The primary sensoriae are provided with hair-rims and are normal.

Both pairs of wings are of the same type as in Aphidinae; the veins are well marked and the stigma brown.

The lateral tubercles on the abdominal segments are much larger and their sensorium-like character is brought out with great distinctness as shown in the figure.

Cornicles more cylindrical than those of the apterous female, but of the same form and size; black, imbricated and subconical.

Cauda more pointedly conical; the distal half bearing the usual curved hairs is black and toothed. The ratio of the cornicle and cauda is as 5 to 8.

Rudimentary gonapophyses three.

Legs long; sole-pustules present above tarsi.

The rostrum reaches up to the 2nd coxae; last joint twice as long as the one before it.

Measurements :—

Body	..	..	1·90 × 0·94 mm.
Antennae	..	..	0·75 mm.
Wing expanse	..	..	5·10 ,,
Cornicle	..	..	0·09 ,,
Cauda	..	..	0·12 ,,

The insect has been collected only during May and June on *Carthamus oxycarpa*, a wild spiny compositous weed which grows very abundantly in waste land. The particular spot where it turns up every year is a fallow piece of land in the fields between the Chhota Ravi and the first "Rakh" (reserved forest) along the road leading to the railway bridge.

There are a number of ant colonies in the vicinity and the Aphid is very rarely found unattended by them. Frequently a nest opens just about the roots of the host-plant and the ants coursing up and down the stems are a sure sign of the presence of the Aphid.

It is a striking fact that this Aphid does not thrive well when kept on plants in the field isolated from the ants. There are so many Aphid enemies to contend against during these months that only those colonies have a chance to live and grow that are protected by the ants. It was also noticed that plants on the craters of ant's nests were thickly populated with Aphids, while those even a foot or two away were entirely free from them. Probably their distribution is controlled by the ants to a certain extent.

Life-history.—During the rest of the year the life-history is still unknown. There is only one host; cultivated saffron (*Carthamus unctorius*) is not known to be attacked and is not grown in Lahore.

The systematic position of this new Aphid is quite interesting. I have very hesitatingly placed it along with the *Peganum*-species in the genus *Brachyunguis*. The spur being shorter than the base, the cornicles smaller than the cauda, and the presence of lateral tubercles are features in common with that genus. But important differences, some of them given below, mark it off clearly from *Brachyunguis*:—

(1) The cornicles are black, conical and broad-based, not hyaline or cylindrical.

(2) The spur of the 6th antennal article is not so small, sometimes it is almost subequal with the base.

(3) The cauda is not quite double the length of the cornicles but much less.

(4) Specially noteworthy is the presence of secondary sensoria on articles III and IV even in the case of the apterous viviparous female.

Of all the genera catalogued from Europe and America that combine *Aphis*-like characters (*Aphis*, Linn., Mordw., van der Goot) with the cornicles smaller in length than the cauda, this species approaches nearest to *Brachyunguis*, gen. nov It, however, considerably diverges from the type. But for fear of multiplying and erecting new genera for single species I have tentatively allowed it to stand in this group.[1]

Eichochaitophorus himalayensis, sp. nov.

Host.—Several species of *Salix* that grow along the banks of canals, streams and rivers.

A small insect, chiefly sitting along the midrib of the leaves, or encrusting the tender shoots just above the stipules. Light greenish to yellowish in colour; two crescentic bands around the bases of the cornicles on the dorsum, meeting two elongated spots on the first abdominal segment; another blotch on the thorax; all of a dark green colour.

Cornicles truncate, with a network of lines on the surface; cauda constricted, knob-like; anal plate notched and a few large sensoria on the third joint of the winged female are distinctive characters. Plenty of sooty fungus blackens the lower leaves of the host-plant and ants both small and large are always in attendance.

Description.

Apterous viviparous female.—Body oval to ovate, covered with long bristly hairs, directed backwards.

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[1] [*Brachyunguis carthami*, Das, is indeed somewhat different from the other species of the genus, especially in the somewhat conical form of the cornicles, in which respect it shows some relation to the genus *Longiunguis*, v. d. G. The different other characters of this species however, such as the shortness of the "unguis" (spur) and the very flattish, almost rudimentary lateral tubercles, make it advisable that *Br. carthami* should not be separated from its original genus.

Secondary sensoriae on the antennal joints of the apterous female, as present in this species, are likewise found, as far as known, in *Aphis jacobeae*, Schrk. and *Aphis senecionis*, Williams. P. v. d. G.].

Head yellowish ; front broad, carrying two groups of bristles.

Eyes brilliant red.

Antennae short, reaching about half way down the back ; basal part concolorous with head, the distal part from fifth joint onwards black; sparingly hairy ; last joint slightly curved.

Length proportions :—

	III.	IV.	V.	VI.
	16	8	6	5+11
Actual lengths ..	0·26	0·14	0·12	0·08+0·20 mm.

No sensoria are present except the normal primary ones.

Prothorax as broad as head ; on the lateral sides of the groove behind is a small tubercle.

Mesothorax large, with an irregular green black blotch, broad in front and narrow behind and meeting with a smaller spot on the metathorax. Near the lateral edges there is another small faint dot.

Abdomen very bristly ; on the first abdominal segment there are two flattened latero-dorsal green spots and another in their middle with which they are often confluent. Another pair of broad crescentic bands passes internal to and around the bases of the cornicles, leaving large circular areas around them and extending up to the last segment but one. The seventh annulus also bears two greenish spots. The pattern is shown in the figure.

The cornicles in surface-view appear ring-like, very little above the body level, brown. A clear circular space of a light greenish colour brings them into relief. Under a high power, in lateral view, they are truncate, with a wide base and narrower somewhat flanged tip. There are circular lines over the basal part and a network of them on the distal part (see figure).

The cauda projects beyond the body as a spherical knob, between which and the broad base there is a narrow constriction. Knob yellow-coloured; there are a few curved hairs over it ; length about double the cornicles.

The anal plate can be seen from above ; it is almost rectangular, with a shallow but a very distinct notch or depression in the middle of the posterior border. Its bilobed character is just indicated and is not at all so well marked as in *Callipterina*.

The genital plate is not well seen ; the colour, like the anal plate, is greenish-yellow, but the vulva between is quite large.

Rudimentary gonapophyses four ?.[1]

Legs normal, hairy ; of the same colour as the body throughout except the dusky tarsi ; the "sole-pustules" are indistinct above them.

Rostrum very light greenish, almost hyaline, showing a clear narrow brown groove in its middle running up to the slightly darker extreme tip. It reaches up to the third coxae.

[1] [The number of rudimentary gonapophysae was not filled in in the original manuscript ; very likely the number is 4, as in other Chaithophorinae. P. v. d. G.].

Measurements (the size is very variable) :—

Body length	..	..	1·35—1·50 mm.
Breadth	..	..	0·70—0·85 ,,
Antennae	..	..	0·75 to 0·90 ,,
Cornicle	..	..	0·06 mm.
Cauda	..	..	0·10 ,,

Pupa long oval; on the brown head the red eyes and smaller ocelli are visible. Prothorax and central mesothorax green. Wing-pads whitish. The abdomen shows a similar pattern on the back as in the apterous viviparous female.

Alate viviparous female.—Body a little smaller than the apterous viviparous female, but very variable, with long hairs all over the body situated on tubercles.

Head dark brown, slightly grooved in front; median ocellus placed ventrally.

Eyes red.

Antennae dark, short, reaching half way down the back, somewhat curved near the apex.

The length proportions of the articles vary considerably, but usually III is subequal to IV and V taken together and smaller than VI including the spur, which is less than three times the base (about two and a half times). The spur in most specimens is a little shorter than III but sometimes subequal.

Average proportions :—

	III.	IV.	V.	VI.
	16	9	7	5+13
Actual lengths (variable) ..	·26	·16	·14	·09+·21 (=·30 mm).

The secondary sensoria are large and few in number, placed only on the distal half of article III. The number varies from two to five (2–5), usually there are four. There are no hair-rims and the double contour is circular.

The primary sensoria possess a circlet of hair and are of normal type.

Prothorax and mesothorax normal, black; after immersion in alcohol two spots are seen on the former.

Wings hyaline; venation normal but variable, as shown in the figures. Costa thicker than other veins, but not as thick as the subcosta. Stigma brown; its posterior border bears a row of characteristic hooked spines, and behind these runs another streak like a false vein. The cubitus sometimes has three forks. The posterior wing rarely has two oblique veins, usually only one.

Abdomen pyriform, greenish-yellow, with a similar pattern of dark green bands as in the apterous viviparous female, that is two large latero-dorsal spots on first abdominal, two crescentic ones around cornicles not meeting with each other anywhere, and two small spots on the precaudal segment. There are no lateral tubercles but two rows of black dots are well seen on the lateral grooves and margins.

The cornicles appear as rings from above, with a clear light greenish space around their bases. They are similar in form to those of the apterous viviparous female but

not so broad at the base, and the network of anastomosing lines extends much nearer the base; there are fewer circular lines. The length is a little greater than the width at the base; smaller than the cauda.

The cauda and anal plate are of the same form as in the apterous viviparous female.

Rudimentary gonapophyses four ?.[1]

Legs longer and dusky.

Rostrum up to a little beyond the 2nd coxae.

Measurements :—

Length	..	..	1·05—1·45 mm.
Breadth	..	..	0·45—0·65 ,,
Antennae	..	..	0·80—0·96 ,,
Wing expanse	..	..	3·70—4·30 ,,
Wing	..	..	1·90 × 0·70 ,,
Cornicle	..	..	0·080—0·095 mm.
Cauda	..	..	0·10 mm.

Systematic.—This small pretty Aphid of *Salix* evidently belongs to the genus *Eichochaitophorus*, recently founded by Essig to receive a populous Californian species (*Pom. College Jour. Entom.*, May 1912).

So far there is only one species in the genus and I add another from India. The Californian insect is very variable in all its structural characters and so is the Indian one. It would be quite possible in some cases on a cursory examination to confuse specimens of the two species mounted in Canada balsam with one another. But the main points of difference are the smaller size and different host of the Indian insect. The green pattern on the back is also different as well as the length proportions of the antennal articles. The number of sensoria in the American insect ranges from 3 to 9 while in the Indian insect there are from 2 to 5 only. The posterior wing in most cases has only one oblique vein, though occasionally a second one is present either wholly or in part.

The generic characters in the form of the cornicles, cauda, anal plate and the presence of a row of short hooked spines or hairs on the posterior border of the stigma are all alike.

The species is distributed over the plains of Northern India and may be collected from March to September, on the banks of streams and canals that branch from the main rivers. The indigenous home appears to be the Himalayas from where rivers issue and spread the species in the plains along with the host-plant. Near hills it is more abundant and has been observed at Saharanpur, Jammu, Rikhikesh, etc. I have for this reason called it *Eichochaitophorus himalayensis*, sp. nov.

Life-history, etc.—After the rains, in September, the leaves of *Salix* spp. begin to be attacked very severely by a rust, *Puccinia Kuui* (identification by Dr. Butler, Pusa). The Aphid, also, not getting sufficient nourishment leaves this host and prob-

[1] See footnote, p. 241.

ably migrates to some other place. The further life-history and the formation of sexuals has not been noticed.

There are the usual insect enemies; specially active are *Scymnus communis* and *Chilomeles sexmaculata*.

The small brown ants (Myrmecinae) and larger ants (Camponotidae) are always found attending the Aphid colonies.

Callipterus trifolii (Monell).

(Lucerne or Clover Aphis).

Synonym.—*Chaitophorus maculatus*, Buck.

Literature :—

(1) Monell, *Canadian Entom.*, XVI, p. 14, 1882 (contains the original description).
(2) *Ind. Mus. Notes*, IV, p. 277, and a reprint of the same in *Indian Insect Life* by Lefroy, p. 746 (gives an indifferent description with figures under a wrong name).
(3) Davis, *Ann. Entom. Soc. America*, I, 1908 (gives a description with figures).

This Aphid is very widely distributed in India and has been collected at most of the places where lucerne (*Medicago sativa*) is grown as horse fodder.

The first notice of it is to be found in *Indian Mus. Notes*, Vol. IV, no. 5, 1899, when it was reported from the Jodhpur State Farm.

The specimens were submitted to Buckton who gave a short description of it as a new species of *Chaitophorus*. It seems to have nothing in common with the characters of that genus but, as reported to me by Mr. J. J. Davis and compared with published descriptions, is evidently identical with the American insect *Callipterus trifolii*, the yellow Aphid of clover.

I have found it in several districts in the Punjab on various species of *Medicago*, also on the introduced Egyptian clover, from March to May. The lucerne Aphid is medium-sized, somewhat fusiform, pale yellow in colour, with rows of dusky spots on the back. These spots make it appear under a low lens or to the naked eye of a dark grayish colour or mouse colour.

It is extremely sensitive and the adults are very often found singly or with a brood of a few young around them. With the slightest touch or shake of the twig, on the under sides of the leaves of which they may be sitting, they fall to the ground. After remaining perfectly still for a short time—feigning death—they scramble up the branches again. On account of this habit it has been found much easier to collect them by spreading a piece of cloth under the plant and then shaking it gently. The young are not so active, nor are those that are about to moult or that are reproducing.

Both apterous and alate females reproduce parthenogenetically, which is said to be rather unusual in this genus.

As accurate and fairly detailed descriptions are available in American literature, no further morphological account is given here.

Systematic.—The generic position of this species seems to be an unsettled question so far. That it is not a *Chaitophorus*, as Buckton took it to be, is perfectly clear. It

evidently belongs to the tribe Callipterina, Mordw. A key to the genera has been published by Wilson in the *Canadian Entomologist* for August 1910, based chiefly on the relative lengths of the spur and the base of the sixth antennal segment, taken in conjunction with the form of the cornicles. According to these characters it may as well belong to *Myzocallis* as to *Callipterus*, but its cornicles differ from both. The antennal lengths are not now regarded as very satisfactory characters for the separation of genera, so if we overlook that character, the species would fit into *Tuberculatus* of Mordwilko with characters as emended by van der Goot (1913). The new type taken by the latter is *Callipt. betulicolus* (Kalt.), again an aberrant species, but possessing several features in common with the lucerne Aphid under review. These features are:—

(1) Capitate hairs over the body.
(2) Lateral tubercles on the abdomen.
(3) The presence of apterous parthenogenetic females with sensoria on their antennae.

In view of this van der Goot has recently proposed that a new genus may be erected for *C. betulicolus* (Kalt.) and that *C. trifolii* (Monell) may be styled *Neocallipterus*.

For the present therefore we may leave it as an open question until further knowledge of these forms is forthcoming. Some further information may be expected in a Bulletin on the "Yellow Clover-Aphis" that is about to be issued by U.S. Department of Agriculture.[1]

Shivaphis, gen. nov.

Type : Shivaphis celti, sp. nov.

Characters.—Head grooved in front, without frontal tubercles.

Antennae long, ringed with black; 3rd joint longest, equal to any of the two following which are subequal; article VI furnished with a nail-like process as in Lachninae or in *Phyllaphis*.

Sensoriae somewhat elliptical.

Wings with cubitus twice forked, with clouded veins which flatten into pigmented areas at the apices; stigma similar.

Abdomen ovate and provided with four rows of wax-glands, which are also present on the head and thorax and secrete profuse quantities of white powdery and fibrous flocculence.

Cornicles ring-like, small, almost flush with the level of the body, not rising above that of the glands.

Cauda well developed, cylindrical, resting upon a broad watchglass-like base.

Anal plate in viviparous females deeply bilobed as in Callipterinae.

[1] [Since Mr. Das finished his manuscript, a detailed account of the "Yellow Clover Aphis" has been published by Mr. J. J. Davis (*U.S. Dept. of Agr.*, techn. series, nr. 25, part 2, 1914), in which paper the species is still called *Callipterus trifolii*, Monell. Later investigations by Theobald have definitively settled that the "clover-aphis" is identical with *Aphis ononidis*, Kalt., and therefore has to be called in future *Callipterus ononidis*, Kalt. (see Theobald, African Aphididae II; *Bull. Ent. Res.*, Vol. 6, 1915, p. 134) P. v. d. G.].

Rudimentary gonapophyses three in viviparous females and four in oviparous females.

Rostrum very short.[1]

Shivaphis celti, sp. nov.

Host.—Celtis australis (The Indian Elm).

Vern. "Batkar"; the fruit is known as "Indarba."

Distinguishing features.—This pretty insect is not likely to be mistaken for any other occurring anywhere in the vicinity, so characteristic is its appearance even to the naked eye. They give one the idea of small pieces of cotton wool, ranged along the ventral veins of the *Celtis* leaves. They jump off with the slightest touch or shake of the branch and settle upon another leaf or twig always scrambling to the lower surface, unless the upper surface happens to be quite in the shade.

Under a lens the species shows the whole body, including the legs and wings, quite laden with the waxy flocculence, which flows at the two ends of the body into long thick, hair-like processes. Over the white back four rows of dark glands running lengthwise from the head to the cauda are conspicuous.

Other distinguishing characters are:—

The speckled wings; very small ring-like cornicles; U-shaped, bilobed anal plate, and the ringed antennae, bearing a very small nail-like terminal process to the 6th article.

Figures 1 and 2 show it as it appears to the naked eye and under a lens respectively.

Morphological Description.

Apterous viviparous female.—Body covered on all sides with white woolly flocculence, streaming out more particularly from the head, legs, anal end, and the lateral and dorsal glands; after removal of the flocculence with a drop of spirit the insect shows an elongated oval form, with wavy or festooned edges. Large glands occupy the lateral convexities.

Prevailing colour pale or dusky greenish; intermixed in the colony pink-coloured individuals are more abundant from September to November than in March and April.

Head black or dark green, without frontal tubercles; the front is grooved, with a large gland on either side. Two more glands on the dorsal surface. These secrete the flocculence which often projects anteriorly or upwards.

---

[1] [A few corrections and additions are necessary to the characters of the genus *Shivaphis*, as given by Mr. Das:—

(*a*) Mr. Das does not mention the presence of a distinct hair-rim with the primary sensoriae and a very small one on the secondary sensoriae.

(*b*) The cornicles are distinctly raised above the level of the dorsum, their length being about half their diameter.

(*c*) The rudimentary gonapophysae in the viviparous females are 2 in number; in most cases they are fused together. In the oviparous female the number will very likely be the same.

(*d*) No mention is made of 2 well-developed enlarged "empodial hairs" ("haftläppchen") at the base of the tarsal claws, as present in all Callipterinae. P. v. d. G.].

Eyes brilliant red, with well-developed ocular tubercles.

Antennae wide apart at their bases, reaching half way down the back; junctions of articles black, alternating with the rest of the segment that is whitish or yellowish; appearance ringed. Last segment (VI) with a very short spur or "processus terminalis," similar to that found in Lachninae or *Phyllaphis*; 3rd article longest, about twice the size of IV, V or VI, which are all subequal[1]:—

	III.	IV.	V.	VI.
Lengths ..	0·34	0·17	0·17	0·16 mm.

Prothorax well defined, elliptic, broader than long; lateral edges rounded, bearing large black glands; four more glands in two pairs, one behind the other, on the upper surface, and two latero-dorsal black depressions.

Meso- and metathorax like the abdominal segments furnished with two median and two lateral dusky round glands.

The abdomen bears four rows of black spots which are the wax-secreting glands, one on either side on the carinae and bulging outwards and two on the middorsum. Over the greenish or pinkish dorsal surface three or four faint whitish longitudinal lines or grooves are noticeable; transverse segmentation of the abdomen cut these grooves across, marking the surface into squarish areas in the middle of which lies a gland. A row of blackish depressions runs upon the lateral grooves, continuous along the whole body. The two median spots of the penultimate segment are larger, while those of the last one are confluent with each other. This segment has no lateral glands.

Cornicles little more than black rings with whitish centres, hardly rising above the level of the wax-glands; outline double, like a sensorium.

Cauda of the colour of the body, with the tip only dusky; almost cylindrical, resting on a broad watchglass-like swollen base; there are strong spines as usual.

Anal plate blackish, deeply bilobed or cleft like the letter U; the two limbs of the U enclose the cauda and project as far, so that three processes seem to be present at the anal end.

Genital plate much in front, large and prominent, about the same colour as the anal plate. With a high power three rudimentary gonapophyses can be discerned just behind the genital plate.[2]

Legs pale brown, almost of the body colour, except the stout black coxae, specially the hindmost ones. Distal femora and tarsi also black. In life covered with thick flocculence.[3]

---

[1] [The spur of the sixth joint is not so very short, its length being about ¼ the basal part of the ultimate joint.

On the under side of the antennal joints 3, 4 and 5, there are present at the tip a number of small wax-glands, of the same form as those on the dorsum. P. v. d. G.].

[2] [The number of rudimentary gonapophysae is apparently 2; they are placed very close together and often seem to be united. P. v. d. G.].

[3] [On the basal part of the tibia and the distal half of the femur small wax-glands are visible of exactly the same form as those on the dorsum of the body. P. v. d. G.].

Rostrum very short, just reaching a pit between and in front of the second pair of coxae. The short beak is probably correlated with the sensitive nature of the insect; some other Aphids that also have a similar beak resemble it in the habit of dropping down at the slightest alarm.

Measurements :—

Body	.. .. ..	1·90 × ·85 mm.
Antennae	.. .. ..	1·20 mm.
Cauda	.. .. ..	0·12 ,,
Cornicle	.. .. ..	0·05 ,, in diameter.

Alate viviparous female.—The alate female has often a larger amount of white flocculence, specially on the head, from which some pieces flow towards the front and others backwards and upwards; from the sides two very long and thick masses project backwards along the margin of the wings and extend beyond them like a tail. There is a predominance of a dark colour over the greenish yellow (or pink in September, October and November). The size of the individuals varies a great deal, particularly those kept in rearing pots under glass chimneys which are distinctly smaller in size.

Head black; front with two black wax-glands with a groove between as shown in the figure. Two more glands situated behind between the dark red eyes.

Antennae long, about the size of the body, ringed with black at the joints of the two articles; the third is the longest, black in the middle, and the 6th has a very short spur.

Length proportions :—

	III.	IV.	V.	VI.
	33	16	15	12+3
Actual lengths ..	·55	·25	·24	·24 mm.

Sensoria about the middle of the 3rd article, the black portion with from 9 to 11 sensoria. They appear to go in pairs; the number in larger specimens may even run up to thirteen. The third joint in such cases is longer. All the sensoria are circular and placed in one line.[1]

Prothorax similar to that of the apterous female; two pairs of glands form a single transversely elongated band; the band is darker than the prothorax and raised above its level. Two glands present on the rounded lateral side, but there are no lateral tubercles.

Mesothorax with shining black muscle-bosses; on the dorsum and sides a conspicuous black stigmal spot. The lateral lobes of the muscle-bosses are again subdivided by a longitudinal line. Those towards the inside are light in colour and smaller in size.

Wings iridescent, long and slender, stigma smoky; all the veins are clouded with

[1] [The primary sensoriae have a distinct hair-rim; the secondary sensoriae show an exceedingly short one. P. v. d. G.].

dusky pigment. At their ends near the margins the flattening of the nervures is conspicuous ; the cubitus after its first fork bends sharply and the two branches of the second fork are equal. Stigmal vein hardly visible near its basal end, but a clouding at the distal end is always present, the wing appearing speckled. The hindwings also have similar clouding at the apex of the wing and vein ends.

The pattern on the abdomen is slightly different, but in the main is the same as in the apterous female ; on the first three abdominal segments the blackish glands of the middle pair are large and confluent with their fellows, and form a straight or slightly crescentic band quite raised above the level of the abdomen, as shown in the plate. The glands on the carina make the contour of the abdomen wavy. On the hind segments the glands again become larger than those of the middle segments which have them only faintly marked, while on the penultimate segment all are confluent in a single mass.

The cornicles are like rings ; rather large, with a distinctly double outline.

The cauda and anal plate are exactly like those of the apterous female.

The legs are more dusky and possess larger flocculence.

The rostrum is small, just reaching to the black sternal bosses. On the ventral surface just above the coxae a black blotch is noticeable a little on the lateral side ; the segmentation of the abdomen is much more marked on this side.

Measurements :—

Body	.. ..	1·45 × ·75 mm. (may be smaller or larger).
Antennae	.. ..	1·50 mm.
Wing expanse	.. ..	6·5 ,,
Wing	.. ..	2·75 × 0·98 mm.
Cornicle	.. about	0·05 mm. in diameter.
Cauda	.. ..	0·12 ,,

Glands.—Each gland consists of a large number of more or less regular polygonal plates, grouped together into a rounded elevation. Over the surface of each plate are present from 5 to 8 small black dots or pores from which the flocculent secretion exudes in the form of very fine threads. They either retain their long form for a considerable time and give rise, by their coming together, to the larger threads or hairs already noticed, or break down and form the cottony mass.

The plates near the anal end and on the head are a little larger ; the number of pores on the surface also is greater and the majority of them are disposed in a circle round a single central pore.

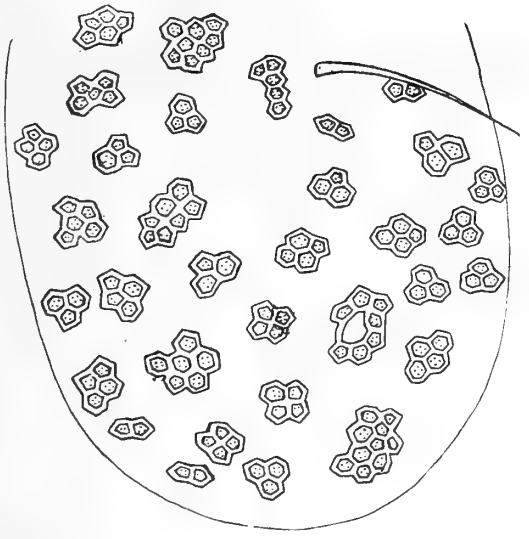

FIG. 3.—*Shivaphis celti*, sp. nov. Part of wax-plate with facets of alate female, × 890.

The cottony flocculence resembles very much a similar secretion met with in Pemphiginae and Chermesinae, but the structure of these glands is quite different.[1]

Alate male.—Body rather slender; its small size and black colour differentiate it from the alate viviparous female. There are alate viviparous females which are of the same dimensions and even smaller, but their bodies are either greenish or pinkish, never dark rusty which is the prevailing tinge in the male. Moreover, the antennae and legs are black throughout, the former unlike the ringed antennae found in viviparous females.

Head black, with conspicuous eyes; much broader than long; front bifid; not very flocculent in life.

Antennae comparatively long; 3rd joint longest; all the rest subequal.

Length proportions :—

	III.	IV.	V.	VI.
	33	16	15	15
Lengths ..	0·55	0·26	0·25	0·25 mm.

Sensoriae somewhat elliptical, not quite circular; present on all the joints. On article III about twenty (20); on IV, 8—10; on V, 8—10; on VI, 6—8. These are in addition to the primary sensoria on articles V and VI. Almost all the sensoria have a hair-rim; on the primary ones it is more distinct, consisting of larger hairs.

Prothorax with rounded lateral edges, narrower than the head, concolorous; two glands of a whitish colour are conspicuous near the posterior edge.

Mesothorax and metathorax, including wings and legs, like the alate viviparous female, but darker.

Wings not voluminous as mentioned by Western authorities for males in other Aphids. In the males of other Punjab Aphids also I did not find the wings voluminous.

Abdomen narrow, well segmented, blackish rusty, with the usual four rows of glands.

Cauda distinctly smoky; below it is the conspicuous genital armature. It consists of two lateral claspers, triangular in form and with the apices directed forwards; their ventral surface has a black boundary and is beset with whitish spiny tubercles. Between them, in the angle formed by their inner edges and nearer their bases, is the conical light-coloured, small penis, also bearing tubercles ending in curved spines. On either side of the penis running backwards and outwards is a lateral black ridge. There is a ridge in front of the two claspers and two more, one on either side,

[1] [Mr. Das' description of the wax-glands of *Shivaphis celti* not being quite accurate I feel obliged to add the following notes :—

The wax-glands open on rounded or ovate, somewhat chitinized wax-plates. A plate bears numerous groups of facets, the groups being always distinctly separated from one another; each group consists of a small number of facets (mostly 4 to 10), of a polygonal form, with a broad chitinous rim, and completely fused together. The membrane of all facets shows some fine pores, through which the waxy substance is secreted.

Each plate bears a single long plate-hair; the outlines of the plate are in most cases not distinct. P. v. d. G.].

enclosing the genital armature-like hoops. The whole structure is shown from the ventral side in the camera lucida drawing.

The anal plate is not strongly bilobed in a U-shaped manner as in the viviparous female, but the bifid character is indicated by a small notch, as illustrated.

Other characters are like the alate viviparous female.

Measurements :—

Body	..	..	.. 1·25 × 0·48 mm.
Antennae	..	..	.. 1·45 mm.
Wing expanse	..	..	.. 5·10 ,,

The males are fairly abundant in early December; late in the month they become scarce and are only to be found as isolated specimens here and there.

Oviparous female.—Long rows of oviparous females are to be noticed in late December on the under sides of yellowish leaves along the larger veins. The black legs, scarlet bodies and tapering abdomen make them conspicuous; the woolly flocculence also is not very abundant. Four rows of blackish glands run along the dorsum with slight grooves in between; the segmented abdomen causes similar grooves or shallow lines in a transverse direction. The body, therefore, appears as if divided into squarish areas each enclosing a gland in the middle. The sides of the thoracic segments often become very dark, almost as black as the head or legs.

The pore-like cornicles appear as if they were very large sensoria with a double outline; they are slightly raised above the general surface.

The post-cornicular segments taper gradually and are much lighter, almost yellowish in colour.

The ringed antennae, cauda, rostrum, etc., are all like those of the apterous viviparous female.

Genital plate large and conspicuous, concave anteriorly.

Anal plate peculiar in being stumpy, not at all bilobed; even the bifid indication of the alate male is absent; it projects beyond the cauda. In front of it are four rudimentary gonapophyses. These are furnished with shorter but stouter spines than those of the anal or the genital plate.[1]

The hind legs are conspicuous on account of their very much swollen tibiae, brownish-yellow in colour and covered over by numerous sensoria.

Eggs.—In mounted specimens the red bodies of the females show several eggs through the transparent skin, packed up even to the thoracic segments. All of them appear to be mature, of equal size and yellow. Several individuals that had not laid their eggs were dissected in chromaceltic-acid which fixes them at the same time. The number of eggs in each was from 4 to 7; the average being 6. So many eggs are quite unusual in Aphids. Generally they have only one or two at a time and in most cases never more than one in their whole life, the egg invariably being of a large size.

[1] [Very likely the number of rudimentary gonapophysae in the oviparous female is 2, like that in the viviparous forms. I had no opportunity to study this sexual form myself. P. v. d. G.].

The eggs are oval, about twice as long as broad and sticky on one side, on account of the glue with which they are fastened down. They are yellow when first laid, but soon turn shining black. Length 0·5 or ½ a millimetre.

The oviparous females can be observed in early January coursing up and down the branches, and often they wander a good deal with an egg sticking out through the genital aperture, before depositing it in any convenient place.

The young twigs of the Indian Elm are very tomentose and frequently the eggs are buried in the hairs; they may also be glued on to any roughened surface; small lenticels which appear about this time are sometimes chosen for the purpose. But the most favourite places are either small cracks in the bark or the ventral surfaces of any scales which cover the future shoots and happen to be sticking out. These eggs are quite bare and, so far as I have observed, no waxy flocculence is used to hide them from view, as noticed in the case of *Phyllaphis* (Weed, *Nat. Hist. of American Insects*).

Natural history and life-cycle.—After one or two winter rains, about the middle or the latter part of December, followed by cold winds and frosty nights in Lahore, the leaves of *Celtis* trees begin to turn yellow and slowly drop off. For the most part of January and February the larger trees are all bare and without foliage. At this time there are hardly any living Aphids present; only the eggs that are deposited by the oviparous females in January are to be met with after a careful search. In early March or even in the last week of February the plants begin to put forth their tender leaves and the Aphid eggs also hatch at this time. The young from these eggs are what are termed *stem-mothers*. They start the colonies and about the 10th or 12th of March one may notice these flocculent apterous females with a brood of four or five young, produced parthenogenetically. They resemble in all essential features the apterous viviparous females of later generations. After two or three generations, as the young develop into viviparous females and begin to reproduce actively, the winged females are produced. These are the *alate migrants* that fly off to other plants or to different parts of the same plant. They also give birth viviparously to apterous females, without the usual fertilisation. So that even in March we find plenty of alate and apterous females which multiply rapidly.

Habits.—These insects are extremely sensitive and with the slightest touch or shake of the leaf on which they are resting, they jump off and either fall to the ground or to a lower leaf or fly off. Only the very young specimens and those in the act of reproducing are disinclined to move.

Pink forms.—Most of the individuals at this time are of a greenish colour, with a brown or blackish tinge, though in April and May some pink-coloured forms are also to be met with. The size is very variable; one may find individuals hardly exceeding one millimetre in length, while others may be a little less than two.

Honey-dew is passed very copiously.

There is a marked decrease in their numbers in the second half of May and hardly any are to be seen on the lower branches of the trees in June. For the last three years I have not had the opportunity of staying in Lahore from June to Sep-

tember so have nothing definite to say about this period. I believe that they do not produce sexual individuals that would lay eggs and probably hide themselves in shady places. Not only is the heat very trying, but the flow of sap also is very scanty in the plants during this interval. The insect is no doubt present in the hills of the Punjab as I have collected it in July and August around Simla.

As the plants resume activity in the autumn for secondary growth about September, the plant-lice also become prominent. From September onwards through October and November wingless and winged females are produced in extremely large numbers. There is a preponderance of alate females and quite a large number of them as well as apterous females are pink-coloured.

Experiments.—A series of experiments were started with one Aphid on each young pot-plant, covered over by a lamp chimney with a piece of muslin tied over the top. A circular piece of white or black paper was spread over the soil to find out the number of moults, the skin being cast down each time. The pot was kept in a dish in which water was poured as desired for irrigating the plant from below. The whole arrangement is shown in the accompanying illustration.

FIG. 4.—A seedling of *Celtis australis* under a muslin-topped chimney. The pot stands in a shallow dish of water and is irrigated from below. This American device is very satisfactory for studying the life-history of plant-lice.

The number of moults that each Aphid undergoes to reach the adult reproducing stage is four, and in pot plants they were spread over from 12 to 20 days. In nature I believe the period is shorter.

The apterous viviparous females under these conditions almost invariably gave birth to young ones which changed into alate viviparous females. The size of these laboratory specimens was usually smaller than those on the garden plants. Each individual lived upwards of forty and even fifty days. They become very inactive after about the middle of November.

Experiments were also arranged to find out when the true sexes were produced. Some of the pink pupae in December ultimately changed into small-sized males with black antennae and conspicuous genital armature. In the botanical gardens, under natural conditions, they appeared in the second half of November, and were fairly abundant up to the middle of December. After this only a few isolated individuals were to be met with. At this time large numbers of apterous females turn red or scarlet and after December have their true characters well developed. They are the true oviparous females described above and chiefly cluster along the veins of leaves that are about to fall. In the last week of December and early in January there are large numbers of these oviparous females; an occasional winged male and a few apterous and alate viviparous females are also present.

The eggs are collected best in muslin bags tied over the whole twig containing these females with one or two males, but the latter apparently are not necessary. They can also be made to deposit their eggs in tubes. It is these eggs mainly that carry the species through the winter. In March they hatch into stem-mothers to start the new life-cycle.[1]

Natural enemies.—Chilomeles is the worst enemy of this Aphid; it comes upon the scene almost simultaneously with the appearance of the insect in March. Both the larvae and the imagines actively devour the Aphid and the latter lay their yellow clusters of eggs freely near them.

This species, probably because of its active habits, is singularly free from the attacks of Syrphid larvae, and very few internal parasites have been bred from them. On one or two occasions I have obtained a Dipterous fly, not noticed as an Aphid parasite before by me, from their colonies. The woolly covering of the Aphid apparently serves as a good protection.

The life-history of another insect (*the Punjab Spotted Chrysopa*) has been worked out which seemed to feed actively on this Aphid but was not found common on others. It is a species of *Chrysopa*, but quite distinct from the common "Lace-wing" or "Golden eyes" which is abundant wherever plant-lice are to be had. It differs from the latter in its black eyes and mottled or spotted wings, besides other characters; it also does not carry the wings so vertically but rather flat or at a smaller inclination. The larvae are beset with strong lateral processes carrying bunches of radiating spines; the back of the larva is covered over with a heap of dry Aphids and Aphid wings that hides it as it moves forwards in a leech-like manner. The cocoon is also protected in a similar manner. It pupates for about ten or eleven days; the pupa (or nymph) after cutting out a circular lid in the spherical cocoon creeps out and either on the top of the cocoon or some distance from it moults for the last time to emerge as a delicate green insect with spotted gauzy wings.

It appears that there is only one species of *Chrysopa* so far recorded from the plains of India, figured by Lefroy in *Indian Insect Life*, pp. 154—157. We do not even know its specific name and Lefroy mentions it as *Chrysopa* sp.

The movements of the pupa before the final moult, which I have noticed even in this species, has apparently been overlooked at Pusa (Behar), where the life-history seems to have been studied and figured.

For the sake of future reference and for want of a better name we have been calling it in Lahore "The Punjab Spotted *Chrysopa*."

It has been figured among the insect enemies of Aphids.

Systematic.—According to the majority of the earlier and some of the recent authorities, *e.g* Lichtenstein, Buckton, Ashmead, Gillette, the systematic position of this Aphid ought to be among the Lachninae. This sub-family of the Aphididae is

[1] [In connection with our knowledge of the geographical distribution of Aphididae, it is perhaps interesting to know that *Shivaphis celti* has been collected in Ceylon (Peradenyia) by the late Mr. Rutherford. P. v. d. G.].

distinguished chiefly by the antennae being six-jointed and by the sixth article bearing a small nail-like spur, the "processus terminalis," the latter could not be counted as a seventh joint as in the sub-family Aphidinae. It would in that case be placed very close to the genus *Phyllaphis* of Koch and *Ptychodes* of Buckton.

In common with *Phyllaphis*, it possesses wax-glands that secrete the woolly flocculence over the body, small pore-like cornicles, and antennal articles of the same proportional lengths. Winged males and apterous viviparous as well as oviparous females (the latter containing from six to eight eggs) are also present in both genera (*Phyllaphis* and *Shivaphis*).

The main points of difference are the well-developed cauda and the pigmented wings; the former is said to be obsolete and the latter plain in the case of *Phyllaphis*.

The resemblance to *Ptychodes* is as follows:—

(i) In the wings, where the nervures dilate at their apices into triangular fuscous spots.

(ii) In the deeply bilobed character of the anal plate, which is situated below a distinct though not quite similar cauda.

The differences to *Ptychodes* is that in *Ptychodes* there is no trace of wax-glands, the body instead being very pilose, the young specially so. The cornicles also are "buccinate" and all the parthenogenetic females are always said to be winged.

The Indian insect agrees with neither of these genera, nor have I been able to find any among the genera so far described in which it could be properly placed. It had, therefore, to be separated into a new genus, *Shivaphis*. It was fortunate in this connection that I was in a position to consult and also to have the agreement of a distinguished European student of Aphids.

In proposing the name *Shivaphis* for this insect, I have followed the lead of some of the distinguished naturalists who have carried out their investigations in this country. The Aphid is named after a chief Indian deity "Shiva," who is usually represented with long ash-gray hair flowing down his back, from amongst which the sacred waters of the Ganges take their origin. The long and white flocks of waxy material over the head and body of the insect does remind one of Shiva's hair, though the comparison between the Ganges and the copious honey-dew that the insect discharges may not be quite appropriate.

Shivaphis has further a systematic interest of its own, specially in view of the recent overhauling of the "classification of aphids" which even now can not be considered as quite satisfactory.

Buckton, as indicated above, was the first to establish a new genus (*Ptychodes*) for a walnut Aphid first described as *Aphis juglandis* (Frisch), and later transferred by Koch and Passerini to *Callipterus*. The short antennae, aborted spur, and some differences in the form and metamorphosis required in Buckton's opinion the creation of a new genus. But he has had little support from modern aphidologists and the species *juglandis* has been placed, with good reason no doubt, again in *Callipterus* with *Ptychodes* as a synonym.

In 1908 Mordwilko included *Phyllaphis* in his tribe Callipterina and in this he has been followed by van der Goot in 1913. But American authors like Ashmead, Gillette and Wilson do not seem to agree in regarding *Phyllaphis* as a Callipterine genus at all. The characters proposed for Callipterina by van der Goot in "*Zur systematik der Aphiden*" are as follows:—

(i) Body bare, with short sting-like hairs or with long capitate hairs. *Wax-glands very seldom present.*

(ii) Antennae seven-jointed; *very seldom six-jointed*; last joint scaly or with indistinct small corns; primary sensoria always and secondary very often with hair-rims.

(iii) Cornicles very small, somewhat cone-like; *very seldom pore-like.*

(iv) Cauda almost always "wart-like"; *seldom not or hardly constricted.* Anal plate often bilobed; rudimentary gonapophyses two.

(v) Cubitus twice forked; tarsi with two "haftlappchen" ("hold lappets").

The Callipterini if defined in this comprehensive way would include *Phyllaphis* and for that matter *Shivaphis* as well. But the part of the definition relating to *Phyllaphis* is chiefly made up of characters that are more exceptional than normal. They are given in italics above. They evidently introduce an element of heterogeny into a group otherwise noted for its uniform nature. Most writers have thought so and among the most recent we may mention Wilson, *vide* his "Key and Synonyms of the genera in the tribe Callipterini (*Canad. Entom.*, XLII, 1910). Essig has followed him (*Pom. Coll. Jour. Ent.*, IV, no. 3, 1912).

The chief reason why *Phyllaphis* has not been recognised as a Callipterine genus seems to be that externally it had little in common with the Callipterinae, while with the Lachninae it agreed at least in having an aborted antennal spur and small cornicles. But it was probaby placed there more for lack of any definite group to receive it than for any true affinity with *Lachnus*.

This point has been emphasised recently by Mordwilko and van der Goot, who have taken the same number of "rudimentary gonapophyses" and the presence of "haftläppchen" on the tarsi as the main grounds for grouping it with the Callipterine genera. For the aberrant characters the definition has been apparently stretched. That the views of Mordwilko and van der Goot are nearer the truth is strikingly proved by the discovery of the Indian genus *Shivaphis*. Along with many of its pronounced resemblances to *Phyllaphis* in the wax-glands, cornicles, etc., the possession of a bilobed anal plate and pigmented wings show a decided relationship with the Callipterinae.

But it still seems very hard to imagine that genera like *Phyllaphis* and *Shivaphis* could possibly have originated from Callipterine ancestors. Even if we leave aside other characters, there is little parallel or justification in regarding a replacement of sting-like hairs in one by wax-glands in the other as of minor importance and of conceivable occurrence in the same sub-family.

In my opinion, now that we have at least two genera, they have every claim to be recognised as forming a separate group or a subgroup of their own. It would be

near Callipterina of course, but distinct from it and in no way connected with Lachnina. It might for the present be called Phyllaphidina and defined thus:—

Body furnished with rows of "gland-groups" secreting a flocculence of a waxy nature.

Antennae six-jointed; the sixth article bearing a rudimentary "processus terminalis" or spur.

Cornicles small, pore-like, hardly rising above the level of the body.

Cauda scarcely constricted.

Wings plain or pigmented.

Rudimentary gonapophyses in viviparous females two in number (oviparous females in *Shivaphis celti* have four).

Other characters much as in Callipterina.[1]

Tuberolachnus viminalis (Fonsc.) Mordw.

Hosts.—Salix tetrasperma; *Salix aegyptica* (*Bed-mushk* or Scent willow); *Salix* sp.

Synonyms.—Lachnus viminalis (Fonsc.), *L. dentatus* (Le Baron) and *L. fuliginosus*, Buck.

Literature :—

Buckton, *Mon. Brit. Aphids*, II, pp. 53—57, 1887 (gives description and previous literature).

Essig, *Pom. Coll. Jour. Ent.*, IV, No. 3, pp. 774—789, 1912 (a complete bibliography with excellent description and plates).

Wilson, *Ann. Entom. Soc. America*, IV, p. 53, 1911 (notes on synonymy).

This is the largest Aphid of the plains, possessing characteristic facies which render its recognition very easy. In every respect it is identical with the insect as met with in Europe and America, but seems so far to be unrecorded from Asia. The larger branches of *Salix* trees are covered over in patches of several inches in length with

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[1] [The genus *Shivaphis*, Das, is a very remarkable one, but it does not deviate so much from other Callipterinae as Mr. Das thought. Indeed, in my opinion, this genus forms a very interesting and hitherto missing link between the bulk of true Callipterinae and the somewhat aberrant genus *Phyllaphis*, Koch.

From all true Callipterinae *Shivaphis celti* shows the greatest resemblance to "*Ptychodes*" *juglandis*, Frisch (sub *Pterocallis* by v. d. Goot). But whilst in *Pt. juglandis* the aborted spur is still about half as long as the base of the ultimate joint, in *Shivaphis celti* its length is much more reduced, to about $\frac{1}{4}$ the length of the basal part of joint VI. The caudal parts and wings in both species are nearly similar. The cornicles, although smaller, in *Shivaphis* still distinctly show above the level of the body; they are somewhat conical, not pore-like as Mr. Das shows them to be. The presence of wax-glands in *Shivaphis celti* does not separate it from other Callipterinae, as Mr. Das thinks, since we find such glands in some other true representatives of this tribe, such as *Euceraphis betulae*, Koch, *Subcallipterus alni*, Fabr. (♀) and *Pterocallis tiliae*, L. (♀).

The principal character of *Shivaphis* in common with *Phyllaphis* is the smallness of the spur; other common characters, as mentioned by Mr. Das, are of little or no importance.

I do not think that the discovery of *Shivaphis celti* should necessitate the creating of a new separate tribe next to Callipterina. The discovery of *Shivaphis* gives us one more very valuable contribution to our knowledge of the Callipterina, showing that the genus *Phyllaphis* does not indeed deviate very much, but is connected by some intermediate forms to the bulk of typical Callipterinae. P. v. d. G.].

countless young and adults sitting compacted together, all facing in one direction. Very frequently the insects wave their long hind legs in the air, either to ward off enemies or for the sake of pleasure as they do it even when there is nothing to fear. The discharge of honey-dew is very copious, drenching the lower leaves and branches and later congealing into solid sugar which does not crystallise.

A very thorough account of its external anatomy, with fine illustrations, is published by Essig (1912) so that no further account is given here.

The most outstanding features are its large size and grayish-brown colour, as shown in the figures; a prominent black dorsal tubercle situated between and a little in front of the equally conspicuous cornicles, and present in all stages of life; rows of black spots on the back; hind legs and rostrum very long, the latter in newly born individuals reaching beyond the abdomen; sensoria in one line on the antennae of the alate female; wings large, hyaline and carried normally; body and cornicles covered with fine hair; cauda obsolete.

In California, according to Essig, winged females are rare, but this is not so in Lahore; the vast majority of them in February are alate, while very few are apterous. It is also said to be free from the attacks of predaceous insects in other countries, but this is not true in the Punjab. Several Coccinellids and the larger Syrphid larvae attack it, but not so much as other species of Aphids.

The earliest date for its appearance in Lahore is late in December or in January. Only apterous females are found then; about the last week of February all forms are abundant in the botanical gardens outside the city as well as on willows near the Ravi.

No appreciable injury is inflicted on the larger trees. The pest therefore has little or no economic importance in the West, but in Lahore it also occasionally attacks the delicate *Salix aegyptica*, the scent willow, vernacular "bed-mushk," which is cultivated for the sake of its male catkins. From these are extracted a "bed water" (*arg bed-mushk*) and a "bed essence" (*ruh bed-mushk*), both of which are officinal in the Indian systems of medicine and very much in demand during the summer. The nature of the attack on these male plants (females are not known) seems never to have been very serious so far, but it might just as well be considered as a possible source of danger, hence the economic value of this otherwise more or less harmless Aphid.

In earlier literature the Aphid has been referred to the genus *Lachnus*, but, in view of the presence of dorsal and lateral tubercles coupled with slight differences in wing venation, Mordwilko (1909) has separated it into his new genus *Tuberolachnus*. This procedure has been justified by Wilson (1911) on the grounds of priority as well.

In 1891, from the Indian Museum, Calcutta, some Aphid material in alcohol was forwarded to Buckton with the information that the insect "infested peaches and apricots in Quetta (Baluchistan) and caused their bleeding." Considering it to be a distinct species and naming it *Lach. fuliginosus*, Buckton published a very poor description with worthless plates in *Ind. Mus. Notes*, II, no. 1, p. 40. The chief point of difference that he notices is in the form of the pupae of his new species from that of

Lach. viminalis of the willow. Buckton says that a dorsal horn-like process is present in the former, while in the latter "it is restricted to the apterous female." This is a mistake as the tubercle in *Lach. viminalis* is present in all stages; Buckton was evidently misled by the name of the wrong host being supplied to him.

I have had the opportunity of examining a part of this material in Calcutta and I found that in the same phial were also included a few apterous and young females of a peach Aphid, described below as a *Tuberodryobius*, which is altogether a different insect. I have therefore placed *Lach. fuliginosus* (Buck.) among the synonyms of *Tuberolach. viminalis*.

Tuberodryobius persicae (Cholodk.)[1]

(Clouded Peach-stem Aphid.)

(*Vernacular*, Aru ka Tela).

Hosts :—

(1) *Prunus persicae* (peach).—*Vernacular*, Aru.

(2) *Prunus communis* or *domesticus* (plum).—*Vern.* Alucha.

(3) *Prunus armenica.*—*Vern.* Khurmani.

(4) *Prunus amygdalis* (almond).—*Vern.* Badam.

Distinguishing characters.—One of the largest Aphids of the plains, infesting the main trunk and branches of the fruit trees named above, more particularly the peach. Big patches numbering thousands of individuals cover the branches in lengths varying from a few inches to yards. If one stands beneath an infested branch the "honey-dew" falls like a gentle shower of rain, trickling along the lower parts of the plant it gives it an oily appearance; the plant later turns black from the growth of a sooty fungus (*Capnodium*). The vegetation below is quite smothered and blackened. Numerous ants, bees, flies, wasps and other "honey-seeking" insects gather about these trees which are conspicuous from a distance in early winter and spring.

The apterous insects are variegated in colour, to the naked eye appearing like small castor-oil seeds; the colours are grayish-white and dark reddish or pitch black intermixed.

The most prominent parts are the two rows of median dorsal tubercles, two very large conical and black cornicles and many black spots in rows. The mesothorax is covered with whitish pulverescence and similar gray areas are noticeable in front and behind the cornicles. The small antennae, long red-brown legs, silvery white ventral surface showing a huge rostrum in the middle, rather slender wings with deeply pigmented black areas are all characteristic.

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[1] [Mr. Das having apparently forgotten to give a summary of the characters of his new genus *Tuberodryobius*, I will for completeness sake add it here.

Genus *Tuberodryobius*, Das. (Type: *Lachnus persicae*, Cholodk.).

Morphological characters. Body large, pilose, with 2 rows of distinct dorsal tubercles on the 6 foremost abdominal segments.

Other characters are similar to those of *Pterochlorus*, Rondani. P. v. d. G.].

MORPHOLOGICAL DESCRIPTION.

Apterous viviparous female.—Body ovate or pyriform, in fat specimens somewhat flask-like; thick and rounded behind about the region of the cornicles, gradually narrowing towards the head.

The prevailing colour is variegated black and white.

Head quite black, bearing one white spot about the middle of the posterior edge; twice as broad as long. On either side of the median line there are two slight elevations with radiating hairs placed upon small tubercles. The front is flat and hairy.

Eyes black, with very small ocular tubercles.

The antennae rest directly upon the head; the basal two articles concolorous with the head; the proximal halves of articles III, IV and sometimes of V reddish-brown, the rest black. There is a slight curvature beyond the basal two joints; the last segment is swollen and bears the nail-like spur. On the whole the antennae are short, about one quarter the length of the body; tuberculate hairs are scattered over the surface.

Length proportions :—

	III.	IV.	V.	VI.
	30	15	14	7+4
Lengths ..	0·50	0·25	0·24	0·12+0·07(=0·19) mm.

Sensoria.—From 3 to 5 large sensoria are found on the distal quarter of the 3rd article and from 1 to 3 on the 4th. One primary sensorium on the 5th and another with a few more scattered around it on the 6th. The hair-rims are not distinct in any.

Prothorax well defined, somewhat rectangular; it bears two ⌊-shaped broad bands, the transverse limbs on which are longer and meet at their ends a black rounded elevation beset with hairs, near the posterior angles; the other limbs are shorter, slightly converging towards the middle of the anterior border. Between them they enclose a mealy triangular spot, the base of which is the middle of the posterior border; the latter bears two more smaller white spots.

In the angles of these bands, which face outwards, there is one white spot, the centre of which is occupied by another black hairy spot. On the pleurae, *i.e.* the lateral side just above the coxae which are ventral, there is a distinct lateral tubercle.

Mesothorax separated from the prothorax by a black line extending over the anterior border; at its ends near the lateral edge it bends at right angles into an elongated, hairy black spot on either side. There is a very large pair of black dorsal tubercles, somewhat flattish and hairy; each bears in front one black spot and another on the dorsal space which is grayish-white. The pleurae are very dark black and even encroach upon the dorsal surface. On the groove behind there is another spot behind the latero-dorsal one on each side.

Metathorax similar to the mesothorax, so far as the tubercles and spots are concerned. The dorsal tubercles, one on each side of the median line, are smaller;

the tubercles near the lateral edge are very small and represented by a few hairs; the rest of the dorsal surface is covered over by the whitish pruinose secretion and forms a conspicuous band or white area.

Both of these thoracic segments bear conical lateral tubercles, situated a little above the coxal membranes of the leg joints. The groove behind has four spots upon it, two median and two latero-dorsal which are larger.

Abdomen globular or ovate, thickest about the cornicles; it is exactly bilaterally symmetrical and is made so by a mealy line which runs longitudinally in the mid-dorsum and can even be traced over the thoracic segments, up to the head. Immediately on either side of it, each abdominal segment carries a conspicuous black projection—the "dorsal tubercle," surrounded at its base by a concolorous circular spot and beset with short radiating hairs. Near the lateral edge there is another flattish tubercle with similar hairs, which might be termed the "dorso-lateral" tubercle. Just on its outer side there is one black spot.

Upon the groove, which divides two consecutive segments, are placed six black round spots; one pair in front of the "dorsal tubercles," and one pair on either side in the space between these and the dorso-lateral tubercle. The spots are quite black, with a round depression in the centre; after treatment with caustic potash it is this depression which remains black, the rest becoming bleached.

The first three segments are quite like each other; on the fourth the dorso-lateral tubercle is very small and upon the fifth and sixth it is represented by small spots only, over which a blackish broad band runs backwards and outwards from the cornicles to the lateral border. In all other respects these segments are similar, but the dorsal tubercles of the seventh segment are very large and transversely flattened and apparently confluent with the 7th dorso-lateral tubercles. On the eighth segment they are alike but smaller.

Pattern.—The pattern, therefore, consists of two *dorsal* rows of tubercles and two *dorso-lateral*. Of the spots there are eight longitudinal rows, two dorsal, four dorso-lateral and two almost lateral. In addition to these, each ring of the abdomen carries a prominent lateral tubercle situated on the carinae with spots alternating with the tubercles.[1] The ultimate segment is telescopic and forms a ring encircling the cauda and the anal plate.

Cornicles large, black, truncated cones; their bases are very broad and surrounded again by black basal areas, which occupy a considerable portion of the dor-

[1] [The description of the arrangement of tubercles, etc., as given by Mr. Das, is in my opinion not fully correct.

We find 2 spinal (="dorsal") tubercles on the dorsum of the mesothorax, metathorax and the abdominal segments 1—6. On segment 7 and on segment 8 there are two large, oval, chitinous "pleural" plates, but no "tubercles."

On the margins of the abdominal segments 1—3 there is visible on either side a chitinous rounded plate, which in my opinion cannot be termed a "tubercle" (= "dorso-lateral" tubercle of Mr. Das).

The "prominent lateral tubercles situated on the carinae", as mentioned by Mr. Das, I have not been able to discover. Perhaps Mr. Das may have mistaken the large stigmata for them? P. v. d. G.].

sum on the fifth abdominal ring and encroach upon the fourth and the sixth as well. Over the surface there are numerous hairs and the truncated end is bounded by a rim, across which is stretched a white membrane. Upon this membrane lies another black incomplete ring. The diameter at the apex is about one-third of that at the base. The secretion from the cornicles is dirty black.

The cauda is a flattened semicircular plate with its posterior convex edge much thickened, black and strongly spiny; it is attached by its broad base and does not project much beyond the body.

Anal plate below large, broadest in the middle; black and spiny like the cauda.

These two structures bound the anus, which is a large opening facing postero-laterally. The clear drops of limpid "honey-dew" exude at this place and are thrown off at very short intervals of time.

Genital plate smaller, somewhat elliptic in form; it forms the anterior boundary of the genital aperture. In colour and spinose character it resembles the anal plate.

Three rudimentary gonapophyses are to be discerned as faintly marked small processes, with a few spines to each.

The ventral surface in living specimens is silvery white on account of its pruinose character. The colour otherwise is dark purple, due chiefly to a similar tinge of the body juices. Near the lateral edges on either side runs a row of large black spots.

The legs are remarkable for their length; the hindmost are the longest and proportionately longer than in most other Aphids. The colour is shining orange or reddish-brown, with some parts pitch black.

In the hind legs the coxae, their membrane, a small patch to the outer surface of the femora, the femoro-tibial joint, the ankle and tarsi are quite black. Most of the femora and tibiae are orange brown, the later shading into a darker colour. The tibae are a little less than double the length of the femora and are a little curved towards their distal half as shown in the camera drawing.

Tarsus.—There are no sole-pustules present on the tibial points; the first joint of the tarsus is about one half the length of the second; the latter is furnished with two stout claws. The other legs are shorter but similarly coloured; on the middle of the femora they bear a complete ring of black which may sometimes extend very near to the coxae.

The rostrum is remarkable for its length; it reaches much beyond the level of the third coxae, often up to the level of the cornicles and even further in thinner specimens. The longest article is brownish in colour, while the last two are black and subequal. The three setae that may be seen in the ventral groove are very long, while the labrum at the base is a well-developed, narrow, triangular piece, overhanging the setae. The rostrum in the new-born young is proportionately much longer and projects like a tail from the ventral side of the body end.

The face is shining black, elevated from the middle of a depression, bounded by a mealy ridge which runs on its anterior and lateral sides as a white line.

The measurements on an average are as follows:—

Body	4·0 × 2·2 mm.
Antennae	1·40 mm.
Hind leg	5·35 ,,
Cornicle (base)	0·46 ,,
,, (apex)	0·15 ,, in diameter.
Cauda (length)	0·20 ,,
,, (breadth)	0·41 ,,

Alate viviparous female.—Head deep black, comparatively large, about as broad as long, bearing pitchy black eyes with ill-defined ocular tubercles. On the sides of the dorsum are two hairy elevations which mark out a central rectangular area that is somewhat depressed.

The median ocellus is placed rather ventrally, a little above the lower edge of the front, that runs like a hood on the sides and in front of the face, forming a white mealy border.

Antennae comparatively short; in living specimens perfectly black. In length the proportions are the same as in the apterous female; article III is the longest, about equal to the two following taken together, which are of the same length, about one and a half times the 6th.

Sensoria large, without very distinct hair-rims either on the secondary or primary ones. Their number on article III is about fifteen, while four or five are present on IV.

The prothorax is clearly marked off and shows a broad band over its anterior half, somewhat constricted in the middle as shown in the drawing. The lateral tubercles are placed over the posterior angles.

The mesothorax is shining black, with broad muscle-bosses; its anterior edge projects into a black peg-like process that goes beneath the prothorax into a triangular concavity.

The metathorax forms a broad convex band, similar in colour to the mesothorax and bounded externally by the dark brown insertions of the hind legs.

Wings.—Anterior pair rather short, well rounded and narrow in width. On distended large viviparous females they look much smaller and out of proportion. They seem to be seldom used for flight; when disturbed, the insect trusts to its legs more than its wings. In fact it is very rare to catch this Aphid on the wing. They are further characterised by being deeply pigmented with black which often shines like jet. The disposition of the pigment is shown in the camera drawing.

The stigma is long, black, lighter towards the centre. There is a big black patch along the first oblique vein, occupying largely the space between the first and the second oblique vein; the next cell contains a small area near the hind margin. Most of the space between the stigmal vein and the cubitus, with its two forks, is pigmented, except a small triangular area behind the stigma; near the margin, between two consecutive veins, are noticeable blotches of deeper black, six in number, beginning with the one just in front of the stigmal vein.

The hind wings are hyaline, with two oblique veins; the subcostal along its

anterior edge is pigmented as a distinct band. All the veins are striated transversely and, except the patch along the first oblique in the forewing, the pigmented parts and the margins bear complete or incomplete hexagonal figures, raised above the general surface on both sides. These are imbricated one above the other.

The abdomen is somewhat oval, not so broad as long, like that in the apterous viviparous female, with which in other respects it exactly corresponds; the lateral, dorso-lateral and dorsal tubercles are disposed in the same manner, as are also the rows of spots between them.

The cornicles, like the abdomen, are slightly smaller than those of the apterous female; they are covered over by scattered hairs upon tubercles. Upon the membrane stretched across the mouth a black incomplete ring is prominent and characteristic.

The cauda and anal and genital plates are similar.

Legs reddish-brown; coxae, a ring on the femora, knees and tarsi black; they are only a little longer than those of the apterous viviparous female.

Rostrum large, extends much beyond the hind coxae, almost to the level of the cornicles and even beyond.

The measurements on an average are:—

Body	3·50 × 1·65 mm.
Antennae	1·50 mm.
Wing expanse	9·20 ,,
Wing	4·22 × 1·48 mm.
Cornicle	0·20 × 0·41 mm., base 0·45 mm., apex 0·15 mm. in diameter.
Cauda (length) about	0·20 mm.

The alate females that are produced in December and January are smaller in size than those developed earlier. Their bodies are much attenuated and therefore the wings, which are deeper black, appear comparatively long, extending much beyond the apex of the abdomen. They look very much as if they were males, but they lack their genital armature and by opening up the abdomen one always finds the ovarian tubes containing immature embryos of various stages.

These females seem to be the product of malnutrition, the flow of sap in the plants at this season being at its lowest. Most of them die without ever giving birth to a single young.

Apterous oviparous female.—The apterous females that lay eggs appear in early January and are remarkably similar to the apterous viviparous females in external anatomy. There appear to be present in this case hardly any secondary sexual characters, which in other Aphids distinguish the oviparous from the viviparous female. Neither is there a change in colour or pattern or any difference in the posterior abdominal segments observable. Sensoria on the hind tibiae are entirely lacking.

There may be a little more duskiness on the legs and a slightly greater curvature of the antenna near the basal part of the third article. The sensoria are not so well

marked and their number is often restricted to only two or three, besides the primary sensoria on the fifth and sixth article.

They are recognised if one catches them either ovipositing or carrying about an egg which is protruding, or by opening up the abdomem under a strong lens or a binocular. The ovarian tubes are then seen to contain eggs in place of immature embryos. These are packed inside the body right up to the mesothorax ; the number is about a dozen in each, but it was found to vary from about 10 to 15 in the specimens dissected.

Abnormalities.—In some cases I have also obtained a few embryos along with the usual or a smaller number of eggs. A similar oviparous and viviparous character of the females has been noticed by Hunter in *Toxoptera graminum* (Rond.) (*Kansas Univ. Bull.*, No. 2, 1909), but probably if further investigated it would be found to be the case in a much larger number of Aphids. Another uncommon variation is a stumpy oviparous or viviparous female, very much similar to the alate female in appearance, but with rudimentary or no wings. A still more unusual form is met with in the " short-beaked " specimens. These also may be either oviparous or viviparous females. The rostrum is so small that it hardly reaches beyond the second coxae, and is even less than half the length of that of a normal individual. It is the first joint that is reduced, otherwise the beak is quite complete in all respects.

The true males have so far escaped my observation, but they may be expected to be alate and not very different from the winged females. In other species of *Dryobius* they are said to be slender insects with well-developed genitalia, a sickle-shaped penis forming a conspicuous element in the centre.

The eggs are generally laid in large clusters, each cluster containing several hundreds ; smaller clusters are also found but frequently the eggs are scattered singly, particularly those laid during the latter part of January. Each oviparous female contains about a dozen eggs. There are seldom more than this number but frequently less ; 8 to 10 usually. The eggs are shining black, oval bodies. The laying period commences in December and continues in some cases up to the beginning of February. The last date of my collection is 25th January.

The life-history can be summed up briefly. The eggs hatch in March, with the flowering of the peach, some days previous to the forming of leaves. These stem-mothers give birth to wingless females. There are from 2 to 4 generations of the latter before any winged ones are produced. They reproduce at quite an extraordinary rate. Five apterous viviparous females, colonised on two peach trees in December, kept up a steady rate of progress in January, February and the middle of March, but only a patch or two of a few hundred specimens was all that resulted from them. During March and April, however, there was no limit to their numbers. All the larger branches from the bottom upwards were quite covered with them. The trees looked as if bathed in oil ; the black smothered grass and dry twigs beneath the branches were sticky with the half dried " honey-dew." These twigs readily take fire as if immersed in inflammable material.

The above experiment proved at the same time that the winter can be passed in

a viviparous condition if circumstances are favourable and the weather mild and rainless.

In May their numbers are always very considerably reduced, while in June one has to search a good deal before finding an isolated group of a few individuals. As the egg-laying period in this species is spread over a considerable time and the oviparous females do not in any material respect differ from viviparous females, it is likely that some eggs are deposited even at this time. These again hatch out in September and the insects are abundant afterwards. Some apterous viviparous females may also live through the summer. The sexes are produced in November and December and the eggs are laid about the same time.

Enemies.—All the larger Coccinellids and Syrphids abound on the branches of infested trees and feed on them freely, without appreciably reducing their numbers. The worst enemy they encounter is the exigencies of the weather. After a few clear days of strong heat one suddenly finds that the insects have completely disappeared, leaving only their skins sticking to the leaves and branches as reminiscences of their presence.

Loss.—The loss to the peach crop from the attack of this Aphid is immense. Very few fruits mature and attain the normal size and colour on infested trees. It is rather strange that the attention of the Agricultural Department has never been directed towards estimating and remedying the actual loss. Neither are any preventive measures adopted to eradicate the pest by the peach growers. The only remedy occasionally resorted to, when it gets too menacing, is to employ boys to rub them off with handfuls of ashes. This affects a temporary relief only as even if a few escape death they multiply again very quickly.

Historical and systematic.—The "Peach-stem Aphid" has probably been here for ages, and is known to the people as "Aru ka Tela"; there is nothing to indicate that it was imported from elsewhere. The only other places where it has been definitely collected are Baluchistan and Palestine.

The first European to take any notice of the insect was Mr. Elliot in Quetta (Baluchistan), who observed apricots being attacked very seriously and remarked that the trees bled profusely as a result. As a matter of fact it was only the "honey-dew," the excreta of the Aphids coursing down the stems. Whatever else he noted was quite correct and referred to this insect. He sent specimens to the Indian Museum in Calcutta for identification in 1890, and probably at the same time sent some more Aphids amongst which might have been specimens of what is now known as *Tuberolachnus viminalis* (Fonsc.) on willows. On the other hand it is also likely that there may have been some mixing up of the peach and *Salix* Aphids in Calcutta. I have examined this material in the Museum, and it is a part of what was sent to Buckton for examination. I found very few individuals of the peach Aphid and only apterous forms, the rest being *Tuberolachnus viminalis*, both alate and apterous. Both are labelled "On Peaches, Quetta."

Buckton treated the material as one, naming it *Lachnus fuliginosus*, Buck., a new species, and published a description in *Indian Museum Notes*, vol. II, no. 1, p. 41,

1891, that applies chiefly to *Tuberolachnus viminalis*. He remarked on the close similarity of the two forms, but was mistaken in saying that the characteristic dorsal process of the *Salix* Aphid is confined to the apterous viviparous female, while in the case of the Quetta Peach Aphid it is present in all stages. The obscure illustrations that accompany the description have apparently been drawn from the *Salix* Aphid. Buckton, therefore, was only redescribing *Tuberolachnus viminalis*, although he may have seen some apterous specimens of the real insect on peach, originally sent by Elliot. On this account Buckton's name *Lachnus fuliginosus* appears as a synonym of *Tuberolachnus viminalis* and the peach aphid is left without a name. After comparing the Calcutta material and sending for the insect from Quetta and also satisfying myself that no other reference to it was on record in the literature available in India, it was decided to give it a new name in our laboratory.

Recently, however, a short paper has come under my notice, published in 1912 from the Natural History Museum, Hamburg, by P. van der Goot and styled " Uber einige Wahrscheinlich neue Blattlausarten." In it a rather brief and in some respects incomplete account has been given of the salient features of the morphology of this insect, from alcoholic material, collected from almond branches in Palestine. He has called it *Dryobius amygdali*, n. sp. On referring to van der Goot it has further been brought to light that the same insect is supposed to have been described before as *Dryobius persicae* by Cholodkowsky from some part of Russia. I have not been able here to trace the publication containing Cholodkowsky's description, but the fact is mentioned on the authority of Mordwilko. I have, therefore, adopted Cholodkowsky's name, which is really quite appropriate, and I have furnished in these pages a rather detailed description of the various forms of the insect.

The generic position of this insect is somewhat doubtful. The long legs, short antennae and pigmented wings, in common with the habit of laying eggs in clusters, have a strong resemblance to the species of *Dryobius* on oak, etc. But the latter are totally devoid of any tubercles either on the dorsum or on the lateral sides. It is really this character, more than any other, that has been considered by Mordwilko of sufficient importance to warrant the separation of *Lachnus viminalis* into a new genus (*Tuberolachnus*) from the original *Lachnus*. The peach and the *Salix* Aphid possess these characters in common, besides others of minor importance, but their wings are quite different ; in the former they are deeply pigmented and in the latter clear and hyaline.

Thus we have *Tuberolachnus* differing about as much from *Lachnus* as the peach *Dryobius* from the type of that genus (*D. roboris*). I have therefore for the present accepted Mr. van der Goot's suggestion of calling it *Tuberodryobius*, even at the risk of forming a new genus for a single species.

It may at the same time be mentioned here that as the genera *Lachnus* and *Dryobius* are not very sharply defined from each other, except in the case of the alate female, they might at some later revision be amalgated. It would also not be very wrong to keep *Tuberolachnus viminalis* and this peach *Tuberodryobius* in one genus, if too much importance is not attached to the pigmentation of the wings. They both

possess similar habits of grouping themselves into patches, and sticking out their long hind legs into the air at the same time and in the same direction.

HOST-INDEX OF THE APHIDIDAE (PLANT-LICE) OF LAHORE.

In the following pages is given a host-index for the Aphids collected by me in the neighbourhood of Lahore; the names of the plants, in alphabetical order, are placed on the left side of the page and against them are noted those Aphids known to infest them. The time of the year when they were observed has also been indicated in most cases.

This index from its very nature must be incomplete and only provisional. It covers a very limited area and there is no reference in it to the numerous hill species, as yet entirely unworked. Therefore, the only justification for preparing it is the entire absence of any other, and yet to a certain extent it forms a fair representative for the plains in other parts of India as well. I hope it will be of some use to those who take up the study here or elsewhere in this country, and with that view the common vernacular names of plants, and in some cases their English equivalents, have also been included in the index.

Plants.	Aphids.	Date.
Abutilon indicum	*Aphis malvae* (Koch)	Novr. and Feb.
Abutilon sp.	(i) *A. gossypii* (Glover)	
	(ii) *Aphis malvoides*, n. sp.	
Ageratum conyzoides	(i) *Brachycaudus pruni* (Koch)	March to August.
	(ii) *Myzus persicae* (Sulz.)	May.
Ak (see *Calotropis*).		
Althea vasea (khatmi)	*A. malvae* (Koch)	Feb.-April.
	A. gossypii (Glover)	
Alhagi manrorum	(i) *Macros. pisi* (Kalt.)	March.
	(ii) *A. medicaginis*, Koch	March.
Alucha (see *Prunus armenica*).		
Antirhinum sp.	*Myzus persicae* (Sulz.)	March.
Apple (see *Prunus malus*).		
Aru (see *Prunus persicae*).		
Arundo donax	*Hyalopterus pruni* (Fabr.)	Feb., March-May, Sept.-Novr.
Avena sativa	(i) *A. maidis* (Fitch)	Oct.-March.
	(ii) *Siphocoryne avenae* (Fabr.)	Novr.-March.
	(iii) *Macrosiphum granarium* (Kirby)	Novr.-March.
Asgand (see *Withania*).	(iv) *Toxoptera graminum* (Rond.)	Feb.-March.
Bakla (see *Vicia faba*).		
Bathu (see *Chenopodium alba*).		
Beta bengalensis	*Myzus persicae* (Sulz.)	Feb.
Bhakhra (see *Tribulus* sp.)		
Bhang (see *Cannabis sativa*).		
Bongainvillia sp.	*A. medicaginis*, Koch	Novr.-Decr.
	A. malvoides, n. sp.	Novr. (very occasional)

PLANTS.	APHIDS.	DATE.
Bhindi (see *Hibiscus esculentis*).		
Brassica campestris (toria or taramira).	(i) *Siphocoryne indobrassicae*, n. sp.	Oct. to Feb.
	(ii) *Myzus persicae* (=*Rhopalosiphum dianthi*).	Augt. to Oct.
	(iii) *Brevicoryne brassicae* (Linn.)	Feb.-March.
Brassica juncea (mustard)	Do.	Oct.-Feb.
B. rapa (turnip)	Do.	Do.
B. oleracea (cabbage)	Do.	Octr.-June.
Brinjal (see *Salanum melongium*).		
Bed (see *Salix* sp.).		
Bryophyllum, sp.	*Myzus persicae* (Sulz.)	Feb.-March.
Cabbage, cauliflower (see *Brassica* sp.).		
Cajanus indica	*Aphis medicaginis*, Koch	Novr.-Jan.
Calotrophis gigantea	*A. nerii* (Boyer)	Feb.-Mar.
C. procera	Do.	Aug.-Oct.
Carthamus oxycarpa	*Brachiunguis carthami*, n. sp.	May and June.
Capsella bursa-pastoris	(i) *Myzus persicae* (Sulz.)	Feb.-Apr.
	(ii) *A. gossypii* (Glov.)	
Cannabis indica (or *sativa*)	*Phorodon cannabis*, Pass.	Oct.-Dec.
Carum carraway	*Brevicoryne coriandri*, n. sp.	April.
Carrot (see *Daucus carota*).		
Chari (see *Sorghum*).		
Celtis australis	*Shivaphis celti*, n. sp.	March, May, Sept.-Dec.
Chenopodium alba }	*Brevicoryne chenopodii* (Schr.)	Dec.
Chenopodium sp. }		
Cheiranthus cheiri	(i) *Siphocoryne indobrassicae*, n. sp.	Feb., Mar.
	(ii) *Myzus persicae* (Sulz.)	Apr.
Chrysanthemun sinense (cultivated)	(i) *Macrosiphum sanborni* (Gill.)	Sep., Jan., Mar., Apr.
	(ii) *A. malvoides*, n. sp.	
	(iii) *Stephensonia lahorensis*, n. sp.	Oct., Jan., March.
Centaúria sp.	*Aphis rumicis*, Linn.	Dec.
Citrus aurantii	*A. malvae* (Koch)	Oct.
	A. malvoides, n. sp.	
Citrulus vulgarus (tartmz)	(i) *A. malvoides*, n. sp.	Jun.-Sep.
	(ii) *A. gossypii* (Glov.) ?.	
Cinanaria sp.	(i) *Myzus persicae* (Sulz.)	Feb., Apr.
	(ii) *A. malvae*, (Koch)	March.
Clianthus puniceus or *damperii* (parrot's beak).	*Macrosiphum pisi* (Kalt.)	April.
Cnicus arvensis	(i) *A. rumicis*, Linn.	Nov., Mar.
	(ii) *Phorodon cannabis*, Pass.	
Colocasia antiquorum (or *esculentis*)	(i) *Aphis durranti*, n sp.	Oct., Dec.
	(ii) *A. malvae* (Koch)	Oct., Dec.
Convolvulus majus	*Myzus persicae* (Sulz.)	Feb., Apr.
Coronopus dydimus	(i) *Myzus persicae* (Sulz.)	Dec., Apr.
	(ii) *Siphocoryne indobrassicae*, n. sp.	Feb.
Cotton (see *Gossypium*).		
Coriandrum sativa	*Brevicoryne coriandri*, n. sp.	Mar., Apr., Dec., Jan.

Plants.	Aphids.	Date.
Crotalaria juncea (san)	*A. malvae* (Koch)	Nov., Dec.
	A. malvoides, n. sp.	
Cryptostegia grandiflora	(i) *A. nerii* (Boyer)	Mar., Oct.
	(ii) *A. malvae* (Koch)	Oct., Nov.
Cucurbita moschata (kadu)	*A. malvae* (Koch)	May, June
	A. malvoides, n. sp.	Oct., Nov.
Cucumis sativa	*A. malvae* (Koch)	Feb., Apr.
Cucumis melo (kakri and kharbuza)	*A. malvoides*, n. sp.	May.
Cynodon dactylon (dub)	(i) *Pemphigus* sp.	Nov., Mar.
	(ii) *A. maidis* (Fitch)	Dec.
	(iii) *Siphocoryne avenae* (Fabr.)	Mar., Apr.
	(iv) *Toxoptera graminum* (Rond.)	Apr.
Cyperus rotundus (dila or motha)	(i) *Toxoptera cyperi* (van der Goot.).	Sep., Nov.
	(ii) *Toxoptera graminum* (Rond.)	Mar.
	(iii) *A. maidis* (Fitch)	Mar.
Cyperus niveus	*Toxoptera graminum* (Rond.)	Nov.
Cyamopsis psoraliodes (guara)	*A. medicaginis*, Koch	Nov., Dec.
Dalbergia sissu	(i) *A. medicaginis*, Koch	Feb., Mar.
	(ii) *Myzus persicae* (Sulz.)	Apr.
Dianthus caryophyllus (pink)	(i) *Myzus persicae* (Sulz.)	Feb., Mar.
	(ii) *A. malvae* (Koch)	Mar.
Datura stramonium	(i) *Myzus persicae* (Sulz.)	Jan., Feb.
	(ii) *Siphocoryne avenae* (migrants only).	Sep.
Daucus carota	*Brevicoryne coriandri*, n. sp.	April (scarce).
Dila (see *Cyperus* or *Scirpus* sp.).		
Dolichos lablab (viru sem; pink and white).	*A. medicaginis*, Koch	Oct., Dec.
Dregea sp. (Asclepiadaceae)	*A. nerii* (Boyer)	May.
Durranta sp. (hedge plant)	(i) *A. malvoides*, n. sp.	Sep., Dec.
	(ii) *A. durranti*, n. sp.	
Dhania (see *Coriander*).		
Erruca sativa	(i) *Myzus persicae* (Sulz.)	Oct.
	(ii) *Siphocoryne indobrassicae*, n. sp.	Oct., Dec.
Elm (Indian) (see *Celtis australis*).		
Euphorbia helioscopia (sun spurge)	*Myzus persicae* (Sulz.)	Jan., Feb.
Eriobotrya japonica	*A. malvae* (Koch)	Oct.
Eragrostis sp.	(i) *Macrosiphum granarium* (Kirby)	Apr.
	(ii) *Siphocoryne avenae* (Fabr.)	
Faeniculum vulgare	*Siphocoryne coriandri*, n. sp.	Apr. (scarce).
Gallium sp.	*Myzus persicae* (Sulz.)	Apr.
Gossypium harbaccus (cotton)	(i) *A. malvae* (Koch)	Apr., Nov.
	(ii) *A. gossypii* (Glov.) ?	Apr., Nov.
	(iii) *A. malvoides*, n. sp.	
Gulab (see *Rosa*).		
Guldaudi or Guldhudi (see *Chrysanthemum*).		
Guara (see *Cyamopsis* sp.).		

PLANTS.	APHIDS.	DATE.
Gobhi (see *Brassica* sp.).		
Halon (see *Lepidium*).		
Hibiscus esculentis (bhindi)	*A. malvae* (Koch)	Aug., Nov.
	A. malvoides, n. sp.	March.
Hibiscus canabis	*A. malvae* (Koch)	Dec.
Hibiscus magnifica	*A. malvae* (Koch).	
	A. malvoides, n. sp.	Dec.
Hoya volubillis	*A. nerii* (Boyer)	Sep., Nov., May.
Hordeum vulgaris (jan.)	(i) *Macrosiphum granarium* (Kirby)	Nov. to March.
	(ii) *Toxoptera graminum* (Rond.)	
	(iii) *A. maidis* (Fitch)	
	(iv) *Siphocoryne avenae* (Fabr.)	
Harmal (see *Peganum*).		
Holly (see *Malva* sp.).		
Iberis sp.	*Brevicoryne* (= Aphis) *brassicae* (Linn.)	Feb.
Indian Corn (see *Zea mays*).		
Ipomea mexicana	(i) *A. malvae* (Koch) or (ii) *A. malvoides*, n. sp.	Sep., Oct. and Nov.
I. palmata		
I. guttata		
Indigofera tinctoria	*A. medicaginis*, Koch	Nov. and Dec. (in Bihar).
Jasminum sp. (hasna)	*A. malvae* (Koch), dark green variety	Dec.
Jaintar (see *Sesbania*).		
Jau (see *Hordeum*).		
Jawi (see *Avena*).		
Juar (see *Sorghum*).		
Kachalu (see *Colocasia esculentis*).		
Kakkar Singi (see *Pistacia*).		
Khub Kalan (see *Sisymbrium*).		
Kanwal (see *Nelumbium*).		
Kali tori (see *Luffa*).		
Lagenaria vulgarus (ghia)	*A. malvae* (Koch)	Apr., Jun.
	A. gossypii (Glov.)	
	A. malvoides, n. sp.	
Lathyrus sativa (charal)	*A. medicaginis*, Koch	Jan.
Lathyrus odoratum (sweet peas)	(i) *Macrosiphum pisi* (Kirby)	Feb., Mar.
	(ii) *Macrosiphum* sp.	April.
Lemna sp.	*Siphocoryne nymphaeae* (Linn.)	Nov., Dec., Apr., July.
Leucas sp. (labiate weed)	*A. malvae* (Koch)	Nov. (at Pusa).
Letsonia scandens	*Brachiunguis letsoniae*, n. sp.	Oct.
Lepidium sativa	(i) *Myzus persicae* (Sulz.)	Feb., Mar.
	(ii) *Siphocor. indobrassicae*, n. sp.	
Loqat (see *Eriobotrya* sp.).		
Lobia (see *Dolichos*).		
Luffa octangula	*A. malvae* (Koch)	Aug., Sep.
	A. malvoides, n. sp.	
Lucerne (see *Medicago sativa*).		

PLANTS.	APHIDS.	DATE.
Malva sylvestris *M. parviflora*	*A. malvoides*, n. sp. *A. malvae* (Koch) *A. gossypii* (Glover)	Nov., Feb. Oct., Nov. Apr.
Malvestrum tricuspidatum	(i) *A. malvae* (Koch) (ii) *A. malvoides*, n. sp.	Oct., Dec. Mar., Apr.
Mazus sp.	*Myzus persicae* (Sulz.)	May.
Medicago sativa (lucerne)	(i) *Callipterus trifolii* (Monell) (ii) *Macrosiphum pisi* (Kalt.)	Apr., May.
Medicago dentatus	*A. medicaginis*, Koch	Jan., Feb.
Melilotus parviflora (senji)	*A. medicaginis*, Koch	Feb., Apr.
Melon (see *Cucumis*).		
Muli (see *Raphanus*).		
Mustard (see *Brassica*).		
Milkweed (see *Calotropis*).		
Nicotiana tabacum	(i) *Siphocoryne avenae* (Fabr.) (ii) *Myzus persicae* (Sulz.), pink variety.	Nov., Dec. (at Pusa). Mar., Apr.
Nelumbium speciosum (kanwal)	*Siphocoryne nymphaeae* (Linn.)	Nov.-Dec.
Nepeta sp.	*A. malvae* (Koch) (green variety)	Aug.
Nasturtium sp.	(i) *Aphis nasturtii* (Kalt.) (ii) *Myzus persicae* (Sulz.) (iii) *Siphocoryne indobrassicae*, n. sp.	Feb., Apr.
Oats (see *Avena*).		
Orange (see *Citrus*).		
Palak (see *Beta* sp.).		
Pansy (see *Viola*).		
Panicum colonum	(i) *A. maidis* (Fitch) (ii) *A. sacchari* (Zehnt.)	June, Sep., Dec. June, Sep., Dec.
Panicum sp.	*A. maidis* (Fitch)	March.
Peganum harmala	(i) *Brachiunguis harmalae*, n. sp. (ii) *A. malvae* (Koch) (iii) *Macrosiphum pisi* (Kalt.)	Sep., Dec., Mar., May. Nov. Feb.
Pennisetum typhoideum (bajra)	*A. maidis* (Fitch)	Sep., Oct.
Phaseolus radiatus *Phaseolus* sp.	*A. medicaginis*, Koch	July, Sep., Oct.
Phragmitis karki (reed)	*Hyalopterus pruni* (Fabr.)	Sep., Dec., Mar.
Pistacia integerrima	*Pemphigus* (?) *aedificator* (Buck.)	Apr., Nov.
Prunus domesticus (plums, alucha)	*Tuberodryobius persicae* (Cholodk.)	Sep., Dec., Feb., Mar., May.
	Toxoptera punjabipyri, n. sp.	Dec.
Prunus malus (apple)	*A. malvoides*, n. sp.	Oct., Nov.
Prunus persicae (peach, aru)	(i) *Brachycaudus pruni* (Koch) (= *Aphis pruni*). (ii) *Myzus persicae* (Sulz.) (iii) *Tuberodryobius persicae* (Cholodk.) (iv) *Hyalopterus pruni* (Fabr.)	Mar., May. Mar., May. Sep., Jan. Mar., Apr., Oct., Nov. and Dec.

PLANTS.	APHIDS.	DATE.
Pyrus communis (pear)	(i) *A. malvae* (Koch)	Feb., Mar. and Apr.
	(ii) *Myzus persicae* (Sulz.)	
	(iii) *Toxoptera punjabipyri*, n. sp.	
Pyrus sp. (wild)	*T. punjabipyri*, n. sp.	Mar., Apr.
Potato (see *Solanum tuberosum*).		
Pilak (see *Solanum nigrum*).		
Raphanus sativa (radish)	(i) *Myzus persicae* (Sulz.)	Oct., Apr.
	(ii) *Brevicoryne brassicae* (Linn.)	Mar., Apr.
	(iii) *Siphocoryne indobrassicae*, n. sp.	Oct., Mar.
Rape (see *Brassica* sp.).		
Rosa damascous	(i) *Macrosiphum rosaeiformis*, n. sp.	December to Apr.
Rosa spp.	(ii) *A. malvae* (Koch)	Dec.-Mar.
Salix babilonica	*Tuberolachnus viminalis* (Boyer)	Feb.-May.
Salix tetrasperma	(i) *Tuberolachnus viminalis* (Boyer)	March.
	(ii) *Eichochaitophorus himalayensis*, n. sp.	Mar., June.
Salix aegyptica Das (bed mushk)	*Tuberolachnus viminalis* (Boyer)	March.
Salvia sp. (wild)	*A. malvae* (Koch) (green variety)	Mar., Apr.
Sisymbrium irio (khub kalan)	*Siphocoryne indobrassicae*, n. sp.	Dec., Mar.
Setaria verticillata	*A. maidis* (Fitch)	Nov.
Scirpus lacustrus	(i) *Siphocoryne nymphaeae* (Linn.)	Jan.
	(ii) *Toxoptera* sp.	
Sesbania aegyptica (jaintar)	*A. medicaginis*, Koch	Feb., Mar.
Shalgum (see *Brassica*).	*A. malvoides*, n. sp.	April.
Solanum indicum (kandiari)		
Solanum lycopersicum	*A. malvoides*, n. sp.	Mar.
Solanum melongium	(i) *A. malvoides*, n. sp.	Mar., Apr
	(ii) *A. gossypii* (Glover) ?	Oct., Nov.
Solanum nigrum	(i) *A. rumicis*, Linn.	Sep., Dec.
	(ii) *A. malvae* (rarely)	Feb., Apr. and Aug.
Sonchus oleracea	(i) *Macrosiphum solidaginis*, Fabr.	Jan.-May.
S. arvensis	(ii) *Rhopalosiphum lactucae* (Kalt.)	May, June.
Sorghum vulgare	(i) *Aphis sacchari* (Zehnt.)	June-Sep., Dec.
	(ii) *A. maidis* (Fitch)	
Tori, tomato, tobacco (see *Luffa ; Solanum ; Nicotiana*).		
Tribulus terrestris	*Aphis medicaginis*, Koch	May-June.
Triticum sativum	(i) *Macrosiphum granarium* (Kirby)	Nov., Apr.
	(ii) *Toxoptera graminum* (Rond.)	Feb., Apr.
	(iii) *Siphocoryne avenae* (Fabr.)	Oct., Dec.
Trigonella foenum-graecum (methi)	(i) *A. medicaginis*, Koch	Mar., Apr.
	(ii) *Macros. pisi* (Kalt.)	
Vicia faba (bakla)	*A. medicaginis*, Koch	Oct , Dec.
Viola tricolor	(i) *A. malvae* (Koch)	Apr.
	(ii) *Myzus persicae* (Sulz.)	Mar.
	(iii) *A. malvoides*, n. sp.	Apr.
Vitex negundo	*A. durranti*, n. sp.	Dec.
	A. malvoides, n. sp.	

Plants.	Aphids.	Date.
Willows (see *Salix* spp.).		
Withania somnifera	*A. malvae* (Koch)	Mar.
Woodfordia floribundis (dhawa)	*A. malvae* (Koch)	Oct. and Apr.
Zea mays	*Aphis maidis* (Fitch)	Aug., Sep.

The more important literature is cited at the beginning of each description; a complete separate bibliography is not given for considerations of space.

MEMOIRS OF THE INDIAN MUSEUM

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By the late Bashambar Das, *M.Sc.*

Edited, with Notes and an Introduction.
By P. van der Goot.

(Plates)

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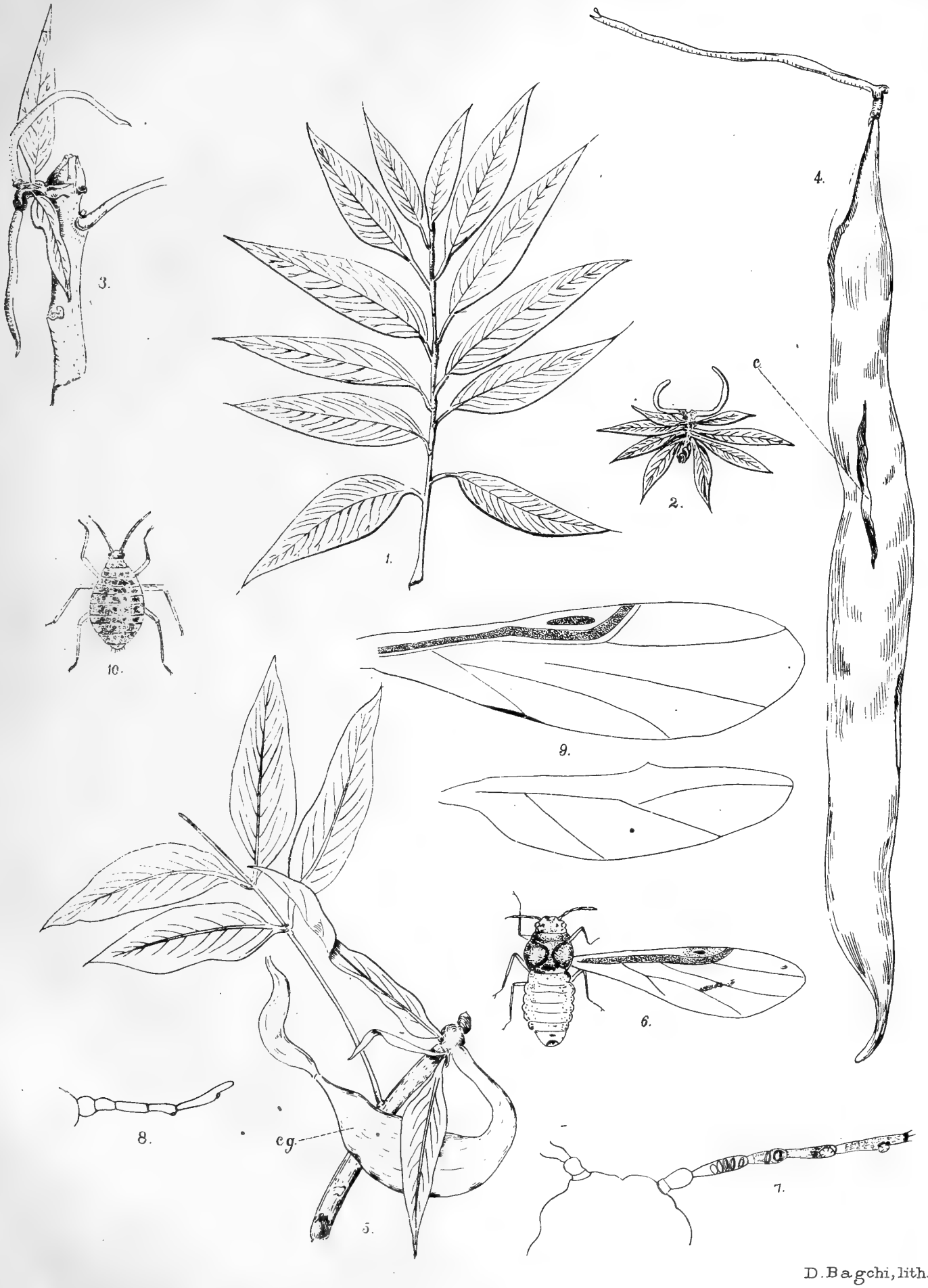
EXPLANATION OF PLATE XIII.

Dasia aedificator (Buckton), p. 152.

[= *Phemphigus* (?) *aedificator* (Buckt.), p. 144.]

FIG. 1.—Normal leaf of *Pistacia integerrima*, the food-plant of the species. × $\frac{1}{3}$.
,, 2.—Stunted leaf with two leaflets changed into galls. × $\frac{1}{3}$.
,, 3.—Two galls and two leaflets (nat. size).
,, 4.—Full-grown gall. × $\frac{3}{4}$. *c* = crack through which the aphids swarm out.
,, 5.—A curved gall (*c. g.*).
,, 6.—Alate viviparous female.
,, 7.—Antenna of alate female.
,, 8.—Antenna of apterous female.
,, 9.—Wings of alate female.
,, 10.—Apterous viviparous female.

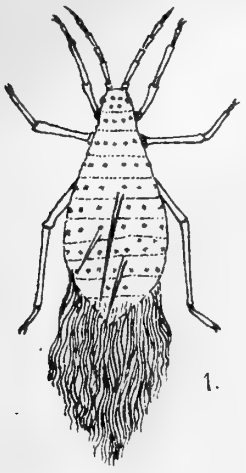


D. Bagchi, lith.

EXPLANATION OF PLATE XIV.

Pemphigus (?) cynodonti, n. sp., p. 153.

FIG. 1.—Apterous viviparous female (dorsal view).
FIGS. 2 and 3.—Threads of flocculence.
FIG. 4.—Apterous viviparous female (ventral view).
,, 5.—Gland. *gla. h.* = gland on head.
,, 6.—Antenna of apterous female.
,, 7.—Surface view of wax-plates.
,, 8.—Wax gland (lateral view).
,, 9.—Antenna of alate female.
,, 10.—Branch of *Cynodon dactylon,* the food-plant of the species. *nor. b.* = normal branch; *def. b.* = deformed branch.
,, 11.—Posterior end of abdomen. *wax. g.* = wax gland; *anal p.* = anal plate; *rud. gonap.* = rudimentary gonapophyses.
,, 12.—Wings.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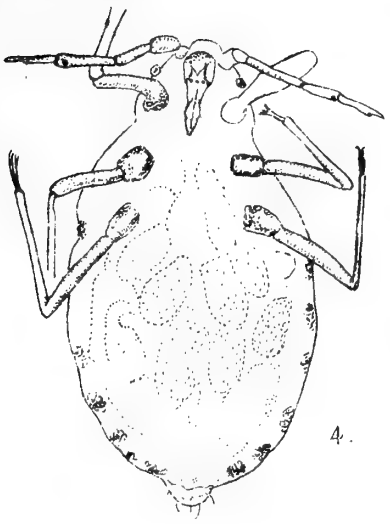
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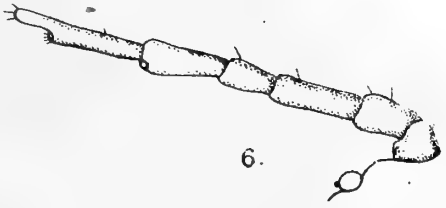
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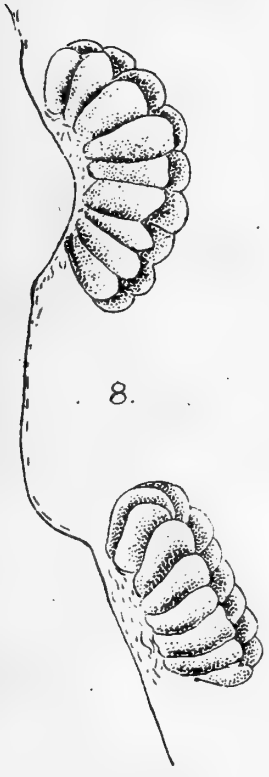
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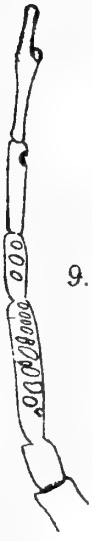
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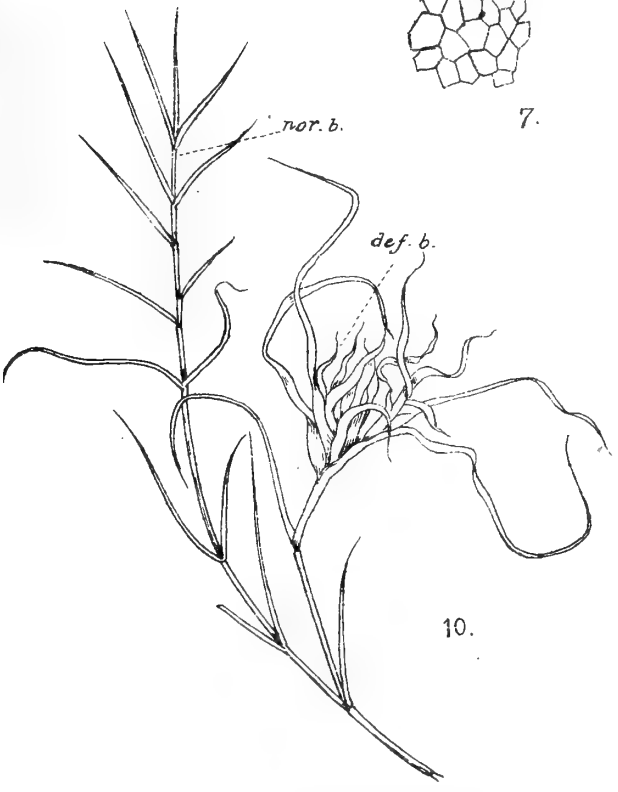

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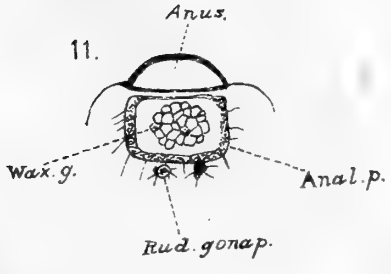

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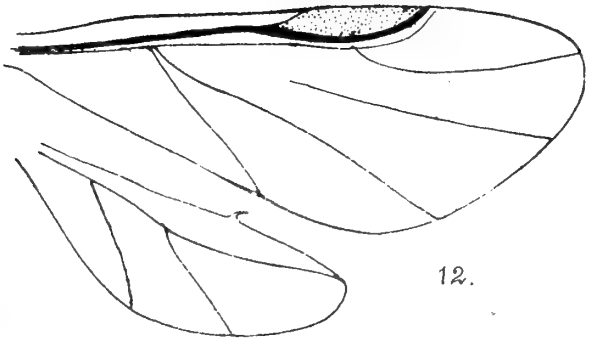
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A. Chowdhary, lith.

EXPLANATION OF PLATE XV.

Macrosiphum pisi (Kalt.), p. 157.

FIG. 1.—Antenna of apterous female.
,, 2.—Antenna of alate female.
,, 3.—Cauda and cornicles of alate female.

Macrosiphum rosaeiformis, n. sp., p. 158.

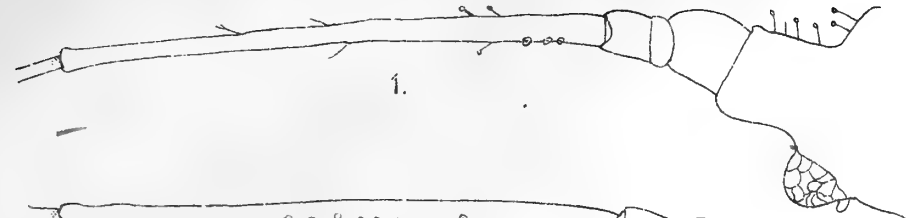
FIG. 4.—Apterous viviparous female and young. *a* = young just emerging.
,, 5.—Base of antenna of alate female.
,, 6.—Base of antenna of apterous female.
,, 7.—Anterior wing of alate female.
,, 8.—Alate viviparous female, showing pattern on abdomen.
,, 9.—Cornicle of alate female.
,, 10.—Cauda of alate female.

Macrosiphum rosae (Linn.), p. 161.

FIG. 11.—Antenna of alate female.
,, 12.—Antenna of apterous viviparous female (after Theobold).

Macrosiphum granarium (Kirby ; Pergande), p. 162.

FIG. 13.—Antenna of alate female.
,, 14.—Antenna of apterous viviparous female (after Theobold).
,, 15.—Cauda of alate female.
,, 16.—Cornicle of alate female.
,, 17.—Abdomen of alate female.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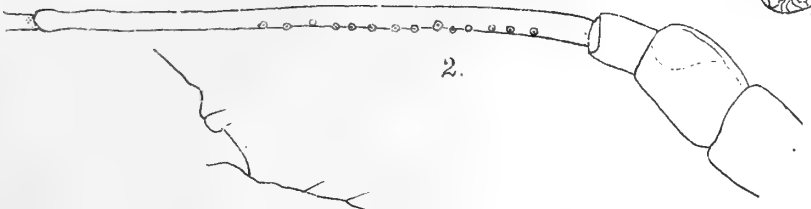
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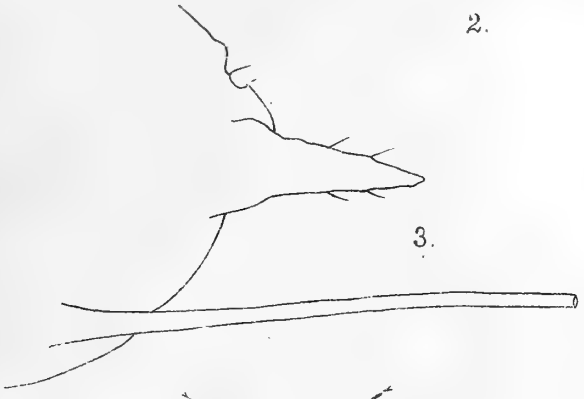
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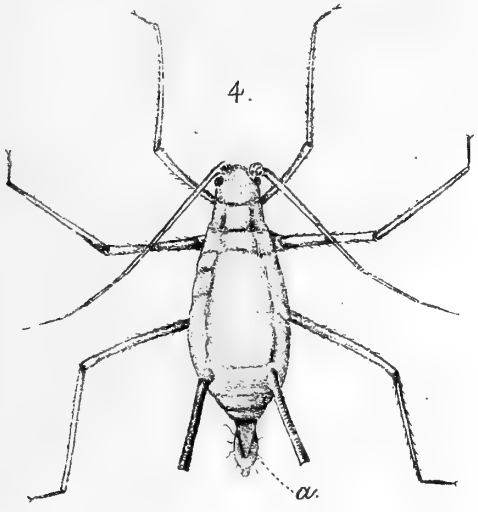
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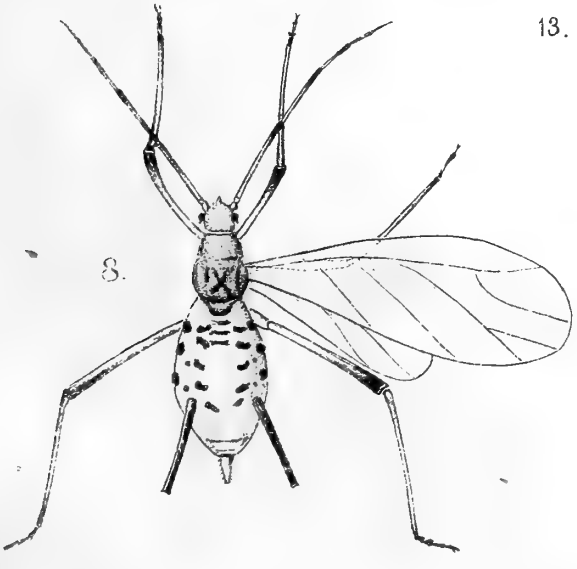
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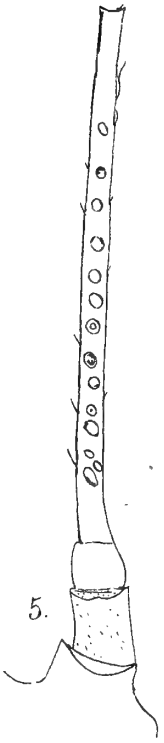
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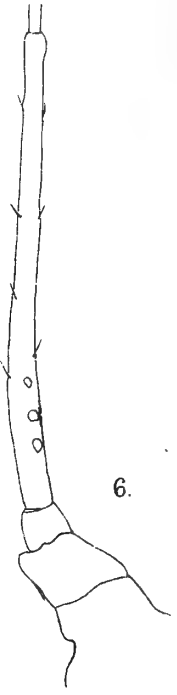
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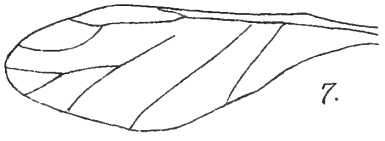
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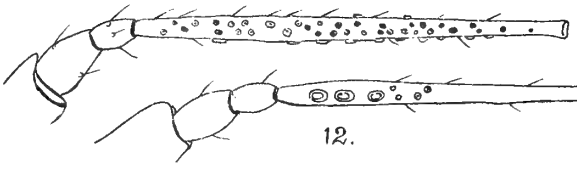
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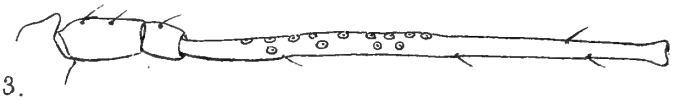
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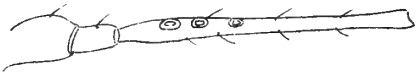
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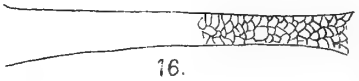
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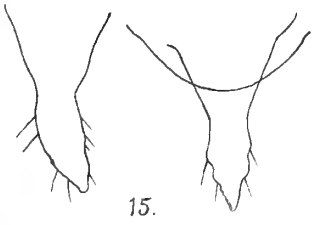
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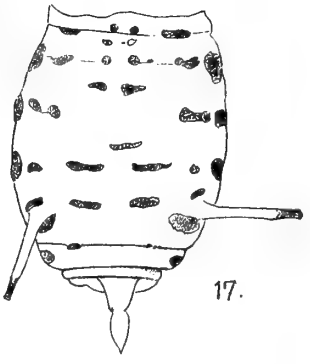
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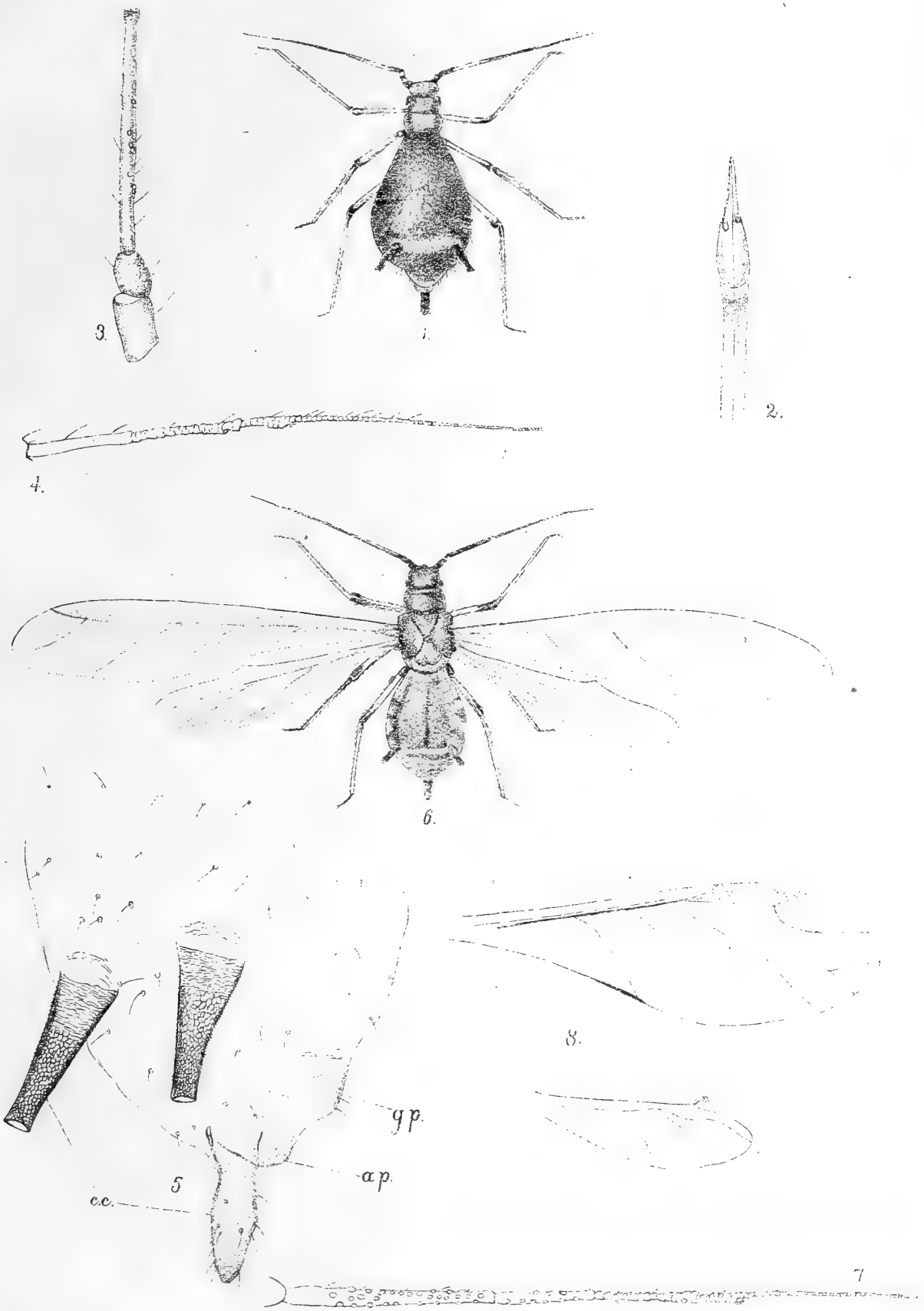
A. Chowdhary, lith.

EXPLANATION OF PLATE XVI.

Macrosiphoniella sanborni (Gillette), p. 164.

(=*Macrosiphum sanborni* (Gillette), p. 163).

FIG. 1.—Apterous viviparous female.
,, 2.—Rostrum of apterous female.
,, 3.—Basal part of antenna of apterous female.
,, 4.—Distal part of antenna of apterous female.
,, 5.—Hind end of apterous female showing the cauda and cornicles. *c. c.* = cauda and cornicles; *a. p.* = anal plate; *g. p.* genital plate.
,, 6.—Alate viviparous female.
,, 7.—Antenna of alate female.
,, 8.—Wings of alate female.



D. Bagchi, lith.

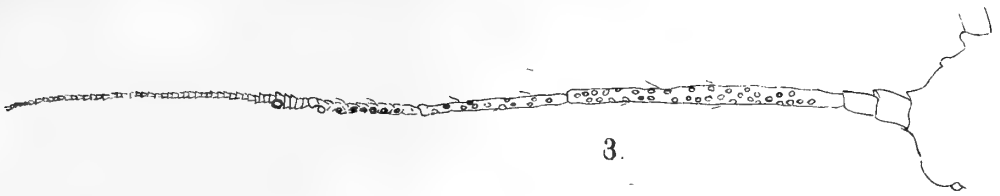
EXPLANATION OF PLATE XVII.

Rhopalosiphum lactucae (Kalt.), p. 165.

FIG. 1.—Alate female showing relative size of parts.
" 2.—Cauda and cornicles of alate female.
" 3.—Antenna of alate female.
" 4.—Antenna of apterous female.

Myzus persicae (Sulz.), p. 166.

FIG. 5.—Cornicle of alate female.
" 6.—Antenna of alate female.
" 7.—Wings.
" 8.—Antenna of alate male.
" 9.—Head and antenna of apterous female.
" 10.—Third joint of antenna of alate female.
" 11.—Cornicle of apterous female.
" 12.—Cauda of alate female.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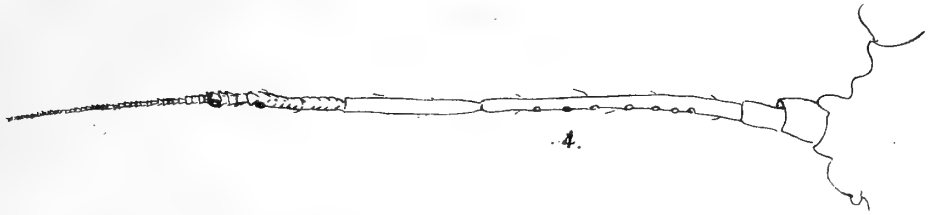
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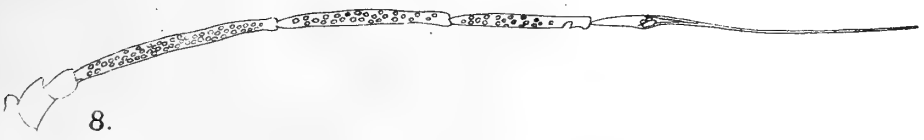
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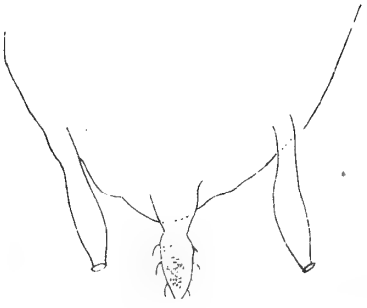
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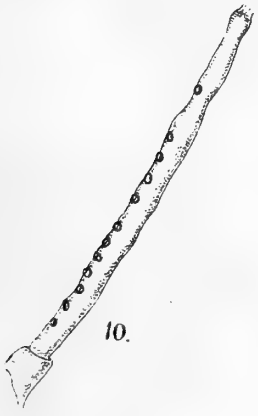
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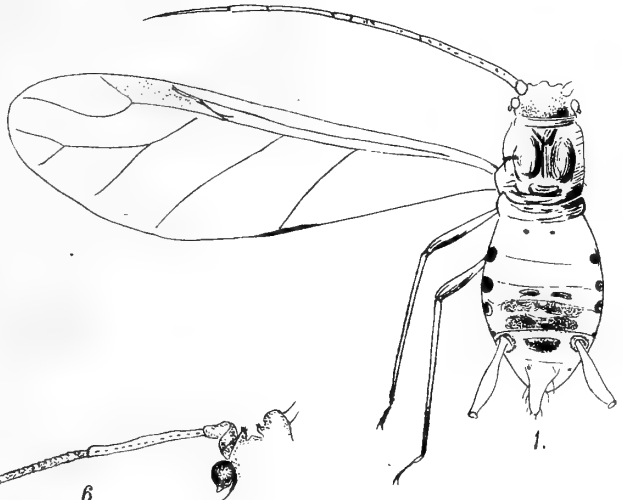
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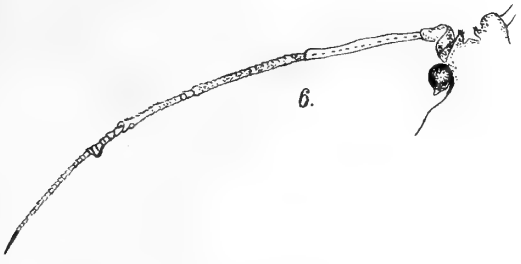
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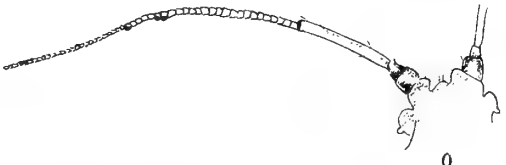
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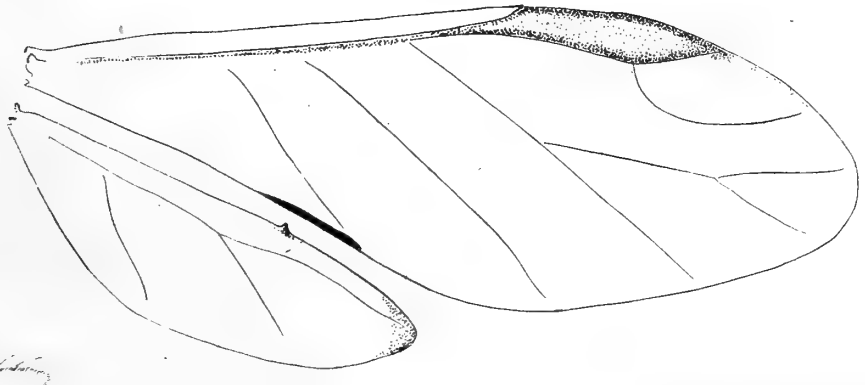
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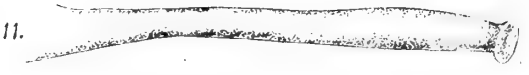
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D. Bagchi, lith.

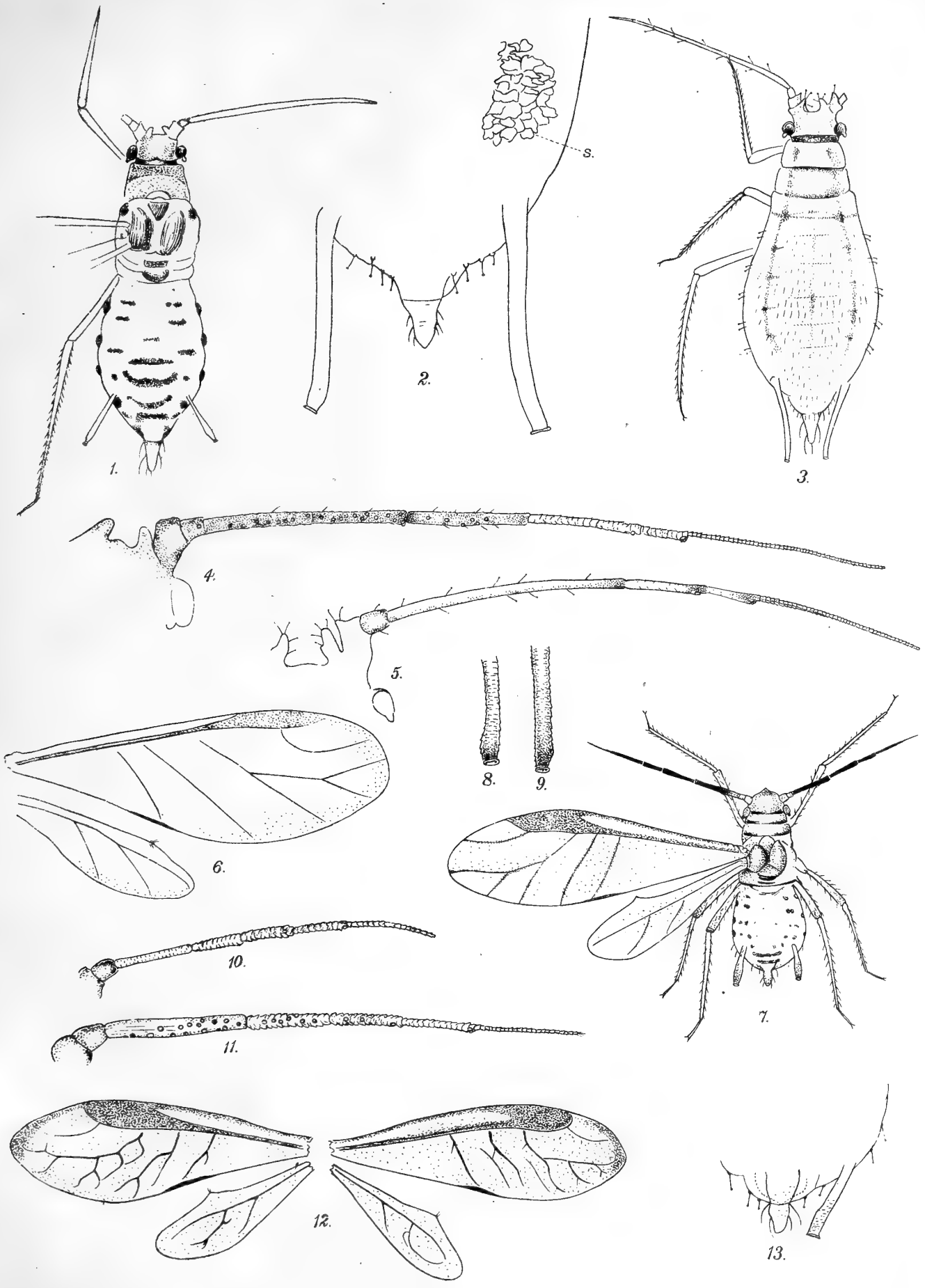
EXPLANATION OF PLATE XVIII.

Phorodon cannabis, Pass., p. 169.

FIG. 1.—Alate female.
,, 2.—Caudal end of apterous female. *s.* = skin.
,, 3.—Apterous female.
,, 4.—Antenna of alate female.
,, 5.—Head and antenna of alate female.
,, 6.—Wings.

Siphocoryne lahorensis (Das), v. d. Goot, p. 179.
(= *Stephensonia lahorensis*, n. sp., p. 175.)

FIG. 7.—Alate viviparous female.
,, 8.—Cornicle of alate female.
,, 9.—Cornicle of apterous female.
,, 10.—Antenna of apterous female.
,, 11.—Antenna of alate female.
,, 12.—Wings.
,, 13.—Abdominal extremity of alate female.



S. C. Mondul, lith.

EXPLANATION OF PLATE XIX.

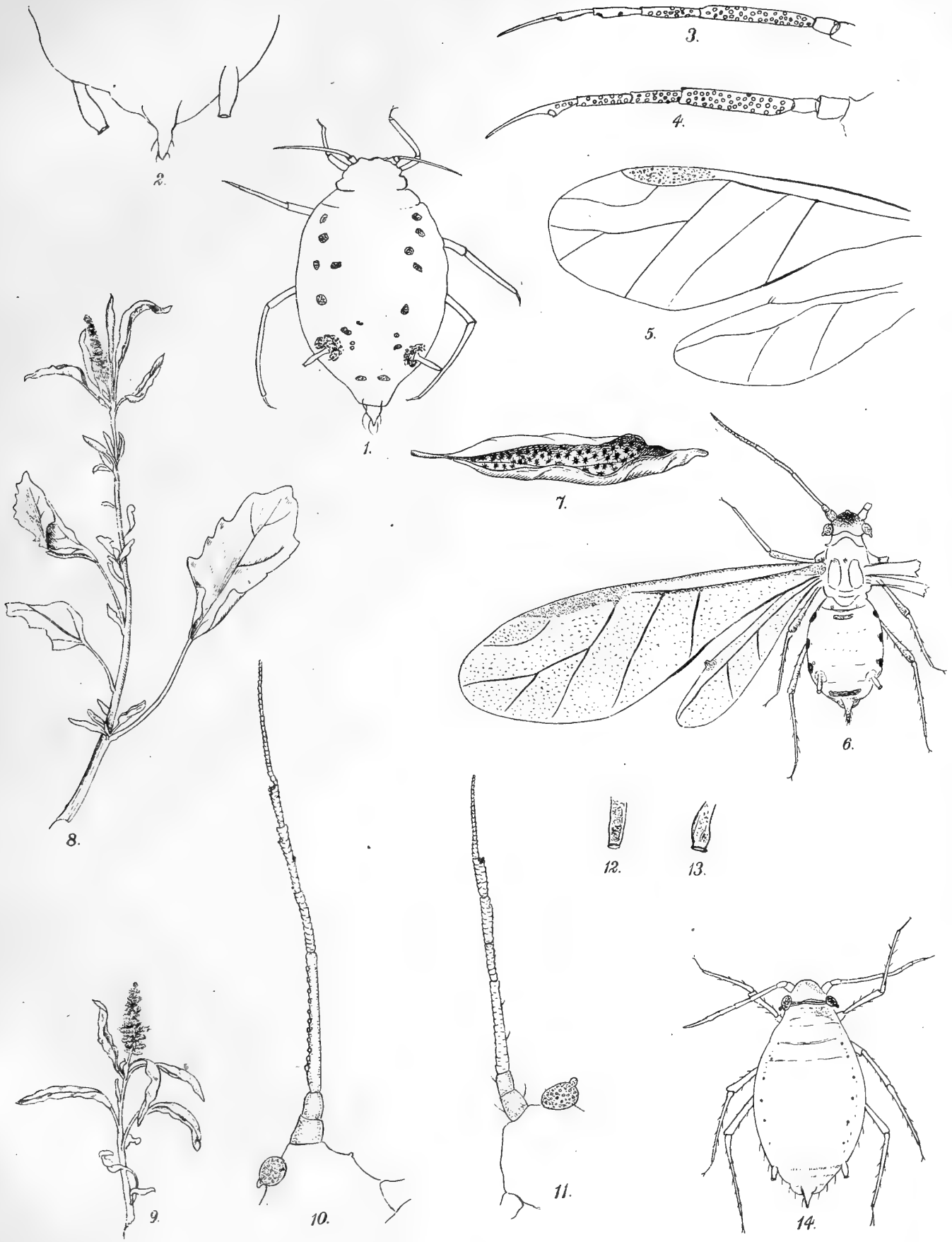
Brevicoryne coriandri, n. sp., p. 180.

FIG. 1.—Apterous viviparous female.
,, 2.—Cornicle and cauda of alate female.
,, 3.—Antenna of alate female.
,, 4.—Antenna of alate male.
,, 5.—Wings.

Brevicoryne chenopodii (Schrank), p. 183.

(? = *Aphis atriplicis*, Linn., p. 187.)

FIG. 6.—Alate female.
,, 7.—Pseudogall opened to show aphids within.
,, 8.—Deformed leaves of *Chenopodium alba*, the food-plant of the species.
,, 9.—Pseudogall on *Chenopodium alba*. Nat. size.
,, 10.—Antenna of alate female.
,, 11.—Antenna of apterous female.
,, 12.—Cornicle of apterous female.
,, 13.—Cornicle of alate female.
,, 14.—Apterous viviparous female.



S. C. Mondul, lith.

EXPLANATION OF PLATE XX.

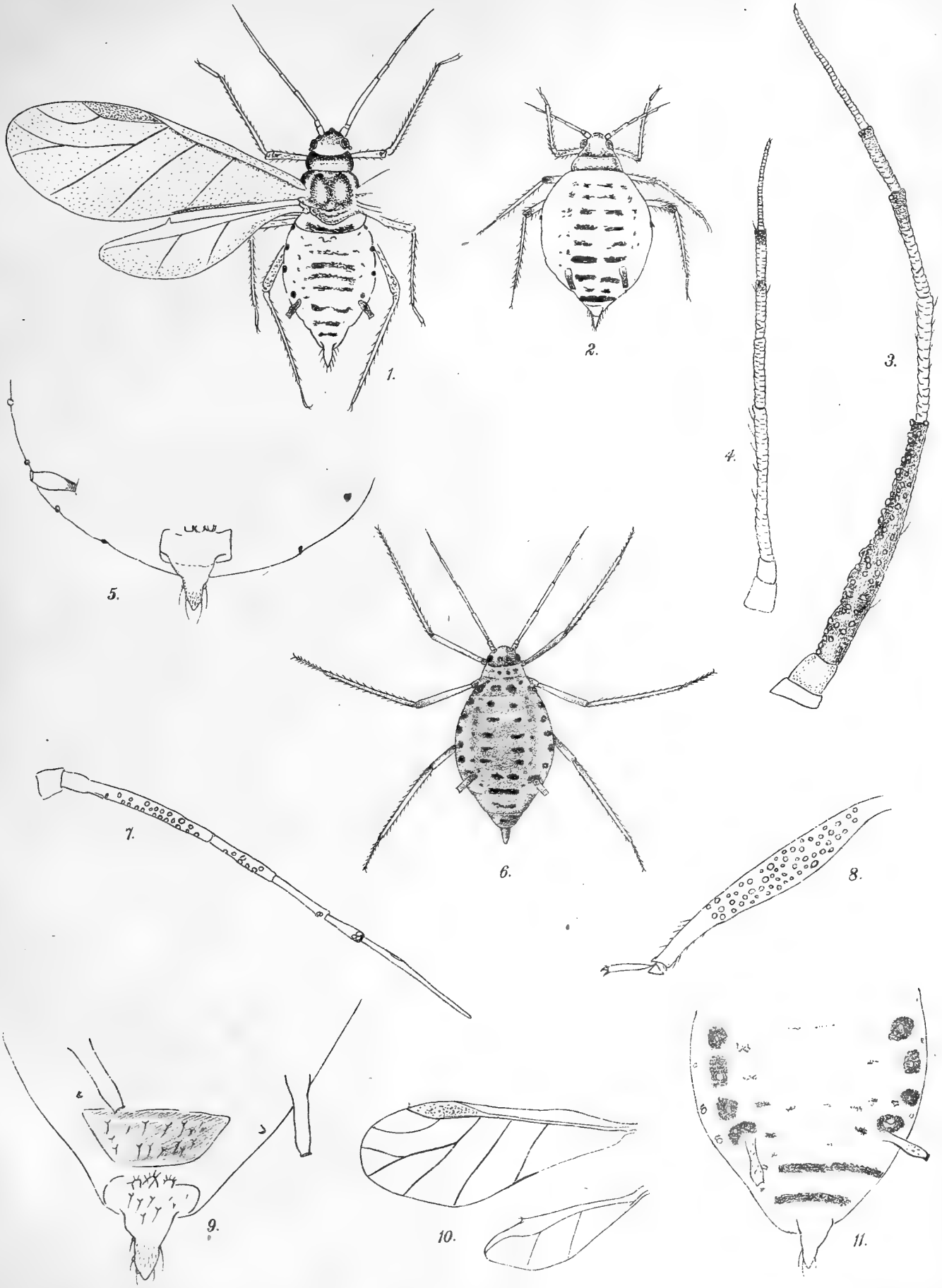
Brevicoryne (Aphis) brassicae (Linn.), p. 187.

FIG. 1.—Alate viviparous female (after Essig).
" 2.—Apterous viviparous female (partly after Essig).
" 3.—Antenna of alate female.
" 4.—Antenna of apterous female.
" 5.—Anal end of alate female showing the cornicle and cauda.

Siphocoryne pseudobrassicae (Davis), p. 188.

(= *Siphocoryne indobrassicae*, n. sp., p. 188.)

FIG. 6.—Apterous viviparous female.
" 7.—Antenna of alate female.
" 8.—Hind tibia of oviparous female.
" 9.—Anal end of apterous viviparous female showing the genital plate, the cauda and cornicle.
" 10.—Wings.
" 11.—Abdomen of alate female.

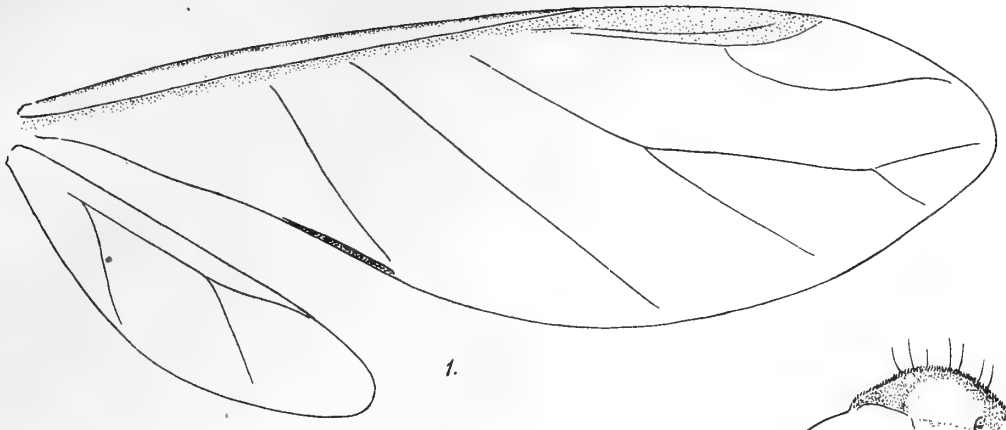


S. C. Mondul, lith.

EXPLANATION OF PLATE XXI.

Siphocoryne nymphaeae (Linn.), p. 191.

FIG. 1.—Wings.
" 2.—Cauda of alate female.
" 3.—Antenna of alate female.
" 4.—Apterous viviparous female.
" 5.—Cornicle of apterous female.
" 6.—Cornicle of alate female.
" 7.—Antenna of alate female.
" 8.—Antenna of apterous female.
FIGS. 9 and 10.—Pattern of external glands.
FIG. 11.—Antenna of "return migrant."
" 12.—Antenna of alate male.
" 13.—Anal end of alate male showing the cauda reflected, the genital armature and the penis.



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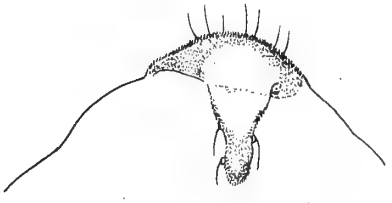

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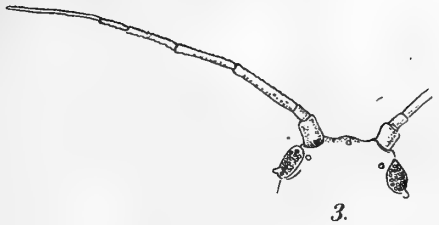

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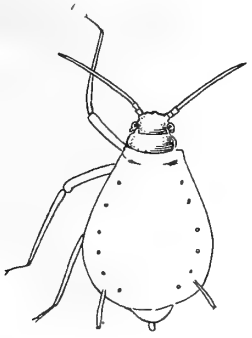

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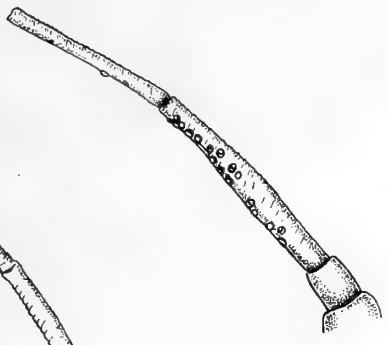

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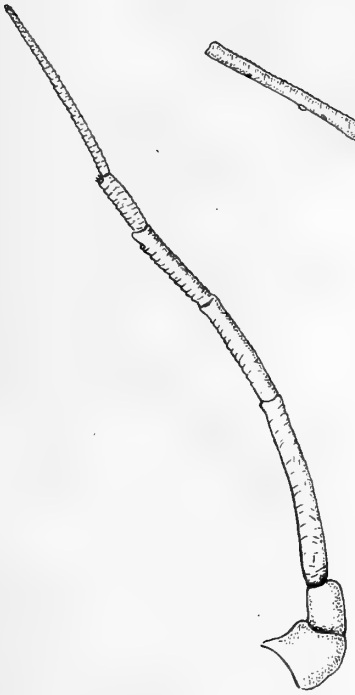

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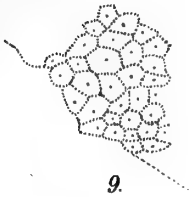

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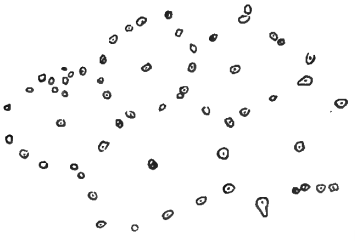

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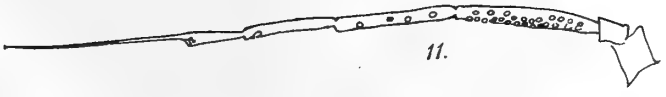

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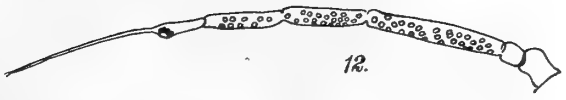

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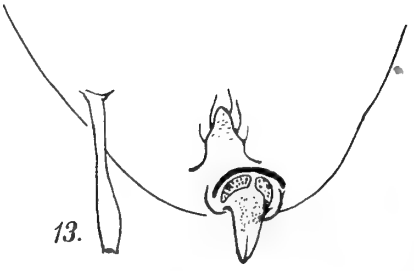

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S. C. Mondul, lith.

EXPLANATION OF PLATE XXII.

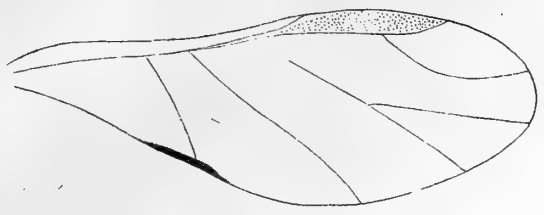
Siphocoryne padi (Linn.), p. 194.

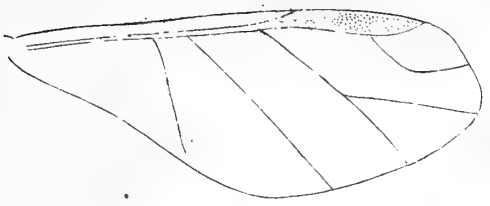
[= *Siphonaphis avenae* (Fabr.), p. 194.]

FIG. 1.—Variation in wing.
,, 2.—Normal wing.
,, 3.—Abdomen of alate female.
,, 4.—Antenna of alate female.
,, 5.—Abdominal end of alate male (after Pergande).
,, 6.—Seedling of "Avena." *a. v. p.* = apterous viviparous female; *s. c.* = stalk of cotyledon; *s. a.* = seed of "Avena"; *s. s.* = surface soil.
,, 7.—Antenna of apterous female.
,, 8.—Antenna of five joints.

Toxoptera graminum (Rond.), p. 196.

FIG. 9.—Apterous female (dorsal view).
,, 10.—Apterous female (ventral view).
,, 11.—Wing.
,, 12.—Antenna of alate female.





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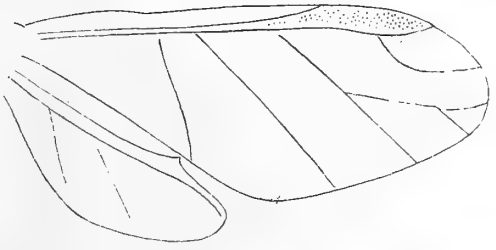

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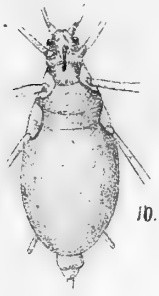

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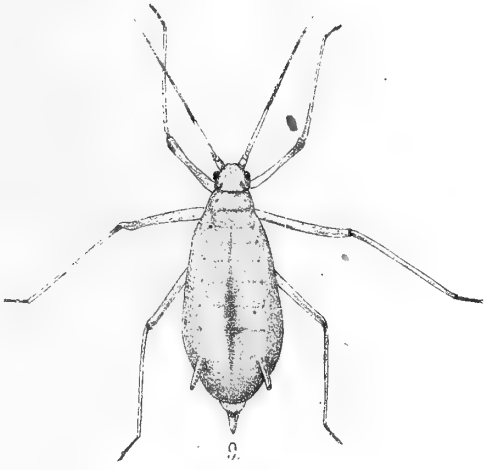

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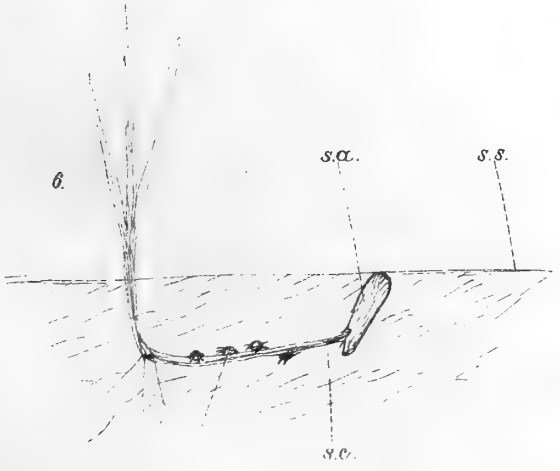


a.v.p.

8.

D. Bagchi, lith.

EXPLANATION OF PLATE XXIII.

Toxoptera cyperi (van der Goot), p. 197.

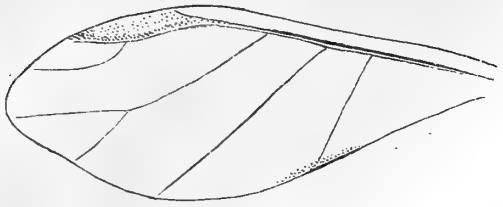
FIG. 1.—Alate female.
„ 2.—Apterous female.
„ 3.—Front wing.
„ 4.—Cauda of apterous female.
„ 5.—Cornicle of apterous female.
„ 6.—Head and antenna of alate female.

Toxoptera punjabipyri, n. sp., p. 198.

FIG. 7.—Abdominal end of alate viviparous female. × 60.
„ 8.—Head and antenna of apterous viviparous female.
„ 9.—Antenna of alate viviparous female.
„ 10.—Wing of alate female.
„ 11.—Antenna of alate male.
„ 12.—Tibia of apterous viviparous female.
„ 13.—Tibia of apterous oviparous female.

Aphis rumicis, Linn., p. 203.

FIG. 14.—Pupa.
„ 15.—Apterous viviparous female.
„ 16.—Alate viviparous female.
„ 17.—Antenna of alate female.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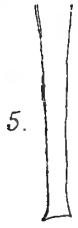
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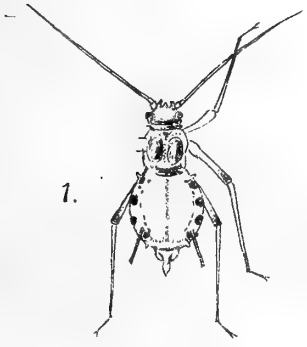
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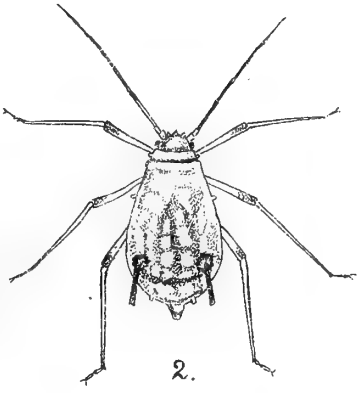
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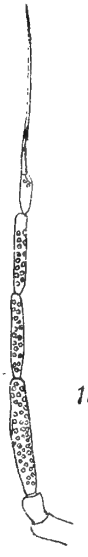
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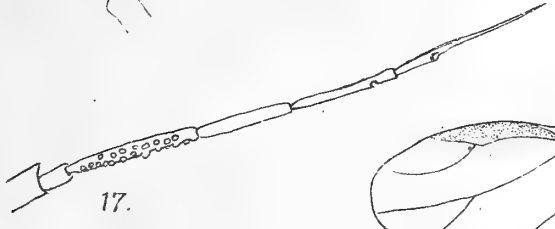
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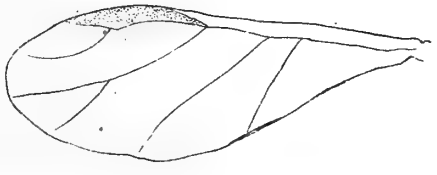
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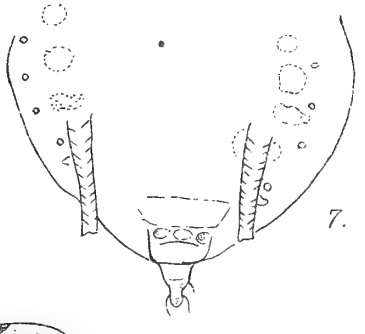
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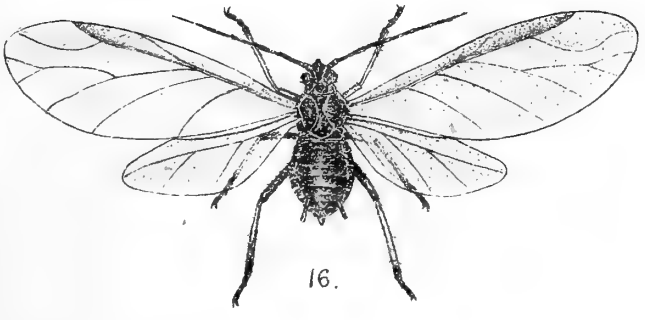
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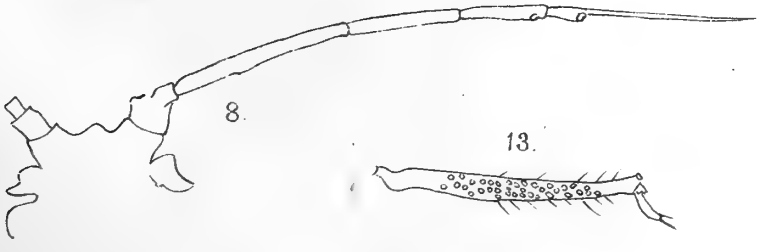
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A. Chowdhary, lith.

EXPLANATION OF PLATE XXIV.

Aphis medicaginis, Koch, p. 203.

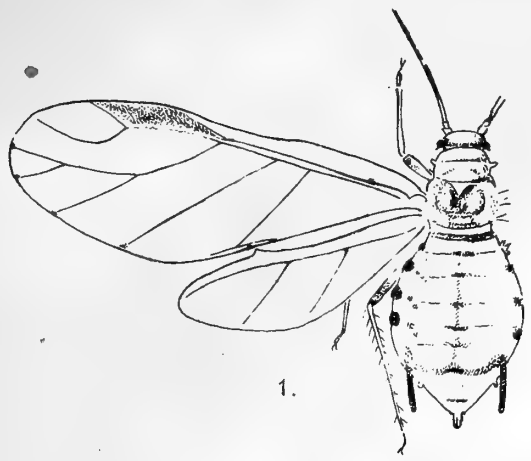
FIG. 1.—Alate female (after Essig).
„ 2.—Apterous female, American form (after Essig).
„ 3.—Apterous viviparous female.
„ 4.—Antenna of alate female.

Aphis nerii (Boyer de Fonscolombe), p. 204.

FIG. 5.—Alate viviparous female.
„ 6.—Apterous viviparous female.
„ 7.—Antenna of alate female.

Aphis sacchari (Zehntner), p. 206.

FIG. 8.—Alate female.
„ 9.—Apterous female, yellow variety.
„ 10.—Apterous female, pink variety.
„ 11.—Antenna of alate female.
„ 12.—Cauda and cornicle of alate female.



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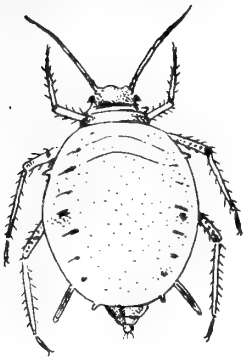

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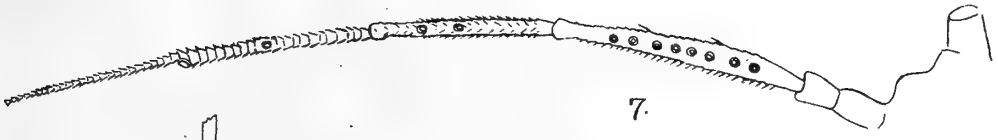

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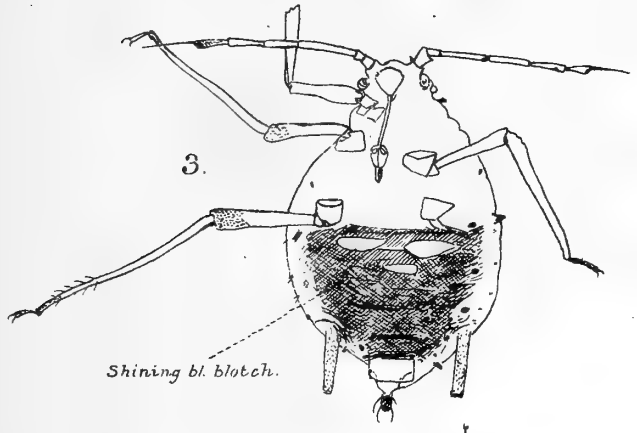

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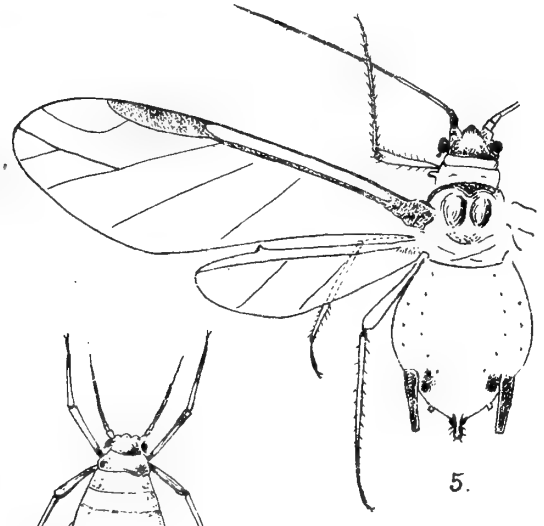

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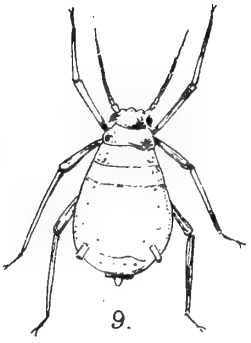

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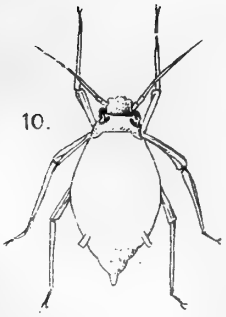

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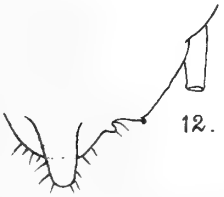

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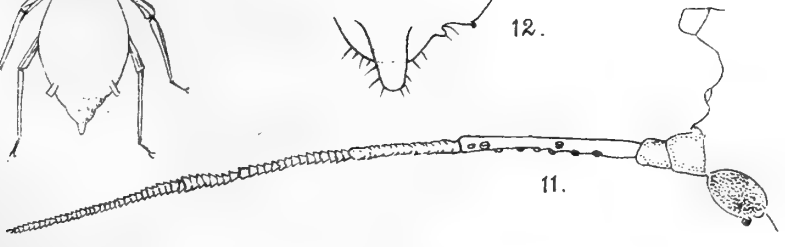

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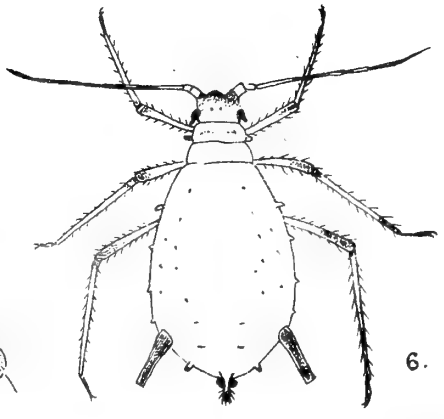

6.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXV.

Aphis maidis (Fitch), p. 208.

FIG. 1.—Apterous viviparous female (dorsal view).
,, 2.—Apterous viviparous female (ventral view).
,, 3.—Apterous viviparous female, light-coloured variety.
,, 4.—Alate viviparous female.
,, 5.—Antenna of alate female.
,, 6.—Antenna of alate male.
,, 7.—Cauda and cornicle of alate female.
,, 8.—Wings.

Aphis cucurbitii (Buckton), p. 215.

[=*Aphis malvae* (Koch), p. 213.]

FIG. 9.—Apterous viviparous female, green variety.
,, 10.—Pupa.
,, 11.—Apterous viviparous female, yellow variety.
,, 12.—Antenna of alate female.
,, 13.—Cornicle of alate female.
,, 14.—Cauda of alate female.
,, 15.—Alate female.
,, 16.—Anterior wing.

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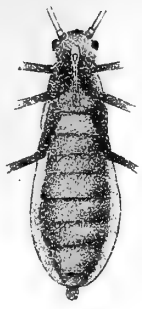

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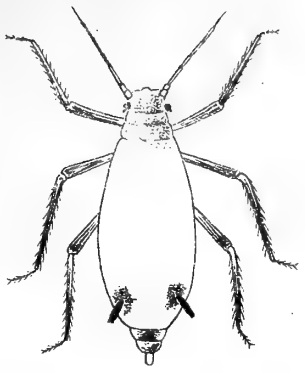

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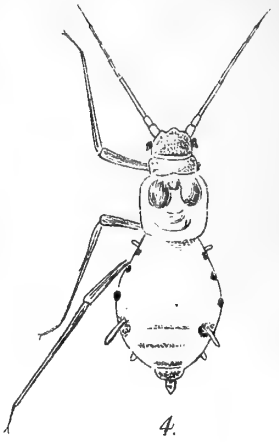

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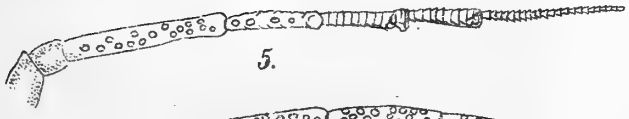

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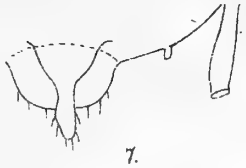

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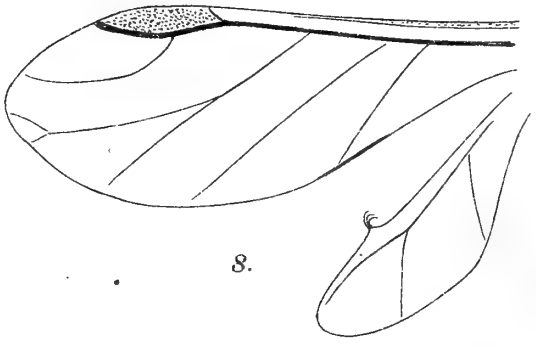

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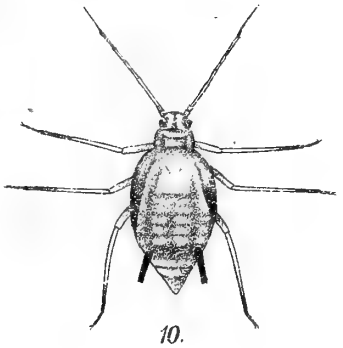

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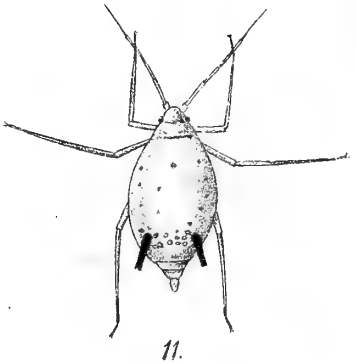

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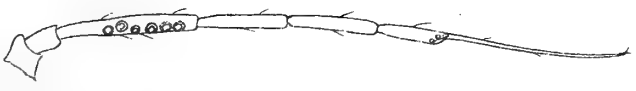

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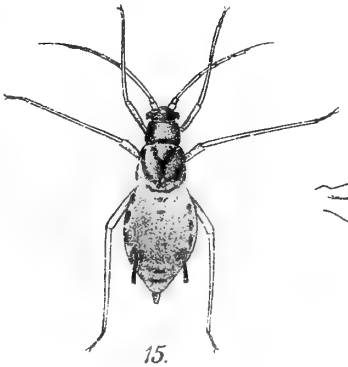

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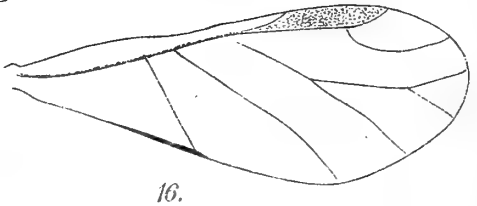


16.

S. C. Mondul, lith.

EXPLANATION OF PLATE XXVI.

Aphis malvacearum, v. d. Goot (*nov. nom.*), p. 217.

[=*Aphis malvoides*, n. sp., p. 215.]

FIG. 1.—Anterior wing.
,, 2.—Cauda of alate female.
,, 3.—Cornicle of alate female.
,, 4.—Antenna of alate female.

Aphis durranti, n. sp., p. 217.

FIG. 5.—Anterior wing.
,, 6.—Cauda of alate female.
,, 7.—Cornicle of alate female.
,, 8.—Antenna of alate female.

Aphis gossypii (Glover), p. 219.

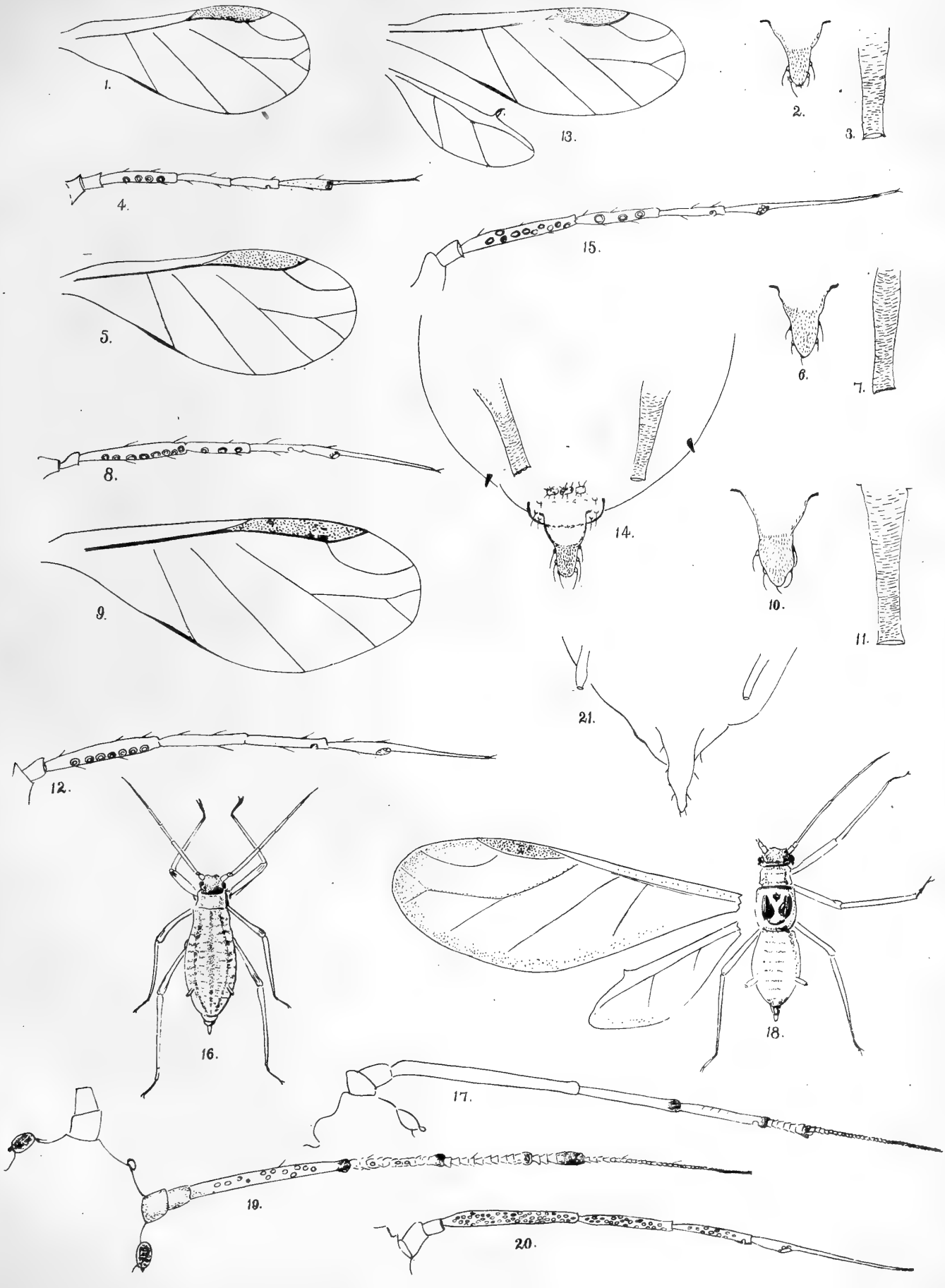
FIG. 9.—Anterior wing.
,, 10.—Cauda of alate female.
,, 11.—Cornicle of alate female.
,, 12.—Antenna of alate female.

Aphis nasturtii (Kalt.?), p. 220.

FIG. 13.—Wings of alate female. × 32.
,, 14.—Abdominal end of alate female.
,, 15.—Antenna of alate female.

Hyalopterus pruni (Fabr.), p. 225.

FIG. 16.—Apterous viviparous female, showing four rows of spots.
,, 17.—Antenna of apterous viviparous female.
,, 18.—Alate female.
,, 19.—Antenna of alate viviparous female.
,, 20.—Antenna of alate male.
,, 21.—Cauda and cornicles of alate female.



D. Bagchi, lith.

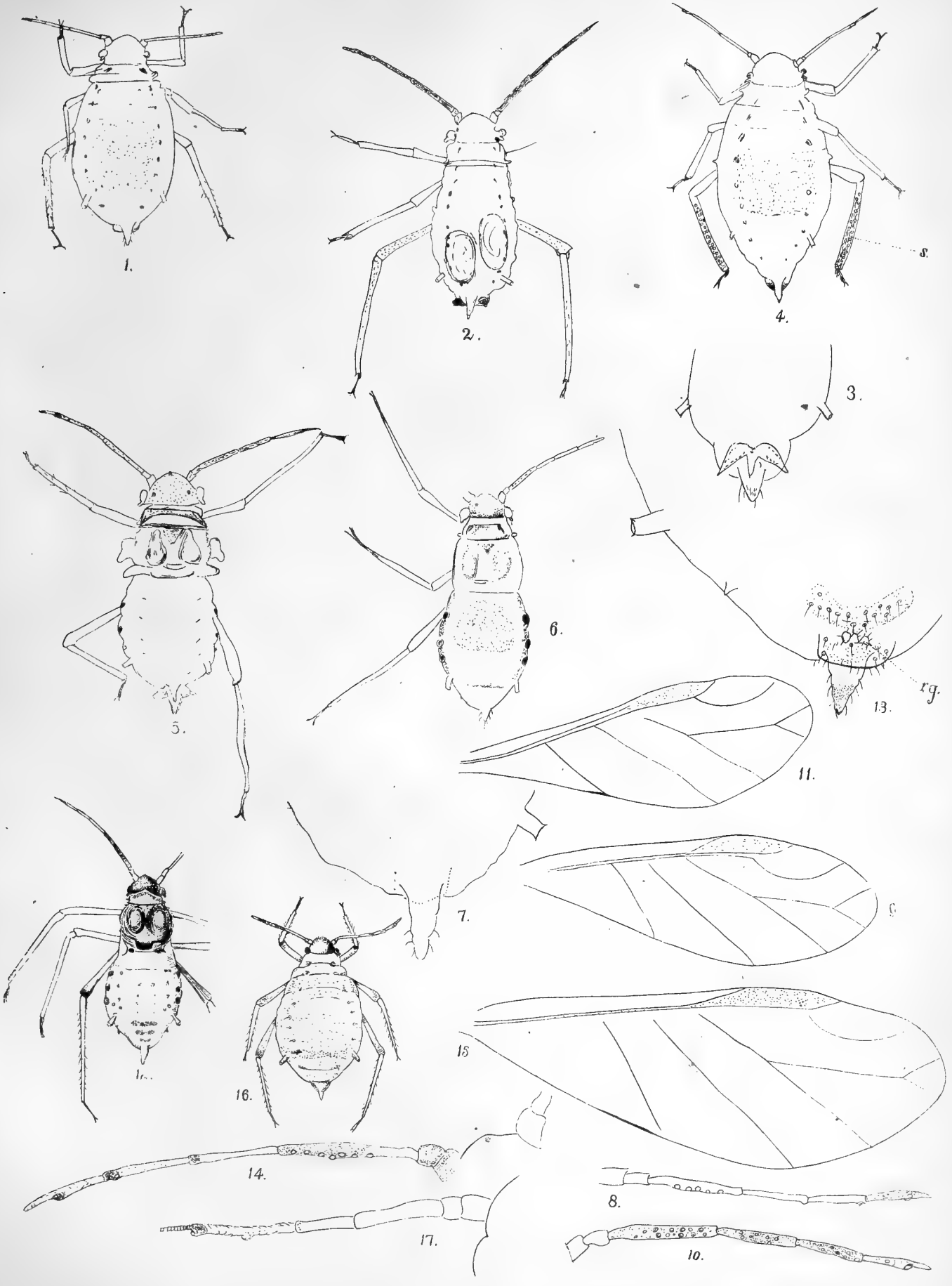
EXPLANATION OF PLATE XXVII.

Brachyunguis harmalae, n. sp., p. 228.

FIG. 1.—Apterous viviparous female. × 24.
,, 2.—Apterous male. × 24.
,, 3.—Genital armature of apterous male. × 60.
,, 4.—Apterous oviparous female. × 24. *s.* = swollen hind tibia bearing sensoria.
,, 5.—"Stumpy male." × 24.
,, 6.—Alate viviparous female.
,, 7.—Abdominal end of alate viviparous female.
,, 8.—Antenna of alate viviparous female. × 75.
,, 9.—Wing of alate female.
,, 10.—Antenna of male. × 75.
,, 11.—Wing of male.

Brachyunguis letsoniae, n. sp., p. 235.

FIG. 12.—Alate female.
,, 13.—Ventral abdomen of alate female. *r. g.*=rudimentary gonapophyses.
,, 14.—Antenna of alate female.
,, 15.—Anterior wing of alate female.
,, 16.—Apterous viviparous female.
,, 17.—Antenna of apterous female.



D. Bagchi, lith.

EXPLANATION OF PLATE XXVIII.

Brachyunguis (?) carthami, n. sp., p. 237.

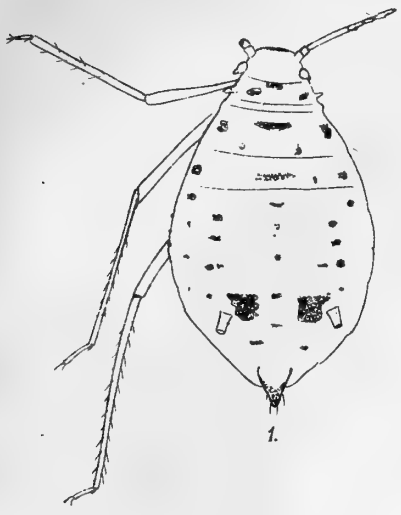
FIG. 1.—Apterous viviparous female. × 20.
,, 2.—Wings.
,, 3.—Abdomen of alate female. × 80. *l. t.* = lateral tubercle.
,, 4.—Antenna of alate female.
,, 5.—Antenna of apterous female. × 80.

Eichochaitophorus himalayensis, n. sp., p. 240.

FIG. 6.—Wing of small alate female. × 30.
,, 7.—Apterous viviparous female. × 30.
,, 8.—Abdomen of alate viviparous female. × 75. *c.* =cauda ; *a. p.*=anal plate.
,, 9.—Wings of alate female. × 30.
,, 10.—Antenna of alate female. × 75.

Callipterus trifolii (Monell), p. 244.

FIG. 11.—Wings of alate viviparous female. × 32.
,, 12.—Alate viviparous female. × 32.
,, 13.—Apterous viviparous female. × 32.
,, 14.—Cornicle.
,, 15.—Cauda and anal plate from below.
,, 16.—Antenna of alate female.
,, 17.—Antenna of apterous female. × 45.
,, 18.—Cauda and anal plate (lateral view).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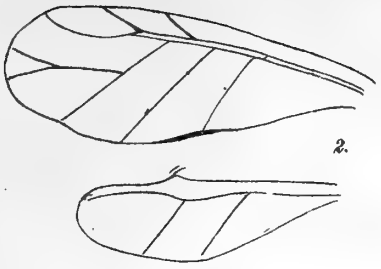
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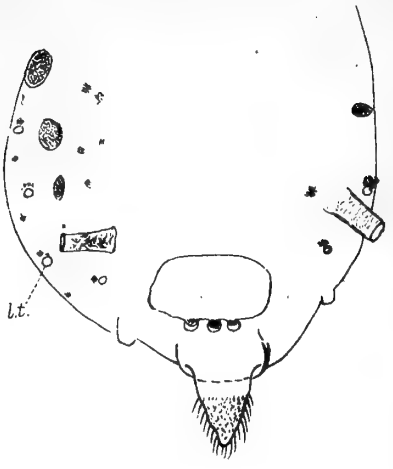

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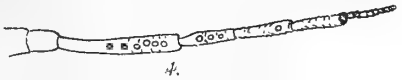
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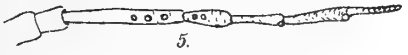
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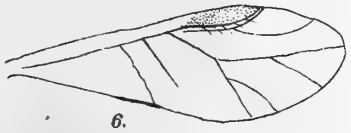
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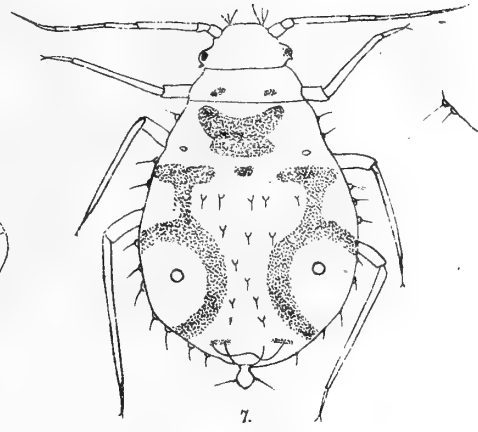
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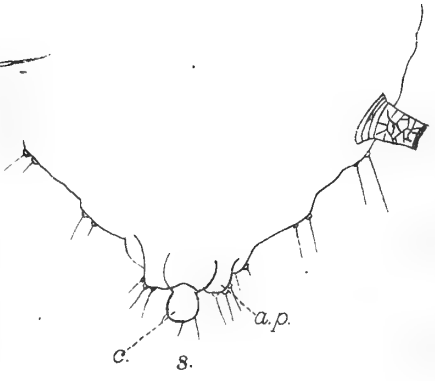

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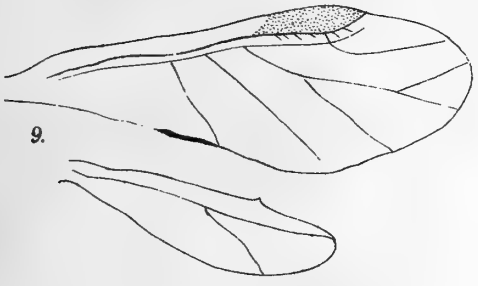
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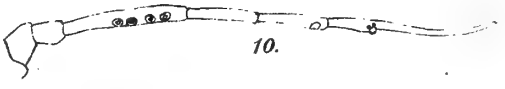
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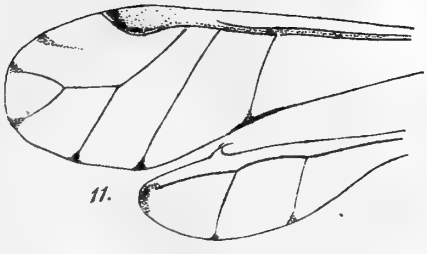
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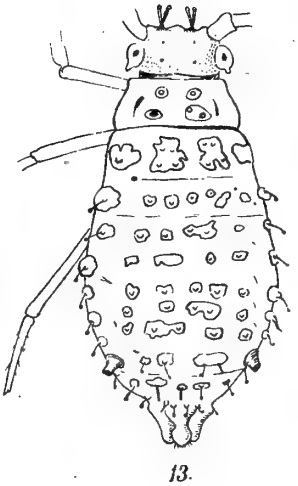
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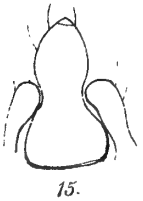
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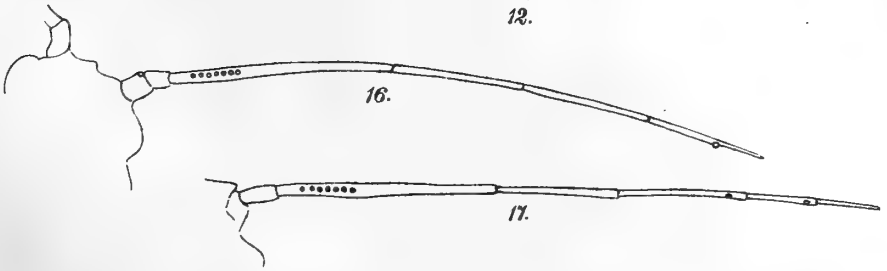
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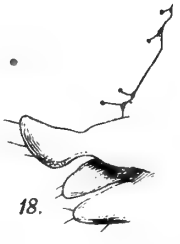

18.

S. C. Mondul, lith.

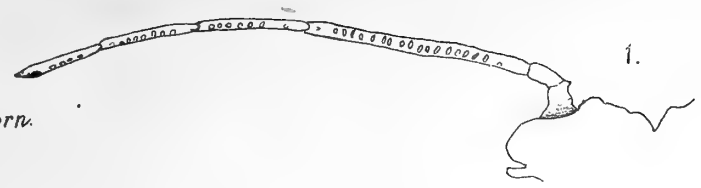
EXPLANATION OF PLATE XXIX.

Shivaphis celti, n. sp., p. 246.

FIG. 1.—Antenna of alate male.
„ 2.—Ventral caudal end of alate male.
„ 3.—Ventral caudal end of alate female.
„ 4.—Hind tibia of oviparous female.
„ 5.—Specimen enlarged.
„ 6.—Antenna of alate female.
„ 7.—Alate female.
„ 8.—Apterous viviparous female.
„ 9.—Antenna of apterous female.
„ 10.—Cornicle and wax gland. *cor.* = cornicle; *w. g.*=wax glands.

Tuberolachnus viminalis (Fonsc.) Mordw., p. 257.

FIG. 11.—Pupa.
„ 12.—Anterior wing.
„ 13.—Antenna of alate female (after Essig).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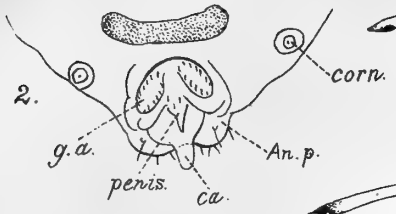

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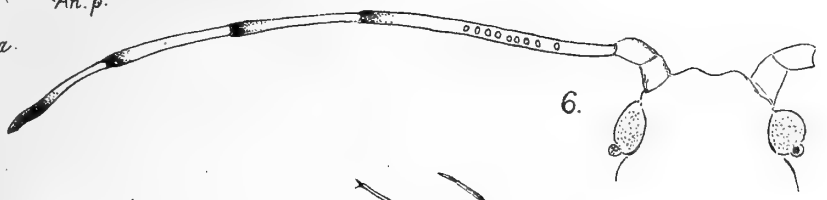
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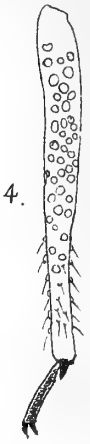
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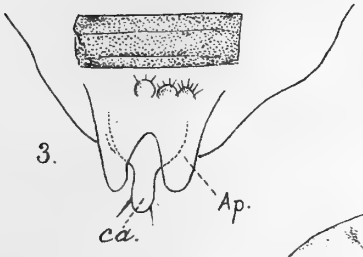

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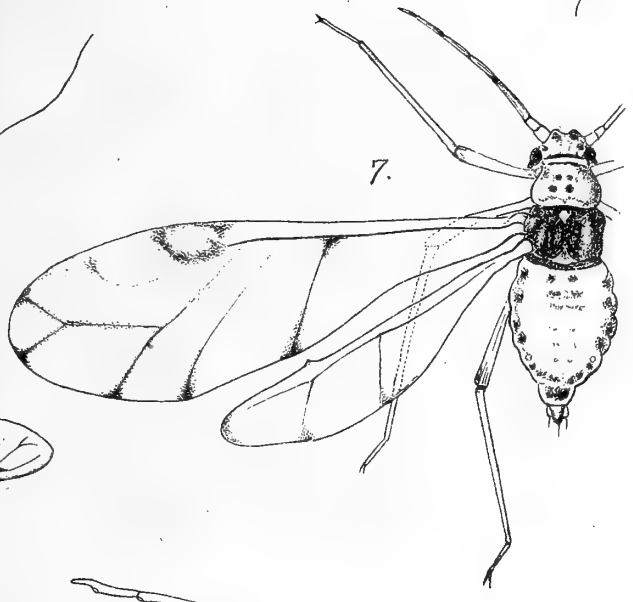
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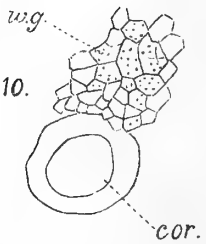

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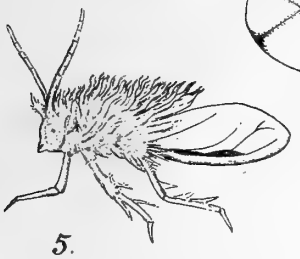
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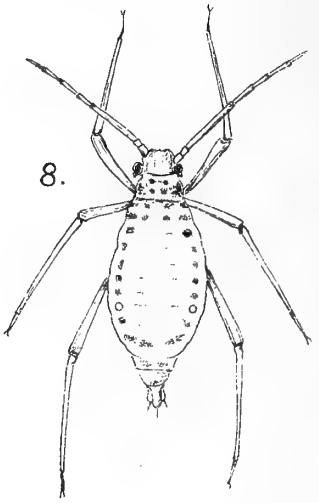
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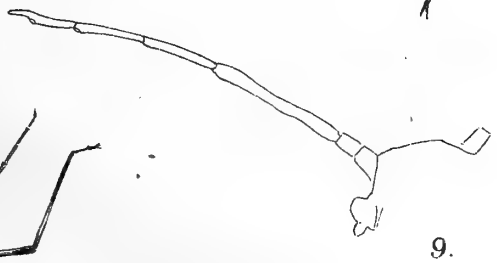
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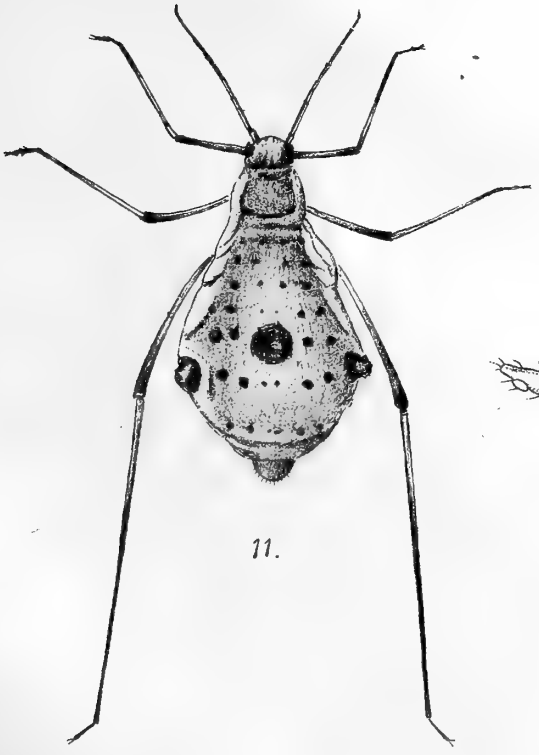
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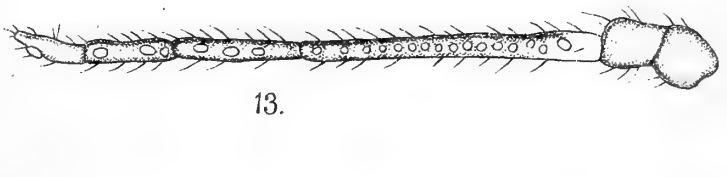
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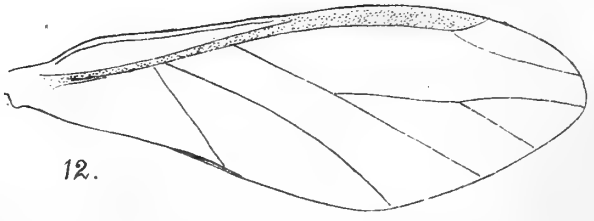
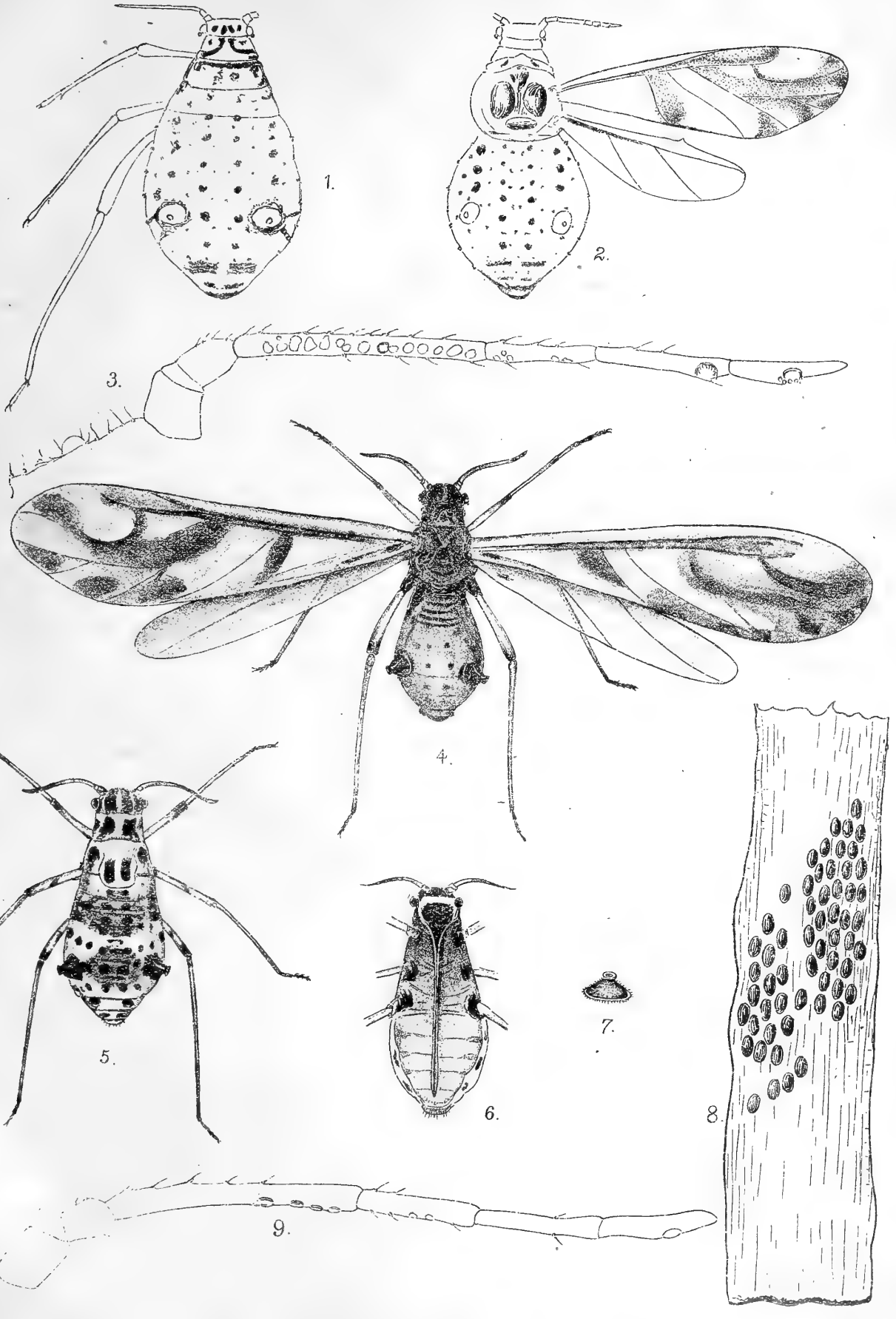

12.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXX.

Tuberodryobius persicae (Cholodk.), p. 259.

FIG. 1.—Apterous viviparous female.
,, 2.—Alate viviparous female.
,, 3.—Antenna of alate female.
,, 4.—Alate viviparous female.
,, 5.—Apterous female.
,, 6.—Ventral surface of apterous female.
,, 7.—Cornicle of alate female.
,, 8.—Cluster of eggs on Peach bark.



A. Chowdhary, lith.