

VI SOME SPONGES ASSOCIATED WITH GREGARIOUS MOLLUSCS OF THE FAMILY VERMETIDAE

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the
Indian Museum.*

Among the most interesting of the specimens received at the Indian Museum as a result of the work of the trawler "Golden Crown" in the Bay of Bengal are a number of rocky masses consisting of the contorted and worm-like shells of molluscs of the family Vermetidae embedded in sponges. Unfortunately they did not reach us until they had been exposed to the air for some days and were in a dry or putrid condition, and only a few broken fragments were preserved in spirit; but as they offer material for certain observations and speculations of a general as well as a taxonomic nature I have prepared the following notes regarding them.

I.—GENERAL.

The masses received at the Museum can be readily separated into two series, one consisting of shells with strongly serrated external ridges and of sponges of an intense black colour and only of moderate hardness, the other of much smoother shells embedded in sponges that are of stony hardness and either of variegated grey and purple or of some shade of red, orange or yellow.

The masses of the first kind were apparently taken only off Gopalpur in the Ganjam district of Madras at depths between 30 and 38 fathoms. Only three specimens were sent us, but probably more were brought up in the trawl and thrown away. A description of the largest and most perfect specimen preserved (pl. viii, fig. 1) will apply equally well, so far as general characters are concerned, to the others also.

The mass is roughly heart-shaped, measuring 40·8 cm. in length, 40·8 cm. in greatest breadth and 16·6 cm. in depth, and weighing 9 lb. 15 oz. dry. It is possible to distinguish the upper from the basal surface by the fact that the shells open, in a more or less horizontal direction, on the former; the latter is irregular but nearly flat as a whole, there is no sign of it having been attached to any foreign object and the mass appears to be complete in itself, not merely a part of a larger mass. The shells, of which several hundreds are present, appear to radiate outwards from a number of different centres, but each is twisted and contorted in a manner different from its neighbour, although the main course of all is

horizontal rather than vertical. Although they do not actually twine round one another, they are so confused in their twistings that it is impossible to isolate a single shell from the mass; the length of the longer shells, measured along their loose and irregular whorls, would be considerable, if it could be accurately measured.

It is not my intention to give a technical description either of this shell or of the other Vermetidae mentioned in these notes, for they all represent well-known species and are admirably figured by Reeve in vol. xx of his *Conchologia Iconica*. Mr. H. B. Preston has identified the ridged species as *Siliquaria muricata* (Born.), but this species is believed by some authorities to be synonymous with *S. anguina* (Linn.). The mollusc is, in any case, widely distributed in Indo-Pacific seas.

The sponge associated with our specimens of *S. muricata* is identical with a species recently described from the Gulf of Manaar by Dendy under the name *Spongosorites topsenti*. The original specimens were not associated with *Siliquaria* shells, but one of them had grown over calcareous nodules and it is probable that the sponge makes use of any suitable support, living or dead, in its growth. As I have already stated, the colour of the specimens before me is an intense black. These specimens are dry, and there is evidence that they were dark green when fresh. The shells are of a dirty white, so that there is considerable contrast between them and the sponge. The latter fills up the spaces between the shells and covers the greater part of the base of the mass but leaves the distal part of the shells free, as a rule for several inches. As it possesses no definite skeleton, the sponge would not persist for long after its death, for the spicules to which its hardness is due would soon fall apart.

The masses of the second series may be further divided into two groups. At first sight they resemble one another closely as regards structure but are easily distinguished by colour. A closer examination, however, reveals the fact that colour is associated with structural peculiarities, and that we are dealing with different species of shell and with sponges that exhibit certain idiosyncrasies correlated with those of the shells with which they are associated. In those masses in which the sponge is red, yellow or orange, the shell is extremely delicate and fragile, has a lustreous appearance and is at no point tightly coiled, while the sponge is not very massive. In those in which the sponge is grey diversified with purple the molluscs have thicker shells which lack the lustre of those in the other masses and are more tightly coiled, while the sponge is more compact. The shells of the first kind have been identified by Mr. Preston as those of *Spiroglyphus cummingi* (Mörch), a species originally described from the Philippines; those of the second kind he has named *Siliquaria cochlearis*, Mörch. this species having originally been described from Ceylon.

It will be convenient in the following notes to refer to the denser masses as the *Siliquaria*-masses, to the others as the *Spiroglyphus*-masses; but it should be noted that *Siliquaria* and

Spiroglyphus are closely allied groups of species which many authorities recognize only as subgenera.

The sponges associated with these shells must be regarded as varieties of a species originally described by Carter from the Gulf of Manaar under the name *Discodermia sceptrallifera* and now assigned to the genus *Racodiscula*. Those that help to form the *Siliquaria*-masses are hereafter described as the types of the new variety *siliquariae* of the species, those associated with the *Spiroglyphus* as the types of the new variety *spiroglyphi*. The two varieties differ not only in colour and compactness but also as regards certain details of spiculation.

The *Spiroglyphus*-masses must have when fresh a very gorgeous appearance, the sponge being red or orange, the shells of a delicate pink and the body of the molluscs yellow. The largest of the specimens (pl. viii, fig. 2), of which a considerable number were obtained, measures about 47.4 cm. by 38.6 cm. by 18 cm. (the last measurement being that of the depth), weighs (dry) nearly 22 lb. and has a regular oval or wreath-shaped form (pl. viii, fig. 2). The smallest, which is very irregular in outline, measures 17.5 cm. by 14.5 cm. by 7.5 cm. In the centre of each mass there is usually either a concavity at the base or an empty space extending from the base through to the upper surface. This concavity probably represents that formerly occupied by the object to which the *Spiroglyphus* shells originally attached themselves on quitting their active larval life—in one specimen this object remains in the form of an oyster-shell, in another in that of the shell of a gastropod: for there is evidence that molluscan shells when not occupied by a living animal dissolve rapidly in the Bay of Bengal, even in shallow water. "Dead" shells (to use a conchologist's phrase) from the Bay are usually very "dead," their surface being much corroded; and immediately north of the area on which the *Spiroglyphus*-masses occur, the bottom of the sea is coated with a recent conglomerate formed of partially dissolved shells consolidated with sand-grains into a layer of stony hardness. Most of the *Spiroglyphus*-masses seem from their regular outline to be complete in themselves, but some of the smaller specimens appear to have once formed parts of wreath-shaped masses which have been broken by some accident and have repaired the actual fracture in the course of growth. The collection offers no proof of the existence of masses larger than the larger one of which the measurements are given.

The *Siliquaria*-masses are not so numerous as the *Spiroglyphus*-masses and must have been much less conspicuous objects when fresh. None of our specimens appear to be complete, for all are irregular in form and show evidence of being merely fragments of larger masses. The largest fragments obtained are about half the size of the largest *Spiroglyphus*-masses. While the *Spiroglyphus* shells radiate more or less distinctly from a common centre, run mainly in a horizontal direction and have a very open and irregular spiral, those of *Siliquaria cochlearis* are coiled in almost

regular snail-shell fashion in their oldest portion, and although they become uncoiled and very irregularly spiral in their distal parts, adopt a course much nearer the vertical than that adopted by *Sp. cummingi*. The shell is thicker and stouter than that of the *Spiroglyphus*. The difference in growth between the two shells appears to produce or at any rate to be correlated with structural differences in the sponge associated with them, for there can be no doubt that the same *species* of sponge is associated with both molluscs.

Unfortunately our data as regards the *provenance* of the two species of shell with their associated varieties of sponge are not sufficiently precise for it to be possible to say whether they affected habitats in any way diverse. All that we know is that both species are common in an area that extends in a southerly direction from opposite Gopalpur on the coast of the Ganjam district at least to the neighbourhood of Vizagapatam, and that they are found in depths of between 15 and 30 fathoms.

The sponge *Racodiscula saccitrullifera* belongs to the Tetractinellid grade Lithistida, which is characterized by the possession of much proliferated spicules (primarily of the Tetractinellid type) welded together to form a compact siliceous skeleton. This skeleton, even after the death of the sponge, can be broken up only by the exercise of considerable violence.

It is probable that the masses, with which this paper deals, will be of considerable interest to the geologists of some future epoch, when the bottom of the Bay of Bengal has become dry land, if there be geologists then. This is especially the case as regards those masses in the formation of which *Racodiscula* plays a part, for, "The Lithistids are peculiarly well suited for preservation, owing to the massive, stony character of their skeletons; and their remains occasionally form thick deposits, especially in the Jurassic and Cretaceous." (Zittel's *Text-Book of Palaeontology*, vol. i, p. 47, Engl. ed., 1900.) We have no evidence, however, that the combined growth of the shells and the sponges is producing in Indian seas, reefs at all comparable to those now being formed by Vermetid shells alone off the coast of Florida. These reefs are described by Dall¹ as being of sufficient size for boats to be wrecked upon them at low tide, and as covering very large areas. But it is evident that masses of considerable weight and stability, and possibly larger than any that have as yet been examined, are being produced in enormous numbers off the coast of the Ganjam and Vizagapatam districts of the Madras Presidency. From a practical point of view these masses would interfere seriously with trawling operations off this coast, for the net of the "Golden Crown" was seriously damaged by them on more than one occasion: from a zoological point of view they seem to be characteristic of a definite faunistic area of somewhat limited

¹ *Bull. Mus. Zool. Harvard*, xviii, p. 262 (1889).

extent. Northwards the fauna they represent gives place to one consisting largely of sedentary organisms such as Alcyonaria and Antipatharia fixed to the recent conglomerate to which reference has already been made. Still further northwards, all round the head of the Bay, only those animals can exist which can endure muddy water and can live without a solid surface of attachment. Southwards the *Siliquaria*-beds are replaced, in the more sheltered and probably salter waters of the Gulf of Manaar, by coral reefs.

From a strictly biological point of view it is interesting to notice that neither of the two species of sponges found associated with the three species of Vermetidae is peculiar to these shells or, indeed, to a habitat or manner of life similar to that implied by the mollusc's peculiar method of growth. In two cases out of three, however, the sponge appears to be modified to some extent by the peculiarities of the shell with which it is associated, or at any rate in accordance with these peculiarities.

Several other organisms were found in large or considerable numbers and in some degree associated with the shells and sponges. Dead shells (of which there were a considerable number in some masses) of both *Siliquaria cochlearis* and *Spiroglyphus cummingi* were often inhabited by the peculiar little hermit-crab *Troglopagurus manaarensis*,¹ hitherto only known to frequent holes in corals in the Gulf of Manaar. A small bivalve mollusc (*Arca domingensis* var. *divaricata*) was also found in considerable numbers in dead shells of the two species, anchored to the inner surface by a byssus of horny consistency, while specimens of a larger species of the same genus (*A. adamsiana*) were found in interstices of the sponges and between the shells. Sedentary organisms were not so numerous on the external surface of the masses as might perhaps have been expected, but a considerable number of small monaxon sponges and a few polyzoa occurred in this position and shells of the bivalve *Chama ruppelli* were common.

II.—DESCRIPTION OF THE SPONGES.

The sponges here described belong to two grades of the order Tetraxonida, namely the Lithistida and the Monaxonellida, if we adopt the nomenclature proposed by Prof. Dendy in his account of the sponges in part iii of Prof. Herdman's report on the pearl-fisheries of Ceylon; for two of the three forms found in association with *Siliquaria* shells off the Madras coast represent varieties of a species of *Racodiscula* (Lithistida) originally described by Carter from the Gulf of Manaar, while the third represents a species of *Spongosorites* (Monaxonellida) also described from the Gulf of Manaar, by Prof. Dendy in the report to which reference has just been made.

¹ Dr. J. R. Henderson, the author of the species, has been kind enough to identify specimens.

Racodiscula sceptrellifera (Carter).

Discodermia sceptrellifera, Carter, *Ann. Mag. Nat. Hist.* (5), vol. vii. p. 372, pl. xviii, fig. 2 (1881).

Racodiscula sceptrellifera, von Lendenfeld, *Das Tierreich*, Lief. 19 (Tetraxonia), p. 132 (1903).

Carter's description of this species was based on a specimen "not only small but imperfectly developed" and partially embedded in a nodule of the calcareous alga *Mclobesia*. It is therefore unfortunate that the form he described must be regarded as the *forma typica* of the species. Among the specimens obtained by the "Golden Crown" two other forms may be distinguished, each associated in several or many instances with a particular species of *Siliquaria* or *Spiroglyphus*. Possibly they are mere phases, their peculiarities being due to the direct effects of environment, but it will be convenient to regard them provisionally as varieties of Carter's species, with which I have no doubt they should be associated.

Var. *spiroglyphi*, nov.

(Plate viii, fig. 2; plate ix, figs. 1—15.)

Sponge of a deep orange or bright red colour when fresh, yellow when dry, coating and filling the interstices between shells of *Spiroglyphus cummingi* (Mörch), often massive, but without definite form, very hard; the surface smooth, with scattered oscula of oval form and varying from 2×2.5 mm. to 3×4 mm. in dried specimens; pores sieve-like, scattered, minute, each aperture measuring about 0.33×0.5 mm. The main efferent channels run as a rule obliquely. The surface of the sponge, immediately under the dermal layer, is scored with narrow channels which enter the efferent canals close to the oscula. The lining of the latter is a collenchyma which is sometimes as much as 3 mm. thick and consists of numerous nuclei embedded without visible cell-limits in a gelatinous substance. This substance is not destroyed even by hot nitric acid, at any rate without prolonged boiling. Slender fibres can be detected in parts of the collenchyma, running vertically. (My material is not sufficiently well preserved to render a detailed description of the soft parts possible.)

Skeleton and Spicules.—The skeleton consists of stout desmas (pl. ix, figs. 8—14) of the typical form firmly welded together by means of the proliferations at the ends of the branches. The shafts are smooth or nearly so. Where the sponge is in contact with the shells with which it is associated the tips are flattened and splayed out in a horizontal plane. Towards the external part of the sponge, where growth is evidently most active, many of the desmas afford a transition, more apparent than real, to the phyllotriaene dermal spicules (pl. ix, figs. 8, 9; see also Carter, *op. cit.*, pl. xviii, fig. 2e). Their shafts are more slender, their terminal proliferations less developed than in other desmas, and often

one cladus is less well developed than the other three. They can always be distinguished, however, from true phyllotriaenes by the fact that in the former this cladus, although apparently vertical in direction and often only a little proliferated at the tip, has never the regular pointed form of the vertical spike of the phyllotriaene. I have no doubt that these "intermediate" desmas are simply young spicules that have not yet become firmly united with their fellows. The true phyllotriaenes are entirely confined to the external surface, on which they form a single reticulate layer, the branches of different spicules overlapping at the extremities and the spike pointing vertically downwards. The subdermal channels lie directly under this layer and the spikes project into their lumen. I have not found any of the discoidal forms figured by Carter, *op. cit.*, pl. xviii, figs. 2a, 2b; but spicules agreeing with his figs. 2c and 2d are abundant in my preparations (pl. ix, figs. 4—7). Possibly the discoidal spicules are only found in young or stunted sponges. The most noteworthy difference between Carter's specimens and those of this variety is the apparent absence in the former of the slender rhabdi that form a conspicuous feature in the latter. These rhabdi vary greatly in length but are always very slender, the longest measuring 0.9 mm. $\times$ 0.007 mm. They are not inflated in the middle or at the ends and their tips are bluntly pointed, but one end is often stouter than the other. The longer specimens are sinuous and hair-like. These rhabdi lie in a more or less vertical position in the interstices of the skeleton, and more especially in the walls of the efferent canals, sometimes forming loose strands in the latter situation. They do not project on the surface of the sponge. The microscleres (pl. ix, fig. 15) are somewhat irregular amphiasters with a circle of spines round the shaft; but the spines are often asymmetrical in form and disposition. The spicules measure about 0.01 mm. in length and 0.006 mm. in greatest breadth. The amphiasters are found chiefly in the dermal layer, in which they are densely scattered.

Habitat.—Off the coast of the Ganjam and Vizagapatam districts of the Madras Presidency in 15 to 30 fathoms: associated with *Spiroglyphus cummingi* (Mörch).

Var. *siliquariac*, nov.

(Plate ix, figs. 16—18.)

Sponge denser and more massive than that of var. *spiroglyphi*, of a dull grey colour diversified with large spots which are of a deep purple colour and have irregular but well-defined outlines; oscula larger, main efferent canals wider and more vertical.

Spicules and Skeleton.—The desmas, phyllotriaenes and amphiasters agree almost exactly with those of the var. *spiroglyphi*, except that the desmas are a little stouter; but the rhabdi are very few or altogether absent. The sponge has the habit of collecting spicules from other sponges that grow in its vicinity, and I

have found in different preparations of a considerable number of specimens, single spicules or small groups of spicules belonging to seven different types, the commonest of which consists of amphioxi that have clearly been derived from the skeletons of monaxons growing on the surface of the Lithistid. In several instances I have found the sponge from which they clearly originated. These adventitious spicules are scattered, together with small grains of sand, in the collenchyma of the efferent canals and in the outer parts of the sponge. In one preparation I found several rhabdi like those of the var. *spiroglyphi*. They apparently formed a small vertical strand in the collenchyma of an efferent canal, but it is impossible to be quite sure that they were not adventitious. The external surface has been rubbed off most of my specimens of the var. *siliquariac*, and with it the phyllotriaenes and amphiasters have disappeared, but I have found them both in one preparation, having the same forms and arrangement as in var. *spiroglyphi*, except that the amphiasters were perhaps a little shorter and more regular in shape.

Lying loose in the efferent channels near the osculum of a dried specimen of this variety I found several little siliceous bodies (pl. ix, fig. 18) that are probably the skeletons of embryo sponges. They are formed of closely welded spicules resembling the desmas of the adult sponge but smaller and more slender. Each body has the form of a figure of eight somewhat attenuated, and measures between 2 and 3 mm. in length; the proportions differ in different specimens, but one of the loops is usually rather larger than the other. One surface is flat, the other distinctly convex. Each loop contains three relatively large apertures, one on the convex surface, a corresponding but smaller aperture on the flat surface, and one (still smaller) at the free extremity. The last is surrounded by projecting cladi of desmas. There is no channel, so far as can be seen from a bare skeleton, between the two loops.

Habitat.—Off the coast of Ganjam and Vizagapatam in 15—30 fathoms; associated with *Siliquaria cochlearis*, Mörch.

It is unfortunate that the data supplied with the specimens of these two varieties are not sufficiently precise to enable me to state whether their peculiarities are correlated with any difference in habitat or environment. The colour of the two is of course strikingly different, while the absence or paucity of rhabdi in the var. *siliquariac* enables sections or other preparations of this form to be distinguished at a glance from those of the var. *spiroglyphi*. The former variety, therefore, seems to agree as regards spiculation (except in the absence of discoidal phyllotriaenes) with the typical form of the species, but to differ both from it and from the var. *spiroglyphi* in colour. It differs from both in its more massive structure. Colour is perhaps a more important character as regards the forms of *R. sceptrifera* than it is in most sponges, for in the case of all the specimens examined I have found it to some extent persistent. In the var. *siliquariac*, however, the purple patches are probably due to the sporulation of some

micro-organism, for they are produced by enormous numbers of minute morula-like masses contained in the soft parts of the sponge.

Spongosorites topsenti, Dendy.

(Plate viii, fig. 1.)

S. topsenti, Dendy in Herdman's *Report on the Pearl Oyster Fisheries of Ceylon*, pt. iii, p. 182, pl. xii, fig. 1.

Sponges of this species were found associated with *Siliquaria muricata* off the coast of Ganjam near Gopalpur in from 30 to 38 fathoms. They agree well as regards structure with Dendy's description of the type specimens from the Gulf of Manaar, one of which had grown partially round calcareous nodules; but certain differences may be noted as regards external form and colour, although these differences are perhaps due to the fact that my specimens are dry. Their surface is smooth, except where the sponge forms a thin layer over the spinose shells of the *Siliquaria*, and except for a few scattered and irregular cones less than 5 mm. high. I have not observed the vents. Externally the sponge is of an intense black colour, but the inner parts are dark green, which was probably the colour of the fresh sponge.

EXPLANATION OF PLATE VIII.

- FIG. 1.—Mass formed of shells of *Siliquaria muricata* (Born.) and the sponge *Spongosorites topsenti*, Dendy, viewed from above. (Scale about $\frac{2}{7}$.)
- „ 2.—Mass formed of shells of *Spiroglyphus cummingi*, Mörch, and the sponge *Racodiscula sceptrifera* var. *spiroglyphi* nov., viewed from below. (Scale about $\frac{2}{9}$.)

In both figures the lower end of the mass is obscured to a slight extent.

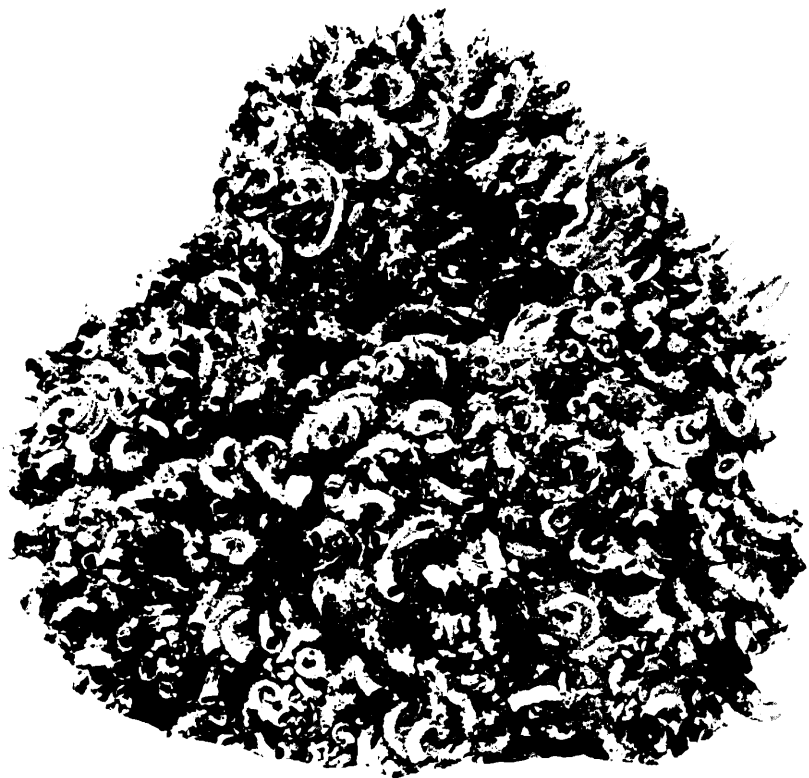


Photo. by A. C. Chowdhury

1.

SILICUARIA MURICATA Born.
with *Spongosorites topsenti* Dendy.



2.

SPIROGLYPHUS CUMMINGI Mörh.
with *Racodiscula sceptrifera* Carter, var. *spiroglyphi*, nov.

EXPLANATION OF PLATE IX.

FIGS. 1—15.—*Racodiscula sceptrellifera*, Carter, var. *spiroglyphi*, nov.—

Figs. 1—7.—Phyllotriaenes, $\times 75$.

„ 8—11.—Desmas, $\times 75$.

„ 12, 13.—Fragments of the skeleton (lateral view), $\times 75$.

„ 14.—Fragment of the skeleton in contact with a shell (surface view), $\times 75$.

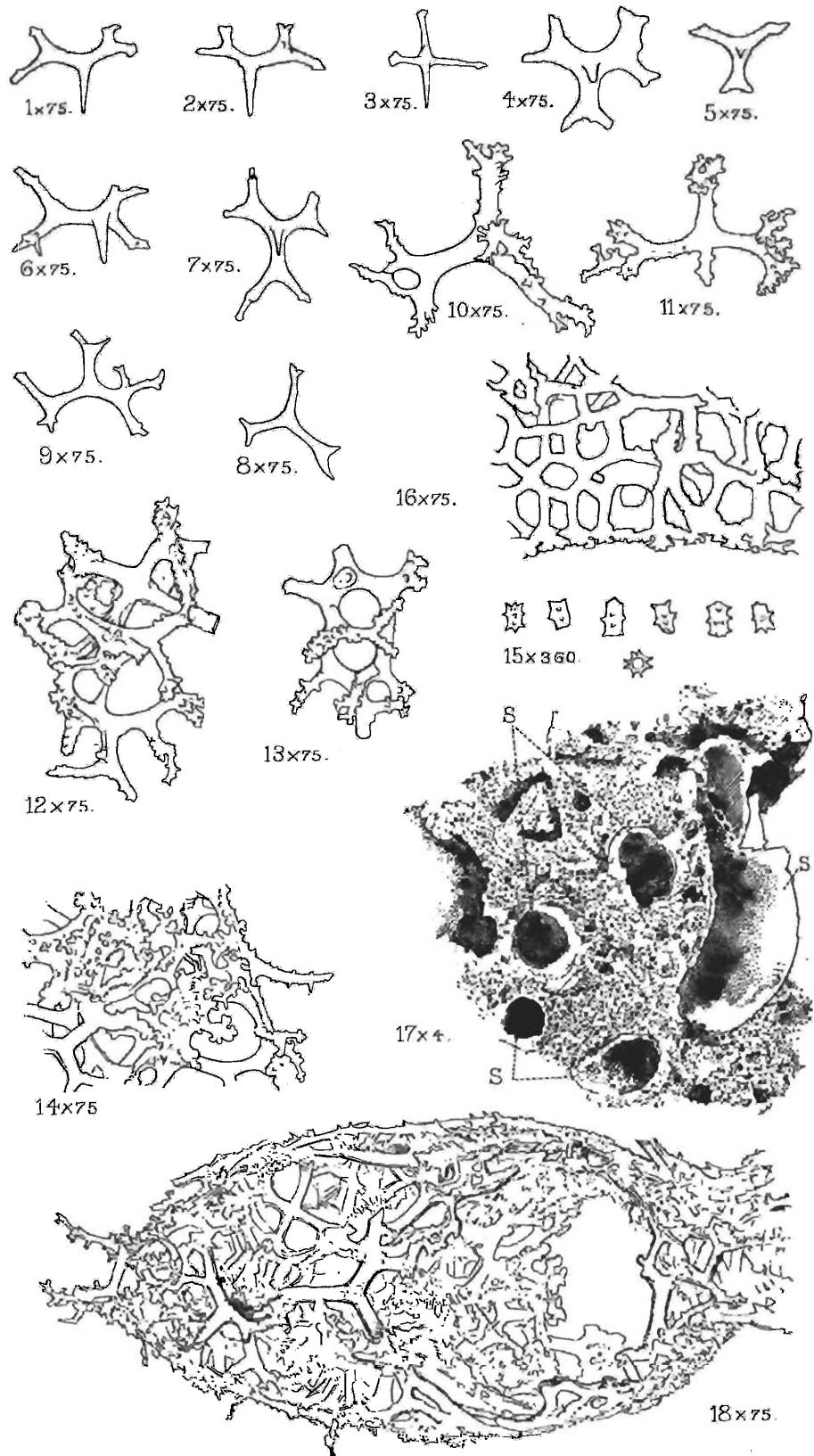
„ 15.—Microscleres (amphiasters), $\times 360$.

FIGS. 16—18.—*Racodiscula sceptrellifera*, Carter, var. *siliquariae*, nov.—

Fig. 16.—Vertical section of a fragment of the skeleton in contact with a shell, $\times 75$. (To show how the cladi of the desmas become splayed out horizontally in such positions.)

„ 17.—Vertical section of a fragment of the dried sponge with enclosed shells from near the surface of a mass, $\times 4$.

„ 18.—Half of (?) embryonic skeleton from efferent channel of the sponge, $\times 75$.



VII. REPORT ON A COLLECTION OF AQUATIC ANIMALS MADE IN TIBET BY CAPTAIN F. H. STEWART, I.M.S. DURING THE YEAR 1907.

PART III.—TURBELLARIA AND SUMMARY.

REPORT ON A COLLECTION OF TURBELLARIA MADE BY CAPT. F. H. STEWART, I.M.S., IN TIBET.

Von DR. A. MEIXNER und A. MUTH. Graz (Steiermark).

Die von Mitte Januar bis Anfang September 1907 von Capitän F. H. Stewart in sehr beträchtlichen Höhen der tibetischen Gebirge gesammelten Turbellarien gehören theils zu den Rhabdocoeliden, theils zu den Tricladen. Charakteristisch für alle ist die auffallende Kleinheit der Individuen (auch der geschlechtsreifen); man wird kaum fehlgehen, wenn man für diese interessante Thatsache die bedeutende Seehöhe (13,120—14,500 ft.) mit den damit zusammenhängenden klimatischen Verhältnissen verantwortlich macht.

I. RHABDOCOELIDA.

(Von DR. A. MEIXNER.)

Die Rhabdocoeliden des vorliegenden Materiales vertheilen sich auf drei Familien und vier Gattungen. Die meisten Exemplare sind nicht oder nicht völlig geschlechtsreif, so dass nur bei einer einzigen Form die Artzugehörigkeit festgestellt werden konnte.

System, Nomenclatur und Terminologie folgen *L. von Graff's* Bearbeitung der Turbellarien in *H. G. Bronn's* Klassen und Ordnungen des Thier-Reichs. Benutzt wurden ausserdem hauptsächlich:

W. E. Bendl, Rhabdocoele Turbellarien aus Innerasien. Graz 1909.

M. Braun, Die rhabdocoeliden Turbellarien Livlands. Dorpat 1885.

L. von Graff, Monographie der Turbellarien. I. Rhabdocoelida. Leipzig 1882.

A. Luther, Die Eumesostominen. Leipzig 1904.

In den folgenden Beschreibungen beziehen sich die Grössenangaben stets auf das conservierte Material; Breite und Dicke sind stets an der breitesten bez. dicksten Stelle gemessen. "Rostral-

und Caudal-Ende" des Körpers werden stets mit R. E. und C. E. abgekürzt.

Familie CATENULIDAE.

Stenostomum (?) sp.

No. 63. Small Rhabdocoel. Gyantse, 13,120 ft., Tibet, 4-viii-07, among algae, in hill stream.

Zwei conservierte Exemplare, 290 μ lang, 70 bez. 75 μ dick. Körper drehrund, gestreckt, in der Mitte am dicksten, rostral und caudal verjüngt, an den Enden mehr oder minder abgerundet. In Alkohol opak, schwarzgrau; in Cedernholzöl durchscheinend bräunlichgelb.

Die *Mundöffnung* liegt am Ende des ersten Körperfünftels. Der *Pharynx*, ein Ph. simplex, ist schwach gebogen und etwas mehr als ein Körpersechstel lang. Der sackförmige *Darm* füllt die beiden letzten Körperdrittel vollständig aus. Mehr lässt sich von der Organisation auch an Querschnitten nicht erkennen. Geschlechtsorgane fehlen.

Für die Zurechnung der beiden vorliegenden Exemplare zur Gattung *Stenostomum* O. Schm. sprechen folgende Erwägungen: Ein Pharynx simplex findet sich nur bei den *Catenuliden* und *Microstomiden*. Von den letzteren schliessen sich die *Microstominen* durch das Vorhandensein eines praeoralen Darmblindsackes, die *Macrostominen* durch den Besitz einer caudalen Haftscheibe aus. Unter den vier Gattungen der *Catenuliden* fällt *Rhynchoscolex* Leidy durch den Besitz eines keulenförmigen Rüssels ausser Betracht; *Catenula* Ant. Dug. und *Fuhrmannia* Graff scheiden durch das Vorhandensein einer praeoralen Ringfurche aus, die ich an den vorliegenden Exemplaren vermisste, so dass nur *Stenostomum* O. Schm. übrigbleibt.

Familie DALYELLIIDAE.

Dalyellia sp.

Nos. 45 and 53. Microscopic Rhabdocoel. Gyantse, 13,120 ft., Tibet, 6-vi-07 and 7-vii-07, among algae in slow flowing water. Cocainised. Fixed with HgCl_2 sat. sol., $\rightarrow$ 70 % alcohol.

Zwei in oben angegebener Weise conservierte Exemplare, das grössere 530 μ lang und 180 μ dick. Körper drehrund, spindelförmig, in der Mitte am dicksten. R.E. abgerundet, C.E. zugespitzt. In Alkohol bräunlichgelb; in Glycerin oder Cedernholzöl scheinen Pharynx und Darm dunkler graubraun, das Uterusei bräunlichgelb durch.

Das Epithel ist 3 μ , gegen das C.E. 4·5 μ hoch, die über den ganzen Körper gleichmässig verbreiteten Cilien sind 3—3·5 μ (am C.E.) lang. Das C.E. trägt 4—6 Haftpapillen, in die ebenso viele grosse, birnförmige Schwanzdrüsen mit langgestreckten Ausführungsgängen münden. Die körnchenförmigen dermalen Rhabditen, die am zahlreichsten in der Nähe des C.E. vorkommen, messen höchstens 0·5 μ .

Die *Mundöffnung* liegt etwas vor dem Ende des ersten Körperachtels. Der *Pharynx*, ein Ph. doliiformis, misst nicht ganz ein Körperviertel in der Länge und besitzt einen deutlich abgesetzten Saum. Der *Darm* ist nahezu kugelig, caudal durch den gefüllten Uterus etwas eingebuchtet. Die birnförmigen oder unregelmässig gestalteten Speicheldrüsen liegen in grosser Zahl unmittelbar unter dem Hautmuskelschlauch und münden mit langen Ausführungsgängen in die Uebergangsstelle von Pharynx und Darm. (Der Oesophagus ist nicht erkennbar.)

Das *Gehirn* liegt im zweiten Körpersiebentel, über dem Pharynx, und besteht aus zwei, durch eine breite und dicke Quercommissur verbundenen, längsovalen Körpern. Auf Querschnitten lassen sich die kurzen und dicken Nervi optici, die etwas schwächeren Lateralnerven, sowie die noch schwächeren Längsnervenstämmen in ähnlicher Anordnung, wie sie Lippitsch¹ für *Phaenocora unipunctata* Oe. constatiert hat, erkennen.

Die *Augen* liegen zu beiden Seiten der vorderen Gehirnpartien. Von der Dorsalseite betrachtet erscheinen sie nierenförmig, schwarz. Auf Schnitten erkennt man die Becherform; das Pigment bildet grosse, fast opake schwarzbraune Kugeln, deren Zahl gering ist.

Genitalporus, *Copulationsorgane* und *Hoden* sind auch auf Schnitten nicht mehr erkennbar. Beide Exemplare befinden sich im Stadium der Trächtigkeit.

Das einfache, der rechten Körperseite angehörende *Germarium* ist von mässiger Grösse, retortenförmig, und liegt unmittelbar hinter dem Darne. Der Germiduct entspringt am caudalen Ende und zieht senkrecht ventralwärts. Die beiden compacten, langgestreckten *Vitellarien* beginnen in der hinteren Pharyngealregion und ziehen zu beiden Seiten des Darmes und über diesen hinaus caudalwärts; ihr Querschnitt ist oval, lateral stark abgeplattet, wobei sich die Vermehrungsherde der Dotterzellen in der dorsalen und ventralen Partie befinden, während der centrale Theil als Sammelgang functioniert. Die Vitelloducte entspringen an den caudalen Enden und steigen senkrecht ventralwärts. Das kugelige *Receptaculum seminis* liegt dem Germiduct seitlich an, die Art der Einmündung lässt sich leider nicht ermitteln. Der *Uterus* ist bei den vorliegenden Exemplaren fast kugelig; er nimmt den grössten Theil des hinter dem Darne liegenden Raumes ein und drückt die Copulationsorgane zu einer unkenntlichen Masse zusammen. Das Uterus-Lumen wird im Leben von dem einzigen, ausehnlichen Dauerei jedenfalls ganz ausgefüllt; im conservierten Zustande ist letzteres stark geschrumpft, oblong-oval, etwas flachgedrückt, die Schale in starke Längsfalten gelegt; es misst dabei 113 μ Länge, 62 μ Breite und 50 μ Dicke. Die chitinartige bräunlichgelbe Schale ist kaum 2 μ dick und besitzt weder Sculpturen noch Stiele.

Zur selben Art gehört zweifellos auch—

No. 85. Te-ring Gompa, 28-viii-07.

¹ K. Lippitsch, Beiträge zur Anatomie von *Derostoma unipunctatum* Oe. Leipzig, 1890.

Skizzen (ohne Material) des lebenden und des mit Sublimat (anscheinend unter Deckglas) konservierten Thieres lassen erkennen, dass sich das äusserste, hinter dem Uterus (mit Dauerei) gelegene Körperende scharf schwanzartig absetzen kann. Am Epithel beobachtete Stewart: "Under action of HA 5%,¹ cellular (?) outlines appear in epidermis, each with tuft of cilia."

Ebenfalls zu dieser *Dalyellia*-Art gehören höchst wahrscheinlich sieben Exemplare, die z. Thl. in höheren Lagen und zu früherer Jahreszeit gesammelt wurden—

Nos. 29, 30, 31 and 44. Microscopic Rhabdocoel. Te-ring Gompa, 14,000 ft., Tibet, 15—24-v-07. Not common; only one found in an afternoon.

No. 47. Dto., 19-vi-07.

Sechs konservierte Exemplare von 280—420 μ Länge und 87—160 μ Dicke, die in Form, Farbe und Anatomie, soweit erkennbar, gut zu der oben beschriebenen *Dalyellia*-Art stimmen. Das gleiche gilt von—

No. 48. Changho, 24-vi-07.

Ein konserviertes Exemplar, das kleinste, nur 240 μ lang und 70 μ dick.

Die beigegebenen, z. Thl wohl nach lebendem Material angefertigten Skizzen zeigen leider von der Anatomie auch nicht mehr als die konservierten, aufgehellten Exemplare so dass eine Bestimmung der Species nicht möglich ist. Der hinter dem Darm gelegene Körperabschnitt erscheint im Leben bei den unreifen Exemplaren als längerer, deutlich abgesetzter Schwanzanhang, der am Ende die Haftpapillen trägt.

Familie TYPHLOPLANIDAE.

Tribus Typhloplanini.

Castrada sp.

No. 86. Green planarians among green algae. Te-ring Gompa, 14,000 ft., Tibet, 3-ix-07.

Zwei konservierte Exemplare, 670 bez. 380 μ lang, 390 bez. 225 μ dick. Körper drehrund, plump spindelförmig, in der Mitte am dicksten. Ueber Gestalt und Farbe bemerkt Stewart zu einer beigegebenen Skizze: "Body appears fairly cylindrical, not flattened. Anterior end more rounded than tail. Length extended about 2 mm. Bright green colour. Green pigment in small granules. General diffused colour yellow by transmitted light. Central whitish area (Darm!) with more opaque white mass (Vesicula seminalis!)." Die grüne Farbe rührt von Zoochloellen her, die fast unmittelbar unter dem Hautmuskelschlauch eine förmliche Schichte bilden, am R.E. aber im ganzen Mesenchym zerstreut vorkommen. Die konservierten Thiere sind in Alkohol völlig opak, bleich ocker-gelb; auch nach Aufhellung in Cedernholzöl lässt sich von der

¹ Jedenfalls 5% Essigsäure.

Organisation wenig erkennen. Die folgenden Angaben beziehen sich auf das grössere Exemplar, das in Querschnitte zerlegt wurde.

Die *Mundöffnung* liegt gerade in der Körpermitte, etwas hinter dem Mittelpunkt des Pharynx; der Excretionsbecher ist durch Vortreibung des *Pharynx* verstrichen. Letzterer, ein *Ph. rosulatus* misst im Durchmesser $190\ \mu$, in der Höhe $120\ \mu$. Der Darmmund liegt etwa $50\ \mu$ vor der Mundöffnung am Ende des ersten Darmdrittels. Der *Darm* beginnt $130\ \mu$ hinter dem R.E. und schliesst $50\ \mu$ vor dem C.E.

Das *Gehirn* liegt im zweiten Körpersechstel und ist in der Medianebene deutlich eingeschnitten. *Augen* fehlen.

Der *Genitalporus* liegt nahe (cca. $60\ \mu$) hinter der Mundöffnung; er führt in ein geräumiges, caudal ziehendes *Atrium genitale commune*; in dessen caudales Ende öffnet sich, durch einen doppelten Sphincter scharf abgegrenzt, das *Atrium copulatorium*.

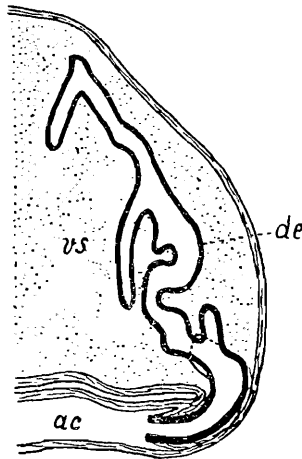


FIG. 1. *Ductus ejaculatorius* von *Castrada* sp., von der linken Seite betrachtet. Reconstruction aus Querschnitten. $283\times$. *ac*, Atrium copulatorium; *de*, Ductus ejaculatorius; *vs*, Vesicula seminalis (Lumen punctiert).

Die beiden einfach keulenförmigen, transversal comprimierten *Hoden* liegen ungefähr in der Mitte zwischen Dorsal- und Ventralseite den Seitenwänden des Körpers an; sie beginnen bereits $120\ \mu$ hinter dem R.E. und gehen in der hinteren Pharyngealgegend in die Vasa deferentia über, die gemeinsam in die Dorsalwand der Samenblase einmünden. Das *männliche Copulationsorgan* befindet sich bei dem vorliegenden Exemplare in starker Expansion; es ist retortenförmig, fast kugelig, misst $180\ \mu$ im Durchmesser und liegt rostral dem Pharynx dicht an. Die stark ausgedehnte und daher dünn erscheinende Muskelhülle umschliesst die prall mit erythrophilem Kornsecret gefüllte *Vesicula seminalis*, deren ventraler Wand ein Spermaballen anliegt. Zahlreiche grosse, birnförmige Körnerdrüsen umgeben von allen Seiten das männliche Copulationsorgan. Der *Ductus ejaculatorius* (Text-fig. 1) ist

zweifelloos ganz ähnlich gebaut, wie Luther (*l.c.*, pag. 199) für *Castrada hofmanni* M. Braun, angiebt; er mündet in die caudale Partie des Atrium copulatorium, an der Spitze einer winzigen Papille (*Penis s. str.*), proximalwärts spaltet er sich zunächst in einen ganz kurzen rechten und einen langen, gewundenen linken Ast, der neben kleineren zwei grössere Zweige bildet. Öffnungen konnte ich leider nicht erkennen.

Die *Bursa copulatrix* ist ein musculöser Blindsack mit noch wenig entwickeltem Lumen, eine rostrale Ausstülpung des Atrium copulatorium. Chitinzähnen konnte ich weder in diesem noch in der Bursa copulatrix erkennen. Eine gemeinsame Muskelhülle umschliesst—typisch für die *Castrada*-Arten—Atrium copulatorium, männliches Copulationsorgan und Bursa copulatrix.

Germarium und *Receptaculum seminis* sind noch nicht entwickelt. Die Anlagen der beiden *Vitellarien* liegen den Hoden unmittelbar dorsal auf. Die *Uteri*, ebenfalls erst in Anlage begriffen, aber an der "geldrollenförmigen" Anordnung der Zellen bereits erkennbar, münden getrennt in die rostrale Wand des Atrium genitale commune.

In oekologischer Hinsicht erwähnt Stewart "wriggling motions in addition to ciliary gliding."

"The water and algae had stood for some time. These green forms appear to have taken the place of No. 44 as in spec. 85, which is from same water." Augenscheinlich findet sich diese *Castrada*-Art vergesellschaftet mit der oben beschriebenen *Dalyellia*-Art.

Höchst wahrscheinlich gehört zur selben *Castrada*-Art, jedenfalls aber zu den Typhloplaninen, ein ganz junges, eben dem Ei entschlüpftcs Thier, das am gleichen Fundort, aber $4\frac{1}{2}$ Monate früher, gesammelt wurde—

No. 41. Te-ring Gompa, 14,000 ft., Tibet, 20-iv-07.

Ein conserviertes Exemplar, 470 μ lang, 190 μ dick. Körper drehrund, R.E. abgerundet, C.E. zugespitzt. Die beiliegende Skizze lässt am lebenden Thier die gleiche Gestalt erkennen. Das Verhältnis von Länge und Dicke wird mit 115 : 44 Micrometer-Theilstrichen angegeben.

Farbe in Alkohol gelblichgrau.

Der *Pharynx*, ein Ph. rosulatus, liegt am Ende des zweiten Körperfüntels, das Lumen der Pharyngealtasche steht noch nicht mit der Aussenwelt in Verbindung.

Das *Gehirn* liegt, der Ventralseite stark genähert, am Ende des ersten Körperfüntels; *Augen* fehlen.

Ein Paar compacter, keulenförmiger *Hoden*anlagen liegen in der Mitte zwischen Dorsal- und Ventralseite, zwischen Gehirn und Pharynx.

Tribus Mesostomatini.

Mesostoma craci, O. Schmidt.

Nos. 66 and 68. Mang-tsa, 14,500 ft., Tibet, July 1907, spring, among moss and stones.

Zehn conservierte Exemplare, 2.5—3.5 mm. lang, 0.8—1.3 mm. breit und 0.5—0.7 mm. dick. Körper länglich oval, R.E. mehr oder minder abgerundet, C.E. zugespitzt. Der Querschnitt (Text-

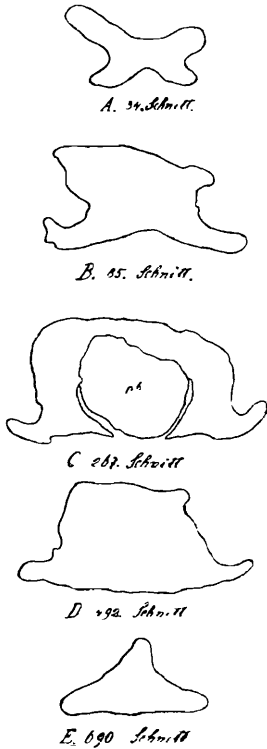


FIG. 2.—*Mesostoma craci* O. Schmidt: 5 charakteristische Querschnitte aus einer vollständigen Serie von 815 Schnitten, 26 $\times$.

fig. 2) ist deutlich vierkantig, dorso-ventral meist etwas comprimiert. An den Kanten treten besonders am R.E. (A) je ein Paar dorsaler und ventraler Leisten hervor; die dorsalen praevalieren in der Nähe des R.E. (A), nehmen aber caudal rasch an Grösse ab, so dass in der Gehirngegend (B) bereits die ventralen stärker hervortreten; diese erreichen eine Breite von 0.3 mm. und sind in ganzer Länge des conservierten Thieres deutlich erkennbar, während die dorsalen in der Gegend des Pharynx (C) und des Copulationsapparates ganz verstreichen, dahinter aber wieder hervortreten (D) und schliesslich in der Nähe des C.E. (E) zu einer unpaaren medianen Firste verschmelzen.

Die Farbe des in Alkohol opaken Körpers ist dunkel lederbraun, die Leisten sind etwas durchscheinend, gelblichbraun. Die Farbe wird durch bräunlichgelbe, sternförmig verästelte Pigment-Körperchen hervorgerufen, die dicht unter dem Hautmuskelschlauch vertheilt sind, ausserdem aber Hoden, Vitellarien, Copulationsorgane und Gehirn umgeben und auch im Mesenchym des Pharynx sich vorfinden.

Die *Rhammiten* gerade oder einfach bis S-förmig gebogene Stäbchen von etwa 15 μ Länge und 1 μ Dicke, liegen in grösseren Paketen im Mesenchym zumal an den Körperenden und in den Leisten. Cyanophile *Schleimdrüsen* münden an der ganzen Ven-

tralseite, mit Ausnahme der Leisten, aus.

Die *Mundöffnung* liegt am Anfang des zweiten Körperdrittels. Die Form des *Excretionsbeckers* ist infolge Vortreibung des *Pharynx* nicht erkennbar. Letzterer, ein Ph. rosulatus, ist kugelig bei einem Durchmesser von 0.7 mm. Der *Darmmund* liegt ziemlich senkrecht über der äusseren Mundöffnung, 1.45 mm. hinter dem R.E. Der *Darm* beginnt 0.55 mm. hinter dem R.E. und endet 0.4 mm. vor dem C.E.

Das *Gehirn* ist ganz unscharf begrenzt; in ihm vollständig eingebettet, liegen die beiden *Augen*, 0.45 mm. hinter dem R.E., der Ventralfläche bis auf $\frac{1}{4}$ der Körperdicke genähert; es sind lateral offene, aus unregelmässig verästelten Pigmentkörperchen gebildete Becher, die je einen Retinakolben umschliessen.

Der *Genitalporus* liegt nahe (0.2 mm.) hinter der Mundöffnung.

Die Hoden durchziehen den Körper 0·35 mm. vom R.E. bis 0·5 mm. vom C.E., der Dorsalwand mehr oder minder anliegend, als zwei im Querschnitt bald ovale, bald fast kreisrunde Stränge, die durch zwei tiefe Einschnitte in drei hintereinandergelegene Partien gegliedert sind. In ihrer vordersten Region verschmelzen sie in der Medianebene auf kurze Strecke (50 μ), und desgleichen kommt in den caudalsten Partien, wo beide Hoden einander dicht anliegen, eine local beschränkte, dorsale Verschmelzung vor.

Die *Vasa deferentia* münden in die dorso-caudale Wand der Samenblase. Das männliche Copulationsorgan liegt unmittelbar hinter dem Pharynx, etwas links von der Medianebene; es ist retortenförmig, 0·23—0·27 mm. dick. Die *Vesicula seminalis* enthält grobkörniges erythrophiles und feinkörniges cyanophiles Kornsecret. Ein Spermaaballen liegt im proximalen Ende. Der *Ductus ejaculatorius* ist von einem geraden, proximalwärts trichterartig erweiterten cuticularen Rohr ausgekleidet und von cyanophilem Kornsecret erfüllt. Der *Penis* s. str. ist eine kurze halbkugelförmige Papille.

Die birnförmige *Bursa copulatrix* liegt ungefähr in der Medianebene, unmittelbar hinter dem Pharynx und enthält bereits Sperma und beiderlei Kornsecret.

Das rechts neben dem Pharynx gelegene, wurstförmige, etwa 100 μ dicke *Germarium* geht allmählig in den ebenso dicken Gerniduct über, der sich zu einem kugeligen *Receptaculum seminis* (Durchmesser cca. 170 μ) erweitert, das bereits Sperma enthält.

Die folliculären *Vitellarien* begleiten die Hoden in ganzer Ausdehnung lateral und ventral; z. Thl. rücken sie auch in die dorsalen Leisten hinein. Der *Ductus communis* mündet in die Caudalwand des Atrium genitale commune; unmittelbar darunter münden von den Seiten her die beiden *Uteri* ein, die, wenn noch leer, cca. 90 μ weite, caudal ziehende Schläuche darstellen, bei einem anderen Exemplar enthalten sie 1 resp. 3 *Dauer Eier*, die in conserviertem Zustande halbkugelförmig sind und 250 μ im Durchmesser messen.

Nach den vorstehenden Angaben dürfte es kaum zweifelhaft sein, dass die vorliegenden Exemplare eine bedeutend kleinere (höchstens $\frac{1}{4}$ bis $\frac{1}{3}$ der von Braun und Luther angegebenen Grösse!) Hochgebirgsform von *Mes. craci* O. Schm. repraesentieren. Die bei beiden, in Schnitte zerlegten Exemplaren deutlich vorhandene Gliederung der Hoden erscheint mir zur specifischen Abtrennung der tibetanischen Form nicht ausreichend.

II. TRICLADIDA.

(Von A. MUTH.)

SOROCELIS Grube (1872)

(Plate iv.)

Die vorliegenden Tricladen sind mit Rücksicht auf die Stellung der Augen dem Genus *Sorocelis* Grube einzureihen. Wie bei

den übrigen Arten des genannten Genus, so bilden auch hier die Augen Bogenreihen oder lang gestreckte, gegen die Mitte des Stirnrandes zu convergierende Haufen, in grösserer oder geringerer Entfernung vom Körperande. Verschiedenheiten in der Gruppierung derselben, fernerhin Verschiedenheiten in der Form des Kopflappens, sowie der Färbung deuten darauf hin, dass es sich um verschiedene Arten handeln dürfte. Mehr lässt sich jedoch nicht sagen, da sämtliche Exemplare der Copulationsorgane entbehren.

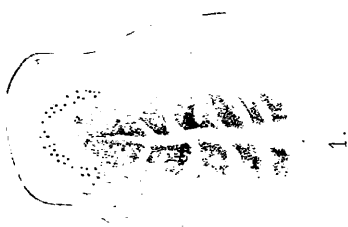
Das Material wurde teils in Te-ring Gompa, 14,000 ft., teils in High Hill Gompa ober Gyantse, 14,500 ft., gesammelt.

ERKLAERUNG ZU PLATE IV.

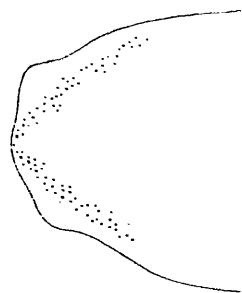
Zugleich Material-Verzeichnis.

FIGS. 1—8.—*Sorocelis* div. sp., Vorderende mit den Augen-
gruppen, Dorsalansicht, $20\times$; Fig. 2 und 7 in Alkohol, die übr-
igen in Xylol.

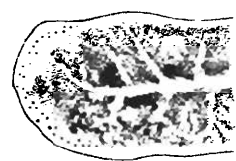
- Fig. 1. No. 18. Te-ring Gompa, 14,000 ft., Tibet, 22-ii-07.
Fixed HgCl_2 sat. solut., $\longrightarrow$ 70% alcohol. 9
Exemplare.
- „ 2. No. 33. High Hill Gompa above Gyantse, 14,500 ft.,
Tibet, 28-iii-07. Small mountain stream, among
moss and stones. 1 Exemplar.
- „ 3. No. 14. Te-ring Gompa, 14,000 ft., Tibet, 22-i-07.
Same stream (as No. 10). Fixed HgCl_2 sat. solut.,
70% alcohol. 3 Exemplare.
- „ 4. No. 15. Dto. 3 Exemplare.
- „ 5. No. 17. Te-ring Gompa, 14,000 ft., Tibet, 3-ii-07.
Formalin 5%. 4 Exemplare.
- „ 6. No. 10. Te-ring Gompa, 14,000 ft., Tibet, 15-i-07.
Small hill stream, among algae. Seen at edges
of stream only. Fixed alcohol form. acetic. 2
Exemplare.
- „ 7. No. 13. Te-ring Gompa, 14,000 ft., Tibet, 22-i-07.
Same stream (as No. 10). Fixed HgCl_2 sat. sol.,
 $\longrightarrow$ 70% alcohol. 3 Exemplare.
- „ 8. No. 54. High Hill Gompa above Gyantse, 14,500 ft.,
Tibet, 8-vii-07.



1.



2.



3.



4.



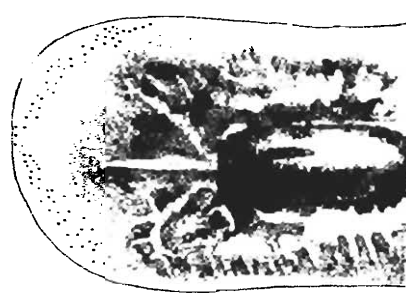
5.



6.



7.



8.

A. Muth, del.

TIBETANISCHE TRICLADEN.

A. C. Chowdhary, lith.

LIST OF THE AQUATIC ANIMALS HITHERTO RECORDED FROM THE PROVINCES OF TSANG AND Ü¹ IN CENTRAL TIBET, WITH A TABLE SHOWING THEIR GEOGRAPHICAL DISTRIBUTION.

By F. H. STEWART, M.A., D.Sc., M.B., *Captain, Indian Medical Service.*

The animals included in the following list fall into the following groups:—

1. Hydroidea.
2. Turbellaria.
3. Nematoda.
4. Gordiidea.
5. Rotifera.
6. Gastrotricha.
7. Oligochaeta.
8. Hirudinea.²
9. Entomostraca.
10. Hydrachnida.
11. Mollusca.
12. Pisces.
13. Amphibia.

		Cosmopolitan.	Palearctic.	Oriental.	Not previously described.
Hydroidea—					
Hydra fusca, Linn. (= Hydra oligactis, Pall.).	{ Tsang Europe Lahore N. America }	..	..	..	..
Turbellaria—					
Stenostomum, sp. ..	..	Tsang	..	..	?
Dalyellia, sp. ..	..	Tsang	..	..	?
Castrada, sp. ..	..	Tsang	..	..	?

¹ The province of Tsang lies roughly north of Sikhim and Nepal and includes the district from the Tang-la to Gyantse and Shigatse. The province of Ü lies to the east of Tsang and includes Lhasa.

² The report on the Hirudinea has not yet been received.

	Cosmopolitan.	Palaeartic.	Oriental.	Not previously described.
Mesostoma craci, O. Schmidt.	..	{ Europe Tsang }	..	..
Sorocelis, sp.	..	Tsang	..	?
Nematoda—				
Dorylaimus, sp.	..	..	..	?
Gordiidea—				
Parachordodes pustulosus, Baird.	..	{ Europe Central Asia }	..	..
Rotifera—				
Philodina erythrophthalma, Ehrenb.	{ Europe Natal Tsang }	..	..	..
Philodina roseola, Ehrenb.	{ Europe Turkestan Tsang Paraguay Natal New Guinea }	..	..	..
Philodina citrina, Ehrenb.	{ Darjiling Calcutta Tsang Cape Colony }	..	..	..
Rotifer tridentatus, Stewart.	..	Tsang	..	Yes.
Notommata aurita, Ehrenb.	{ Europe Tsang Cape Colony }	..	..	..
Copeus labiatus, Gosse		{ England Tsang }	..	..
Proales gibba, Ehrenb.	..	{ England Tsang }	..	..
Diglena catellina, Ehrenb.	{ England Tsang Paraguay }	..	..	..
Mastigocerca auchinleckii, Stewart.	..	Tsang	..	Yes.
Dinocharis pocillum, Ehrenb.	..	Europe	..	..
Scaridium longicaudum, Ehrenb.	{ Europe S. Africa Paraguay Calcutta }	..	..	..
Diaschiza exigua, Gosse.	{ England Rhodesia Tsang }	..	..	..
Diaschiza semiaperta, Gosse.	{ Europe New Zealand Tsang }	..	..	..
Salpina shapé, Stewart	..	Tsang	..	Yes.
Euchlanis dilatata, Ehrenb.	{ Europe N. Asia Ceylon Natal }	..	..	..
Cathypna amban, Stewart.	..	Tsang	..	Yes.
Notholca scaphula, Stewart.	..	Tsang	..	Yes.

	Cosmopolitan.	Palearctic.	Oriental.	Not previously described.
Gastrotricha—				
Lepidoderma squamatum, F. Dujardin	{ Europe Tsang New Jersey }	..	..	..
Oligochaeta—				
Aelosoma hemprichii, Ehrenb.	} ..	{ Europe N. Africa Tsang }	..	..
Chaetogaster orientalis, Steph.	} ..	{ Lahore Tsang }	..	..
Nais, sp. ..	..	..	..	?
Fredericia stewarti, Steph.	..	Tsang ..	..	Yes.
Limnodrilus, sp. ..	..	..	..	?
Entomostraca—				
Cyclops viridis (Jur.)	..	{ N. Europe Siberia Turkestan Tsang }	..	..
Cyclops strenuus, Fisch.	{ Europe N. Asia N. America }	..	..	..
Cyclops serrulatus, Fisch.	Yes ..	..	..	..
Diaptomus tibetanus, von Daday.	..	Tsang ..	..	Yes.
Diaptomus paulseni, G. O. Sars.	} ..	{ Pamir Tsang }	..	..
Chydorus sphaericus (O. F. M.).	Yes ..	..	..	..
Dunhevedia crassa, King.	Yes ..	..	..	..
Aulana guttata, G. O. Sars.	Yes ..	..	..	..
Euryalona annandalei, von Daday.	..	Tsang ..	..	Yes.
Macrothrix hirsuticornis, Brady-Norm.	} ..	{ N. Europe Mongolia Tsang }	..	..
Moina rectirostris (Jur.)	..	N. America ..	..	..
Ceriodaphnia pulchella, G. O. Sars.	} ..	{ N. Europe Siberia Turkestan Tsang }	..	..
Scapholeberis mucronata (O.F.M.).	{ Ceylon Siberia Tsang }	..	..	..
Simocephalus elizabethae, King.	Yes ..	..	..	..
Daphnia longispina (O. F. M.).	} ..	{ N. Europe Turkestan Tsang }	..	..
Eucypris tibetana, von Daday.	..	Tsang ..	..	Yes.
Eucypris minuta, von Daday.	..	Tsang ..	..	Yes.
Herpetocypris stewarti, von Daday.	..	Tsang ..	..	Yes

	Cosmopolitan.	Palaeartic.	Oriental.	Not previously described.
Herpetocypris smarag-dea, von Daday.	..	Tsang ..	..	Yes.
Potamocypris stewarti, von Daday.	..	Tsang ..	..	Yes.
Estheria davidi, Simon	..	{ E. Mongolia Tsang }	..	..
Branchinecta orienta-lis, G. O. Sars. }	..	{ E. Europe Pamirs E. Mongolia Tsang }	..	..
Hydrachnida—				
Eulais tibetana, von Daday.	..	Tsang ..	..	Yes.
Mollusca—				
Planorbis saigonensis, Crosse and Fischer. }	..	{ Japan .. Tsang ..	E. Asia Java	..
Planorbis stewarti, Ger-main.	..	Tsang ..	..	Yes.
Planorbis himalayen-sis, Hutton. }	..	{ Himalaya Tsang }	..	..
Planorbis barrakporen-sis, Clessin.	..	Tsang ..	India ..	..
Limnaea hookeri, Reeve	..	Tsang ..	..	Yes.
Limnaea bowelli, Pres-ton.	..	Tsang ..	..	Yes.
Agriolimax tibetanus, Godwin Austen.	..	Tsang ..	..	Yes.
Pisidium stewarti, Pres-ton.	..	Tsang ..	..	Yes.
Pisces—				
Parexostoma stoliczkae (Day). }	..	{ Leh Ladak Tsang }	..	..
Parexostoma macula-tum. Regan.	..	Tsang & Ü ..	..	..
Nemachilus stoliczkae, Day. }	..	{ Leh Ladak Tsang Yarkand }	..	..
Nemachilus lhassae, Regan.	..	Ü ..	..	..
Nemachilus tibetanus, Regan.	..	Tsang & Ü ..	..	..
Gymnocypris waddel-lii, Regan.	..	Tsang & Ü ..	..	..
Oreinus baileyi, Lloyd	..	Tsang ..	..	Yes
Ptychobarbus coniro-stris, Steind. }	..	{ Leh Ladak Tsang }	..	..
Schizopygopsis stolicz-kae, Steind. }	..	{ Leh Ladak Pamirs Tsang }	..	..
Schizopygopsis young-husbandi, Regan.	..	Tsang & Ü ..	..	..

	Cosmopolitan.	Palaeartic.	Oriental.	Not previously described.
Gymnocypris (Schizopygopsis) stewartii, Lloyd.	..	Tsang ..	..	Yes.
Schizothorax o'connori, Lloyd.	..	Tsang ..	..	Yes.
Schizothorax dipogon, Regan.	..	Tsang & Ü ..	..	..
Schizothorax waltoni, Regan.	..	Tsang & Ü ..	..	..
Schizothorax macropogon, Regan.	..	Tsang & Ü ..	..	..
Amphibia— Rana pleskii, Günther	..	Central Asia ..	..	..
Number of species	18	57	2	21

It will be noticed in the above list that of those species which are not cosmopolitan all, with two exceptions, are Palaeartic. These two exceptions, *Planorbis saigonensis* and *P. barrakporensis*, are found in the Oriental as well as in the Palaeartic region.

Papers from which the above list is compiled.

1. Stewart, Annandale, de Man, Camerano, von Daday and Lloyd. Report on a collection of aquatic animals made in Tibet by Captain F. H. Stewart, I.M.S., during the year 1907. Part I. Introduction, Coelenterates, Nematomorpha, Rotifers and Gastrotricha, Entomostraca, Arachnids, Fish (Systematic) and Batrachia.
Rec. Ind. Mus., vol. ii, p. 309 (1908).
2. Stephenson, Preston, Germain and Stewart. Ditto. Part II. Oligochaete Worms, Mollusca and Fish (Geographical).
Rec. Ind. Mus., vol. iii, p. 105 (1909).
3. Meixner and Muth. Ditto. Part III. Turbellaria.
Rec. Ind. Mus., vol. vi, p. 57 (1911).
4. Tate Regan. Descriptions of five new Cyprinid fishes from Lhasa, Tibet.
Ann. Mag. Nat. Hist. (7), vol. xv, p. 185 (1905).

5. Tate Regan Descriptions of two new Cyprinid fishes from Tibet.
Ann. Mag. Nat. Hist. (7), vol. xv, p. 300 (1905).
6. von Daday .. Monographie systématique des Phyllopo-
des anostracés.
Ann. Sci. nat., Zool. (9), t. xi, p. 158 (1910).

VIII. NOTES ON CYPRINIDAE FROM TIBET
AND THE CHUMBI VALLEY, WITH A
DESCRIPTION OF A NEW SPECIES OF *GYMNOCYPRIS*

By F. H. STEWART, M.A., D.Sc., M.B., Captain, Indian
Medical Service.

I. *Schizopygopsis stoliczkae*, Steind., and *Schizopygopsis
severzovi*, Herz.

1. Source of recent collection. Stations with their altitude.
2. Source of older collections in Indian Museum.
3. Literature.
4. Geographical range. General characters of country inhabited.
5. Is the separation of the two species *S. stoliczkae* and *S. severzovi* justified?
 - (i) Five points of distinction by means of which the two species are separated from each other by Herzenstein and Alcock.
 - (ii) The specimens of which measurements are available divided into 11 groups.
 - (iii) Analysis of the five points of distinction in 8 of the groups.
 - (iv) Variation in the relative size of the head to the body.
6. Coloration.
7. Relative frequency of this and of other species of fish in the district under consideration.
8. Breeding and migration.
9. Summary.

1. *Schizopygopsis stoliczkae*, Steind., has been obtained lately from various localities between the Chumbi valley and the town of Gyantse in the Tibetan province of Tsang. I am indebted to Captain Kennedy, I.M.S., for the greater number of the specimens, and his collection is so much the more valuable in that it was made in the course of journeys between Chumbi and Gyantse, and contains specimens from a series of localities on both the south and the north faces of the Himalaya, and also from the immediate neighbourhood of the watershed (the Tang-la). Mr. F. M. Bailey, lately British Trade Agent at Gyantse, also kindly sent me

some specimens from the Chumbi valley and I myself had found this species in considerable numbers in the neighbourhood of Gyantse in 1906-1907.

The following is a list of the localities with their altitudes :—

- (1) Ling-ma-tang, Chumbi valley, 11,500 feet. In the Ammo-chu, a tributary of the Raidak. At this point the river traverses a sedgy plain. Its breadth is roughly 10—15 yards. The fish can be seen in considerable numbers.
- (2) Phari, at the head of the Chumbi valley, eight miles S. of the watershed, 14,300 feet. In a small tributary of the Ammo-chu.
- (3) Guru, 25 miles N. of the watershed, 15,000 feet. In a hill stream which disappears into the ground.

[The streams in the latter two localities are small rivulets running off the face of barren stony mountains, but ending in broad and marshy plains. They are frozen for at least six months of the year, but nevertheless both animal and vegetable life is remarkably abundant. It should be noticed that migration of fish from the third locality is out of the question. Not only do a number of the smaller streams end by disappearing in the ground, but the only river flowing out of the Rham Tso ends in the Kala Tso, 14,600 feet above the sea, from which there is no visible outflow. The aquatic population of this area is therefore unable at any time of the year to descend lower than 14,600 feet.]

- (4) Kang-ma, 30 miles S. of Gyantse, 13,900 feet. In the Nyang-chu.
- (5) Gyantse, 13,100 feet. In the Nyang-chu and its tributaries.

2. I was fortunate in being able to compare this collection with two other collections of *Schizopygopsis* from Central Asia which are stored in the Indian Museum. The first is that which Dr. Stoliczka obtained during Sir Douglas Forsyth's Mission to Yarkand in 1873-74. The second consists of the specimens of *S. severzovi*, Herz., which Dr. Alcock collected while serving with the Pamir Boundary Commission of 1895.

3. The measurements of the individual fish of these two species, in the collection of the Imperial Academy of Science in St. Petersburg, are also available in the report by Dr. Herzenstein (4).

4. Stoliczka found the fish which was afterwards honoured with his name in the headwaters of the Indus in the neighbourhood of Leh in Ladakh, at an elevation of 11,500 feet above sea level, of the Oxus (Aktash, 12,880 feet, Upper Kora-Kul and Panjah) and of the Yarkand river at Sarikol.

Day (2, p. 9) doubts the accuracy of this latter record: "I am very dubious of these specimens, and hardly think that they can have been obtained from waters that flow into the Yarkand

river, as the adults have not been obtained thence. The adult however has been taken in the Oxus; and I find by the diary that on the day the specimens in question were captured, the camp was at Sarikol a few miles from a valley where a stream enters the Aksu river, a tributary of the Oxus."

The species was also found by the brothers Schlagintweit in Nari-Khorsum, presumably in the upper reaches of the Sutlej.

Herzenstein (4) describes specimens of *S. stoliczkae* from the Amu-darya (Oxus) system on the Pamirs obtained by Ssewerzoff and Grumm-Grshimailo, and a single example obtained by Grombtschewski from "Abdu-Gafar-Tom" in the Khotan river basin.

Ssewerzoff obtained the specimens which were afterwards named after him from the Pamirs (Bulun-kul and Kurasu), while Alcock's examples of this species come from "a river near Oikul, Little Pamir."

It has not hitherto been found in any river of the south face of the Himalaya with the exception of the Ammo-chu.¹

According to our present knowledge, therefore, the two forms range from Badakshan, the Pamirs and Khotan, through Baltistan, Ladakh and Nari-Khorsum, along the northern face of the Himalaya to the Chumbi valley, in a tract of country 1,400 miles long by 150—300 broad, including the upper waters of the Oxus, the Khotan river, the Indus, Sutlej and Brahmaputra and the Ammo-chu.

The character of the country in the streams of which *S. stoliczkae* is found is very uniform. Alcock writing of the Little Pamir says (1, p. 56): "The Little Pamir is the broad alluvial basin of the first fifty miles, or so, of the River Aksu. Its greatest breadth is not more than four or five miles at an elevation of about 13,000 feet. It is bounded north and south by grassy downs which rise to a height of 18,000 feet and culminate in sharp peaks, most of these, especially on their northern faces, being capped with perpetual snow. The surface of the Pamirs although largely covered with tussocks of grass and other stunted vegetation, often consists of bare stretches of hard sand and shingle coated with a saline efflorescence.

The river runs with some rapidity in a broad bed of boulders and often expands into marshes and lakelets, one chain of which, known as Chakmak-tin Kul or Oi Kul, is of respectable size. A very characteristic feature of the Pamir in summer are the tracts of deep grassy bog that skirt the river and all its tributaries. Equally characteristic is the rolled or beaten-down appearance of the surface soil everywhere, the evident result of a long-lying weight of snow."

These sentences might have been copied almost word for word as a description of the country between Ling-ma-tang and Gyantse. There are the same snow- or spring-fed streams and

¹ Since the above was written Erich Zugmayer has also reported the finding of large numbers of *Schizopygopsis stoliczkae* in the Indus and Western Tibet. *Zool. Jahrb., Syst., Geogr. und Biol.*, vol. xxix (1910).

rivers, in places running noisily and rapidly through channels filled with boulders, again spreading out into marshes and great shallow lakes in the broad flat upland valleys.¹ At Ling-ma-tang, Phari and around the Rham Tso are the same widespreading grassy downs, although it must be admitted that to the north of the watershed the grass is not very abundant. It is a region barren of trees,—for twenty miles on the south and forty miles to the north of the Tang-la not a single tree can be seen. It is a very different country from the south slope of the Himalayas with its narrow valleys, its plunging torrents, and hillsides covered with pines.

5. The collection with which the present notice deals contains some specimens which can be referred without hesitation to Stoliczka's species, others which obviously belong to Ssewerzoff's, and again others which appear to be intermediate between the two. It was necessary, therefore, to enquire into the validity of the separation of the two species, taking into consideration the knowledge gained by the study of this new collection.

Herzenstein (4, p. 199), in defining the species *S. severzovi*, writes: "Diese Form ist auf Grund von Exemplaren beschrieben worden, welche z. Th. schon vom verstorbenen Prof. Kessler von dem typischen *Sch. stoliczkae* als *Sch. macrophthalmus* oder *Sch. stoliczkac* var. *macrophthalma* getrennt worden sind. Der Hauptunterschied besteht meiner Meinung nach in der relativen Lage der Mundspalte und des unteren Augenrandes, wie ich es in der Synopsis angeführt habe. Freilich lassen sich einige der kleineren Exemplare weniger sicher nach diesem Kennzeichen bestimmen. Doch halte ich es vorläufig für mehr passend beide Formen zu trennen, da *Sch. severzovi* ausserdem noch einige besondere prävalierende Variations-Neigungen zu zeigen scheint, so namentlich ein in Durchschnitt grösseres Auge und dunklere Färbung."

Alcock also does not accept the separation without some doubt (1, p. 14), "I was at first inclined to disagree with Herzenstein in separating this species from *S. stoliczkac*, but on comparing the large series of the latter in the Indian Museum with those collected by myself among which are numerous spawning males and females, I can find five ripe males and a ripe female all taken at the same spot, which differ constantly from ripe adults of *S. stoliczkae* in the following characters:—

- (1) they are smaller, sexually mature individuals not being longer than 175 mm.; whereas I can find no sexually mature *S. stoliczkae* less than 200 mm. long, while most are about 250 mm. and some nearly 350 mm.;
- (2) the body is higher, its height in the adult being one-sixth of its total length; whereas in typical adults of *S. stoliczkac* the body-height is only one-seventh or one-eighth of the total length;

¹ See *Rec. Ind. Mus.*, vol. ii, part iv, pl. xxvi. The upper photograph represents Chalu Bridge.

- (3) as pointed out by Herzenstein, the anterior end of the mouth cleft is on a level with the lower edge of the orbit, whereas in *S. stoliczkae* it is altogether below the level of the orbit. This is due to the fact that in *S. severzovi*:—
- (4) the eye is larger, its diameter in sexually mature adults being one-fourth, or nearly one-fourth, the length of the head; whereas in sexually mature adults of *S. stoliczkae* its diameter is only one-fifth to one-sixth the length of the head.

The six adults here separated as *S. severzovi* all came from a small ice-cold streamlet which seems to have only a periodic connexion with larger waters, so that, after all, they may be only dwarfs of *S. stoliczkae*."

For the purpose of this enquiry the various specimens have been arranged in a series of groups. It will be well first to give a summary of these groups and then to discuss the various characters given as separating the two species.

- P. 1. The specimens of *S. severzovi* from the Pamirs described by Herzenstein. (For detailed measurements of the individuals see Herzenstein, 4, p. 199.)
- P. 2. The specimens of *S. stoliczkae* from the Pamirs described by Herzenstein. (*Ibid.*, p. 195. Nos. 8734—8812.)
- P. 3. Stoliczka's collection of *S. stoliczkae* from the Pamirs and Ladakh in the Indian Museum.
- P. 4. Alcock's six specimens of *S. severzovi* from the Little Pamir (Ind. Mus. Nos. 14141—14146): *vide* pl. iii, fig. 2.
- Ch. Four specimens from the Chumbi valley (Ind. Mus. Nos. $\frac{2570}{1}$ — $\frac{2572}{1}$ and $\frac{2853}{1}$): *vide* pl. iii, fig. 1.
- D. 1. Four specimens from Guru with head characters of *S. stoliczkae* (Ind. Mus. Nos. $\frac{2850}{1}$, $\frac{2851}{1}$, $\frac{2854}{1}$ and $\frac{2855}{1}$).
- D. 2. One specimen from Guru intermediate as regards head characters (Ind. Mus. No. $\frac{2856}{1}$).
- K. 1. Five specimens from Kang-ma with head characters of *S. stoliczkae* (Ind. Mus. Nos. $\frac{2857}{1}$ — $\frac{2861}{1}$): *vide* pl. iii, fig. 3.
- K. 2. Eleven small specimens from Kang-ma (Ind. Mus. Nos. $\frac{2864-2868}{1}$, $\frac{2900-2911}{1}$, $\frac{2946-2948}{1}$).
- G. 1. Four small specimens from the Nyang-chu at Gyantse.
- G. 2. Five small specimens from marsh pools near Gyantse.

The last three groups, K. 2, G. 1 and 2, consist of fish too small for the present purpose.

We can now proceed with an analysis of the five distinguishing characters in the groups.

Analysis of differences between *S. stoliczkae* and *S. severzovi*:—

Character (a). Body higher in *S. severzovi* than in *S. stoliczkae*.

„ (b). Eye larger „ „ „ „ „

„ (c). Mouth: anterior margin on level with lower border of orbit in *S. severzovi*; below this level in *S. stoliczkae*.

„ (d). Darker colour of *S. severzovi*.

„ (e). Smaller size of sexually mature specimens of *S. severzovi*.

Character (a). The two groups named *S. severzovi* (P. 1, Ssewerzoff's, and P. 4, Alcock's) are both from the Pamirs. The relation of the body-length to the maximum body-height is 5·4 in both (see table i). That is, on the average they are higher in the body than the two groups of *S. stoliczkae* from the same region (P. 2, Ssewerzoff's, and P. 3, Stoliczka's). *Vide* table i. On consulting the table of extreme measurements, on the other hand (table iii, col. 3), it will be seen that this is only true for the average measurements: the lowest-bodied fish of the Ssewerzoff groups (6·20) is considerably lower than the highest-bodied fish of the Stoliczka groups (4·48), and indeed the latter is higher than even the highest-bodied of the Ssewerzoff groups (5·00).

Although the two Ssewerzoff groups from the Pamir (P. 1 and P. 4) have a greater average body-height than the two Stoliczka groups (P. 2 and P. 3), this average is lower than that of groups D. 1 and K. 1, which have the head of Stoliczka's type in a marked degree (character c).

Character (b). It is clear that the eye diminishes in size relatively to the head with the increase in size of the fish. Therefore groups of fish of the same average size only, can be compared in regard to this character. The two Ssewerzoff groups P. 1 and P. 4 taken together have an average length of about 150 mm. and the two Stoliczka groups from the Pamir-Ladakh region, P. 2 and P. 3, combine to very much the same average: these may be compared with the medium-sized Kang-ma K. 1 group (table i, col. 3). The three arrange themselves as follows:—Larger eye (4·3) *S. severzovi*; smaller eye (4·75) *S. stoliczkae* (Pamir-Ladakh and Kang-ma).

The characters *b* and *c* then do show some parallelism. But, again, there is considerable overlapping of the extreme measurements, some specimens in P. 3 having larger eyes (4·00) than some of P. 1 and P. 4 (4·32 and 5·00).

The evidence of the Chumbi group Ch. is, moreover, definitely against this parallelism. Their average length is only 136 mm. and therefore their eyes should be proportionately larger than in larger fish. They have the Ssewerzoff type of head (character c)

but their eyes are actually of the same average size (4.75) as the average of groups P. 2 and 3 (4.75), and are considerably smaller than the average of the other two Ssewerzoff groups P. 1 and 4 (4.30) (*vide* table i, cols. 4 and 5, Ch.).

Character (c) (*vide* pl. iii, figs. 1, 2 and 3). Herzenstein states that in *S. severzovi* the anterior end of the mouth-cleft is on a level with the inferior margin of the orbit, and that in *S. stoliczkae* it is below this level.

Alcock considers that this difference is due to the greater relative size of the eye in the former species. After examining the new collections from Tibet the present writer cannot agree with the view that this character is entirely dependent on the size of the eye. The heads of the two extreme types, Ssewerzoff's and Stoliczka's, differ in the following points:—

Stoliczka's (pl. iii, fig. 3)—

- (a) the lower surface of the head from the tip of the snout back to the pericardial region is almost perfectly flat;
- (b) the mouth, which opens on this flat surface some few millimetres from the tip of the snout, is entirely ventral;
- (c) since the tip of the snout lies in the lowest horizontal level, the angle formed by the frontal line curving from the snout to the occiput with the horizontal is greater than if the tip of the snout were in a higher level.

Ssewerzoff's (pl. iii, figs. 1 and 2)—

- (a) the lower surface of the head is curved, rising from the pericardium to the tip of the snout;
- (b) the mouth is thus more terminal than ventral and is only slightly overhung by the tip of the snout;
- (c) the snout being in a higher level the angle referred to is less than in Stoliczka's type.

Gradations between these two extremes occur. Stoliczka's type is more common than Ssewerzoff's.

The Ssewerzoff type of head occurs in groups P. 1 (Herz.) and Ch., and in half the specimens of P. 4; in the other half the heads incline more to Stoliczka's type as here defined.

Character (d), colour. There is no type of coloration absolutely characteristic of either the Stoliczka or Ssewerzoff head types. Spotted and uniformly coloured forms occur in both but the former is more generally uniform in colour, the latter spotted.

Character (e), smaller size of sexually ripe specimens of *S. severzovi*. In group D. 2, with the Stoliczka head type, the reproductive organs are at least as well developed as in P. 4, although the average length is 123 mm. in the former as compared with 145 mm. in the latter.

The two species, then, cannot be separated by all five characters, since different combinations occur in each group.

Table i shows the distribution of the characters distinguishing *S. stoliczkae* from *S. sewerzovi* among eight groups: col. 1 gives the group; col. 2, the average total length of the members of the group in millimetres; col. 3, average of the relation of total length to maximum body-height; col. 4, average of the relation of head-length to the diameter of the eye. In cols. 5, 6 and 7, E represents that the group belongs to the Ssewerzoff type for this character, T that it belongs to the Stoliczka type, ET that the group contains individuals of both types: col. 5 deals with the same proportion as col. 3; in Ssewerzoff's type the relation is 5·4 and less, in Stoliczka's 5·5 and more: col. 6 is the same proportion as col. 4; Ssewerzoff's type is 4·5 and below, Stoliczka's 4·6 and above: col. 7 represents the relation of the anterior end of the mouth-cleft to the lower margin of the orbit; in Ssewerzoff's type the former is on the same level or above the latter, in Stoliczka's it is below the latter.

TABLE I.

1		2	3	4	5	6	7
Group.		T. L. mm.	T. L. Mx. Bo. Ht. Charac- ter (a).	Hd. L. E. Charac- ter (b).	T. L. Mx. Bo. Ht. Charac- ter (a).	Hd. L. E. Charac- ter (b).	M. O. Charac- ter (c).
P.	1 ..	153	5'40	4'10	E	E	E
P.	2 ..	177	5'60	5'00	T	T	T
P.	3 ..	114	5'70	4'50	T	E	?
P.	4 ..	145	5'40	4'50	E	E	ET
Ch.	..	135'75	4'97	4'75	E	T	E
D.	1 ..	123	4'62	5'00	E	T	T
D.	2 ..	115	4'30	4'35	E	E	
K.	1 ..	148'8	4'51	4'70	E	T	TT

The question then arises whether the two species can be separated on the differences in the shape of the head alone (character c), and as a complete series of gradations between the two extremes occurs (pl. iii, figs. 1, 2 and 3) it does not appear to the present writer that this can be done.

If all the specimens from one particular narrow locality are brought together it will be found that one head type or the other predominates. One type may be present to the exclusion of the other but intermediates are also generally present and occasionally the opposite type as well. The specimens from Guru (D. 1 and 2) are of Stoliczka's type 4 specimens, intermediate 1; those from the Chumbi group consist of Ssewerzoff's type only; those from Kang-ma (K. 1) of Stoliczka's only. Alcock's specimens from Oikul, Little Pamir, of Ssewerzoff's 3, intermediates or Stoliczka's 3.

There is another character in which very considerable variation

exists in the species, namely in the proportion of the size of the head to the body. These differences are exhibited by the three proportions—

Length of body Length of body Length of body
Breadth of head' Length of head' Height of head

In table ii the groups are arranged in order according to this measurement (cols. 3, 4 and 5), and it will be seen that the Pamir specimens have the smallest heads, the Kang-ma specimens the largest, while the Guru and Chumbi groups are intermediate. It is noteworthy that a classification by this character is a cross-classification to the division into the two species, since P. 1 and 4 are separated by P. 2 and 3 and P. 2 is widely separated from D. 1 and K. Table iii also shows that there is no overlapping of the extreme measurements between the Pamir and Kang-ma groups.

TABLE II.

Group.			T. L. mm.	B. L. Hd. B.	B. L. Hd. L.	B. L. Hd. Ht.	Number of species measured.
P. 1	..	..	153	9'2	4'4	6'6	5
P. 2	..	..	177	9'06	4'5	..	11
P. 3	..	..	114	8'5	4'7	6'5	12
P. 4	..	..	145	7'9	4'3	6	6
Ch.	..	..	135'75	7'42	4'15	5'90	4
D. 1	..	..	122'75	7'02	4'06	5'06	4
K. 1	..	..	148'8	6'28	4'35	5'21	5
K. 2	..	..	47	6	3'7	4'7	11
G. 1	..	..	40	6'5	3'8	5'3	4
G. 2	..	..	38	7'3	4	5'5	5
							67

The above table gives the average measurements of groups in regard to—

col. 2, total length;
 ,, 3, body length divided by head breadth;
 ,, 4, ,, ,, ,, ,, length;
 ,, 5, ,, ,, ,, ,, height.

Column 6 gives the number of specimens measured.

The following table (p. 82) gives the extreme measurements of individual specimens in the various groups:—

Col. 2, total length in millimetres.
 ,, 3, ,, ,, divided by maximum body height.
 ,, 4, ,, ,, ,, head breadth.
 ,, 5, ,, ,, ,, length.
 ,, 6, ,, ,, ,, height.
 ,, 7, head length divided by diameter of eye.

Column 8 gives the number of specimens.

TABLE III.

Group.			Total body length. mm.	T. L. Mx. Ro. Ht.	T. L. Hd. Br.	T. L. Hd. L.	T. L. Hd. Ht	Hd. L. E.	Number of specimens measured.	
P. 1	..	..	185 126	5'66 5'12	9'90 8'60	4'66 4'21		4'32 3'83	5	<i>S. severzovi</i> , Herzenstein. Pamirs.
P. 2	..	..	217 125'5	6'80 4'48	9'38 8'74	4'83 4'37		5'70 4'14	11	<i>S. stoliczkae</i> , Herzenstein. Pamirs.
P. 3	..	..	185 60	6'60 5'00	9'50 8'00	5'00 4'25	7'30 5'50	5'25 4'00	12	<i>S. stoliczkae</i> , Forsyth M. Pamirs and Leh.
P. 4	..	..	154 136	6'20 5'00	8'50 7'20	4'50 4'22	6'30 5'50	5'00 4'00	6	<i>S. severzovi</i> , Alcock Little Pamir.
Ch.	..	..	150 128	5'20 4'70	8'30 7'00	4'30 4'00	6'25 5'75	5'00 4'50	4	Chumbi. Bailey, Kennedy.
D. 1	..	..	135 113	5'00 4'35	7'35 6'75	4'25 3'75	5'25 5'00	5'00 5'00	4	
K. 1	..	..	116 133	4'75 4'25	6'50 6'00	4'50 4'20	5'50 5'00	5'00 4'50	5	Kang-ma, medium.
K. 2	..	..	60 34	4'50 4'00	6'50 5'50	4'00 3'50	5'00 4'50	4'00 3'00	11	Kangma, small.
G. 1	..	..	45 33	5'00 4'50	6'70 6'25	4'00 3'70	5'50 5'00	3'50 3'20	4	Gyantse, river.
G. 2	..	..	45 33		7'23 7'00	4'00 4'00	6'00 5'30		5	Gyantse, marsh pools.

The differences between the specimens from the Pamir and those from the Nyang-chu at Kang-ma may be due to differences in the character of the waters they inhabit or to differences in nutrition. The Nyang-chu is a stream of a most muddy character and it is possible that muddiness of the water, by interfering with respiration, tends to cause an increase of the gill-surface and hence an increase in size of the gill-containing portion of the head.

It should be noted that the relative breadth of the head is less in group G. 2 than in group G. 1 although these two groups are composed of young fish of practically the same size. G. 1 were obtained in the muddy streams around Gyantse, G. 2 from marsh pools close to Gyantse the water of which was entirely free from mud. The value of this observation is of course considerably diminished by the small numbers of the fish in the two groups and their small size.

The specimens from the Nyang-chu were also exceptionally fat and well nourished, whereas those from the Pamirs were of a more hungry appearance.

6. There are considerable variations in the colour of different individuals. The Chumbi race is roughly separated in this respect from the Nyang-chu race.

The following is a note of the colour of a fresh fully grown fish from the Nyang-chu: "Head and body above the latera line a mixture of olive-green and slate-blue, this colour extending somewhat below the lateral line posteriorly. A faint purplish stripe about 3 mm. broad along each side of the dorsal line, commencing at the dorsal fin and extending backward. Flanks below the lateral line rather dull orange-gold; belly dull white."

In the Chumbi valley, on the other hand, the back is pale olive in the anterior half, pale steel-blue in the posterior, and the black pigment is concentrated into irregular spots which are not by any means closely set. The ground colour of the head in spirit is greyish white. The flanks have the golden tinge, but the belly is silvery. Altogether the Chumbi fish is more elegant than its heavily-built cousin from the north. Steindachner (7) describes the colour of the Leh specimens as follows: "Die obere Körper hälfte ist grau, die untere silberfarben. Kopf, Rumpf und Flossen sind mit kleinen schwarzbraunen Flecken und Pünktchen geschprenkelt,"—apparently they resemble the Chumbi specimens.

Specimens from Phari, Guru and Dochen are intermediate between those of Chumbi and the Nyang-chu in respect of colour as well as of general shape. They have the spots of the former but less clearly defined, and the olive ground colour of the back is lighter than in the Nyang-chu and darker than in the Chumbi race.

As I have stated above, the Ssewerzoff type is more often spotted than the Stoliczka: thus Ch. and P. 4 are mainly spotted whereas K. 1 are entirely plain. On the other hand several in D. 1 are spotted.

In the fry (70 mm. and under) the back is of a chocolate-brown with a slight tinge of slate, and there are two rows of irregular

spots on either side, one close to the dorsal line the other on the lateral line.

7. In the district between Chumbi and Gyantse *S. stoliczkae* is the predominant fish. The only species which at all approaches it in numbers is the small loach which also bears the name of *Stoliczka* (*Nemachilus stoliczkae*, Day). Our present subject is, however, much more numerous than even this common species. During the summer numbers were caught every day in the river at Gyantse, while the irrigation channels, the small shallow ponds amongst the fields, and the pools of the marshes at Sechen were alive with shoals of the fry.

In comparison with the above two very numerous forms other species are somewhat uncommon. During an entire summer, although I had about half a dozen men in my employment who all had some acquaintance with the art of fishing, I did not obtain more than four or five specimens of any other species. Arranged roughly in order of frequency the other species found would run (*vide* Lloyd, 5): *Ptychobarbus conirostris*, Steind., *Oreinus baileyi*, Lloyd, *Schizothorax macropogon*, Regan, and *S. o'connori*, Lloyd, *Gymnocypris* (*Schizopygopsis*) *stewartii*,¹ Lloyd, and *Parexostoma stoliczkae*, Day.

It is clear that this fish is also one of the most common if not the most common of the inhabitants of the upper waters of the Indus, Oxus and Sutlej.

8. Breeding and migration.—The breeding season in the neighbourhood of Gyantse appears to occur about June. In the less favoured waters near the watershed it is probably somewhat later. Adults with large ovaries and testes are found in the former district as early as March when the river is still partially covered with ice and the smaller streams and channels are completely frozen over.

Small post-larval fish (*vide* pl. iii, fig. 4) measuring 14-15 mm. in length were caught among the water-weeds of a shallow pond near Gyantse on the 9th July. I believe that these are the young of *S. stoliczkae*; they are elongated narrow little beings, the maximum height including the fins being to the length as 1 : 7. The head is roughly cylindrical, the snout is rounded and projects beyond the mouth. There is an upper and a lower lip at the corners of the mouth; and the mouth and lower jaw closely resemble those of the reputed parent

The following are the measurements of two specimens:—

Total length	14 mm.	15 mm.
Length of head	2·8 ..	2·5 ..
Snout to commencement of preanal fin	4·5 ..	4 ..
" " " " " dorsal	6·8 ..	6·5 ..
" " anus	9·5 ..	10 ..

¹This animal was described by Lloyd as *Schizopygopsis stewartii*, but as the mouth is terminal and the lower jaw does not bear a sharp horny cutting edge, it appears more in place in the genus *Gymnocypris*.

Anus to tail	..	4.5 mm. 5 mm.
Pectoral fin, length		1.5 „
Maximum height	2	„

The caudal fin is in process of being formed on the upturned end of the cord. The pectoral fins arise close behind the gill-opening; ventral not present. The dorsal and anal fins are continuous round the tail. There is a preanal fin.

They are marked with pigment of two kinds—chocolate-brown and black. The former appears to be situated very superficially in the skin; the latter lies more deeply in mesodermal structures such as the peritoneum and periosteum. The skin is so delicate as to be transparent.

The brown pigment occurs in round corpuscles on the back of the head and body, and in stellate corpuscles on the flanks, on the caudal fin and on either side of the ventral-median fins. The black pigment, on the other hand, is found along the lateral line, on the abdomen and in a few corpuscles on the head.

In view of what is known regarding the development of other carp, such as *Cyprinus carpio*, *Leuciscus rutilus* and *idus*, and *Alburnus lucidus* (Ehrenbaum, 3), we will be safe in regarding these young forms as being from 10—20 days old, so that, allowing 4—5 days for hatching, the eggs must have been laid in the second half of June.

Coming to the older fry, the following table gives the measurements in millimetres of the specimens taken during different months of the year:—

March	30, 32, 42, 43, 45, 47.—Gyantse, in the Nyang-chu, under ice.
April	{ 22, 26, 27, 31, 34, 37, 42, 49.—Gyantse, in marsh pools. 125.—Ling-ma-tang.
July	{ 14, 15, 27, 31, 34, 45, 53, 60, 135.—Gyantse. 58, 103, 120.—Dochen. 135.—Ling-ma-tang.
August	70.—Phari.
November	32, 35, 36, 40, 42.—Gyantse.

The November group, clearly, are in their first year, the March and April groups from Gyantse in their second; there is, however, practically no difference in the measurements if we leave out of account the 125 mm. specimen from Ling-ma-tang. It is therefore probable that an average of 40 mm. represents the first summer's growth, that growth does not occur in the winter months or until May or June and that the 125 mm. specimen was in its third year. The reproductive organs of specimens of about this size are still immature.

Arranging the specimens in the order of their age we would probably get the following result:—

First year.

June	..	..	Spawning.
July	9th		14—15 mm.
	„	27th	26 „
	„	„	34 „
November			32—42 „

Second year.

March	..		31—57 mm.
April	..		22—49 „
July			45—60 „
August			70 „

Third year.

April	..	125	mm.
July	..	103—135	„

All the inhabitants of Gyantse whom I consulted in regard to obtaining fish during the winter agreed that the larger fish migrated from the Nyang-chu to the Brahmaputra (Tsang-po) for the winter and returned to breed in spring. It is certain that I did not obtain any large fish during this season, but this fact could also be accounted for by the hibernation of either the fish or the fishermen. We shall see that in the neighbourhood of Dochen fish of the genus *Gymnocypris* attain to a great size and complete sexual maturity although unable to migrate below 14,600 feet.

Enemies.—The only predatory fish in the district under consideration is *Gymnocypris stewartii*, Lloyd. This animal undoubtedly preys on the fry of its ally *Schizopygopsis stoliczkae*, but it does not appear to be very numerous. I have heard from anglers who have had considerable experience in Kashmir that “snow trout” occur above the Mahseer. *Schizopygopsis stoliczkae* is certainly included in the vague group of snow trout, and it is highly probable that its descent to lower levels is prevented by the voracious *Barbus tor*. The geese and duck which occur in great numbers on the Rham Tso and along the Nyang-chu must be reckoned among its most active enemies.

9. Summary.—It is not justifiable to separate *Schizopygopsis severzovi* from *S. stoliczkae* as a distinct species, since they can only be distinguished by one character and a complete series of gradations occur from the one extreme type of head to the other. The fish from any single narrow locality appear to incline to one type or the other. Thus all specimens from Kang-ma are Stoliczka's type, from Guru Stoliczka's, the Chumbi valley Ssewerzoff's. The Oikul group P. 4, on the other hand, contains both the extremes as well as intermediates.

The western members of the species differ from the eastern Tibetan in the size of the head relatively to the body, the head

in the former being narrower, shorter and lower than in the latter. The Chumbi valley race is intermediate in this proportion. Variation in this character is independent of variation in head form.

The species inhabits an extensive but clearly defined area extending from Badakshan and the Pamirs to the Eastern Himalaya and including the upper waters of the Oxus, Indus, Sutlej, and Brahmaputra (Tsang-po). On the south face of the Himalaya it has hitherto been found in the Chumbi valley only.

Its characteristic habitat is in the streams and small rivers of the open, treeless, flat, grassy uplands at an elevation of 11—16,000 feet: broad valleys in the centre of which a river runs with moderate rapidity, while on either side are marshy pools fed by springs, shallow ponds or irrigated land.

It is a highly successful and very numerous species, closely adapted to its surroundings. It breeds in June and possibly also in May and July. Sexual maturity is not attained before the fourth year.

Table iv (p. 88) gives measurements of the individual fish in groups P. 4, D. 1, D. 2, K. 1 and Ch., in regard to the following characters. Column 2 gives the registered number of the specimen in the Indian Museum:—

Col. 3,	length of body in millimetres.
„ 4,	$\frac{\text{total length}}{\text{maximum height of body.}}$
„ 5,	$\frac{\text{total length}}{\text{maximum breadth of head.}}$
„ 6,	$\frac{\text{total length}}{\text{length of head}}$
„ 7,	$\frac{\text{total length}}{\text{height of head.}}$
„ 8,	$\frac{\text{length of head}}{\text{diameter of eye.}}$
„ 9,	relation of anterior margin of mouth-cleft to the lower margin of orbit.

II. THE ADULT AND YOUNG FORMS OF *Gymnocypris waddellii*, REGAN.

Gymnocypris waddellii, Regan (6).

Ind. Mus. Nos. F. $\frac{2862}{1}$, $\frac{2863}{1}$ and $\frac{2841-2849}{1}$.

Two adults and six young were taken by Capt. Kennedy in a stream flowing into the Rham Tso near Chalu Bridge (*vide* pl. iii, fig. 5).

The following description is taken from the two adults:—

Length 417, 440 mm. D. ii. 7, 8. An. ii. 6. P. i. 21. V. i. 9.

TABLE IV.

Group.	Regd. No. of specimen.	Body length. mm.	B. L. Mx. Bo. Ht.	B. L. Mx. Hd. Br.	B. L. Hd. L.	B. L. Hd. Ht.	Hd. L. E.	Ant. margin Mouth. Lower edge of Eye.
P. 4 ..	14142	154	5'3	7'2	4'22	5'5	5	2 mm. below.
	14141	149	5'2	8	4'5	6'1	4'5	3 mm. below.
	14143	150	5	7'8	4'3	5'8	4'8	"
	14144	140	5'2	8	4'3	6'1	4'1	1 mm. below.
	14146	144	5'6	8'3	4'3	6'3	4	At level.
	14145	136	6'2	8'5	4'3	6'3	4'5	"
	Average of group P. 4 ..	145'5	5'4	7'9	4'3	6	4'5	
D. 1 ..	28550	128	4'35	7'35	4'25	5'00	5'00	3 mm. below.
	28551	113	5'00	7'00	4'00	5'25	5'00	"
	28554	115	4'35	6'75	3'75	5'00	5'00	6 mm. below.
	28555	135	4'75	7'00	4'00	5'00	5'00	"
Average of typical Stol. Dochen group.		122'75	4'61	7'02	4'00	5'06	5'00	
D. 2 ..	28556	115	4'30	7'50	4'20	4'75	4'35	2 mm. below.
K. 1 ..	28557	166	4'75	6'20	4'50	5'35	4'75	
	28558	133	4'25	6'35	4'35	5'50	4'50	
	28559	150	4'50	6'35	4'20	5'00	5'00	
	28560	155	4'35	6'00	4'35	5'00	4'75	
	28561	140	4'70	6'50	4'35	5'20	4'50	
Average of group K. 1 ..		148'8	4'51	6'28	4'35	5'21	4'70	
Ch. ..	28570	150	5'00	8'35	4'35	6'25	4'50	
	28571	130	4'70	7'35	4'00	6'00	4'50	
	28572	128	..	7'00	4'25	6'00	5'00	
	28573	135	5'20	7'00	4'00	5'35	5'00	
Average of group Ch. ..		135'75	4'96	7'42	4'15	5'90	4'75	

I was not able to find the small first dorsal spine described by Tate Regan in these specimens.

The snout is blunt, the mouth terminal, jaws equal. The greatest height of the body is attained very shortly behind the head. The distance from the anterior end of the dorsal fin to the snout is less than to the rudimentary rays of the caudal.

Colour.—One specimen is of a dull slate colour on the back of head and body, with a dull white belly and a tinge of gold along the lateral line posteriorly; in the other the pigment of the back is aggregated into small spots about 1 mm. in diameter which are set closely with very narrow spaces between.

The detailed measurements are given in table v (p. 91).

Following Herzenstein's key (4)—

The second dorsal spine is well developed and has somewhat flat teeth; the anterior end of the mouth is below the level of the lower margin of the orbit; there are no scales on the belly in front of the ventrals; the gill-rakers on the first branchial bar number, outer row 17, inner 30. The distance from the beginning of the dorsal to the snout is less than to the rudimentary rays of the caudal. This species therefore comes near *Gymnocypris roborowskii*, Herz. It differs from the latter in the proportion of the maximum height of the body to the length: $6\frac{2}{7}$ — $5\frac{2}{5}$ in *roborowskii*, $4\frac{1}{2}$ in *waddellii*.

The specimens with which we are dealing at present differ from the description of *G. waddellii* given by Tate Regan in that the anterior edge of the upper jaw is distinctly below the lower margin of the orbit. In the specimen of the species (one of the types) which was kindly presented by the British Museum to the Indian Museum, I find, however, that it is somewhat doubtful whether the anterior edge of the upper jaw is not also below the lower margin of the orbit, and, taking into account the differences of size and of the methods of preservation of Waddell's and Kennedy's specimens, it does not appear justifiable to separate them by so small and doubtful a distinction.

Both specimens were females; one was ripe, the other was not so owing to extreme infection with hydatids. In the ripe specimen the largest ovarian ova attain the impressive size of 2.5 mm. in diameter, almost double that of the extruded eggs of *Cyprinus carpio* and *Gobio fluviatilis* (Ehrenbaum, 3, pp. 132 and 135). The snout bears a pad of sharp-pointed horny nuptial tubercles, giving a sensation like a nutmeg-grater to the finger. Rows of large glands are developed on the anal fin, which even between the rays is of almost cartilaginous consistency. The scales of the anal sheath are very prominent, are attached by their bases only and measure as much as 10×9 mm. The glands and the sheath are used presumably in attaching the eggs to the substratum.

It was mentioned above in dealing with *Schizopygopsis stoliczkae* that the waters of the Rham Tso and Kala Tso are isolated by the subterranean egress of the Nyang-chu from the latter

lake; these large fish are therefore never able to migrate below 14,600 feet.

Gymnocypris waddellii, Regan: young forms.

Six specimens from a stream running into the Rham Tso near Chalu Bridge, obtained by Capt. Kennedy, I.M.S., on 30th July, 1909. They are from the same stream as the two large specimens.

Br. iii. D. ii. 8. An. ii. 6. P. i. 19. V. i. 9.

General shape.—This is an elegant fish which does not offer the ground-feeding appearance of its low-born parents and of many of its relatives. This is due chiefly to the fact that there is no humping of the back in front of the dorsal fin. The mouth is practically terminal, being only very slightly overhung by the upper lip and is above the level of the lower margin of the orbit. The maximum height of the body is situated at the commencement of the dorsal fin. The length of body in front of the commencement of the dorsal fin is to that behind this point as 1 is to 1.14. The postdorsal height is to the maximum height as 1 is to 1.35. The height of the tail is to the maximum height as 1 is to 2.87. The length of the first spine of the dorsal fin is to that of the second as 1 is to $1\frac{1}{3}$; the second is serrated in its lower two-thirds, pointed above.

Gill-rakers of first bar number, inner row 19—20, outer row 12.

Colour.—Black or blackish grey with moderate-sized darker brownish spots most marked along lateral line; belly silvery. Dorsal and caudal fins blackish grey; pectorals, ventrals and anals not pigmented.

The largest specimen contains fairly well-developed testes.

III. *Gymnocypris hobsoni*, sp. nov.

(Plate iii, fig. 6.)

A single specimen in the Indian Museum (No. $\frac{152}{1}$) presented by Mr. H. E. Hobson of the Imperial Chinese Customs Service. According to the entry in the register it was obtained from the eastern confines of Tibet.

It measures 145 mm. in length including the caudal fin, 120 without the caudal.

Br. iii. D. ii. 8. A. ii. 5. P. i. 15. V. i. 18.

The mouth is subterminal; the lower jaw slightly shorter than the upper. The anterior end of the mouth is slightly above the level of the lower margin of the orbit. The maximum height of the body is attained about the level of the anterior end of the dorsal fin. The distance from the anterior end of the dorsal to the snout is considerably less than from the same point to the base of the caudal (1 : 1.23). The second dorsal spine is strongly toothed in its lower half.

The animal is of delicate build; the fin-rays fine.

Colour in spirit.—Silvery with yellowish brown underlying colour on back of head and body.

Following Herzenstein's key (4)—

The dorsal spine: the upper half is segmented, the lower half bears well-developed teeth. The anterior end of the mouth-cleft lies slightly above the lower margin of the orbit. The gill-rakers on the first pharyngeal bar number, outer row 11, inner row 15. Among the species described by Herzenstein it appears to approach most closely to *G. maculatus*, Herz. It is separated from the latter by the differences in the fin formulae, by the absence of "humping" in front of the dorsal fin, by the smaller numbers of the pharyngeal teeth, by the forward position of the dorsal fin and by the colour. No grey coloration of back; no spots.

It differs from the young of *G. waddellii* in the following points: An. ii. 5 (not ii. 6); V. i. 18 (not i. 9). Does not slope so rapidly from the commencement of the dorsal fin, thus the maximum body height is to the post-dorsal as 1.10 to 1 (not 1.35 to 1). Maximum body height to the minimum is as 2.30 to 1 (not 2.87 to 1). The predorsal body height is to the postdorsal as 1 to 1.23 (not 1 to 1.14). The length of the first dorsal spine to that of the second is as 1 to 2 (not as 1: 1 $\frac{1}{3}$). The numbers of the pharyngeal teeth, the forward position of the dorsal fin, and the difference of colour.

The following table gives the measurements of two adult specimens of *Gymnocypris waddellii*, Nos. $\frac{2862}{1}$ and $\frac{2863}{1}$, of one young specimen of this species, No. $\frac{2849}{1}$ and of *G. hobsonii*, sp. nov., No. $\frac{152}{1}$:—

TABLE V.

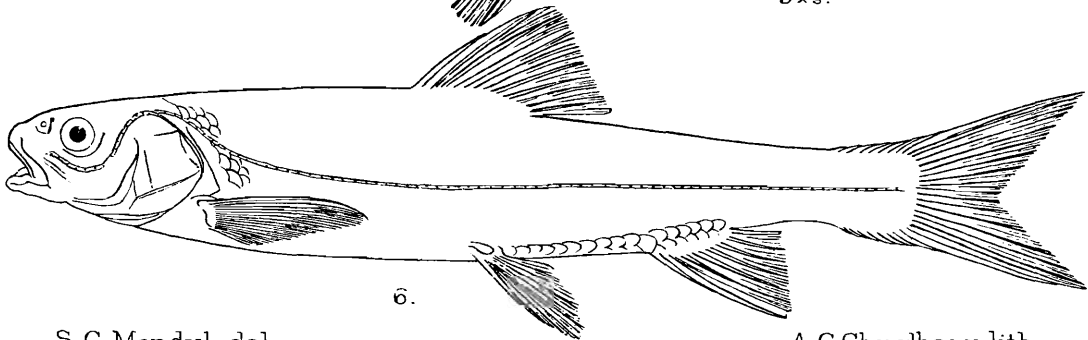
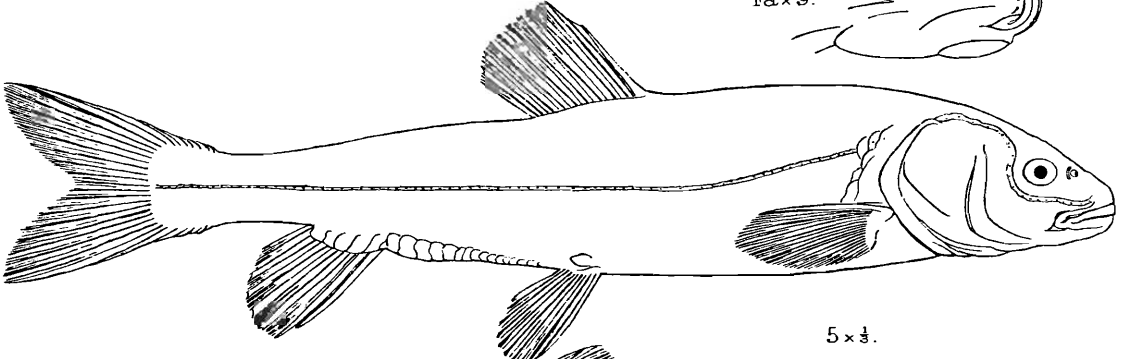
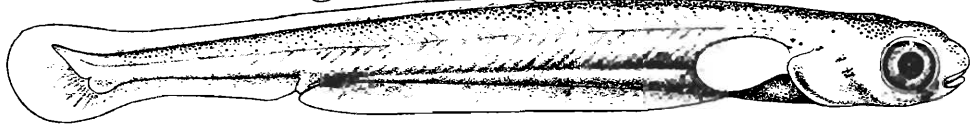
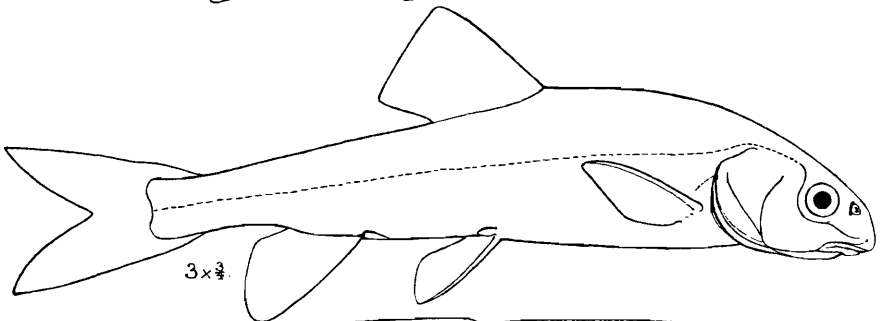
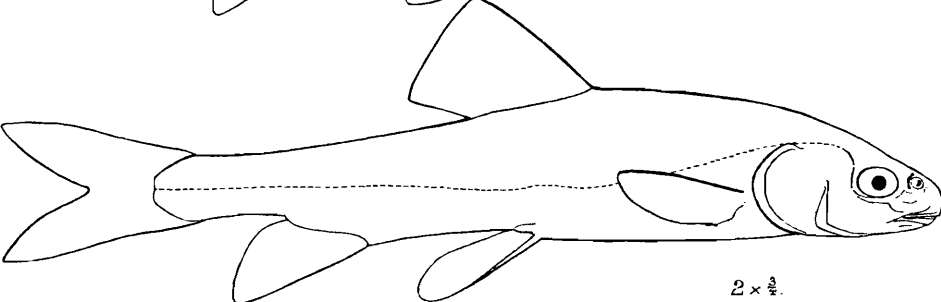
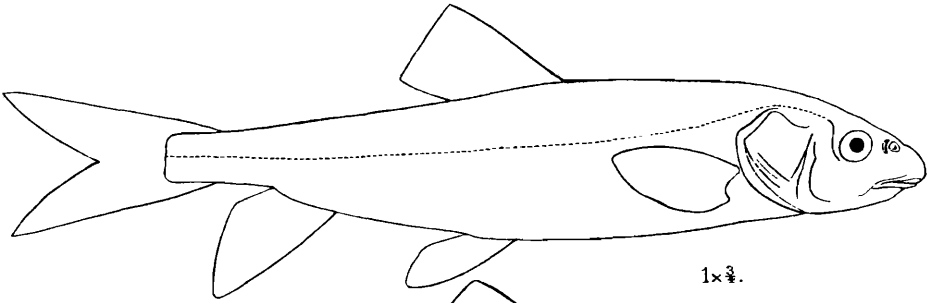
Indian Museum Register No.	..	..	$\frac{2862}{1}$	$\frac{2863}{1}$	$\frac{2849}{1}$	$\frac{152}{1}$
Total length in millimetres	..	..	417	440	125	145
Body length	..	..	360	380	101	122
Body length: maximum body height	..	..	4.50	5.00	5.40	5.50
Maximum body height: postdorsal	..	..	1.46	..	1.35	1.10
Maximum body height: minimum	..	..	3.10	..	2.87	2.30
Body length: length of tail from posterior of base of anal.	..	..	6.00	..	5.50	5.00
Length of tail: height of tail	..	..	2.50	..	2.30	2.90
Body length: head length	..	..	4.35	4.25	4.20	4.60
Head length: head breadth	..	..	1.50	..	1.80	1.90
Head length: head height	..	..	1.50	..	5.80	1.45
Breadth of mouth: length of mouth	..	..	1.65	..	1.20	1.50
Head length: diameter of eye	..	..	6.20	6.00	4.20	4.50
Interorbital: diameter of eye	..	..	2.30	..	1.10	1.60
Head length: postorbital head length	..	..	1.65	..	2.00	1.85
Body length: base of dorsal	..	..	8.00	..	6.60	7.30
Height of dorsal: base of dorsal	..	..	1.20	..	1.20	1.30
Maximum height of dorsal: minimum	..	..	2.30	..	2.00	2.00
Body length: pectoral fin length	..	..	6.30	..	5.20	5.50
Body length: ventral fin length	..	..	7.50	..	6.30	6.40
Body length: head breadth	..	..	6.50	7.00	7.50	9.00
Body length: head height at level of posterior edge of opercle.	..	..	4.75	5.50	5.35	6.50

LITERATURE.

1. Alcock, A. W. *Report on Pamir Boundary Commission*, 1898 (Calcutta).
 2. Day, F. *Scientific Results Second Yarkand Mission*, Ichthyology, 1891 (Government of India).
 3. Ehrenbaum, E. *Nordisches Plankton*, Eier und Larven von Fischen, vol. ii.
 4. Herzenstein, S. *Wissensch. Resultate. Reisen von Przewalski nach Central Asien*, Bd. iii, pt. 2 (Petersburg, 1888).
 5. Lloyd, R. E. *Records Indian Museum*, vol. ii, p. 341.
 6. Regan, C. Tate. *Ann. Mag. Nat. Hist.*, vol. xv, p. 300 (1905).
 7. Steindachner, Fr. *Verhand. zool.-bot. Ges. Wien*, 1866, p. 786.
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EXPLANATION OF PLATE III.

- FIG. 1.—*Schizopygopsis stoliczkae*, Steind., group Ch., No.
F. $\frac{2853}{1}$, $\times \frac{3}{4}$.
- „ 2.— „ „ „ „ P. 4, No. 14146, $\times \frac{3}{4}$.
- „ 3.— „ „ „ „ K. 1, $\times \frac{3}{4}$.
- „ 4.— „ „ „ „ postlarval, $\times 9$.
- „ 4a.—Lower surface of head of same specimen, $\times 9$.
- „ 5.—*Gymnocypris waddellii*, Regan, adult, $\times \frac{1}{3}$.
- 6.— „ „ *hobsonii*, sp. nov., nat. size.



IX PRELIMINARY DESCRIPTIONS OF
NEW SPECIES AND VARIETIES OF
CRUSTACEA STOMATOPODA IN
THE INDIAN MUSEUM

By STANLEY KEMP, B.A., Assistant Superintendent,
Indian Museum.

The following short descriptions of twelve new forms are preliminary in nature and will be succeeded, at no distant date it is hoped, by a full illustrated account.

The late Mr. J Wood-Mason took a special interest in this group and would doubtless have published an extensive memoir on them, had he lived. To a considerable number of the new forms he had assigned manuscript names and from the notes and figures which he had made Col. Alcock, in 1895,¹ was able to edit an account of nine species. Other forms were also recognized under manuscript names, but from the rough notes which were available it was found impossible to draft adequate specific descriptions.

Wherever possible I have retained the names adopted by Wood-Mason and, thanks to the considerable additions which have since been made to the collection, I have also to introduce a number of other new species, most of which have been obtained by the R.I.M.S.S. 'Investigator.'

Gonodactylus (Protosquilla) nefandus, sp. nov.

This species is allied to *Gonodactylus trispinosus*, Dana, *G. pulchellus*,² Miers, and *G. tuberosus*, Pocock. Its closest affinities are with *G. pulchellus* and along with that species it may be distinguished from *G. trispinosus* and *tuberosus* by the smooth and unsculptured median portion of the fifth abdominal somite.

Several examples of *G. pulchellus* from Ceylon (the type locality) are preserved in the Indian Museum and, compared with these, *G. nefandus* shows the following distinctive features:—

The antero-lateral pair of rostral spines are short and stout and though acute are not nearly so slender as the median; the distal concavities between the teeth are also much less deep with the result that the undivided basal part is considerably longer. The dorsal processes of the ophthalmic somite consist of two

¹ J Wood-Mason, *Figures and descriptions of nine species of Squillidae in the Indian Museum*. Calcutta, 1895.

² *G. pulchellus* was originally described by Miers as a variety of *trispinosus*, but in my opinion is entitled to rank as a distinct species.

small plates with rectangular antero-lateral angles; in *G. pulchellus* these angles are narrow and acute and are produced obliquely outwards. The distal margin of the telson is in both species divided into four lobes on either side of the median line, but these in *G. nefandus* are merely bounded by grooves on the dorsal surface whereas in *G. pulchellus* they are separated by three incisions, cut right through the telson, which extend about half way to the outer of the three dorsal boss-like protuberances.

A number of specimens, the largest 39 mm. in length, from the Andamans, Cheduba (Arrakan Coast) and the Straits of Malacca.

***Odontodactylus southwelli*, sp. nov.**

Odontodactylus southwelli is related to *O. hanseni*, Pocock, and *O. latirostris*, Borradaile, and, as in those species, the anterior half of the telson bears three carinae on either side between the median crest and the thickened lateral margin. The outermost of these three carinae is parallel to the external margin and does not diverge to the apex of the lateral spine as in *O. japonicus*. From all species with more than three teeth on the inner margin of the dactylus of the raptorial claw it may be distinguished at a glance by the enormous size of the eyes.

The rostrum is twice as broad as long and the anterior margin is evenly rounded from side to side. The breadth of the cornea is contained from two to two and a quarter times in the length of the carapace. The dactylus of the raptorial claw bears seven to nine teeth on its inner margin in addition to the terminal one. The lateral margins of the sixth and seventh thoracic somites are rounded, the former being a trifle broader than the latter. There are eight carinae on the dorsal surface of the sixth abdominal somite; the first intermediate carina, which alone does not terminate in a spine, is connected proximally by means of a ridge with the submedian. On the margin of the telson there are twelve to sixteen minute submedian spinules, two intermediate denticles and one lateral. In the uropod the outermost of the ten or eleven movable spines which fringe the exopod reaches almost or quite to the apex of the ultimate joint.

Several specimens, the largest 37 mm. in length, from the Andamans and Ceylon.

***Lysiosquilla insignis*, sp. nov.**

This species does not appear to possess much affinity with any form previously described.

The rostrum is triangular, one and a half times as long as wide, and terminates in a sharply acute apex. The cornea is set obliquely on the eyestalk and its breadth is about one third the mid-dorsal length of the carapace. The dactylus of the raptorial claw bears seven or eight teeth including the terminal one, the penultimate tooth, as in *L. acanthocarpus*, being noticeably

shorter than the antepenultimate. The sixth thoracic somite has an angular dorsal elevation on either side near the anterior edge: antero-laterally the margin is deeply excavate and behind this it projects in the form of a truncate lobe with rounded subrectangular anterior and posterior angles. The postero-lateral angles of the last three abdominal somites are sharply spinous. The fifth somite is provided with two obscure longitudinal carinae on either side; the sixth bears laterally near the distal margin a pair of spines in addition to those at the postero-lateral angles. These spines form the terminations of irregular carinae. The telson is provided dorsally with a trilobed median prominence, on either side of which there is a sharp intermediate spine and an angular lateral lobe. This armature is placed near the distal edge and is homologous with the curved row of spines found in *L. acanthocarpus* and *L. latijrons*; in front of it there are eight longitudinal carinae the outermost of which is proximally bifurcate. On the margin of the telson there are two long movable submedian spines and two pairs of large fixed laterals. There are four short spines between the submedians and the first laterals, and one between the two laterals. Six movable spines fringe the outer margin of the basal joint of the exopodite of the uropod and of these the two outermost are curved and much longer than the next of the series.

One specimen found in the neighbourhood of the Andamans in 235 fathoms.

***Squilla gilesi*, Wood-Mason, MS.**

Squilla gilesi is related to *S. lata*, Brooks, but may readily be distinguished from it by the following characters:—

The carapace in front of the cervical groove is wholly without trace of carinae and its anterior margin on either side of the rostrum is strongly sinuous. The lateral edges of the rostrum are not concave near the apex as in *S. lata* but are evenly convex, and the lateral spinous process of the fifth thoracic somite is longer than in that species and has a stronger forward inclination. There are sharp submedian carinae on the last two thoracic and on all the abdominal somites. The sublateral carinae on the last three or four somites and the lateral carinae on the last four, five, or six terminate in spines. On either side of the median crest of the telson the impressed parallel lines found in *S. lata* are not visible and on the margin there are two or three submedian denticles, five to eight intermediate and one lateral. The inner margin of the bifurcate process of the uropod is finely serrate, not spinous.

The median carina and margins of the telson are strongly swollen in the adult male and the raptorial dactylus, which bears six teeth including the terminal one, is, in this sex, strongly sinuous: convex in the female. In the adult male, also, the propodus of the raptorial claw is very strongly dilated near its distal end.

This species bears a somewhat close superficial resemblance to *S. scorpio*, Latr.; but, apart from such details as the form of the rostrum and the carination of the carapace, there is in *S. gilesi* a well-developed three-jointed mandibular palp, an appendage which in *S. scorpio* is entirely missing.

Thirteen specimens of *S. gilesi*, the largest 94 mm. in length, are in the collection. They were found between 35 and 80 fathoms in the Persian Gulf, Bay of Bengal and Gulf of Martaban.

Squilla hieroglyphica, sp. nov.

This species is closely allied to the little known *S. laevis*, Hess. a form which appears to be restricted to the coasts of New South Wales. Mr. D. G. Stead has kindly presented us with examples of that species and, on comparison, *S. hieroglyphica* shows the following differences:—

The anterior bifurcated portion of the median carina of the carapace is entirely absent; the carapace is much narrower than in *S. laevis*, the anterior width being only about half the median length, including the rostrum. The rostrum is as long as wide and its lateral margins converge to a narrow rounded apex. The cornea of the eyes is set transversely on the stalk. The dactylus of the raptorial claw is armed with only five teeth including the terminal one. The lateral process of the sixth and seventh thoracic somites is more broadly rounded and the sublateral carinae of the fourth abdominal somite end in spines. The denticles on the margin of the telson are represented by the formula 5, 10—12, 1, whereas in *S. laevis* the corresponding numbers are 2—3, 6—8, 1.

Both species agree in having the lateral process of the fifth thoracic somite bilobed and that of the two succeeding somites unilobed, differing in this respect from all other species with the same number (eight) of longitudinal carinae on the abdomen; from both species, moreover, the mandibular palp is absent.

A single specimen of unknown locality, 53 mm. in length, is preserved in the Indian Museum.

Squilla gonypetes, Wood-Mason, MS.

S. gonypetes is closely allied to Brooks' *S. quinquedentata*, but may be distinguished by the following characters:—

The rostrum is distinctly longer and its upturned lateral margins are rather more strongly convergent anteriorly. The cornea of the eyes is a little more expanded and is set very obliquely on the stalk. The antennular peduncle is longer than the carapace excluding the rostrum. The outer inferior margin of the merus of the raptorial claw is distally rounded and does not project in the form of a spine. The sublateral carinae of the last three, and the lateral carinae of the last four abdominal somites end in spines.

Four specimens, the largest 56 mm. in length, from the Persian Gulf, Andaman Is. and the Arrakan Coast.

***Squilla boopis*, sp. nov.**

This species is allied, though not very closely, to *S. quinque-dentata* and *S. gonypetes*, and is easily distinguished from both by the enormous size of the eyes.

The rostrum bears a sharp median longitudinal carina in its distal half. The cornea is set very obliquely on the stalk and its greatest breadth is considerably more than one third the median length of the carapace. The antero-lateral angles of the carapace are produced as acute points which project outwards and downwards and scarcely reach at all forwards beyond the adjacent anterior margin. The lateral margin of the seventh thoracic somite is not bilobed but is angled acutely behind and rectangularly in front. The sublateral carinae of the last five and the lateral carinae of all the abdominal somites terminate in spines.

The dactylus of the raptorial claw bears five teeth including the terminal one and the lateral processes of the fifth and sixth thoracic somites are bilobed. In both these characters *S. boopis* resembles the two species mentioned above.

A single specimen, 89 mm. in length, from the Gulf of Martaban, 67 fathoms.

***Squilla holoschista*, Wood-Mason, MS.**

This well-marked species is closely allied to *Squilla nepa*, Latr., and agrees with it in the form of the eyes, the number of spines on the raptorial dactylus and the shape of the lateral processes of the fifth to seventh thoracic somites. It may be distinguished by the following characters:—

The median carina of the carapace, in front of the cervical groove, is bifurcated anteriorly for less than one third of its length and is finely bicarinate throughout almost its entire extent. The cornea of the eyes is slightly but noticeably less expanded than in *S. nepa*, specimens of similar size being compared. The submedian carinae of the fourth abdominal somite never end in spines.

In the adult male the distal end of the propodus of the raptorial claw is much broader than in *S. nepa* of the same sex and the external margin of the dactylus is only very feebly sinuous.

Numerous specimens from the east coast of India, from Ceylon to the Ganges delta.

The three following forms are very closely allied to *Squilla oratoria* de Haan (= *S. affinis*, Berthold), and in order to facilitate comparison the following short account of the principal features which separate that species from its near allies is given:—

The breadth of the carapace, measured at the antero-lateral angles is distinctly less than half its median length, including the rostrum. The median carina of the carapace is bifurcated anteriorly for about one quarter its length in front of the cervical

groove and is sharp and distinct throughout its course. The dorsal surface both of the carapace and abdomen is usually strongly punctate and never presents a polished appearance. The anterior margin of the ophthalmic somite, between the bases of the eye-stalks is squarely truncate or emarginate, never pointed. The dorsal carina of the carpus of the raptorial claw bears from three to five sharp tubercles; the outer margin of the dactylus is sinuous. In the bifurcate process from the basal joint of the uropod the margin anterior to the small lobe on the external edge of the longer spine is always strongly concave.

I have reason to believe that this species is found in its typical form only in Chinese and Japanese waters. Three specimens from the Hawaiian and Philippine Is. have also been examined, but these differ from the others in several minute details. They may possibly represent a distinct sub-species, but the material at my disposal is not sufficient to establish this with any certainty.

All previous references of *Squilla oratoria* or *affinis* from localities west of the Philippine Is. are, I believe, based on one or other of the new forms described below, and of this in several instances I have direct proof. In all, several hundreds of specimens have been examined, including a fine collection from many widely distant localities kindly lent by the Trustees of the British Museum.

***Squilla oratoria*, de Haan, var. *perpensa*, nov.**

This variety is distinguished from the typical form by the following characters:—

The median carina of the carapace is interrupted and wholly absent for a short space at the base of the anterior bifurcation. The two arms of the bifurcate portion are frequently very fine and are rarely obsolete. The carpus of the raptorial claw has a sharp elevated carina on its dorsal aspect which terminates abruptly before reaching the anterior margin; apart from this there is no trace whatever of any dorsal tubercle.

Very numerous specimens from localities ranging from Hong-kong and N. Australia to the Persian Gulf. The largest example is 107 mm. in length. Four specimens only out of the large series examined exhibit characters intermediate between the variety and the typical form

***Squilla interrupta*, Wood-Mason, MS.**

This abundant species may be separated from *S. oratoria*, s.s., by the following characters:—

The median carina of the carapace is interrupted at the base of the anterior bifurcated part precisely as in the var. *perpensa*. The breadth of the cornea of the eyes is distinctly less than in either of the two preceding forms, specimens of similar size being compared. The carpus of the raptorial claw is constantly provided with two, and only two, stout dorsal tubercles. In the bifurcate

process from the base of the uropod the outer margin of the longer spine anterior to the well-developed lobe is never concave; it is occasionally feebly sinuous, but in nearly every instance is definitely convex.

Very numerous specimens, the largest 119 mm. in length, exhibit the above characters with most remarkable constancy. They were taken at localities ranging from Hongkong to the Persian Gulf.

***Squilla wood-masoni*, sp. nov.**

Squilla polita, Wood-Mason, MS., *nec* Bigelow.

Squilla wood-masoni may be separated from *S. oratoria*, its variety *perpcusa* and *S. interrupta* by the use of the following characters:—

The dorsal surface of the carapace and abdomen is smooth, highly polished and without trace of punctuation. The carapace is shorter and broader than in any of the preceding forms, its breadth at the antero lateral angles being *at least* one half its length including the rostrum. The anterior bifurcated portion of the median carina of the carapace is entirely obsolete. The distal edge of the ophthalmic somite is produced to a small point between the bases of the eyestalks and is not truncate or slightly emarginate as in the preceding forms. The eyes are large, much as in *S. oratoria*, and the carpus of the raptorial claw also resembles that species in bearing three or four tubercles on its dorsal edge. The dactylus of the same limb is strongly sinuate externally and is of a much more clumsy build than in any of the preceding forms. The bifurcate process of the uropod is similar to that of *S. oratoria*, but the lobe on the external margin of the longer spine is, in all except very young specimens, much smaller.

Numerous examples, the largest 109 mm. in length, from localities ranging from Hongkong to Aden.

***Squilla annandalei*, sp. nov.**

This species is closely allied to the well-known *S. raphidea*, Fabr., and the propodus of the raptorial claw bears, as in that species, a number of large fixed spines along the margin opposed to the dactylus. It may be distinguished by the following features:—

The rostrum is shorter—more so than in the form of *S. raphidea* which de Haan described under the name of *harpax*—and its apex is more broadly rounded. The antennular peduncle is longer than the rostrum and carapace combined. The anterior lobes of the lateral margins of the sixth and seventh thoracic somites are quite distinct, whereas they are wholly obsolete in *S. raphidea*. The sublateral carinae of the last three thoracic and the submedian carinae of the last *two* abdominal somites end in spines. The marginal spines of the telson are sharper than in *S. raphidea* and the inner uropod is narrower in proportion to its length.

Spirit specimens differ noticeably from the allied species in the colour of the inner uropod. This in *S. annandalei* is entirely jet black, except for a pale median longitudinal stripe, whereas in *S. raphidea* the inner margin only is suffused with black pigment.

Four specimens, the longest 115 mm. in length, from the Gulf of Martaban between 53 and 67 fathoms.

X NOTES ON THE DEVELOPMENT OF SOME INDIAN ASCALAPHIDÆ AND MYRMELEONIDÆ.

By F. H. GRAVELY and S. MAULIK.

[N.B.—The plate (v) illustrating this paper has not yet been received from Europe. It will be published in the next number of these "Records."]

CIRCUMSTANCES OF CAPTURE.

The three species of Ascalaphid and Myrmeleonid larvae described in this paper differ in habit from all larvae of these families whose habits have hitherto been described, in that they neither cover themselves completely with a cloak of debris in order to conceal their real nature from the insects on which they prey nor hide themselves under stones or in the ground, but live upon tree-trunks in hollows and crevices of the bark where the Ascalaphid larvae at least are rendered sufficiently inconspicuous by their form and colour alone (see plate v, figs. 2 and 3). The larvae of *Myrmeleon contractus*, Walk.¹ (figs. 5 and 6), were found by Mr. Paiva on December 20, 1909, at Bhogaon, Purneah District, Bengal, upon the trunks of some mango trees which were coated with dried mud. One specimen was found hidden in an actual pocket in this mud coat, from which only its jaws projected each in its own close-fitting groove; but all the rest (5 or 6) were lying on the surface, in at most a shallow depression, where, being somewhat pale in colour, they were seen without much difficulty. The larva (of an Ascalaphid) which has not yet been identified with any adult form (fig. 4) was obtained at the same place two days later on another mango tree with dark-coloured bark not plastered with mud, but hung with cobwebs and the debris which they catch. This specimen was found in a hollow of the bark where it was very hard indeed to discover. The *Pseudoptynx* larvae (figs. 1—3) were found by Dr. Annandale at Igatpuri in the Bombay Presidency on November 20, 1909. One of these was found by day on the rough bark of a tree-trunk where it was very inconspicuous, and two more were found on a recently whitewashed wall at night. In both cases the larvae were perfectly still when found.

¹ Our thanks are due to Prof. J. G. Needham, who is preparing an account of the Indian Neuroptera, for the identification of the mature insects reared from the larvae dealt with in this paper.

HABITS AND DEVELOPMENT IN CAPTIVITY.

Larvac.

The larvae were brought to Calcutta and kept in glass jars in one of the work-rooms of the Indian Museum. A thin layer of dry soil was placed at the bottom of the jar, a piece of rough bark was supported against the side in an upright position, and the top was covered with muslin. The food supplied consisted of flies, mostly "blue-bottles" (probably *Pycnosoma flaviceps*), but the larvae showed no special preference for any particular kind.

All the larvae hibernated during the winter, neither taking food nor caring to move about; but it was noticed in the case of a *Pseudoptynx* larva which happened to be moved from its chosen position on the bark, that it returned there during the following night. Most of the larvae hibernated immediately on being left to themselves in their cages, but the smaller of the two *Pseudoptynx* larvae kept alive took one or two flies on alternate days with considerable regularity till December 17. It remained inactive till February 21, 1910, and when flies were then again introduced into its cage it started feeding at once and continued to do so till March 23 when it died, still somewhat smaller in size than its companion.

Its companion commenced to feed again on February 24, but was not observed to eat anything more between this date and March 19 when it began to prepare for pupation—at most it cannot have eaten more than two or three flies during this time. The imago (which was deformed) emerged on April 4, 1910.

The other Ascalaphid larva commenced to feed again on February 28, and eat another fly on March 15, very shortly after which it was unfortunately lost. The *Myrmeleon* larvae eat nothing at all during the time of their captivity; one prepared to pupate on February 22 and emerged on March 21. Another prepared to pupate on February 26, but the pupa was not allowed to develop further.

The unidentified Ascalaphid larva not only resembled the *Pseudoptynx* larva in general form (compare figs. 1 and 4) but also in habits; and, except that in the former the mandibles always remained exposed in repose, the following account of the habits of the latter, which were more fully observed, is probably equally applicable to it and in large measure even to the *Myrmeleon* larvae also. It may be observed here that these last resemble the free-living larvae of other genera of Myrmeleonidae in not having the habit of walking backwards that is so well-known a characteristic of the pit-forming larvae of other species of the genus *Myrmeleon*. Their mandibles were kept continuously closed during their life in captivity and extended forwards in front of the head with their tips crossed.

The larva of the species of *Pseudoptynx* here described usually lies motionless in a depression of the bark on which it lives, and by flattening itself down as close as possible upon the bark the larva makes itself almost indistinguishable (see figs. 2 and 3). If

removed from the bark it will remain absolutely motionless for a time, feigning death.

When thus at rest on the bark the legs are entirely hidden beneath the body, and the long powerful mandibles are drawn back and held so widely open as to lie beneath the sides of the head and the lateral processes of the thorax. If, when the larva is hungry, a fly happens to touch it on any part of the head the mandibles are closed instantaneously and the fly captured between them. No suggestion of discrimination as to the qualities of the fly was ever observed in the process. After this the fly is shifted along towards the distal end of the mandibles, and if it is dropped before reaching its destination no effort is made to recover it. If the end is reached in safety the mandibles are thrust into the body, always between two segments—apparently they are too blunt to pierce any harder part of the integument. The sucking of the juices of the fly along the canal on the under side of each mandible is then commenced at once and the piston-like motion in these canals, by which suction is effected, may be seen under a hand-lens. From time to time one or other of the mandibles is withdrawn in order to commence sucking in another place, the fly being held aloft and quite clear of the bark throughout the whole time of feeding. Flies continued to move for a long time after they were caught; they did not appear to be poisoned as did those caught by Mr. S. Green's species in Ceylon (Westwood, 1888, p. 8). A fly is finished in from half an hour to an hour. The mandibles only—never the legs—are used in manipulating it.

Cocoons and Pupae.

The *Pseudopteryx* larva constructed its cocoon at the surface of the loose dry soil provided, by fastening together pieces of earth with tough silk (fig. 15).

The larvae of *Myrmeleon contractus* spun cocoons in crevices of the bark on which they were living, although all other Myrmeleonids of which the cocoon is known appear to spin in soil. Having found a suitable crevice the larva sits in it with the head erect and jaws projecting upwards, and proceeds to spin round the edge with silk extruded from a retractile spinneret at the posterior end of the abdomen, the abdomen being moved to and fro throughout the process. The edges of the cocoon become broader and broader, being carefully covered with dust as they are elaborated, and the aperture in the middle becomes narrower till finally the jaws are withdrawn and the cocoon or at least its outer covering completed. If a cocoon be opened it is found to consist of two layers of silk, the inner one being softer and more loosely spun together than the outer. When the mature insect emerges the pupal skin is left projecting from the aperture made in the cocoon (see figs. 9 and 10). Presumably the pupa eats its way through the silk with its peculiar jaws (fig. 12) as suggested by Westwood in the case

of a Ceylonese species of *Ascalaphus* (1888, pp. 11-12) and comes half out itself before the transformation takes place.

DESCRIPTIONS OF LARVAE AND PUPAE.

The following descriptions are based primarily on preserved specimens (in spirit); but a few notes on the living larvae have been incorporated with them.

Pseudoptynx, sp.

Larva (pl. v, figs. 1—3 and 14, and text-fig. A).—Length (excluding jaws 4 mm.) about 12 mm. Head cordate, flattened dorso-ventrally, somewhat broader than long, widest opposite the middle of the deep posterior sinus. Ocular tubercles (text-fig. A) not very prominent, somewhat flattened dorso-ventrally, each bearing six black ocelli all on the dorsal surface. Antennae scarcely reaching to the tip of the ocular peduncle, slightly swollen at the tip. Mandibles

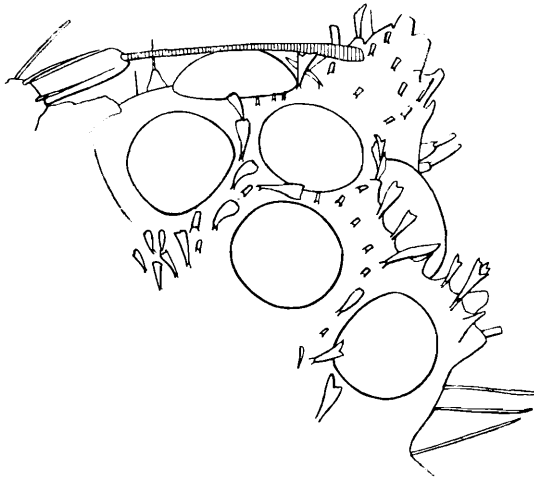


FIG. A.—Ocular tubercle of larva of *Pseudoptynx* sp., $\times 75$.

long, perfectly straight as far as the second and longest tooth, then strongly curved inwards to the tip; third tooth longer than first. Thorax flat: prothorax much narrower than head, broader than long, freely articulated with head and mesothorax. Mesothorax much broader than the head, bearing two pairs of lateral lobes each fringed with hairs—the anterior very large, bent back at an angle in the middle and slightly forwards again close to the tip, the posterior smaller, slenderer, and approximately straight. Metathorax broader than mesothorax and fused to it and to the abdomen; lateral lobes as in mesothorax but smaller, the anterior one not so strongly bent. Abdomen broad and flat; each segment except the last (9th) broader than long, and produced laterally to form a pair of processes fringed with hairs; last segment longer than broad, narrower behind than in front, truncate posteriorly, without lateral processes,

but with a pair of very distinct ventral lobes each bearing four stout blunt spines.

General dorsal colour dull, earth-like. Mandibles dark near the base, reddish in the middle, intense black from the longest tooth to the tip. Head dull brown, mottled with ochraceous between and for a short distance behind the ocular tubercles. Pronotum brown mottled with ochraceous. Mesonotum and metanotum brown near the mid-dorsal line, ochraceous speckled with brown laterally, these extensive pale lateral patches becoming more conspicuous as the larva grows older; the anterior pair of lateral processes of both meso- and metanotum paler than the posterior ones. Abdomen brown with a pair of transverse ochraceous bands on each of the first eight segments but most conspicuous on the anterior ones; these bands are arranged one behind the other so as to form a pair of pale longitudinal stripes continuous in front with the lateral patches of the thorax and fading gradually out behind; the ninth

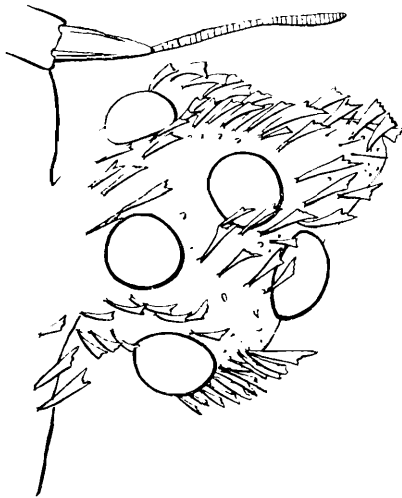


FIG. B.—Ocular tubercle of undetermined Ascalaphid larva from Bhogaon, $\times 75$.

segment is brown in front and ochraceous behind. The whole of the dorsal surface is rough in appearance, and the abdomen is much wrinkled transversely.

On the ventral side the colour of the mandibles resembles that of the dorsal; the head is polished and uniformly brown except for a spot in the middle line between the anterior parts of the two ocular tubercles, a short longitudinal stripe situated on each side about half-way between the ocular tubercles and the middle line, and a patch—bifid behind—at the base of each of these tubercles, all of which are ochraceous; the thorax and abdomen are ochraceous thickly speckled with brown.

Cocoon and Pupa (fig. 15).—Cocoon approximately spherical,

nearly 15 mm. in diameter. Composed of white silk; smooth and glistening inside, coated with attached pieces of soil on the outside. Pupa not examined before hatching for fear of interfering with the completion of its development. The empty skin shows the mandibles to have been stout and strongly toothed on the biting margin.

Undetermined Ascalaphid.

Larva (pl. v, fig. 4, and text-fig. B).—Total length (including mandibles) about 12 mm. Mandibles straight for a greater part of their length than in the *Pseudoptynx* larva; general dorsal coloration somewhat paler than in that larva; and anterior lateral processes markedly different from posterior instead of all being setose alike. As, however, the larva was lost before any complete description of it was drawn up, the figures alone will have to serve for further comparison with other larvae.

Myrmeleon contractus, Wlk.

Larva (pl. v, figs. 5—7 and 13, and text-fig. C).—Length (excluding mandibles 1.5 mm.) about 7 mm. Head approximately

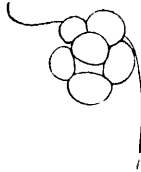


FIG. C.—Ocular tubercle of larva of *Myrmeleon contractus*, Wlk., $\times 90$.

rectangular with the anterior angles sharply re-entrant and the posterior ones rounded; broader than long. Ocular tubercles (text-fig. C) not prominent, bearing six black eyes all in a circular patch on the dorsal surface. Mandibles (fig. 7) long, straight as far as the third tooth (*i.e.*, for about two-thirds of their length), then curved rather sharply inwards; the second tooth the longest, the first the shortest. Thorax flat; prothorax semi-lunar above with the anterior margin faintly convex, much narrower than the head, freely articulated with head and mesothorax. Mesothorax much broader than head, metathorax broader than mesothorax, each with two pairs of minute lateral processes arising just above their margin and not projecting beyond them (fig. 5); these processes are however usually obscured by a coating of mud which gives them the appearance of broad flat discs which do project beyond the margin of the body (fig. 6); mesothorax and metathorax fused together and to the abdomen. Abdomen short and broad, without lateral processes. Eighth segment with a pair of minute conical yellowish horns on the posterior margin below; ninth segment with a pair of loosely opposed and very faintly developed lobes

below the posterior margin, each bearing four stout blunt spines which are quite black.

General colour in life dirty whitish faintly tinged with pink dorsally. Head, mandibles, and pronotum brownish above, the first and last of these covered with a thin layer of fine dust. Meso- and metanotum and abdomen whitish with a faint bluish mid-dorsal line, and a pair of conspicuous black dorso-lateral lines; a slightly irregular row of brown spots on each side between the mid-dorsal and dorso-lateral lines; and numerous spots of the same colour scattered more or less symmetrically outside the latter. The mesonotum however, and to a less extent the metanotum, are obscured in life, like the head and pronotum, by symmetrically arranged plate-like layers of fine dust. Below, the mandibles are brown and the front margin of the head black; the rest of the body is whitish.

Cocoon and Pupa (figs. 8—12).—Cocoon composed of white silk, specked with particles of fine dust; 7 mm. in diameter externally; constructed in a hollow of the bark; consisting of a tough outer and a soft inner layer, the latter almost spherical, the former simply stretched across the hollow so as to roof it in and protect the latter.

Pupa slightly more than 5 mm. long in its natural position with the head and abdomen flexed. Eyes large, greyish; antennae curved back above the eyes; mandibles strong and horny, each strongly toothed on the biting margin, the teeth becoming progressively smaller behind—the distal tooth especially being much larger than the penultimate one; third legs folded separately from the other two pairs and almost entirely concealed from view by the wings, from beneath the extremities of which the claw is seen projecting (fig. 8); wings very dark coloured, almost black; the rest of the pupa dirty whitish, speckled with brown.

COMPARISONS WITH PREVIOUSLY DESCRIBED SPECIES.

Ascalaphidae.

As noted above the two *Ascalaphid* larvae here described differ from all whose habits are at present fully known in that they live upon tree-trunks where their form and colour alone render them sufficiently inconspicuous to allow them to capture their prey; and they do not attempt to conceal themselves further.

One of them has been reared to maturity, and proves to belong to the genus *Pseudopteryx*, Weele. This genus belongs to the sub-family Acmonotinae, which only includes one other known genus *Acmonotus*. The only larvae belonging to this sub-family that have hitherto been described are of the latter genus. Van der Weele has described and figured the larva of *A. sabulosus*, Walk. (1908, pp. 204-5, fig. 157), and a comparison of his account with that of the *Pseudopteryx* of the present paper will show that the former differs from the latter in many respects: notably in the extraordinarily broad head (which is much broader than long), the long single

tooth on the mandibles, the almost circular body (meso- and metanotum and abdomen together), and the uniformly elongated lateral processes. These characteristics are precisely those noted by Hagen (1873 p. 59) as diagnostic of larvae of *Suphalasca*, a genus in which *sabulosus* and other species of *Acmonotus* were included before the latter genus was founded and made the type of a separate subfamily. Hagen's statement concerning the distinctive larval characters of *Suphalasca* appears to have been based on a description published by Brauer (see Hagen, 1873, p. 43), but the two species (*dietrichiae* and *subtrahens*) to one or other of which he (Hagen) provisionally refers Brauer's larva are retained in the genus *Suphalasca* in Van der Weele's Monograph of 1908. Froggatt (pp. 363-4) also describes a larva which he regards as that of *Suphalasca sabulosa*, Walk., but as Van der Weele himself points out, this is a very different form from his larva; and as a matter of fact it does not come within Hagen's definition of the larval characters of *Suphalasca*. Possibly, however, Froggatt's larva may belong to a true *Suphalasca*, and Brauer's, which was not determined with certainty, to some species now separated as *Acmonotus*, in which case Hagen's diagnosis would still appear to hold good, but only to the *Acmonotus* section of the undivided genus to which he applied it. Assuming this to be the case there are at present published the following descriptions of larvae of the Acmonotinae:—Van der Weele on *Acmonotus sabulosus*, Walk., Brauer (followed by Hagen) on some closely-allied (? the same) species; and the above description of a species, as yet undetermined, of *Pseudoptynx*.

As will appear from the above description, the larvae of *Acmonotus* are of a very abnormal form. The *Pseudoptynx* larvae, on the contrary, are in no way abnormal. Of all the larvae hitherto described the *Pseudoptynx* larvae most closely resemble Hagen's "*Glyptobasis incusans*? oder *Ascalaphus? cervinus*?" from Ratnapura, Ceylon (1873, pp. 44—46). This they resemble so closely that it is not at all impossible that the shrivelled larvae from which Hagen drew up his description may have been in reality the young of this very species. Up to the present, however, no *Pseudoptynx* of any species appears to have been recorded from Ceylon.

The undetermined Ascalaphid larva with its curiously modified lateral processes, is a much more abnormal creature and we are unable to connect it with any other form known to us.

Myrmeleonidae.

The larvae of *Myrmeleon contractus* are chiefly remarkable on account of their manner of life. Not only do they not form pits, a habit hitherto believed to be universal with the larvae of this genus, but neither do they hide under stones or rubbish, or cover themselves over with a cloak of foreign matter as do the larvae of some other genera. They only attach a little dust in a thin layer to the dorsal surface of the head and thorax, the abdomen being apparently always bare in spite of its pale colour. The abdomen is however much less conspicuous on a background of bark than

might be supposed; and if these larvae feed, like other Myrmeleons, upon ants, the covering of the anterior part of the body must be quite sufficient in itself to render them inconspicuous to any victim approaching from in front—for to an ant the rest of the body would appear so much foreshortened as to be scarcely noticeable. And it is very natural that in India an ant-eating insect should take to a life upon tree-trunks, up and down very many of which hosts of ants are perpetually streaming, numbers having their nests beneath the bark.

Redtenbacher (1884, pp. 544-5) divides Myrmeleonid larvae into two main classes:—A, those which walk forwards and do not construct pits; and B, those that construct pits. And he subdivides these according to structure, the latter being divided according to their method of progression also. Although the larvae of *Myrmeleon contractus* would clearly fall into class A, they are distinguished from all of the four groups of this class by the structure of the ninth segment. And of the three groups in class B they agree in structure (apart from a minor difference in the armature of the mandibles, which is referred to below) only with the *Myrmeleon* group, in spite of the fact that they always walk forwards and never backwards.

Thus in the classification of Myrmeleonid larvae habits may be misleading; and in this case at least the structure of the eighth and ninth segments is a safer guide to identity and may be relied on with absolute security. The larvae of *Myrmeleon contractus* differ however from all the Myrmeleonid larvae described by Redtenbacher in the much greater proportional breadth of the body, and from all the Myrmeleons in having the third tooth on each mandible slightly shorter instead of longer than the second. In the latter character they tend to resemble *Palpares* and some species of *Acanthaclistis* among free-living forms, and *Creagris* and *Myrmecalurus* among pit-makers; but from all of these they differ in that the third tooth is longer and not shorter than the first.

The pupa resembles in general characters that of the “*Formica-leo*” (*Myrmeleon formicarius* of Hagen and *M. europaeus* of Redtenbacher) described by Reaumur (1742, pp. 368 and 373, xxxiv, figs. 3-5).

LIST OF PAPERS CONSULTED.

Those marked with an asterisk contain descriptions of larvae from the Oriental Region.

- 1742. Reaumur, M. de—“*Mem. pour servir à l’Histoire des Insectes.*” Vol. vi, pp. 333-386, pl. xxxii-xxxiv.
- 1827. Guilding, L.—[On *Ascalaphus macleayanus*.] *Trans. Linn. Soc.*, xv, 1824-5 (1827), pp. 509-512.
- 1833. Percheron, A.—“*Note sur la larve du Myrmeleon libelluloides.*” *Mag. Zool. des Années 1831 à 1838*, Section 3, classe ix; 4 pp., pl. 59.

1842. *Lefebvre*.—[On an Ascalaphid larva.] *Ann. Soc. Ent. France* (i), xi (1842), pp. xvii-xix.
1846. *Guérin-Ménéville*.—[On the larva of *Ascalaphus longicornis*.] *Ann. Soc. Ent. France* (ii), iv (1846), pp. cxv-cxvi.
1871. *Emerton, J. H.*—"The Ant-Lion." *Amer. Nat.*, iv (1871), pp. 705-709.
1872. *Hagen, H. A.*—"On the Larvae of the Hemerobina." *Proc. Boston Soc. Nat. Hist.*, xv (1872-3), pp. 243-248.
- *1873. *Hagen, H. A.*—"Die Larven von *Ascalaphus*." *Stett. Ent. Zeit.*, Jahr. xxxiv (1873), pp. 33-62. [*Helicomitus* (?) sp. from Saugor, Central India, pp. 43-44; and *Glyptobasis incusans*? oder *Ascalaphus*? *cervinus*? from Ratnapura, Ceylon, pp. 44-46, from the Oriental Region.]
1873. *Hagen, H. A.*—"Die Larven von *Myrmeleon*." *Stett. Ent. Zeit.*, Jahr. xxxiv (1873), pp. 249-295 and 377-398.
- *1873. *M'Lachlan, B.*—"An Attempt towards the Systematic Classification of the Family Ascalaphidae." *Journ. Linn. Soc.*, Zool., xi (1873), pp. 219-276. [Eggs and larvae of a species from Saugor, Central India, very briefly described on p. 225.]
1878. *Ragonot*.—[Larva of *Ascalaphus longicornis*.] *Ann. Soc. Ent. France* (5), viii (1878), p. cxx.
1882. *McCook, H. C.*—"On the Habits of the Ant-Lion." *Proc. Philadelphia Acad.* (1882-1883), pp. 258-260.
- *1884. *Redtenbacher, J.*—"Übersicht der Myrmeleoniden-Larven." *Denkschr. Kais. Akad. Wiss. math. nat. Classe*, xlviii (1884), pp. 335-368, pl. i-vii. [Two species from the Oriental Region, one from Pondicherry, p. 358, pl. v, figs. 70-74 (genus?), and a *Myrmeleon* from the Dekkan, p. 361, pl. vi, figs. 88-89.]
- *1888. *Westwood, J. O.*—"Notes on the Life-History of Various Species of the Neuropterous Genus *Ascalaphus*." *Trans. Ent. Soc. London* (1888), pp. 1-12, pl. i-ii.
1902. *McClendon, J. F.*—"The Life-History of *Uhula hyalina*." *Amer. Nat.*, xxxvi (1902), pp. 421-429, text-figs. 1-15.
1902. *Froggatt, W. W.*—"Notes on Australian Neuroptera and their Life-Histories." *Proc. Linn. Soc. N. S. Wales*, xxvi (1902-3), pp. 358-369.
1908. *Rengel, C.*—"Über *Myrmeleon formicarius*, L." *Sitzb. Ges. Naturforsch. Freunde*, Jahrgang (1908), pp. 140-149, pl. viii.
- *1908. *Van der Weele, H. W.*—"Ascalaphiden, Monographisch Bearbeitet." *Collections Zoologiques du Baron Edm. de Sélys Longchamps; Catalogue systématique et descriptif* Fasc. viii; Bruxelles (1908). [Larvae of *Acmonotus sabulosus*, Walker, from South Australia, pp. 204-205; *Hybris borneensis*, Weele, from Borneo, pp. 239-240; and *Ascalaphus cunii*, Sélys, from Spain and Portugal, pp. 302-303, all described and figured.]

MISCELLANEA

INSECTS.

THE OCCURRENCE OF *Dactylopius citri*, RISSO, IN THE HIMALAYAS.—On May 27th last year, while collecting insects in the Himalayas, I met with a number of nymphs of a Coccid in the nests of a small black species of ant. The nests were constructed under loose stones on a mountain-side at elevations varying from approximately 12,300 to 12,500 feet. The locality was about 5 miles north-west of Badrinath, near the Satopanth Glacier in Garhwal. Some of the nymphs were sent to Mr. E. E. Green of Peradeniya who identified them as belonging to the cosmopolitan species *Dactylopius citri*, Risso, and remarked that it occurs commonly in ants' nests in Ceylon. The species secretes a honey-dew similar to that of Aphides, and is farmed by a number of species of ants. The distribution of this insect at this elevation is a fact of some interest, and I may add that the locality from which it was obtained is seldom visited by man, though it is less than 4 miles from the entrance to the Mana Pass into Tibet.

A. D. IMMS.

Muir College, University of Allahabad, 20-iv-11.

NOTE ON AQUATIC RHYNCHOTA.—Two new species (each representing a new genus) of marine Rhynchota have recently been described by Mr. W. L. Distant from the Andaman Sea (*Ann. Mag. Nat. Hist.* (8), v, pp. 146, 147; *Faun. Brit. Ind.*—Rhynchota, v, pp. 154, 155, figs. 82, 83); but unfortunately the specimens figured, having originally been preserved in alcohol, were evidently dried before being drawn, with the result that they have been represented in a shrivelled condition. The acquisition of fresh specimens enables me to add the following supplementary particulars to Mr. Distant's descriptions:—

Euratas formidabilis, Dist.

Specimens of both sexes were taken by Mr. S. W. Kemp on the surface of a backwater at Vizagapatam on the Coromandel Coast in April, 1910, and were preserved dry. They are somewhat stouter and smoother in appearance than Mr. Distant's figure would suggest and the impressions on the collar represented as deep pits are obsolescent. The colour is somewhat darker than that of de-alcoholized specimens.

Fabatus servus, Dist.

Female specimens were taken on the shore of Ross I., Andamans, in March, 1911, by Mr. C. A. Paiva. The body in the adult of this sex is somewhat elongate, the length being 5 mm. and the maximum breadth about 1.5 mm. The sides of the thorax are straight and nearly parallel, except that the collar is much narrower than the posterior part, the anterior angles of which are broadly rounded. A deep mid-dorsal groove runs along the whole length of the thorax. The coloration is very characteristic. The dorsal surface of the head is leaden grey, edged with chocolate-brown and with a pale line running parallel to the margin of each eye posteriorly; that of the pronotum is deep chocolate-brown, with a large transverse oval spot of leaden grey on each side of the mid-dorsal groove on the collar, a much larger and more elongate longitudinal spot of the same colour on each side of the posterior part and, posterior to this spot, a sinuous transverse bar of the same colour running from near the lateral margin to near the mid-dorsal groove a short distance in front of the insertion of each leg of the 3rd pair. The dorsal surface of the legs and abdomen is piceous, but the segments of the latter are edged with silvery grey posteriorly. The ventral surface of the head, thorax and abdomen is yellow, with a streak of leaden grey directed obliquely forwards and inwards in front of the insertion of each leg of the 2nd pair. The ventral surface of the limbs is dark, except that the base of the femora of the anterior legs is tinged with yellow. The eyes, antennae and rostrum are black.

Only the wingless form of the following species has hitherto been described :—

Perittopus rufus, Dist.

The apterous form of this species was originally described from the Siamese Malay States and Tenasserim (*Faun. Brit. Ind.*—Rhynchota, ii, p. 175, fig. 128). I found this form not uncommon in March, 1908, on the surface of pools in jungle streamlets flowing down the western slopes of the Dawna Hills near Kawka-reik in the interior of the Amherst district (Tenasserim) at altitudes of from 2,000 to 3,000 feet, and Mr. C. G. Rogers, I.F.S., has recently (Jan., 1911) taken a winged specimen on a small tributary of the Rangoon River, in Pegu.

The winged form has a pronotum resembling that of *Microvelia*, the postero-lateral angles being subprominent and the posterior part extensive and produced to a point at the extremity. The hemelytra reach the end of the body and are of an intense black colour. The membrane, which is of relatively great extent, is opaque and has a matt surface devoid of hairs, but the rest of the hemelytron is translucent and minutely and sparsely pilose. The veins are not prominent.

N. ANNANDALE.

RECORDS of the INDIAN MUSEUM

Vol. I, 1907.

- Part I.*—Contributions to the Fauna of the Arabian Sea. Records of Hemiptera and Hymenoptera from the Himalayas. Further notes on Indian Freshwater Entomostraca. The Fauna of Brackish Ponds at Port Canning, Lower Bengal, I—III. A Sporozoon from the Heart of a Cow. Miscellaneous.
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