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ARTICLE I

REPORT ON DIPTERA OF THE FAMILY *EPHYDRIDAE*

By Ezra T. Cresson, Jr.

The Academy of Natural Sciences of Philadelphia

(Received November 3, 1933)

The *Ephydridae* submitted to me for study were collected around several saline lakes and hot springs in the Punjab and Indian Tibet, and are represented by thirteen adults of three species belonging to the genera *Ephydra* and *Halmopota*, of which two are here described as new. This did not surprise me as little is known of the Ephydrid fauna of the Tibetan plateau. Becker's contribution on the Diptera of Central Asia[1] is the only report to my knowledge on the species of this family known to occur there. In this report he records thirty species, describing several new genera and species, many from localities adjacent to the saline lakes there. Comparatively few species of insects have adapted themselves to such severe conditions as are presented by these generally alkaline and saline waters which, in addition, are often quite hot. Larvae of this f mily have been previously collected in waters with a temperature as high as 43°C. (109°F.).[2] In the present collection are specimens of larvae from a hot spring at Phuga which were obtained up to 49.1°C.

It is interesting to note that while expecting to find a group of species confined to such a habitat, I was not prepared to encounter such extreme similarity as I did in the species of the genus *Ephydra*, here described, and in one occurring in a similar environment in North America. It required considerable study of all the material of this genus in my hands to secure satisfactory characters for specific recognition. I could not believe that we had one and the same species from such widely separated localities.

This collection also contains some larvae and puparia, but as none of the adults were bred from any of these, I am unable to determine with certainty the species represented. However, as far as I can determine, these larvae and puparia seem to represent one and the same species, although they show a certain degree of variation which I do not think is of specific value. I append some notes on this material at the end of this paper.

Ephydra glauca Meigen

1830. *Ephydra glauca* Meigen, Syst. Beschr. Europ. Zweifl., VI, p. 120.
1896. *Ephydra obscuripes* Becker, Berl. Ent. Zeit., XLI, p. 222. (nec. Loew. 1866.)
1930. *Ephydra glauca* Cresson, Trans. Am. Ent. Soc., LVI, p. 115.

Indian Tibet: Tso-kar, 14,850 feet altitude, September 5, 1932. 1 ♂, 1 ♀.

The water of Tso-kar is very salt, containing 74,832 parts per million non-volatile solids in solution.

This species was originally described from Europe, without any citation of definite locality. I have reported it in 1930 from Lac Sarat, Great Wallacia, Roumania; at the

[1] Ann. Mus. Zool. Acad. Imp. Sci. St. Petersb., XII, pp. 299-306 (1907).
[2] Brnes in the Proc. Am. Acad. A. & Sc., LXIII, p. 202 (1928).

same time recording a male (not female) labelled "Hdiyka, Indus Phal., 1866." These latter data I am unable to interpret, but assume that the specimen was collected somewhere along the Indus River. The present series agrees very satisfactorily with my Roumania specimens, so I have no doubt of their conspecific status. The species is probably well distributed in the arid regions of Central Asia. As material I have seen of this species agrees so well with Becker's description of *obscuripes*, I have no doubt of this synonymy. Becker's species was originally described from Sarepta, Astrakhan, South Russia, and since recorded from Orenburg.[3] Popova[4] also recorded *obscuripes* from Elton Sea, Astrakhan, South Russia.

Ephydra tibetensis n. sp

This species is so similar to several occurring in the thermal waters of North America, that I rather hesitated to describe it as new without studying a larger series of the North American forms than I have before me. However, considering their widely separated habitats and the slight differences that are apparent, I venture to describe the present one as new.

Very similar to *pectinulata* Cresson[5] of the United States, but of a more greenish glaucous tone, not whitish, becoming brownish above. Bristles of the frons stronger; the setulae assuming bristle-like proportions; the metallic medifrons rough. Mesonotum more uniformly metallic, less pollinose, cupreous rather than aeneous; the abdomen greenish glaucous. Palpi, all tarsi and wing veins, black. Differs from *glauca* in its more olivaceous tone, strong setulae, as well as in the flatter, more metallic colored, interfoveal area of the face.

Entirely black except the tawny halteres and squamae.

Head height, length and widths as 15: 18: 22; in profile, facial projection beyond facial orbits, to distance from occiput to facial orbits, as 8: 7. Eyes oblique with vertical diameter slightly in excess of one-half height of head. Frons distinctly broader than long, in profile, slightly oblique; mesofrons subquadrate, broad anteriorly, shining metallic blue, surface finely sculptured, bearing two to three pairs of converging, proclinate bristles on anterior portion; the broad somewhat metallic parafrons, the narrow frontalia and occular tubercle, opaque dark brown, with very strong orbital setae in addition to the four usual bristles. Face opaque, whitish cinereous on the prominent setulose medifacies; the flattened horizontal interfoveal area, shining metallic blue to green; foveae, parafacials and cheeks olivaceous. Facial bristles well developed, the lateral ones longest; oral margin slightly retracted, with very long cilia which are almost as long as the ocellars. Cheeks two-fifths height of head; buccal bristle slender; lower three to four setae of the postorbital cilia bristle-like.

Thorax olivaceous laterally; mesonotum shining, metallic, slightly overcast with brown, sparingly setulose, humerus and notopleura more grayish, two narrow inter-dorsocentral stripes and a broad extra-dorsocentral stripe more opaque and brownish to bluish. Acrostichal setae much stronger than surrounding setulae, the series closer together than their distance from the dorsocentral series; presutural acrostichals weak; some inter-acrostichal setulae present and a few other scattered inter-dorsocentral setulae posteriorly near the dorsocentral bristles. Scutellum broad as long, pilose apically, flattened, transversely rugulose. Mesopleura very sparingly setulose.

[3] Lindner's Flieg. Pal Reg., Fam. 56, p. 75 (1926).
[4] Russ. Hydrob. Zeit., VIII, pp. 140-141 (1929).
[5] Ent. News, XXVII, p. 151 (1916).

Abdomen narrow; fifth segment longer than fourth, greenish glaucous; apical margins of these segments with few long setae.

Legs olivaceous; post-extensors of fore femora very long. Wings blackish; length to width as 60: 32; posterior crossvein perpendicular to fifth vein.

♀. Similar to male but with stronger bristles, many of the mesonotal setulae bristle-like; the prescutellar convexity bearing some setae and the prescutellar acrostichals stronger than in the male, prescutellar acrostichals slightly divergent. Scutellum slightly elongate and noticeably convex. Postmarginal cilia of mesopleura dense and sternopleura strongly pilose above.

Type.—♂; Indian Tibet: Kyam Hot Spring, 15,630 feet altitude, 24 July, 1932.

Paratypes.—3 ♂, 4 ♀; topotypical.

A female from Phuga hot spring, 14,500 feet altitude, 24 August, 1932, is slightly more robust, bristling longer on frons, mesonotum and abdomen less metallic, blackish; face and pleura also more blackish or brownish than cinereous and olivaceous, but structurally there seem to be no marked differences.

Halmopota hutchinsoni n. sp.

This is similar to *H. villosa* Becker from northeastern Tibet, but that species is brownish with pale tibiae and tarsi, and the dorsocentrals are not developed. Only the female sex of *villosa* is known, but I cannot believe the male before me to be of that species.

Entirely black; at most the tarsi are slightly paler distally, and the halteres are pale yellow. Uniformly opaque glaucous gray, with frons, mesonotum and scutellum blackish in some aspects.

Head 1.2 longer than high, 1.6 wider than high; in profile the frons is slightly convex, oblique, setting the antennae but slightly above center-line of head and at, or slightly below, that of eyes; ante-ocellar extension about one-half length of head. Eyes obliquely elongate. Frons broad as long, sparingly setulose anteriorly; seven to eight strong fronto-orbitals and a few small setae mesally; ocellars in line with the anterior ocellus and another pair, as strong, just behind, some slightly weaker setae behind and between these, also a strong post-vertical pair. Face with gibbose medifacies less than one-half width of head, strongly sub-hemispherical, making a distinct sub-horizontal interfoveal hump; four to six facial bristles in a series on lower half; parafacials very broad, about length of second and third antennal segments in width. Cheeks almost one-half height of head in width, with five to six strong dorso-inclinate marginal bristles. Postbucca strongly turgid, setulose. Cilia of posterior orbits of about six strong blistles. First antennal segment distinctly visible, one-half length of second; second segment broader than long, setulose basally with strong dorsal setae; third broader than long; arista twice as long as third, with thick pubescent basal three-fourths, gradually attenuating distally to hair-like tip.

Mesonotum sparingly, strongly, setose, many of the setae may be confused with the macrochaetae; the three postsutural acrostichals as strong as the dorso-centrals; the latter arranged 2 to 3 : 3 to 4; interalar series of bristles and setae; 1 humeral; 1 presutural; 2 to 3 notopleurals; several supralar and postular bristles discernible among the strong setae. Mesopleura strongly setulose with strong postmarginal cilia; sternopleura setulose above; the pleural sclerites otherwise bare. Scutellum triangular, as long as broad, flat or slightly convex, bare, but with two apical and two to four lateral bristles.

Abdomen slightly broader than thorax, sparingly clothed with appressed setulae; laterally and ventrally more strongly so; second to fourth segments subequal in lengths; fifth slightly longer.

Bristles of legs strong and numerous but not seriated except on the flexor margins; setae of posterior margin of fore femora in length equal to diameter of the femora; middle femora with postflexor comb of closely set spinules on distal three-fourths. Wings translucent, immaculate, with dark veins; venation normal except that the post-crossvein very strongly undulated; ultimate section of fourth vein not as long as the penultimate; squamae white with black cilia.

Length, 6 mm.

Type ♂; Indian Tibet: Tso-kar, 14,850 feet altitude. September 5, 1932. (G. E. Hutchinson.)

Note on the larvae and puparia

P 10. Punjab: Son Sakasar Kahar, March 13, 1932, from submerged branches of brush; pH 8.9; 89,306 parts non-volatile solids per million. Three larvae and six puparia.

L 40. Indian Tibet: Panggong Tso, Lagoon II, west end, June 20, 1932; pH 9.3, alkali reserve 0.0085 N., chloride 0.0007 N., cold water. Two larvae and one puparium.

The larvae of this lot have two dorsal longitudinal clusters of closely set spinules on segments one to four, becoming rounded or sometimes coalescing into transverse bands on five to eight; seventh proleg well developed; post-anal tubercle also distinctly developed. The puparia have a total length of 6.5 mm.; greatest thickness at third segment of 2 mm.; length of anal tube 1.5 mm., two and a half times as long as its basal diameter; length of respiratory tube .6 mm.; dorsal profile of segments one to five practically straight, that of six to eight convex, causing the prolegs of six and eight to approximate each other to almost touching; proleg of seven scarcely developed, represented only as a slight swelling bearing a few curved spinules.

L 58. Indian Tibet: Kyam hot springs, July 19, 1932; 1055 parts non-volatile solids per million; one larva and several puparia. This form agrees well with Brues description and figure of *Ephydra pectinulata* Cresson, described from the Yellowstone Park, Wyoming,[6] but I note the following differences: Larva with dorsal patch of spinules as described on the larvae from Panggong; prolegs with two transverse rows of curved hooks, those in the anterior series much the stronger and usually four in number. Otherwise the larva and puparium as described from Panggong except that the anal tube is shorter, which character seems to vary considerably. This form may be *Ephydra tibetensis* here described.

Another larva collected from the above locality, July 20, 1932, in a small pool with temperature of 35.6 C., appears to be of the form described from Panggong, lagoon II.

L 80. Indian Tibet: Phuga hot springs, August 25, 1932, temp. 49.1°C.; pH 8.6; alkali reserve 0.0144N; chloride 0.0112N; very rich in H_2S. Eight larvae which appear to be same as those described from Panggong, but their lengths are 4.2 to 6 mm.; anal tube of largest, .9 mm.

[6] Proc. Am. Acad. A. & Sci., LIX, pp. 403-405, fig. 5 (1924).

ARTICLE II

REPORT ON TRICLAD TURBELLARIA FROM INDIAN TIBET

By Libbie H. Hyman

(Received November 10, 1933)

The planarian material collected by the Yale North India Expedition was turned over to me by Mr. G. E. Hutchinson for examination. It consisted of fourteen vials of specimens in alcohol. These were run up into oil of wintergreen and examined with low power. It was then seen that the contents of thirteen of the vials are all (presumably) of one species, a species of *Polycelis*, while the fourteenth vial contains specimens which are probably to be assigned to the genus *Euplanaria*. Fortunately some of the *Polycelis* are sexually mature and it has therefore been possible to furnish a diagnostic description. The specimens of the second species are unfortunately all asexual and consequently cannot be placed generically with any certainty. All of the material came from Kashmir and Indian Tibet. The stations labelled K 64-K 71 are located to the northeast of Srinagar, Kashmir; those marked K 74-K 83 and L up to number 25 are collecting sites in Indian Tibet on the road between Srinagar and Leh and in the Indus valley above Leh; and the remainder of the numbers under L are situated in Indian Tibet north and east of the Ladak range. The following remarks give the data found on the labels in the vials together with my own notes from examination of the cleared specimens.

K 64. Gund, rest house, 2080 meters, under stones in a very small stream, temperature 9.4°C., May 17th, 1932. This vial contains three specimens which constitute the second species mentioned above whose external appearance suggests the genus *Euplanaria*.

K 66. Small stream with very steep slope, about three miles west of Sonamarg, 2440 meters, temperature 7°C., May 18th, 1932. This vial contains eight good-sized specimens of *Polycelis*, none of which appear to have sex organs.

K 71. Stream west of Sonamarg, 2590 meters, temperature 7.0°C., pH. 7.6, May 19th, 1932. Thirteen specimens of *Polycelis*, mostly rather small. Four of the largest were sectioned but proved to be devoid of sex organs.

K 74. Small stream, temperature 7.3°C., pH. 7.5, mossy, 50 cm. wide, Matayan, 3170 meters, May 20th, 1932. Eight specimens of *Polycelis*.

K 76. Small stream, temperature 19.0°C., about one mile west of Dras, 3080 meters, May 21st, 1932. Of the ten specimens of *Polycelis* found in this vial two were removed and sectioned but proved asexual.

K 77. Stream, Dras, temperature 21.0-22.0°C., 3091 meters, May 21st, 1932. Nine specimens of *Polycelis*, five adult and four young ones, all asexual.

K 78. Karbu between Dras and Kargil, spring, temperature 8°C., pH. 7.5, 2819 meters, May 22nd, 1932. This vial contained four specimens of *Polycelis* of which two were seen to be sexually mature and have been sectioned.

K 83. Spring, Kargil, temperature 10.2°C., 2679 meters, May 24th, 1932. Two specimens of *Polycelis*, not sexual.

L 21. Pool just below Himis Gonpa, temperature 9.5 C., 3500 meters, June 12th, 1932. Contains four specimens of *Polycelis*, asexual.

L 25. Stream above Leh, temperature 7.8-8.6 C., 3570 meters, June 21st, 1932. Six specimens of *Polycelis* of which two were obviously in the sexual state. These were removed and sectioned and furnish the main basis for the taxonomic description.

L 34. Pool, Bao, temperature 20.8 C., 4585 meters, June 25th, 1932. This vial contains one *Polycelis* and three small specimens which are probably rhabdocoels.

L 35. Springs, four miles from Bao, temperature 7.2 C., 41 meters, June 26th, 1932. Five good sized but asexual specimens of *Polycelis*.

L 60. Stream, under stones, Kyam, 4725 meters, July 21st, 1932. Although the several specimens of *Polycelis* in this vial are the largest in the collection they appear to be in the asexual state.

L 75. Springs, Tukmuru Tso, temperature 10 C., 4385 meters, August 11th, 1932. Seven rather small specimens of *Polycelis*.

Search through the literature revealed the fact that this *Polycelis* had been seen before. A number of specimens were taken in the expedition for collecting the aquatic animals of Tibet made by Captain F. H. Stewart in 1907. The planarians of this collection were turned over to Meixner and Muth who published their report in 1911. They described and figured the external features of the specimens, giving several drawings of the arrangement of the eyes, and placed them in the genus *Sorocelis*. Owing to variations in the disposition of the eyes these authors were inclined to think that the material consisted of more than one species. Their specimens came from streams at Te-ring Gompa, 14,000 feet, and High Hill Gompa above Gyantse, 14,500 feet. This form was again mentioned by Muth (1912) as similar to his *Sorocelis eburnea* from the region of Lake Aral. Owing to a lack of sexual specimens, Meixner and Muth were unable to furnish a diagnosis of the Tibetan material.

The genus *Sorocelis* was until recently a badly defined genus into which were thrust a number of many-eyed fresh-water triclads collected chiefly in Asia. In 1930 Kenk, in his invaluable revision of the genera of the fresh-water planarians, proposed to limit this genus to many-eyed forms belonging to the family Dendrocoelidae. Those which from the arrangement of the inner muscular layers of the pharynx fall into the family Planariidae he has rightly transferred to the genus *Polycelis*. The Tibetan specimens at my disposal belong to the family Planariidae and the sexual apparatus corresponds in all respects to Kenk's definition of the genus *Polycelis*. I therefore have no hesitation in placing them in that genus. It is also reasonably certain that my specimens are the same as those recorded by Meixner and Muth. I do not, however, agree with their supposition that more than one species is concerned. It is true that the eyes are somewhat variable in different specimens, but these variations are partly correlated with age and in any case are insufficient to serve as specific distinctions. To the best of my knowledge, the above references constitute the only records of the Tibetan *Polycelis*. Study of the sexual apparatus shows that the form does not correspond to any described species of *Polycelis*, and consequently I consider it a new species which from its habitat I name *Polycelis tibetica*.

Polycelis tibetica n. sp.

Syn. *Sorocelis* sp. Meixner und Muth, 1911.

1. *External features.* As only preserved specimens are available, the size and shape of the living animal cannot be stated. In preserved specimens there is always a certain amount of distortion. The size appears to be moderate, probably not exceeding 15 mm. Judged from the least distorted specimens, the head has much the same shape as in *Polycelis coronata* (see Hyman, 1931a). The anterior margin (Plate I, fig. 5) is rounded in a gentle curve and provided laterally with two fairly prominent auricles.[1] The arrangement of the eyes is also similar to that of *P. coronata*, consisting of a semicircular band passing near the anterior margin, along the base of the auricles, and terminating shortly behind the auricles. Behind the auricles, the body incurves slightly, then broadens toward the middle regions, and finally again diminishes towards the rounded posterior end. Plate I, fig. 1, gives the appearance of one of the less contracted specimens. Presumably in life the auricles would be more prominent, probably still more extended, than in the specimen shown in Plate I, fig. 5, and the body somewhat more elongated. As is common in the genus, the pharynx is very long and powerful, terminating near the posterior end and leaving only a short region for the sexual apparatus.

The eyes in all the specimens form a semicircular band several eyes wide running along the margin of the head and terminating shortly behind the auricles. The number and arrangement of the eyes vary in different specimens, no two worms being exactly alike in these respects. Frequently the posterior end of the band is at a different level on the two sides. The number of eyes varies definitely with age, consisting of thirty to forty in the smallest specimens, sixty to eighty in medium specimens, and eighty to one hundred or more in the largest worms. Plate I, figs. 2 to 5, inclusive, indicate this relationship with age. In Plate I, fig. 6, where the number of eyes is quite small although the worm was a large one, there were various indications that the head was in process of regeneration.

The coloration appears to be a uniform dark brown or black.

2. *General histological features.* Some of the specimens are in a good state of fixation but the histology presents nothing in particular. The ventral epithelium is cuboidal and is ciliated throughout. The dorsal epithelium is slightly taller, contains more rhabdites, and is ciliated at least in part. The anterior part of the dorsal surface is always ciliated to a greater or less extent while posterior dorsal regions usually lack cilia. The adhesive zone is very narrow but so far as could be determined follows the usual course completely encircling the body margin. The most conspicuous histological elements are the large gland cells found in the anterior half of the body distributed thickly below the intestine, slightly less abundant dorsal to the intestine. They consist chiefly of the large rounded gland cells taking basic stains which are called Eiweisszellen by German authors. Gland cells of this type and location are very common in planarians.

The pharynx has the structure typical of the family Planariidae, the circular and longitudinal muscle layers of the inner muscular zone being distinctly separated into two strata.

3. *Reproductive system.* This system follows the plan typical of the genus *Polycelis*. Of the four sexual specimens found in the collection two came from station K 78 and two

[1] In Plate I, fig. Ia, I have ventured to add a copy of a sketch of the anterior end of a living animal, made from one of the specimens of the series from K 66.—*G. E. H.*

from station L 25. The two specimens from each station are obviously specifically identical with each other; but at first the penis and penis bulb of the specimens from different stations appeared to differ. After some study, however, I decided that the difference was one of degree of extension and have concluded that all four specimens belong to one species. As they came from stations rather widely separated, it may be considered that all the *Polycelis* in the collection are of one species.

The ovaries are a pair of small rounded compact masses in the usual anterior position. No parovaria were found. The oviducts exit from their lateral surfaces. They could not be traced very well in any of the specimens but appear to run immediately to the medial side of the ventral nerve cords. At the level of the penis bulb they curve dorsally and above the male atrium unite into a common oviduct (fig. 9, *co*) which immediately turns ventrally and opens into the male atrium just anterior to the junction of the latter with the bursa stalk (Plate I, fig. 7, and Plate II, fig. 3, *co*). This arrangement of course obtains throughout the genus *Polycelis*. The oviducts do not embrace the bursa stalk since they unite anterior to it around the sides of the penis bulb. A few eosinophilous shell glands occur around the point of union of the oviducts. The yolk glands have the usual appearance and occur as masses of large granular cells lying between the intestinal diverticula from the level of the ovaries to the posterior end of the body. In one of the K 78 specimens they are exceedingly numerous and conspicuous. Presumably the yolk glands behind the copulatory apparatus must connect with the oviducts by special yolk ducts.

The testes occupy the position typical of the genus *Polycelis*. They extend near the ventral surface from the ovaries to the root of the pharynx in a double row, one row to each side of the midline, lying between the bases of the intestinal diverticula. The testes could be identified in all of the specimens sectioned consisting in asexual individuals of masses of rounded cells in the resting state. They were also in this condition in the less mature L 25 specimen but were in active spermatogenesis in the other three sexual specimens in which also the vasa deferentia contain sperm.

The vasa deferentia form the usual tubular enlargements termed false seminal vesicles easily seen along the rear part of the pharynx and sides of the bursa copulatrix. At the level of the penis bulb they curve dorsally and enter the bulb separately one from each side (Plate I, fig. 8, and Plate II, fig. 4, *vd*). They penetrate the wall of the penis bulb without enlargement, each one opening on a papilla (Plate I, fig. 8, and Plate II, fig. 4) which projects into the cavity of the bulb from its sides.

The penis bulb and penis differ so strikingly in the L 25 and the K 78 specimens that at first I feared it would be necessary to distinguish two varieties of the species. However, I finally concluded that the differences rest entirely in the muscular state of these parts. In the L 25 specimens (Plate I, fig. 7), the copulatory apparatus is withdrawn and in relaxation. There is a large hollow penis bulb and a small conical penis. But in both of the K 78 worms, the bulb and penis are extruded (Plate II, fig. 3). The penis bulb is strongly contracted into a muscular disk and its cavity has been projected into the penis. The latter organ has thus incorporated the penis bulb and appears as a large muscular elongated organ with a considerable cavity. If my conclusions are correct, these specimens furnish a striking example of the rôle of the bulb in the protrusion of the penis, its contraction converting an apparently small weak penis into a large powerful elongated organ. Probably the penis and bulb should not be considered as separate parts of the copulatory apparatus but as one structure.

In the L 25 specimen, which seems the most mature of the four, the penis bulb is a rounded hollow sac of moderate dimensions immediately behind the bursa copulatrix (Plate I, fig. 7, *pb*). It is well-defined and plainly marked off from the surrounding tissues but is not strikingly muscular. The wall is of moderate thickness and composed chiefly of muscle fibers coursing in several directions. The interior is hollow forming a seminal vesicle (Plate II, fig. 4, *sv*), somewhat hourglass-shaped in transverse section owing to the projection into the lumen of the two lateral papillae which bear the terminations of the vasa deferentia (Plate I, fig. 8, and Plate II, fig. 4). The lumen is lined by what appears to be a glandular epithelium densely packed with secretion granules. However, under oil immersions, the epithelial cells are found to be practically undetectable owing to their penetration by what appear to be tubes packed with coarse granules (Plate II, fig. 2). Similar granules in groups are found throughout the subepithelial wall of the bulb as well as in adjacent tissues. It appears probable that we are dealing with very long-stalked unicellular glands which open by ducts through the lining epithelium of the bulb. These ducts project beyond the epithelial surface and often a cloud of granules is seen emerging from their open ends (Plate II, fig. 2). These granule-filled ducts have been found only in the very ripe L 25 specimen and seem to indicate that some secretion of importance is discharged into the seminal vesicle during the height of sexual activity.

In the L 25 specimens, the penis is a short weak cone-shaped organ projecting into the male atrium (Plate I, fig. 7) and containing a short duct running from the seminal vesicle to the tip of the penis. The duct is lined by a columnar epithelium lacking the granular tubes mentioned above. The male atrium is lined by a cuboidal epithelium encircled by circular, longitudinal, and radial muscle fibers (Plate II, fig. 1). It is expanded where it contains the penis but immediately beyond this organ narrows at once to a short canal which receives in its middorsal line first the common oviduct and then the stalk of the bursa (Plate I, fig. 7). It then immediately opens at the genital pore, the common cavity formed by its union with the bursa stalk being thus so small as scarcely to merit the name of common atrium. All of these relations in the atrium are typical of the genus *Polycelis*.

As already indicated the appearance of penis bulb and penis is very different in the K 78 specimens (Plate II, fig. 3). Here the penis bulb is apparently contracted and forms a muscular mass at the base of the penis. The seminal vesicle seems to have been projected into the penis but its boundaries are still determinable by means of the papillae on which the vasa deferentia terminate. The penis in consequence of having incorporated most of the penis bulb appears very much larger, longer and more powerful than when at rest (compare Plate I, fig. 7, and Plate II, fig. 3). The conditions in these specimens seem to prove that the penis bulb is of great help in the extrusion of the penis and is really an essential part of that organ.

The bursa copulatrix in all the specimens is a large, irregularly rounded sac lying between the rear end of the pharynx and the penis bulb, and considerably larger than the latter structure (Plate I, fig. 7). Its histology is typical, the organ being lined by the usual large bulbous epithelial cells containing rounded masses. From the center of its posterior surface the stalk arises and runs posteriorly above the penis bulb. At first the stalk is large and lined by the same epithelium as the bulb; but at about the level of the union of the oviducts, the stalk narrows abruptly (Plate I, fig. 7, and Plate II, fig. 3) and its epithelium becomes of an ordinary columnar or cuboidal type. It is, however, heavily ciliated. This narrow ciliated stalk turns ventrally and joins the male atrium at the genital pore. A very thin layer of muscles seems to underlie the epithelium of bursa and stalk.

A sagittal section of the copulatory apparatus of one of the L 25 specimens is shown in Plate I, fig. 7, of one of the K 78 worms in Plate II, fig. 3. Plate I, fig. 8, and Plate II, fig. 1, are successive transverse sections through the second L 25 specimen, showing in Plate I, fig. 8, the entrance of the vasa deferentia into the penis bulb with the oviducts at the sides and the wide part of the bursa stalk above; and in Plate II, fig. 1, the male atrium, union of the oviducts, and narrow part of the bursa stalk above. Plate II, fig. 4, is a diagram of the sexual apparatus seen from above.

The sexual specimens in the collection were taken on May 21st and June 21st respectively. The time of sexual maturity is therefore early summer. One of the L 25 specimens taken on May 21st appears to be the ripest of the lot; but presumably the time of sexual maturity depends in part on altitude, those at higher levels maturing later in the season.

4. *Habitat.* The worms came from springs, streams, and pools in the high mountains of Kashmir and Indian Tibet. The altitudes of the collecting sites varied from 2500 to 4700 meters while in the Stewart expedition the species was taken between 4250 and 4400 m. These are probably the greatest heights at which any fresh-water planarians have ever been found. The temperatures of the habitats are recorded in some cases and, as might be expected, are mostly low, ranging from 7 to 22° C. In three cases the acidity is recorded as pH 7.5-7.6, quite a usual figure for such habitats. The habitat of *Polycelis tibetica* is very similar to that of the only known American representative of the genus, *Polycelis coronata*, which also lives in mountain streams and springs. Although the American species has as yet been taken only at moderate altitudes (below 5000 feet), there is little reason to doubt that it will be found distributed throughout the high mountain ranges of western North America. The only other species which seems to be specifically a high mountain form is *Polycelis cornuta* of Europe which occurs in the streams of the high Alps although distributed over a considerable range of altitude. On the other hand some species of *Polycelis* are lowland forms but the entire genus appears to require rapidly flowing water and stony bottom.

Second Species

It seems desirable to make a statement about the second species found in the collection. This is represented by three individuals taken at station K 64 at 2080 meters, in a stream under stones. As this is the lowest altitude at which planarians were found, it seems probable that this species inhabits lower altitudes than does *Polycelis tibetica* and consequently was not taken at any of the higher stations.

The species is of large size, probably reaching a length of 20 mm., of uniform dark-brown coloration, and with an evident triangular head with auricles. From the size, uniform dark coloration, the shape of the head, the appearance of the digestive tract, and in fact, the general aspect of the form, I am quite sure it is a species of *Euplanaria*, very close to the three American members of *Euplanaria* which I have called the *dorotocephala* group (Hyman, 1931 *b*). However, in the absence of sex organs, the form cannot be placed taxonomically with any certainty and I therefore forbear to attach a name to it. It has one peculiarity by which future collectors in this region can probably recognize it. The species tends to be four-eyed.

Of the three specimens, the smallest (Plate II, fig. 6) has four eyes of equal size, the medium-sized one (Plate II, fig. 7) has two eyes of regular size in front of which are two small eyes, and the third, the largest, has one small eye in front of one of the two regular eyes (Plate II, fig. 5). It is possible that in this form the eyes are regularly replaced and the small eyes of Plate II, figs. 5 and 7, represent new eyes in process of development. However, the presence of supernumerary eyes is not at all uncommon in planarians and cannot be used as a taxonomic character.

Affinities

These species appear to resemble American forms more nearly than they do European planarians. The European *Polycelis* species have a single row of eyes along the anterior margin while the banded arrangement, several eyes wide, occurs only in Asiatic and American forms. In the eyes as well as in the anatomy of the copulatory apparatus *Polycelis tibetica* bears considerable resemblance to *Sorocelis sapporo* (presumably a *Polycelis*) of Japan (Ijima and Kaburaki, 1916). Also the *Euplanaria* (?) of the present collection is very like some common *Euplanariae* of the United States while differing from European *Euplanariae*. Altogether it would seem that the Asiatic species have spread toward North America (or vice versa) rather than toward Europe.

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Explanation of Plate I.

Fig. 1. General appearance of *Polycelis tibetica* from a preserved specimen. *m*, mouth; *gp*, genital pore.

Fig. 1a. Sketch of head of living specimen from lot K 66. (G. E. H.)

Figs. 2, 3. Eye number and arrangement of small specimens from lot K 77.

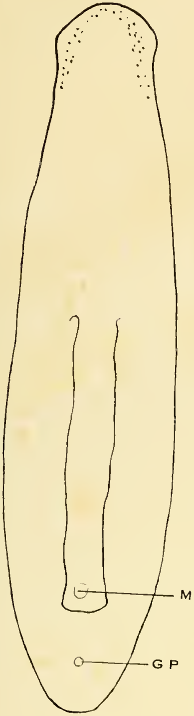
Fig. 4. Eye number and arrangement of large specimen from lot K 76.

Fig. 5. Large specimen from lot L 21 having the best extension of auricles found.

Fig. 6. Large specimen from lot K 66 with head probably regenerating, showing few eyes.

Fig. 7. Sagittal section of the copulatory apparatus of the ripest specimen, from L 25. *bc*, bursa copulatrix; *bs*, bursa stalk; *co*, common oviduct; *gp*, genital pore; *ma*, male atrium; *p*, penis; *pb*, penis bulb.

Fig. 8. Transverse section of second specimen from L 25, taken through the center of the penis bulb. *bs*, bursa stalk; *o*, oviduct; *pb*, penis bulb; *vd*, vas deferens.



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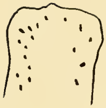

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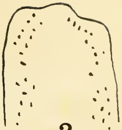

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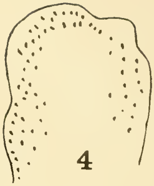

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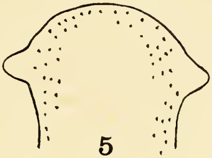

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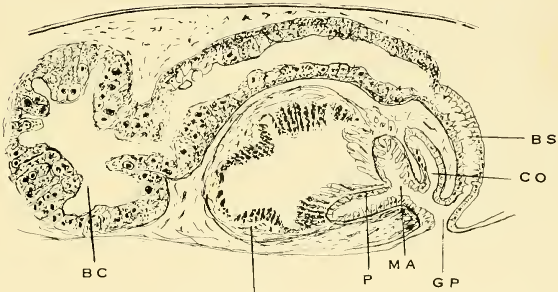

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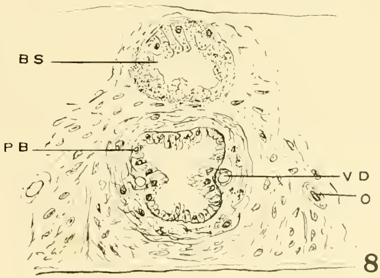

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Explanation of Plate II.

Fig. 1. More posterior section of same series as Plate I, fig. 8, through the male atrium. *bs*, bursa stalk; *ma*, male atrium; *o*, union of oviducts; *p*, penis; *wma*, wall of the male atrium.

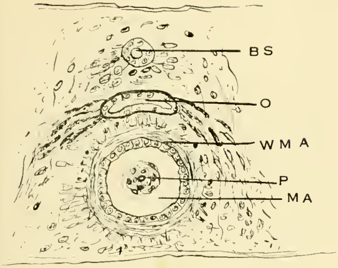
Fig. 2. Detail of the wall of the penis bulb of same section as figure 7, showing the granule-filled ducts projecting through the lining epithelium.

Fig. 3. Sagittal section of the copulatory apparatus of one of the K 78 specimens, reconstructed from several sections. The penis bulb is contracted forcing the seminal vesicle into the penis. *bc*, bursa copulatrix; *co*, common oviduct; *gp*, genital pore; *p*, penis; *pb*, penis bulb; *vd*, vas deferens.

Fig. 4. Diagram of the copulatory apparatus seen from the dorsal side. *bc*, bursa copulatrix; *co*, common oviduct; *ma*, male atrium; *p*, penis; *pb*, penis bulb; *sv*, seminal vesicle; *vd*, vas deferens.

Fig. 5. Largest specimen of the second species, ? *Euplanaria*, from lot K 64.

Figs. 6, 7. The two other specimens of lot K 64, showing four eyes.



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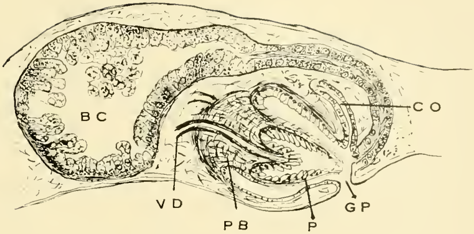

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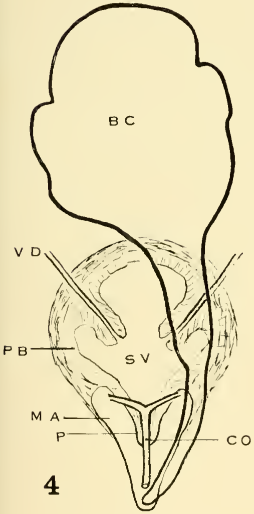

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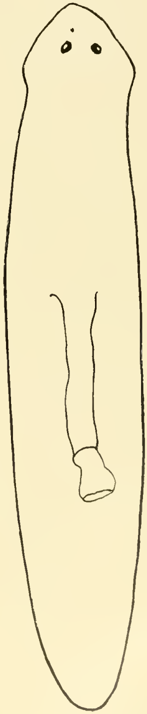

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ARTICLE III

REPORT ON COLEOPTERA OF THE FAMILY *STAPHYLINIDAE*

By Malcolm Cameron, M.B., R.N., F.R.E.S.

(Received January 18, 1934)

The small collection of *Staphylinidae*, obtained by the Yale North India Expedition, comprised material of fourteen species enumerated below; nine species are hitherto undescribed. By arrangement with Yale University the types of these new species have been incorporated in the collection of the British Museum.

OXYTELINAE

Megarthrus rufomarginatus Cam. Nilgiri Hills: Pykara, altitude circa 7000 feet. 15-XI-32.

Lesteva kargilensis sp. n.

Rather shining, black, the antennae blackish; femura reddish-yellow, pitchy at apex, tibiae pitchy, tarsi reddish-yellow. Length 3.75 mm. More robust than *fluviata* Champ., less shining, the antennae much longer, thorax more dilated in front and more finely punctured, elytra more finely punctured. Head bi-impressed between the eyes, closely, moderately coarsely punctured except on the front where only a few fine punctures are present. Antennae long and slender, all the joints much longer than broad. Thorax transverse, cordiform, the sides retracted behind with rectangular posterior angles; before the base with a superficial impression, closely and more finely punctured than the head. Elytra twice as long as the thorax, slightly widened behind, as closely and as finely punctured. Abdomen extremely finely and densely punctured, coriaceous.

Indian Tibet: Kargil. 24-V-32. Mossy stones by spring. Unique.

Geodromicus affinis sp. n.

Rather shining; head and elytra black, thorax and abdomen pitchy (? immature). Antennae and legs reddish-brown. Length 6 mm. Closely allied to *kashmirensis* Cam., but the head is a little narrower and much less punctured, the thorax more finely punctured, the elytra shorter, more coarsely and less closely punctured and widened behind. Head narrower than the thorax, deeply impressed on the vertex, the ocelli slightly more apart from each other than from the eyes, very finely, sparingly punctured near the eyes, almost impunctate elsewhere; ground sculpture absent. Antennae long, all the joints much longer than broad. Thorax strongly cordiform, convex, the sides strongly rounded and widened in front, retracted behind, the posterior angles rectangular, at the middle of the base with a fovea, narrowly and feebly impressed along the middle, moderately, finely superficially and moderately closely punctured; ground sculpture absent. Elytra longer (8:5) than the thorax, widened behind, rather closely and much more coarsely punctured. Abdomen extremely finely, rather closely punctured and coriaceous.

Indian Tibet: Kargil. 24-V-32. Wet mossy stones near spring. A single specimen.

Geodromicus similis Cam.

A single specimen with the preceding.

Trogophloeus (Taenosoma) porosus sp. n.

Entirely black, the fore-parts slightly, the abdomen more shining. Antennae black. Legs black, the apex of the tibiae and the tarsi brownish-yellow. Length 2.2 mm.

Closely allied to *scabrosus* Kr. the sculpture scarcely different, but a little smaller and less robust, the 4th to 6th joints of the antennae a little longer, the penultimate less transverse, thorax a little longer, less transverse, the sides more retracted behind, the elytra longer. Head a little narrower than the thorax, feebly bi-impressed in front, the post-ocular region rounded, a little longer than the eye, the whole surface covered with very coarse, close, rugose, finely umbilicate punctures. Antennae with the 3rd joint shorter than 2nd, 4th and 5th very slightly longer than broad, 6th as long as broad, 7th to 10th transverse. Thorax a third broader than long, the sides rounded and dilated in front, almost straight and retracted behind, the disc without trace of impressions, in the middle with a short, extremely fine shining line, otherwise covered with coarse sculpture as on the head. Elytra broader and a third longer than the thorax, with similar but rather coarser sculpture. Abdomen very finely, moderately closely punctured, finely, moderately closely pubescent.

Nilgiri Hills: Pykara, altitude 7000 feet. 15-XI-32. On wet earth on cliff. Unique.

Delopsis consanguinea sp. n.

In colour and opacity similar to *glareosa* Woll. (*Oxytelus*), but much larger (*2.2* mm.) and more robust, the antennae longer and stouter, the 4th and 5th joints longer than broad, the penultimate less transverse, the sculpture throughout coarser.

Head very slightly dilated behind the eyes, the impressions as in *glareosa*. Thorax very slightly sinuate before the posterior angles, the sulci deeper. Elytra a third longer than the thorax.

Nilgiri Hills: Pykara, altitude 7000 feet. 15-XI-32. Unique.

Stenus (s. str.) **pykaranus** sp. n.

Shining black. Antennae palpi and legs black, the extreme base of the femora yellowish-red. Length 4.4 mm. Allied to *tortuosus* Cam. but smaller, the antennae shorter and like the palpi entirely black, thorax less uneven, less coarsely punctured. Abdomen much more finely and sparingly punctured. Head as broad as the base of the elytra, concave between the eyes, not elevated along the middle, closely, rather coarsely but not rugosely punctured.

Antennae rather short, the 3rd joint a good deal longer than the 2nd, 4th to 7th gradually decreasing in length, 8th to 10th slightly transverse. Thorax a little longer than broad (7: 5.5), widest about the middle, the sides rounded in front, nearly straight and retracted behind, along the middle posteriorly with a narrow impunctate line, before the base on each side with three or four transverse rugae, the rest of the surface closely and more coarsely punctured than the head and somewhat rugose. Elytra a little longer than the thorax, with coarse oblique rugae passing from the middle of each disc backwards and inwards to the suture and sutural angle, a few finer ones also passing forwards and inwards towards the scutellary region; shoulders and base closely and moderately finely punctured, postero-externally coarsely, closely and rugosely punctured. Abdomen gradually narrowed from base to apex, extremely finely, obsoletely, moderately closely punctured, rather more closely and distinctly on the 9th segment. Fore-parts almost glabrous. Abdomen sparingly pubescent.

♂ : Unknown.

Nilgiri Hills: Pykara, altitude 7000 feet. 15-XI-32. Unique.

STAPHYLININAE

Actobius basalis Motsch. var. *humeralis* Cam.

Nilgiri Hills: Pykara, 15-XI-32. Two specimens.

Type widely distributed in the Oriental region, the variety so far only recorded from the Nilgiri Hills.

Philonthus lidarensis Cam.

Indian Tibet: Kargil, altitude 8790 feet. 24-V-32. On wet mossy stones near spring. One specimen. Also known from Lidarwat, altitude 9000 feet, and Gulmarg.

ALEOCHARINAE

Athela (Aloconota) iguensis sp. n.

Entirely black, the elytra with very slight metallic reflex, the fore-parts moderately, the abdomen more shining. Antennae, palpi and legs black, the tarsi brownish-yellow. Length 2.8 mm.

Head transverse, suborbicular, nearly as broad as the thorax, the vertex with a fine short sulcus, extremely finely and very sparingly punctured, strongly coriaceous. Antennae long, the 3rd joint longer than the 2nd, 4th to 10th all longer than broad, gradually decreasing in length, the 9th and 10th only a little longer than broad, together as long as the 11th. Thorax slightly transverse, the sides rounded in front, sinuate and retracted behind, the posterior angles obtuse, the base on each side obliquely truncate as in *insecta* Thoms along the middle in the posterior half superficially impressed, very finely, much less sparingly punctured than the head, the ground sculpture similar. Elytra a little broader and half as long again as the thorax, the puncturation similar but much closer, the ground sculpture similar. Abdomen very finely, moderately closely punctured on the anterior segments, gradually more sparingly behind, less strongly coriaceous than the fore-parts. 8th dorsal segment very slightly arcuately emarginate. The pubescence throughout fine and moderately close. Tibiae without long setae.

A single example which appears to be a ♀ *Aloconota* from the general facies.

Indian Tibet: Igu, altitude 11,210 feet. In stream shingle.

Athela (Bessobia) submetallica sp. n.

Moderately shining, black, head, thorax and elytra with slight metallic reflex. Antennae black. Legs black, the tarsi yellow. Length 2.2 mm.

In build and size very similar to *excellens* Kr., the antennae similarly constructed but less stout. Head large, only slightly narrower than the thorax, the disc with a small impression, extremely finely, sparingly punctured, distinctly coriaceous, but less strongly than in *excellens*. Antennae with the 3rd joint as long as the 2nd, 4th to 10th transverse, the penultimate about twice as broad as long. Thorax a third broader than long, the sides slightly rounded, more retracted behind, the posterior angles rounded, feebly and broadly impressed in the middle behind, the puncturation less fine than that of the head and closer, the ground sculpture similar. Elytra a little broader and a third longer than the thorax, very finely, closely, asperately punctured, the ground sculpture similar. Abdomen with the first four visible segments transversely impressed at the base, very finely, asperately, rather sparingly punctured especially behind, coriaceous. 8th dorsal segment broadly rounded. Tibia without setae.

Indian Tibet: Tsak-Shang, altitude 15,985 feet. 31-VIII-32. Amongst scanty grass near stream. Unique.

Athela (Microdota) ladakiana sp. n.

Rather shining, entirely black. Antennae black. Legs pitchy black, the knees and tarsi yellowish. Length 2.2 mm.

Larger, blacker and more shining than *indubia* Shp. the head larger, the elytra longer, the thorax, elytra and abdomen much less distinctly punctured. Head large, suborbicular, narrower than the thorax, the post-ocular region a good deal longer than the eye, practically impunctate, distinctly coriaceous. Antennae very similar to those of *indubia*, the 3rd joint distinctly shorter than the 2nd, clavate, 4th to 10th transverse, the penultimate twice as broad as long. Thorax about a half broader than long, the sides gently rounded, more retracted behind, the posterior angles rounded, extremely finely, very sparingly punctured, the ground sculpture as on the head. Elytra broader, more than a third longer than the thorax, extremely finely, rather sparingly punctured, coriaceous. Abdomen a little widened towards the apex, extremely finely, very sparingly punctured on the anterior segments, almost impunctate behind, coriaceous: 8th dorsal segment truncate. The whole insect with a fine yellowish pubescence, closer on the fore-parts.

Indian Tibet: Tsak-Shang, above Tso-Moriri, altitude 15,985 feet, near a stream amongst scanty grasses. 31-VIII-32. A single specimen.

Athela (Dimetrota) hutchinsoni sp. n.

Moderately shining, black, the fore-parts with slight metallic reflex. Antennae and legs black, the tarsi yellow. Length 3.2 mm.

In the broad head resembling *cadaverina* Bris. but differently colored, the antennae a little stouter, the elytra longer and in this respect resembling *marcida* Er. Head broad, a little narrower than the thorax, extremely finely, very sparingly punctured, distinctly coriaceous. Antennae with the 3rd joint as long as the 2nd, 4th and 5th slightly longer than broad, 6th as long as broad, 7th to 10th distinctly transverse. Thorax more than a third broader than long, the sides gently rounded, the posterior angles rounded, along the middle behind feebly and broadly impressed, very finely, asperately, much more closely punctured than the head, the ground sculpture similar. Elytra almost twice as long as the thorax, with similar but rather closer puncturation and similar ground sculpture. Abdomen a little narrowed before the apex, finely, moderately closely punctured on the anterior segments, more sparingly behind, less strongly coriaceous, and more shining than the fore-parts. Tibia without long setae.

♂: 8th dorsal segment truncate: 6th ventral segment a little produced, narrowed and rounded.

INDIAN TIBET: Marsimik La, altitude 18,394 feet. 16-VII-32.

OROROTSE TSO, altitude 17,381 feet. 16-VII-32. Two examples under stones amongst scanty grasses.

Aleochara (Coprochara) bilineata Gyll.

INDIAN TIBET: Tsak-Shang, above Tso-moriri, altitude 15,985 feet. Amongst grasses. 31-VIII-32. A widely distributed species.

ARTICLE IV

REPORT ON COLEOPTERA OF THE FAMILY *CARABIDAE*

By H. E. Andrewes

(Received February 7, 1934)

The *Carabidae* collected by Mr. G. Evelyn Hutchinson in the course of the Yale North India Expedition to Ladak comprised seventeen species, of which four are new; an enumeration of these will be found below with some notes on distribution, and following this, the descriptions of the new species. As my Catalogue of *Carabidae* (part 18) in the series *Catalogue of Indian Insects*, published by the Indian Government, has so recently appeared, in which full references are given for all the hitherto described Indian species, original references only are given here. Mr. Hutchinson has kindly allowed me to retain the type specimens of the four new species, which will ultimately be placed in the British Museum.

Of the seventeen species collected by the Expedition, six are also found in other parts of the world, the remainder being endemic. All these six species are found also in Turkestan and three of them are fairly commonly distributed through the palaearctic region, one extending its habitat as far as the western states of North America. While there are at least several species of *Carabidae* common to the countries lying within the sandy belt which stretches from Morocco to Sind, some reaching as far as the North West Frontier Province, there is no evidence of them in this collection, the region explored being apparently both too distant and at too great an elevation, but the connexion with the Central Asian fauna is more apparent.

It is interesting to note that the four genera found at high altitudes were also met with by the Mount Everest Expedition at their base camp on the Rongbuk glacier (16,500 feet), and one species, *Amara brucei* Andr., was taken in considerable numbers by both expeditions up to 17,000 feet.

The enumeration of the species follows:

1. *Nebria psammophila* Solsky in Fedchenko's Reise in Turkestan ii. pt. 5. 1874, p. 12; Andrewes, Fauna of Brit. Ind., Col. Carab. i. 1929, pp. 114 and 118.

   Kashmir: Kiuhnus, Wular Lake, 5100 feet, 17-IV-32, 1 ex.

The species has been met with in various parts of Kashmir, but is not found farther south; it seems to be fairly common in Turkestan.

2. *Nebria limbigera* Solsky in Fedchenko's Reise in Turkestan ii. pt. 5. 1874, p. 13; Andrewes, Fauna of Brit. Ind., Col. Carab. i. 1929, pp. 114 and 120.

   Tibet: Tso Nyak region 12-VIII-32 (*Tzewang Tashi* and *Sonam Tergas*), 2 ex.

Apparently a more widely spread species than the last, for it is found not only in Kashmir, Tibet and the northwestern provinces of India, but also in western China and rather commonly in Turkestan.

3. *Bembidion pluto* Andrewes in Mission dans les Provinces Centrales de l'Inde et dans la région occidentale de l'Himalaya, 1914, par Guy Babault, Carab. 1924, p. 72, t. 1. f. 3.
   INDIAN TIBET: Tang-yar, 14,300 feet, 24I-VI-32, 4 ex.; Lukung, 14,000 feet, 8-VII-32, 3 ex.; Igu region, 12,000 feet, VIII-32, 3 ex.

First discovered in Rupshu and near Leh. The species seems to be almost confined to that region, but Mr. H. G. Champion found specimens in northern Kumaon near the Tibetan frontier, and he reports that they were "taken with *Geodromicus* in running water."

4. *Bembidion livens* Andrewes, Trans. Ent. Soc. Lond. 1930, pp. 3 and 11.
   INDIAN TIBET: Stream at Khalatse, 9600 feet, 29-V-32, 2 ex.; Himis, 21-VI-32, 3 ex. "under leaves or damp moss; dark soil." The two examples from Khalatse are in poor condition and cannot be identified with certainty.

This species was described from specimens taken in Tibet at 10,000-12,000 feet, by the Third Mount Everest Expedition, and is confined to the high regions of the Himalayas.

5. *Bembidion bracculatum* Bates (?), Proc. Zool. Soc. Lond. 1889, p. 212; Andrewes, Ent. Month. Mag. 1924, p. 194.
   INDIAN TIBET: Matyan, 10,000 feet, 20-V-32, 4 ex.

Known only from Kashmir and Kumaon. The specimens found are a little smaller than the type and have a greenish instead of a bluish tinge—as have the Kumaon examples. There are some variations too in the colour of the basal joints of the antennae, of the tibiae and the tarsi so that the identification is not altogether satisfactory.

6. **Bembidion ixion** sp. nov.

7. **Bembidion hutchinsoni** sp. nov.

8. *Bembidion luntaka* Andrewes in Mission dans les provinces Centrales de l'Inde et dans la région occidentale de l'Himalaya, 1914, par Guy Babault, Carab. 1924, p. 75.
   INDIAN TIBET: Himis, 21-VI-32, 2 ex.; "under leaves or damp moss; dark soil"; Tang-tse, Mugleb, 14,000 feet, 27-VI-32, 2 ex.

Widely spread throughout the western Himalayas, and very variable in colour. In the Tang-tse specimens the four pale spots on the elytra are very clearly marked, but those from Himis are dark, with the pale spots barely visible.

9. *Bembidion fuscicrus* Motchulsky, Etudes Ent. iv. 1855, p. 79.
   Pangur-tso, 14,200 feet, 14-VIII-32, 1 ex.; Tso-nyak region, 14,300 feet, VIII-32, 1 ex.

Found throughout Central Asia and Siberia, also in the western states of North America. As in the case of so many widely spread species, there is great variability in the coloration; the two examples in question are very pale and hardly differ from specimens in my collection from Montana and Oregon.

10. *Bembidion varium* Olivier, Enc. Méth. v. 1790, p. 358.

Kashmir: Lokut Dal Lake, 5200 feet, 28-IV-32, 2 ex.; edge of Phashakuri near Pampur, 7-V-32, 7 ex.

Widely spread throughout the palaearctic region, but not extending to America. In the two examples from the Lokut Dal Lake the pale fasciae on the elytra are clearly marked, but in those from Pampur the elytra are dark aeneous, with the pale markings barely visible.

11. **Bembidion eupages** sp. nov.

12. *Chlaenius kuluensis* Bates, Entomologist xxiv. 1891. Suppl., p. 9.

Kashmir: Kiuhnus, Wular Lake, 5100 feet, 17-IV-32, 1 ex.

Confined, so far as I am aware, to Kashmir and Kulu.

13. *Stenolophus discophorus* Fischer, Ent. Russ. ii. 1824, p. 141, t. 26. f. 9.

Kashmir: Kiuhnus, Wular Lake, 5100 feet, 17-IV-32, 1 ex.

Central Europe, the Mediterranean basin and western Asia as far as Turkestan; the only Indian specimens seen were found in Kashmir, between 5000 and 6000 feet.

14. *Amara brucei* Andrewes, Ann. Mag. Nat. Hist. (9). xi. 1923, p. 276.

Indian Tibet: Ororotse-tso, 17,400 feet, 11-VII-32, 9 ex.; Anem La 17,000 feet, 3 ex.; Tso Nyak region, 14,300 feet, VIII-32, 1 ex.

First discovered by the Second Mount Everest Expedition in 1922 at the base camp, 16,500 feet, where it was taken in considerable numbers. The Third Mount Everest Expedition in 1924 met with it again, not only at the base camp, but at various other Tibetan localities. Mr. H. G. Champion took some specimens in northern Kumaon and again near the Supi River in Tibet. This is the first time it has been recorded from so far west. It seems to be common where it occurs.

15. *Cymindis mannerheimi* Gebler, Bull. Ac. Imp. Sci., St. Petersb. 1843, i, p. 36.

Indian Tibet: Tang-yar, 14,300 feet, 24-IV-32, 2 ex.

Not uncommon in Kashmir, the Pamirs and Central Asia.

16. *Cymindis championi* Andrewes, Ann. Mag. Nat. Hist. (10). ii. 1928, p. 589.

Tibet: Tso-nyak region, 14,300 feet, VIII-32, 1 ex. which does not quite agree with type form, the pattern on the elytra being very indefinite.

Northern Kumaon and Tibet.

17. **Cymindis rubriceps** sp. nov.

Bembidion ixion sp. nov.

Length: 4.5 mm.

Piceous beneath, head and prothorax aeneous, elytra black with a very faint metallic tinge and a vague dark red apical spot on each; joints 1 to 3 of antennae, tibiae, and tarsi more or less ferruginous.

Head with fairly deep parallel furrows, eyes moderately prominent, antennae reaching basal third of elytra, surface impunctate. *Prothorax* convex, subcordate, not quite a third wider than head, two-fifths wider than long, base slightly arcuate, as wide as apex, sides rounded in front, slightly sinuate behind, hind angles sharp, but a little obtuse, each with a short but fairly sharp carina, bounding the small deep rounded foveae on the outer side; median line and front transverse impression moderately deep, basal area depressed, finely but not closely rugose-punctate. *Elytra* convex, ovate, not quite a half wider than prothorax and not quite three-quarters longer than wide, border extending inwards a little beyond stria 5, shoulders visible but not prominent; punctate-striate, the inner striae moderately impressed on disk, much less so at sides, 7 represented by a row of minute punctures, all (except 1) evanescent towards apex, but 2 is impressed quite close to apex, scutellary striole and apical stria only moderately developed, intervals a little convex on disk only, dorsal pores fairly distinct, adjoining stria 3, just before middle and at three-fourths. Microsculpture of the elytra consisting of fine transverse lines, which form meshes quite three or four times wider than long, none on disk of prothorax or head. Metasternal process bordered.

Indian Tibet: Matyan, 10,000 feet, 20-V-32, 1 ex. ♂.

The species is smaller than *bracculatum* Bates, but differs mainly in the form of the prothorax, the sides of which are only faintly sinuate behind, while the basal foveae are small, deep and rounded, adjoining the carina.

Bembidion hutchinsoni sp. nov.

Length: 4.6-5 mm.

Piceous beneath, blue-black above; palpi, joints 1 to 4 of antennae, and legs ferruginous; basal two-fifths of the elytra dark red, apical fourth pale ferruginous, so that there is a dark band across them, the outline of which is vague and somewhat variable.

Head with deep uneven furrows, converging very slightly in front, eyes prominent, antennae slender, reaching basal third of elytra, surface punctate at sides behind, and with a few scattered punctures on disk. *Prothorax* convex, cordate, about a sixth wider than head, a fifth wider than long, base slightly oblique at sides, hardly wider than apex, sides well rounded in front, sinuate a litle before base, hind angles right, fairly sharp and with a slight carina; median line and the small basal foveae moderately deep, transverse impressions shallow, basal area a little depressed and finely punctate, disk with some slight transverse triae. *Elytra* subquadrate, moderately convex, a half wider than prothorax, nearly two-thirds longer than wide, shoulders evident, border reaching stria 5; striae clearly punctate, moderately impressed on disk, more lightly at sides and behind, though in some specimens (including type) clearly impressed to apex, scutellary striole and apical stria both present but rather slight, intervals a little convex on disk, dorsal pores very distinct, on stria 3, at about a third and two-thirds. Microsculpture of the elytra consisting of very fine transverse lines, which form very wide meshes, none on disk of prothorax or head. Metasternal process bordered and with a transverse groove behind it.

INDIAN TIBET: Kyam, 15,630 feet, 20-VII-32, 6 ex., taken round the edge of a hot spring.

The subgenus here is *Peryphus* and the species will be readily recognized by the coloration of the elytra.

Bembidion eupages sp. nov.

Length: 2.9-3.1 mm.

Colour black beneath, upper surface aeneous or blue, and very shiny palpi, joints 1 to 3 of antennae (rest fuscous), apex of elytra and venter, trochanters, tibiae, and tarsi ferruginous.

Head with fairly deep, nearly parallel furrows, converging a little on clypeus and diverging behind, eyes prominent, antennae short, submoniliform, surface impunctate. *Prothorax* convex, cordate, slightly wider than head, nearly a third wider than long, base truncate at middle, very oblique at sides, narrower than apex, sides strongly rounded in front and contracted behind, with a rather wide marginal channel, sinuate close to the hind angles which project on each side as a small sharp though slightly obtuse tooth, bounded by a short oblique carina, within which are the small deep rounded foveae; median line very fine, transverse impressions evident, the hind one with a few deep punctures, and one or two generally transverse punctures along the basal margin, surface otherwise impunctate. *Elytra* moderately convex, subquadrate, a half wider than prothorax and a little more than a half longer than wide, shoulders square, border reaching stria 4; striate-punctate, striae 1 and 8 only impressed, the remaining striae formed by the punctures, which are as clearly marked in the outer as in the inner striae, but 2 to 7 all disappear behind, scutellary striole formed by rather large punctures, apical stria wanting and its pore consequently isolated; intervals flat, 1 raised behind, dorsal pores on interval 3 at about a fourth and three-fifths, a fine clavicular fold present. No microsculpture. Metasternal process bordered, and with a transverse groove behind it.

KASHMIR: Lokut Dal Lake, 5200 feet, 28-IV-32, 6 ex.; edge of Phashakuri near Pampur, 7 v. 1932, 3 ex. In the Indian Museum, Calcutta, there is a single specimen labelled "Kashmir," taken by Mr. H. T. Pease in 1915.

The species fits fairly into the palaearctic subgenus *Emphanes*.

Cymindis rubriceps sp. nov.

Length: 7.8 mm.

Colour piceous: head, prothorax, the latter with a vague dark area on each side of disk, and a small area around scutellum and extending backwards nearly to middle along suture, dark red; palpi and joints 2 to 11 of antennae ferruginous; joint 1 of antennae, legs, epipleura, and an elytral pattern more or less flavous. The pattern on the elytra comprises interval 9, a humeral vitta on intervals 5 to 7, not quite reaching middle, and a small spot near apex on intervals 3 to 5, extending a little backwards on 5.

Body covered with a fairly long pale pubescence, scanty on the head and prothorax, a little denser on the elytra, though not concealing the shiny surface.

Head wide, convex, with a slight neck constriction, frontal foveae slight, eyes large but hardly prominent, genae sloping gradually to neck, antennae barely reaching basal fourth of elytra, palpi not dilated, surface moderately punctate along sides and across vertex, disk and neck smooth. *Prothorax* moderately convex, a sixth wider than head, a fifth wider than long, base arcuate, a little narrower than apex, sides rounded and reflexed, sinuate quite close to the hind angles, which are sharp though a little obtuse, almost dentiform; median line and front transverse impression moderately deep, basal foveae also fairly deep, rounded, adjoining the angles, surface moderately punctate, more densely in the foveae, more sparsely on the disk. *Elytra* rather flat, subovate, three-fourths wider than prothorax, about a third longer than wide, widest behind middle, basal border entire, apex truncate; striae moderately impressed and very finely punctate, intervals finely, irregularly, and not very closely punctate, a slight depression on each side on the front of disk. No reticulate microsculpture is present, but the surface of the elytra is vaguely and microscopically rugose-punctate.

A little smaller than *C. championi* Andr., and somewhat differently coloured. The prothorax is less contracted behind, with much less conspicuous hind angles; the elytra are shorter, with a similar pale humeral vitta, but a slight though quite distinct apical spot as well, the surface is more finely and more closely punctate, without any reticulate microsculpture.

Indian Tibet: Anem La, 17,000 feet, I-VIII-32, 1 ex. ♂.

ARTICLE V

REPORT ON PHYLLOPOD CRUSTACEA (ANOSTRACA, NOTOSTRACA AND CONCHOSTRACA) INCLUDING A REVISION OF THE ANOSTRACA OF THE INDIAN EMPIRE

By Richard M. Bond

(Received February 19, 1934)

INTRODUCTION

The Phyllopoda of the Indian Empire have received sporadic attention since the time of Baird, who, in 1860, described *Streptocephalus dichotomus* from a single male specimen which was found swimming in a pail of milk. Since that time Sars, Gurney, Daday and some others have added to the knowledge of the Phyllopoda of the region. Professor G. E. Hutchinson has kindly turned over to me for examination the collections of these animals that he made as Biologist of the Yale North India Expedition.

The Notostraca and Conchostraca taken by the expedition are few in number, and it seems wise, in these groups, to limit this treatment to the forms in this collection. In the case of the Anostraca, however, the collections brought back are much more complete, and for this reason, and because of the ecological and zoogeographical importance of the group, it seems proper to treat them at greater length.

In this undertaking I was greatly aided by Dr. Hem Singh Pruthi, who secured for me the loan of all the unidentified Anostraca in the Indian Museum in Calcutta, in addition to sending me named specimens of certain forms. Records based on this material are marked with an asterisk (*) throughout the present paper. This loan material in addition to the Y. N. I. E. collections has given me an opportunity to compare a larger series of specimens of certain of the species than has probably been assembled hitherto. As a result, I have raised a "variety" to full specific rank, described 3 new subspecies, and am able to record for the first time the occurrence of a species in Kashmir hitherto found only in Mongolia and Manchuria.

In the descriptions of the larger groups, such as families and genera, I have frequently borrowed, almost verbatim, from the clear, concise paper on the South African Phyllopoda, by Barnard (1929), to whom I am much indebted.

Subclass BRANCHIOPODA

The classification used in this paper is not only perfectly defensible on purely morphological grounds, but has the added recommendation that it follows ecological as well as structural lines.

Body uniformly segmented, usually elongate, usually ending in a caudal furca; without carapace, with a dorsal shield-like carapace, or with a bivalve carapace. Compound eyes present, and usually a persistent median eye. Five to 19 (in living forms) pairs of trunk limbs, which are simple foliaceous, modified foliaceous, or (rarely) pediform. Two pairs of antennae and 2 pairs of maxillae present, the 1st antennae and 2nd maxillae usually much reduced.

Order PHYLLOPODA (Euphyllopoda)

Branchiopoda with 10 or more pairs of trunk limbs all simple foliaceous, or with the anterior 1 or 2 pairs somewhat modified for clasping the ♀ or as tactile organs. Development (with the single exception of *Cyclestheria hislopi*) always with a metamorphosis from a free-swimming nauplius or metanauplius stage. The heart has several pairs of ostia.

Suborder I ANOSTRACA

Phyllopoda with an elongate body and without carapace. With 11 to 19 pairs of simple foliaceous trunk limbs. Paired pedunculate compound eyes, a median ocellus in front. First antennae small, 2nd antennae large and modified for clasping in ♂. Eight or 9 post-pedigerous (abdominal) segments, the first 2 of which bear the external genital organs and may be partly fused. Caudal furca when present never segmented. Paired eversible penes in ♂; ovisac formed by united oviducts in ♀ in which ova are retained. Young hatch as nauplii or metanauplii. (In this group the rami of the caudal furca are usually known as cercopods.)

Key to the Families and Genera of Anostraca of the Indian Empire

1. 2nd antennae of ♂ biarticulate
   - A. Basal joints of 2nd antennae of ♂ nearly or entirely separate
     - i. Basal joint of 2nd antennae of ♂ with no processes, or with small and simple ones only .... *Artemiidae*
       - a. Distal joint of 2nd antennae of ♂ greatly flattened .... *Artemia*
       - b. Distal joint of 2nd antennae of ♂ not greatly flattened .... *Branchinecta*
     - ii. Basal joints of 2nd antennae of ♂ bearing 1 or more conspicuous fleshy processes .... *Chirocephalidae*
       - a. (only Indian genus) .... *Pristicephalus*
   - B. Basal joints of 2nd antennae of ♂ firmly joined to each other and to the front of the head to form a clypeus .... *Branchipodidae*
     - i. Front of head of ♂ bearing 2 long filiform processes which are connate at base .... *Branchipus*
     - ii. Front of head of ♂ without filiform processes .... *Branchipodopsis*
2. 2nd antennae of ♂ triarticulate, cheliform .... *Streptocephalidae*
   - A. (only genus) .... *Streptocephalus*

Family ARTEMIIDAE Grochowski

1896 *Artemiidae* Grochowski. Verh. zool. bot. Ges. Wien, 45:99

Eleven pedigerous, 8 or 9 postpedigerous segments. Head without frontal process. Second antennae of ♂ biarticulate, not fused at base, or only slightly so. Legs with a single epite (branchial lamina). Cercopods jointed to last abdominal segment, or fused to it or absent. Ovisac subglobular or cylindrical. Distribution world wide.

Genus *Artemia* Leach

1819 *Artemia* Leach. Dict. Sci. Nat., 14:543

Body slender, abdomen often longer than trunk and head combined. Eight postpedigerous segments, the last one longest. Basal joints of 2nd antennae of ♂ slightly fused; inner margin with a small round setulose knob. Distal joint of 2nd antennae of ♂ much flattened, apically acute. Intromittent part of penes without spines. Cercopods movable, fused to last body segment, or absent. Body form more or less variable according to the salinity of the environment.

Daday (1910) reduced the many "species" which had been described to two, one of which was from Peru, and was placed in the subgenus *Callaonella*. But the "species" described by Daday as *salina*, of wide distribution, has been shown to be heterogeneous by the work of Artom (1906, 1911a, 1911b, 1912, 1922, 1926, etc.), who found that there are at least two types, diploid and tetraploid, which he distinguishes at various times as "univalens" and "bivalens" (1911b) or as "micropirenica" and "macropirenica" (1922), and these may be further divided into sexual and parthenogenetic subraces. Hertwig (1931) and Gross (1932) believe that Artom's "diploid sexual" *Artemia* really are diploid, but that his "diploid parthenogenetic" are tetraploid, and that his "tetraploid parthenogenetic" are octoploid. Their belief is based on the fact that the chromosomes of the parthenogenetic races are much larger, each chromosome probably being bivalent. The most recent review of the situation is by Stella (1933), who agrees substantially with Artom.

Now, the taxonomic value of these races has never been properly established, since Artom did not give formal descriptions, but used his terms rather as conveniences. Daday's species *salina* will undoubtedly have to be divided eventually on cytological and grosser structural grounds, but however the division is made, the name *salina* will have to be reserved for the form originally described under that name. This form (of which I have a few specimens from the type locality) was found in the salt pans at Lymington, England, and has been shown to be diploid and sexual—the type called "univalens" and "micropirenica" by Artom. Fortunately, for the sake of simplicity, this is also the only form that has so far been found in the Indian region.

Artemia salina (Linnaeus)

1758 *Cancer salinus* Syst. Nat. (10th ed.) 1:634

Locality: Indian Tibet: Tso Kar. 200 + ♂♂♀♀. 5-IX-32.

Reported from: Nowhere else in the Indian region, but it has been taken in a great number of localities in central and western Asia, as well as in other parts of the world. The Tso Kar colony may have come from eggs dropped by a caravan carrying salt, though there seems to be no reason for its not being found naturally at several localities in the Indian region.

Types: Ubi?

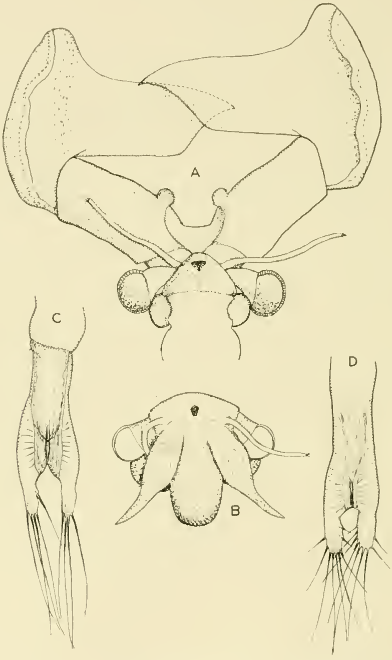

Figure 1.—*Artemia salina.* A, head of Tso Kar ♂ from above. B, head of Tso Kar ♀ from in front. C, end of abdomen of Tso Kar ♂ from above. D, end of abdomen of ♂ raised from Tso Kar eggs in 10% Na Cl solution. (Heads × 23, abdomens × 46.)

Always sexual, usually a more or less even distribution of the sexes (in this case about twice as many ♂♂ as ♀♀). Nuclei of the segmenting egg with 42 very small chromosomes. Nuclei of the ova before emission of polar bodies with 21 diads (observed in some of these specimens). Differences between specimens raised in brines of different densities not so marked as in the parthenogenetic *Artemia*; the caudal furca is never entirely absent, even in specimens from the strongest brines.

In the Tso Kar[1] specimens the abdomen is consistently about 20% longer than the trunk and head combined; the furca is somewhat reduced and bears from 3 to 10 setae on each ramus. The mature ♀♀ carry from 0 to 40 eggs (average 17.2). The ♂♂ average 9.96 mm., and the ♀♀ 11.02 mm. in length.

Professor Hutchinson brought back some viable eggs from Tso Kar which it has been possible to raise in the laboratory, though so far only in brines more dilute than that of the lake. As a consequence, the laboratory-raised specimens show better developed furcae and relatively shorter abdomens than those preserved in the field.

Genus *Branchinecta* Verrill

1869 *Branchinecta* Verrill. Am. Jour. Sci. (ser. 2) 48:250

Nine postpedigerous segments, the last usually shortest. Basal joints of 2nd antennae of ♂ perfectly separate; unarmed, or bearing 1 or more small processes of spines. Distal joint of 2nd antennae of ♂ usually simple, falciform; triangular, oval, or subcircular in cross section. Cercopods always jointed to last abdominal segment and freely movable. Ovisac of ♀ usually cylindrical, though very short in some species.

About 10 species are known from North and South America, Europe, and Asia. Only 1 species reported from the Indian region, though *B. paludosa* is found in Siberia to the north, and *B. ferox* is found east to Odessa and Jerusalem.

Branchinecta orientalis G. O. Sars

1901 *Branchinecta orientalis*. Sars. Ann. Mus. Zool. Acad. Imp. St. Pétersbourg. 6:144

Localities: Tibet: *Gyantse (coll. Maj. F. M. Bailey) 1 ♂, 2 ♀♀. 2-VII-23.

Indian Tibet: Chushol, Western Tibet, pond below village. Altitude 4336 meters. About 20 ♂♂ ♀♀. 10-VIII-32.

Lake near Chushol. Altitude 4491 meters. 1 ♂. 10-VIII-32.

Togarma Tso. Altitude 5217 meters. 7 ♂♂, 2 ♀♀. 10-VII-32.

Reported from: Hungary, Kecsemét; Russia, Charkov; 4 localities in the Pamir region (sec. Daday); Eastern Mongolia, Chuntu-nor (sec. Sars and Daday); Russian Mongolia (sec. Smirnov); Tibet, Gyantse (sec. Gurney).

Abdomen about the length of the head and trunk or a little longer, in both sexes. Mandibles with a sharp dentiform process on the posterior corner of the chewing sur-

[1] An analysis of Tso Kar water shows the following (figures are mg. per liter): Total solids 79266; SiO_2 25; Fe 1.8; Al 5.2; Ca 406; Mg 2716; Na 16346; K 5478; HCO_3 2141; SO_4 35075; Cl 11662.

face. The 2nd maxillae are provided with more setae than is usual in the order. Epite of the swimming legs of pairs 1-10 crenulate along the border; gill on legs of pairs 1-10 with margin entire. Last pair of appendages in both sexes with gill reduced in size and with a setose end; and with an epite the end of which is deeply notched. In ♂, the basal joint of the 2nd antennae is stout and cylindrical, with a slight setulose or smooth bulge on the medial face near the base. Distal joint of 2nd antennae smooth, unguiform, only slightly curved. The ♂ genital pouch has 2 posteriorly directed processes on each side. The dorso-

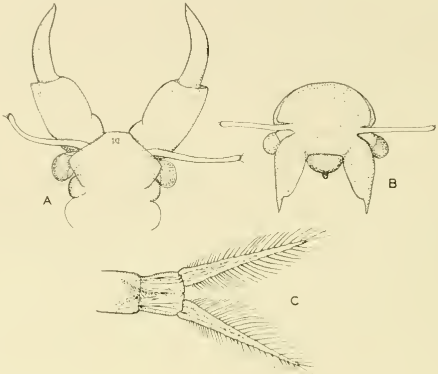

Figure 2.—*Branchinecta orientalis.* A, head of Chushol ♂ from above. B, head of Chushol ♀ from in front. C, end of abdomen of Chushol ♂ from above. (Heads × 11, abdomen × 15.)

lateral process hamiform with a ventrally directed side-process. The ventromedial process cylindrical. The cercopods of the ♂ slender, narrow, and pointed, straight, or slightly curved outward at the tips; both margins fringed with plumose setae nearly to the base. In ♀ 2nd antennae flat and blade-like with a well-marked acute terminal point, with a well-marked notch on the inner margin between the point and the body of the antenna. Ovisac does not reach beyond the 3rd post-genital (5th post-pedigerous) segment. Length: ♂ 12-38 mm.; ♀ 12-43.5 mm.

Daday (1910) divides this species into a small "*forma vernalis*" and a larger "*forma aestivalis*," but since all intermediate sizes are found and at all times of the breeding season, it seems unnecessary to make this distinction.

This species most closely resembles *B. ferox* (Milne-Edwards), and in fact both Daday (1910) and Smirnov (1932) are a little doubtful as to whether the two species are really distinct. It appears to me that they very probably are not the same, though they are certainly closely related. *B. ferox* is proportionately much more slender, and averages considerably longer; the gill of the last pair of limbs appears not to be setiferous (from the descriptions—I have no specimens at hand); the cercopods of the ♂ are always outcurved, and their outer margins bear setae only near the tips; in the ♀ there is not a well-marked notch between the body of each 2nd antenna and its apical point; and the ovisac extends beyond the 3rd post-genital segment. Moreover, *B. ferox* has not been reported from central and eastern Asia, as it should have been if only environmental variations separate the two. *B. orientalis* has been reported from Russia and even Hungary, but both these records (especially the latter) I consider very doubtful. From analogies with the development of other anostracans, it appears very likely that adults of *B. orientalis* will resemble somewhat juvenile *B. ferox* even more closely than they resemble the adults of that species. From some of Daday's figures especially it seems possible that he has confused young specimens of *B. ferox* with *B. orientalis.*

Family CHIROCEPHALIDAE Daday

1910 *Chircocephalidae* Daday, Ann. Sci. Nat. (ser. 9) 11:175

Eleven pedigerous, 9 postpedigerous segments. ♂ with biarticulate 2nd antennae, with separate basal joints. In ♂ basal joints of 2nd antennae bear 1 or more fleshy processes; or if not, the head bears a median frontal process; or there may be a frontal process as well as fleshy processes on the basal joints of the 2nd antennae. Legs with 1 or 2 epites. Cercopods movably articulated with last abdominal segment (except in *Thamnocephalus*). Ovisac usually more or less flask-shaped. Distribution world wide.

This is probably the least homogeneous of the families of Anostraca as defined by Daday. This author further subdivides it into 3 sub-families (which will not be treated here), but even with this division certan genera assigned to it by Daday will probably have to be removed to other families when they are more fully studied. The single Indian genus is close to *Chirocephalus*, and will certainly remain in the same family, whatever the taxonomic future of the group as now defined.

Genus *Pristicephalus* Daday

1910 *Pristicephalus* Daday, Ann. Sci. Nat. (ser. 9) 11:213

Abdomen without furca, usually shorter than trunk. Abdomen of ♂ unarmed, in ♀ bearing various sorts of spines, usually at posterior margins of the segments. Margins of cercopods setiferous, never spiniferous. Male without frontal process. Basal joint of 2nd antenna of ♂ often with a subspherical or cylindrical setuliferous process, and always with a pointed serriform process which is generally carried more or less coiled. Legs with 2 epites, except that last pair may have only 1, or the proximal epite of last leg may be much reduced.

Four species are known, occurring in parts of North Africa, Europe, Western and Central Asia. The species most closely resembling the one found in the Indian region is *P. josephinae*, which is found in Eastern Russia and in Siberia, and hence is the nearest geographically as well.

Pristicephalus priscus Daday

1910 *Pristicephalus priscus* Daday, Ann. Sci. Nat. (ser. 9) 11:224

Localities: PUNJAB: Sargodhar District, 3 miles South of Nuriwala. Altitude *circa* 305 meters. 4 ♂ ♂. 6-III-32.

SIMLA HILL STATES: *Between Theog and Matiana. Altitude *circa* 2300 meters. 5 ♂ ♂, 2 ♀ ♀. Coll. S. Kemp. X-21.

*Below Kupri. Altitude *circa* 2200 meters. 62 ♂ ♂ ♀ ♀ (all slightly juvenile). Coll. S. W. K. 28-IX-21.

Reported from: Naini Tal, Kumaon; Phagu, Simla Hill States; Suka Tal, above Naini Tal, Kumaon; Bhowali Bazar, Kumaon (sec. Daday).

Types: Daday designates no types for any of his species, but he had specimens of *P. priscus* from both the Paris Natural History Museum and the Indian Museum.

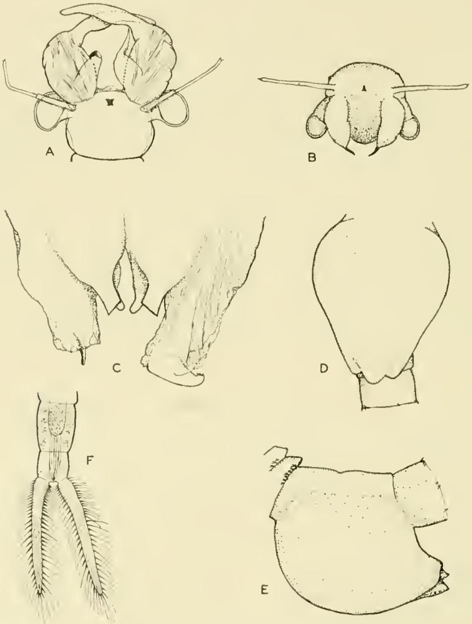

FIGURE 5.—*Pristicephalus priscus.* A, head of Sargodhar ♂ from above (× 15.6). B, head of Theog ♀ from in front (× 15.6). C, external genitalia of Sargodhar ♂ from below (× 33). D, egg sac of Theog ♀ from below. E, same from left side. F, end of abdomen of Sargodhar ♂ from above (× 42).

This characteristically Indian species has not been described nor figured except by Daday. The specimens that I have examined agree exactly on all important points with Daday's description and, moreover, the specimens (except those collected by Professor Hutchinson) are from the same region as Daday's, so that there can be no question of subspecific or varietal differences. None the less, there are a considerable number of small

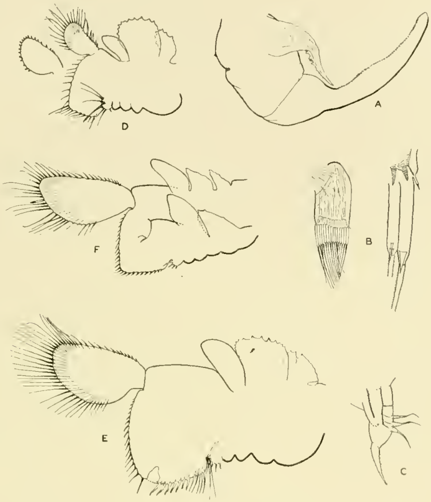

FIGURE 4.—*Pristicephalus priscus*. A, right 2nd antenna of Sargodhar ♂ from above (× 23). B, right 1st maxilla of Theog ♂ (× 38, enlargement × 85). C, right 2nd maxilla of Kupri ♂, finer setae not shown (× 64). D, E, F, 1st, 6th, and 11th legs of Sargodhar ♂. Offset from D, flabellum of same leg of Kupri ♂. Inset in F, gill and epite of same leg of Theog ♂ (all × 22).

points in which these specimens differ from Daday's description, and there are several characters which Daday seems entirely to have overlooked. His descriptions are in general unnecessarily detailed, and to correct all his observation it is needful for me to be very lengthy in my description also.

Male: Penultimate abdominal segment longer than any of the preceding 4. Last abdominal segment (which is about half as long as the penultimate segment) sometimes rather deeply notched between the cercopods. Cercopods long, narrow, ensiform; distal end more or less acutely pointed; fringed all round with moderately long plumose setae (Figure 3, f).

Head rounded in front. 1st antenna biarticulate, considerably longer than the basal joint of 2nd antennae (Figure 3, a). Basal joint of the 2nd antenna roughly 3/4 as broad as long, roughly keg-shaped (Figure 4, a). A slightly raised area on the outer, distal margin of the basal joint of the 2nd antenna may be minutely setulose (not shown in figure); and there may be a short, ill-defined, transverse ridge, on the lateral side of this joint near the base, bearing 10-12 slender setae. Distal joint of second antenna with sub-conical basal portion, becoming flattened distally. Outer margin of distal portion is a flattened arc; inner margin sinusoid, and minutely serrate, with the points of the serrations directed basally. On dorsal interior surface of basal joint of the 2nd antenna is a pointed process called by Daday the "serriform process"; it is taeniform with the distal end drawn out; the margins are entire; a row of short digitiform papillae parallels each margin on the ventral surface. In preserved specimens, the serriform process is usually spirally twisted.

Chewing surface of mandibles in shape of a rough parallelogram, about 30-35 rows of teeth, the teeth being directed anteriorly; at dorsal edge of chewing surface are a few large, conical spines. I have been unable to detect any trace of the mandibular palp (which in several other phyllopod genera is represented by a small papilla). 1st maxilla broad and flat distally, ending in a row of 15-16 long, plumose, biarticulate setae. Basal portions of the setae armed with distally directed spines which number 1 or 2 on the lowermost seta and increase in number up to 8-12 on the uppermost seta. These spines are on the side of the setae opposed to the setae of the opposite 1st maxilla. Lower than the lowermost seta is a small spine which appears to be morphologically a much reduced seta, as it is supplied with its own tendon (Figure 4, b). 2nd maxilla reduced as is usual in the sub-order, ending in a large, slightly curved claw armed with a few minute spines; provided on its medio-anterior edge with three strong, biarticulate, plumose setae; on ventral surface, below bases of setae is a short, stout spine directed distally (posteriorly). Several patches of extremely fine hairs on the 2nd maxilla are much too fine to be shown in the figure (Figure 4, c).

Swimming legs 1-10 with 2 epites with markedly serrate edges. Last pair of legs variable in this respect, having 2 subequal, narrow, pointed epites, or with the proximal epite much the smaller, or entirely absent. Last legs of same individual may be unlike in this respect. Margin of the distal endite of legs 7 and 11 tends to be bluntly pointed; of legs 2-10 more evenly rounded. Gill with entire margin on all legs. Flabellum on legs 2-11 foliaform, with dorsal margin flatter than ventral. Flabellum of 1st leg foliaform, or subtriangular in outline. (Figure 4, d, e, f, setae and spines shown only for 2 distalmost endites.)

Each side of genital sac with 3 processes directed posteriorly. Ventral process ends in a lappet much flattened horizontally, end obliquely truncated, sometimes much more so than in figure. Inner dorsal process digitiform, sometimes slenderer than shown in figure. Outer dorsal process (penis) longer and much thicker than others, approximately cylindrical, ends in a flat, subtriangular plate which is eversible and retractable. The outline of the plate is roughly that of a boot viewed from the side. Following this analogy, the plate is attached by the leg, and bears 3 teeth on the top of the toe. These teeth are absent in juvenile individuals (Figure 3, c).

Total length variable, perhaps depending on season and food supply, averages about 18-19 mm. from forehead to end of cercopods.

Female: Second to 11th pedigerous segments with short transverse ridge across median dorsal line; viewed from the side, the highest point of ridge is towards posterior margin of segments, especially posteriorly; at each end of each ridge are 1-10 curved spines along the posterior margin of the segment, the 2nd pedigerous segment having 1 spine on each side, and the number increasing posteriorly (Figure 3, e). According to Daday the 3rd to 7th abdominal segments have a girdle of spines around the posterior margin. In the specimens I have examined, these segments bear from about 6-25 spines on the posterior margin, increasing in numbers per segment posteriorly to a maximum on the 5th or 6th segment. The spines do not form a girdle, but tend to occur in groups of 2 or 3 with a space between the groups. The spines are absent, or small and few near the ventral mid line, thus giving an effect quite unlike Daday's figure (Figure 3, e). Cercopods as in the male.

Head smoothly rounded in front. First antenna biarticulate and longer than 2nd antenna. Second antenna oval in cross-section, tapering abruptly at distal end, to a pointed spine-like process (Figure 3, b). Eyes smaller than in male. Mouth parts as in male.

Legs as in the male.

Ovisac short and broad; ventral view something like a beef heart, but with an obtusely conical process on each side of the posterior end, and slightly dorsal to it (Figure 3, d, e).

Dimensions about the same as in the male or slightly smaller.

All of the specimens that I have examined are heavily infested with epiphytes and attached protozoa. This suggests that growth is very slow, with long periods between ecdyses.

Family Branchipodidae Daday

1910 *Branchipodidae* Daday, Ann. Sci. Nat. (ser. 9) 11:*287*

Eleven pedigerous, 8 or 9 postpedigerous segments. Front part of head of ♂ fused with basal joints of 2nd antenna to form a clypeus. Front of head of ♂ unarmed, or with a median process, or with paired processes. Second antenna of ♂ biarticulate. Legs with 1 epite. Cercopods freely movable, or fused to last body segment. Ovisac generally subglobular. The family is absent from North and South America.

Genus *Branchipus* Schaeffer-Daday

1766 *Branchipus* Schaeffer. Elementa Entomologica

1910 *Branchipus* Daday. Ann. Sci. Nat. (ser. 9) 11:311

Trunk segments smooth, unarmed. Postpedigerous segments unarmed in both sexes, or with short digitiform processes in ♂. Cercopods movably articulated with last body segment; straight and fringed all round with setae; or curved inward with outer margin setiferous, inner spiniferous. Distal joint of 2nd antenna of ♂ much longer than basal joint; falciform, curved inwards. Clypeus of ♂ with paired short blunt frontal processes. Paired, long filiform processes with bases connate arise from front of head (dorso-proximal part of clypeus). Second antenna of ♀ flat, blade-like, produced into a sharp apical point. Ovisac short, oval, with a prominent ventral lobe. In the present-day restricted sense, this genus contains only 2 species, one of which has been found only once, in the French Alps.

Branchipus stagnalis (Linnaeus)

1752 *Apus pisciformis* Schaeffer. Abhandl. v. Insecten. vol. 2.

1758 *Cancer stagnalis* Linnaeus. Syst. Nat. (10th ed.), p. 634.

1766 *Branchipus pisciformis* Schaeffer. Elementa Entomologica.

1906 *Branchipus pisciformis* Gurney. J. and Proc. As. Soc. Bengal (n.s.) 2:275.

1910 *Branchipus stagnalis* Daday. Ann. Sci. Nat. (ser. 9) 11:312.

Localities: No specimens of this species have come into my hands. It has been reported only once from India, by Gurney (1907), who examined specimens in the Indian Museum labeled "J. A. W. Murray, Sind."

Reported from: The greater part of Europe; North Africa; Palestine. The collections nearest India were made at Sudak in the Crimea, and Bingol Dagh in Armenia. (Cf. Daday (1910).)

Types: Ubi?

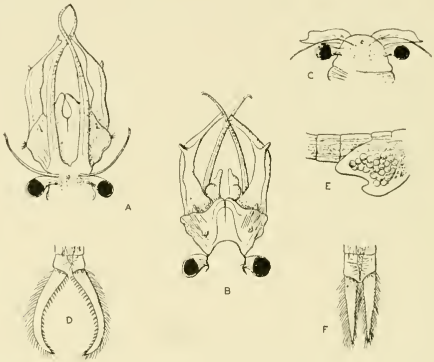

FIGURE 5.—*Branchipus stagnalis*. A, head of ♂ from above. B, head of ♂ from below. C, head of ♀ from above. D, end of abdomen of ♂. E, egg sac of ♀ from right side. F, end of abdomen of ♀. (All from Daday (1910); magnification unknown.)

Since I have seen no specimens of this species, I borrow the description (much shortened) from Daday, as well as some of his figures.

Male: Size very variable according to locality. Abdominal segments unarmed. Cercopods falciform, curved inward, outer margin setiferous, inner margin bearing slender spines. Clypeus with a short conical process on each side dorsally; with paired conical frontal processes; with a conical tubercle on each side, and a distal digitiform process on each side ventrally. Distal points of the 2nd antenna with bituberculate tips, and with a digitiform process projecting anterolaterally from the ventrolateral margin at a point slightly distal to the middle of the joint. Front of head at dorso-posterior margin of clypeus with a pair of long filiform processes with connate bases. Total length, 8-20 mm.

Female: Cercopods straight, both margins setiferous. Front of head unarmed, gently rounded. Ovisac short, oval, acutely rounded posteriorly. Total length, 8.5-23 mm.

Genus *Branchipodopsis* G. O. Sars

1898 *Branchipodopsis* Sars. Arch. Mat. og Naturvid. Krist. 20 (4) : 26.

Nine postpedigerous segments, the last shortest. Cercopods falciform, incurved, movably jointed to last abdominal segment. No median process from the vertex of head of ♂, but there may be a small median, ventral process. Basal joint of 2nd antenna of ♂ (each half of clypeus) with a conical, subconical or digitiform process on inner anterior side, and a small setiferous lamelliform process near the distal end. Distal joint strongly curved inward, often contorted, unarmed. A number of species are found in Africa, one in Asia.

Branchipodopsis affinis G. O. Sars

1901 *Branchipodopsis affinis* Sars. Ann. Mus. Zool. Acad. Imp. St. Pétersbourg. 6: 149

Locality: Kashmir: *Nagmargh. 20-30 ♂ ♂ ♀ ♀. Col. F. Smith. VI-13.

Reported from: Mongolia, Mont Chingan (sec. Sars); Manchuria, near Tyn Chur. (sec. Daday); Russian Mongolia, near Lake Baical (sec. Smirnov).

Types: Museum of Natural History, Leningrad.

These specimens were received in an extraordinarily damaged condition, apparently having been completely dried at some time in the past. They were very brittle as received in alcohol, and not a single specimen had escaped breakage. It was at first impossible even to make sure of the genus, but by treating with 5% KOH solution, the horn-like interior was softened, and the integument resumed something of its former shape. They were then lightly stained with tetrabromfluorescic acid, and preserved in glycerine to protect the now very soft specimens. Since these specimens are in such poor condition, the description and figures are taken largely from Sars (1901).

Body somewhat more slender than usual in the genus. The paired median processes on the dorsal surface of the ♂ clypeus terminate in 2 rounded lobes, having between them a small spine; digitiform processes on dorsal, distal parts of the clypeus well marked. A small ventro-median, spinuliferous process on the clypeus. Distal joints of 2nd antenna of ♂ strongly curved, and somewhat expanded near tips. Second antennae of ♀ terminate in an acute pointed process. The 6th legs of ♂ have 5 rounded, tuberculiform processes between

* Indian Museum specimens.

the spines of the distal endite. (The Kashmir specimens appear to have only 2 such tubercles.) According to Daday (not mentioned by Sars) there are 2 spines on the under side of the last postpedigerous segment. These cannot be made out on the Kashmir specimens, though quite possibly because of their poor preservation. Cercopods of ♀ straight, pointed and setiferous; those of ♂ longer, strongly curved inward, and setiferous on the greater part of the outer margin. On the inner margin they are provided with spines which continue to, and a little around, the tips.

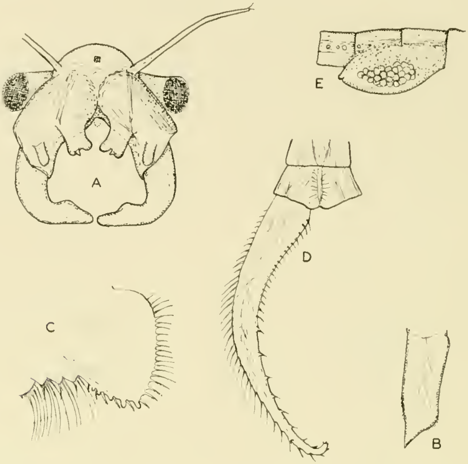

FIGURE 6.—*Branchipodopsis affinis.* A, head of ♂ from in front (× 14). B, 2nd antenna of ♀ (× 39). C, outer endites of 6th leg of ♂ (× 32). D, end of abdomen of ♂. E, egg sac of ♀ from right side (× 10.5). (All redrawn from Sars (1901).)

Family STREPTOCEPHALIDAE Daday

1910 *Streptocephalidae* Daday. Ann. Sci. Nat. (ser. 9.) 11:335

Eleven pedigerous, 9 postpedigerous segments, the last always shortest. Head in ♂ simply rounded in front, or with a frontal process. Second antenna of ♂ triarticulate, with distal joint cheliform, a curved, chitenous process projects more or less ventrally from the juncture of the basal and middle joints. Legs with 1 epite. Cercopods movably articulated with the last abdominal segment (except in *S. scalii?*). Ovisac cylindrical, usually elongate. Only 1 genus, which is found in all continents except South America.

Genus *Streptocephalus* Baird

1852 *Streptocephalus* Baird. Proc. Zool. Soc. London 20:20

With the characters of the family.

The species of the genus *Streptocephalus* hitherto described from the Indian region have been named *S. dichotomus* Baird, and *S. dichotomus* var. *simplex* Gurney. But an examination of the specimens of the Yale North India Expedition and the numerous specimens sent me from the Indian Museum has shown that such a classification is untenable. If it were to be allowed, a number of subvarieties of var. *simplex* would have to be erected, some of which would be geographically distinct; and even though the ranges overlap slightly, there already appears to be a geographical distinction between *S. dichotomus*, and *S. d.* var. *simplex*, so that a sub-specific distinction would be proper at the very least. If var. *simplex*, the more primitive form, had been described first, it would perhaps be possible to express the relationships without too much confusion, but under the present conditions it seems much better to raise Gurney's variety to the rank of a full species, with 3 sub-species. This (to some perhaps drastic) step has sound precedent in the suborder, and even within the genus, since *S. dregei* G. O. Sars, and *S. cirratus* Daday are equally close to each other. I may add that no intermediate forms have ever been recorded between *dichotomus* and *simplex*.

Streptocephalus simplex **simplex** nov. comb.

1907 *Streptocephalus dichotomus* var. *simplex* Gurney. J. and Proc. Asiatic Soc. Bengal (New Series) 2:276

Localities: PATIALA STATES *Base of Simla Hills 1 ♂, collector for the Indian Museum. Date?

UNITED PROVINCES: *Mirihan, Mirzapur, R. B. S. Sewell, coll. 30-XII-12.

Reported from: Cutch (Gurney); Calcutta (Daday).

Types: Indian Museum, Calcutta.

The distal chelate joint of the 2nd antenna of the ♂ is often spoken of as the "hand," the dorsal branch being the "thumb" and the ventral branch the "finger." For the sake of simplicity this terminology will be adopted here. The left hand of the ♂ from Patiala State is shown in Figure 7, with the parts to be mentioned in the descriptions labeled. The terms "dorsal," "ventral," etc., when applied to the 2nd antennae of the ♂ shall be applied as if these appendages were extended out directly forward of the head.

Body rather robust for the genus. Abdomen without furca scarcely longer than the trunk. Head of ♀ evenly rounded, with the 2nd antennae much folded and crumpled, often largely obstructing forward vision. Head of ♂ produced in front into a short conical protuberance which is plainly visible from above, lying between the bases of the 2nd antennae (as in Figure 8, d, d′). Pedigerous and postpedigerous segments simple and unarmed. Male genital sac of the form usual in the genus, with the usual cylindrical, spinous penes. Ovisac of ♀ a slender tapering cylinder, not reaching as far as the last abdominal segment, tip not bent. Cercopods in both sexes narrow and lanceolate, fringed all round with subequal plumose setae. Cercopods very slightly longer proportionately in ♂ than in ♀. First antennae of both sexes not showing segmentation or pseudosegmentation. Second antennae of ♂ triarticulate. Basal joints cylindrical, superficially somewhat creased, usually bent more or less downward. At the juncture of the basal and middle joints is a ventro-laterally directed, slightly curved smooth process which is heavily chitinized. Middle joint of 2nd antennae of

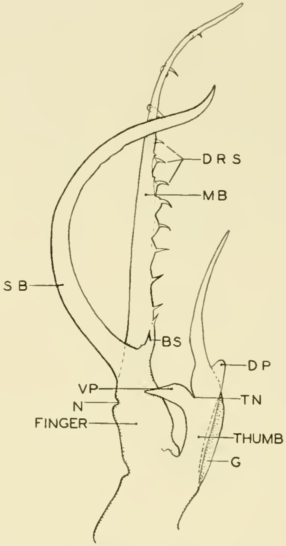

FIGURE 7.—*Streptocephalus simplex simplex.* Left hand of ♂ from Patiala State (× 13). N = finger notch; SB = sickle-shaped branch of finger; BS = basal spine; MB = main branch of finger; G = dorsal groove of thumb; TN = thumb notch; VP = ventral process of thumb; DP = dorsal process of thumb.

♂ with a sigmoid flexure; close to its basal end on the dorsal surface are 3 slender fleshy processes, the innermost one always larger, the other two may nearly equal it, or may be considerably smaller. All 3 are similar in shape, tapering, curved downwards, pointed, and with the lower surface provided with a row of small papillae. On the dorsal surface of this same middle joint is a row of about 10 slender processes, the middle ones usually being shorter. The whole of the middle segment of the 2nd antennae of the male gives the appearance of being superficially annulated. The hand, as seen from the outer side, is well shown in Figure 7. It will be observed that: the distance from the thumb notch to the tip of the thumb is about half the length of the main branch of the finger as measured from the basal spine to its tip. The dorsal process of the thumb is prominent. The dorsal row of spines tends to run over onto the inner side of the main branch of the finger distally, and the sickle-shaped branch of the finger is practically smooth along its concave edge. The legs of both sexes have the epite serrate along the margin, and the gill of the last pair flattened, enlarged, and finely serrate along the end. Length usually about 20 mm. or more.

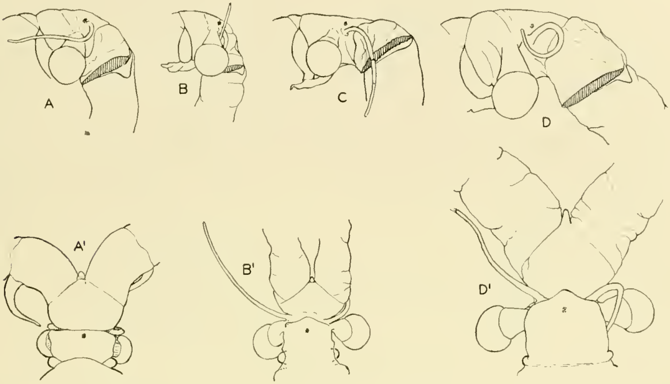

FIGURE 8.—*Streptocephalus*. A, *S. simplex echinus*, head from right side. A′, same, from above. B, *S. s. longimanus*, head from right side. B′, same from above. C, *S. s. arabicus*, head from right side. D, *S. dichotomus*, head from right side. D′ same, from above. (All $\times$ 8.1.) Side views of heads show right 2nd antenna cut away to expose the frontal process; the cut surfaces are lined. Many of the differences other than the frontal processes are the result of the condition of the material. The frontal process of *S. s. simplex* appears to be exactly like that of *S. dichotomus*.

Streptocephalus simplex longimanus n. subsp.

Locality: MADRAS PRESIDENCY: Mahabalipuram. 2 ♂, 3 ♀, coll. Hutchinson. 4-XI-32.

Types: Peabody Museum of Yale University. Paratypes to Professor Hutchinson.

This subspecies differs sufficiently from *S. s. simplex* to make it seem worth while to make the distinction. The terminal joint of the 2nd antennae of the ♂ has a much shallower and less marked notch on the ventral side of the basal part of the finger. The sickle-shaped branch of the finger has no basal spine. The main branch of the finger has the spines on the dorsal edge very few (7-10), short and blunt. The thumb has no dorsal process, though the dorsal groove is present, and the length of the thumb measured from the notch on the distal side of the ventral process is actually greater than the length of the main branch of the finger measured from the dichotomy. The 1st antennae of both sexes are long and exhibit a jointed appearance. The cercopods of both sexes are unusually wide at the base, and are much flattened dorso-ventrally. In other respects the two sexes appear to be essentially like the typical form.

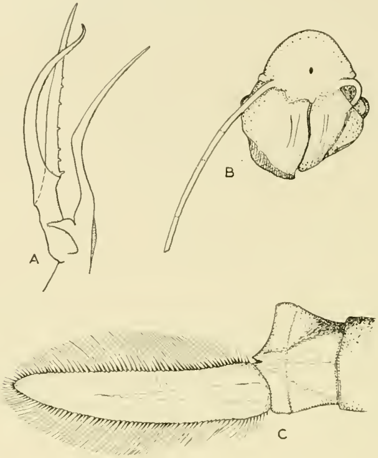

FIGURE 9.—*Streptocephalus simplex longimanus.* A, left hand of ♂ from outside (× 13). B, head of ♀ from in front (× 11). C, end of abdomen of ♂ from above (× 17.4).

Streptocephalus simplex arabicus n. subsp.

Locality: SOUTH ARABIA: Aden. 5 ♂, 5 ♀, coll. G. E. Hutchinson. 21-II-32.
Aden, 100 or more. Coll. G. E. Hutchinson. 7-XII-32.
*Aden?, 2 ♂ ♂, 2 ♀ ♀, coll.? Date?, poor condition and of doubtful provenance, quite possibly *S. s. arabicus.*

Types: : Peabody Museum of Yale University. Paratypes in Indian Museum.

Much like the typical variety, but for the following: First antennae of both sexes often appearing to be divided into 2 or more segments. Second antenna of ♂ with basal joints so much fused dorsally as almost, or completely to hide the short and ill-developed frontal process of the head when viewed from above; with the outer 2 fleshy processes of the 2nd joint much reduced in size (one may be missing), and with the dorsal row of spines on the main branch of the finger not tending to run over onto the inner face of the main branch distally. The finger-notch is well marked, and the proximal edge of it is more or less produced. The 2nd antennae of the ♀ not very rarely bent or folded, and narrower than in *S. s. simplex*; sometimes produced into an obtuse point at the inner side of the end. The gill of the last legs of both sexes is perhaps a little narrower than in the typical form. The specimens collected by Professor Hutchinson on the different dates differ greatly

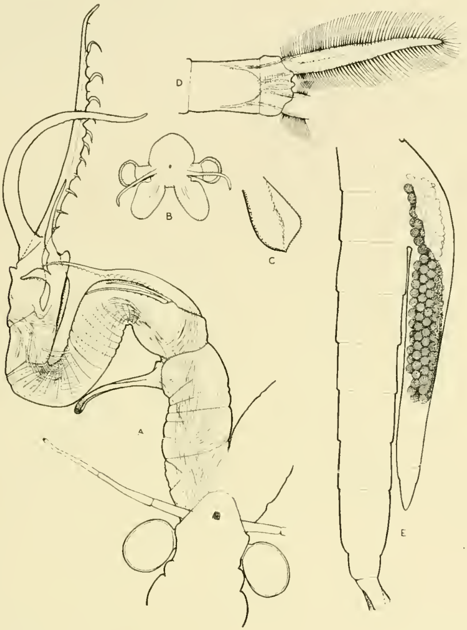

FIGURE 10.—*Streptocephalus simplex arabicus.* A, head of Feb. ♂ from above (× 12). B, head of Dec. ♀ from in front (× 7.4). C, left 2nd antenna of Feb. ♀ (× 12). D, end of abdomen of Feb. ♂ from above. E, abdomen and egg sac of Feb. ♀ from right side (× 12).

in size, those of February measuring about 23 mm. for the ♂♂ and 20 mm. for the ♀♀. The specimens taken in December, however, are the smallest sexually mature specimens I have ever seen reported for the genus, measuring only about 9 mm. for the largest ♂♂, and as little as 6 mm. for ♀♀ carrying eggs. In other respects they are precisely like the larger specimens.

Streptocephalus simplex **echinus** n. subsp.

Locality: MADRAS PRESIDENCY: *Godaveri (Town). 3 ♂, 9 ♀, coll. N. Annandale. 28-VIII-18.

Types: Returned to Indian Museum. One ♂ and one ♀, paratypes, retained.

Body and cercopods of both sexes relatively slender. First antennae of both sexes are relatively longer, and appear irregularly segmented. The 2nd antennae of the ♂ entirely without fleshy processes of the middle joint; the slender processes on the dorsal side of the distal part of this joint are reduced in number to 6-8; in the distal joint, the dorsal

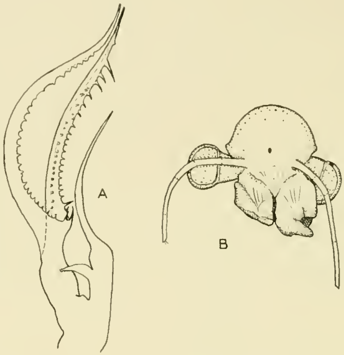

FIGURE 11.—*Streptocephalus simplex echinus.* A, left hand of ♂ from outer side (× 13). B, head of ♀ from in front (× 11).

row of spines of the main branch of the finger is more regular than in *S. s. simplex* and does not run over onto the inner side of the branch, and the spines are much more numerous. There is also a row of short, conical spines along the outer side of the main branch of the finger. The sickle-shaped branch of the finger is armed along the proximal 4/5 of its concave edge with short close-set spines which become somewhat papilliform distally. The thumb is a little longer than in *S. s. simplex*, its length from thumb-notch to tip being about 4/5 of the length of the main branch of the finger as measured from the dorsal spine. The dorsal process of the thumb is lacking, and the dorsal groove of the thumb is scarcely indicated. The finger-notch is obsolescent. The 2nd antennae of the ♀ ♀ are rather narrower than in the typical form. Length of ♂ ♂ about 20 mm., of ♀ ♀ about 18. In other respects this subspecies is very similar to *S. s. simplex*.

Streptocephalus dichotomus Baird

1860 *Streptocephalus dichotomus* Baird. Proc. Zool. Soc. London. 28:445

1900 *Streptocephalus dichotomus* Sars. Arch. Mat. Naturvid. 22(9):4

Localities: Madras Presidency: *Madras, Spur Tank. 10♂, 9♀, N. Annandale. III-11. *Tanjore (S. India). 1♂, 1♀, N. Annandale. 27-X-11.

United Provinces: *Baraunda Tank, Mirzapur. 11♂, 5♀ (juvenile), Mrs. N. M. Johnstone. 15-VIII-13.

Mysore: *Bangalore (India). 1♂, 1♀, N. Annandale. 13-X-10.

Reported from: India (Baird); Calcutta (Alcock); Shevaroy (Stevaroy) Hills (Sars).

Type: Ubi?

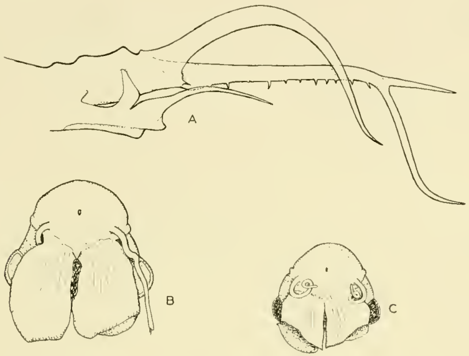

Figure 12. *Streptocephalus dichotomus.* A, left hand of Madras spur tank ♂ from outer side (× 11.6). B, head of Tanjore ♀ from in front. C, head of Madras ♀ from in front. (B and C × 9.9).

(There are also about a dozen ♀♀ from Mirzapur, collected by Mrs. N. M. Johnstone, which may be of this species or of *S. simplex*, as the females are indistinguishable. This is by no means rare among the Anostraca—for example, no distinguishing marks have been reported which allow of the separation of the ♀♀ of any of the numerous species of *Branchipodopsis.*)

Sars' redescription of this species is so very complete that it will be unnecessary to discuss it very fully. A few points of interest have been observed, however, because of the larger collections from a more wide area that have been available to me.

The species in general is very like *S. simplex*, differing mainly in the structure of the 2nd antennae of the ♂, the middle joint of which usually bears proximally 4 fleshy processes, though the ♂ from Bangalore and one of those from the Madras Spur tank have only 3 as in

S. simplex. The finger-notch is generally more deep and open than in the forms described above, and the main branch of the finger is always bifurcated for about its last third. The bifurcation is so constructed that from the outer side the ventral branch appears to be an enlarged spine, while from the inner face, the dorsal branch gives that appearance. Both branches may be smooth, or either or both may bear minute spinules. Baird had only the ♂ of this species, and Sars says "Antennae in female simple, blade-like, bluntly rounded at the tip; . . ." All 16♀♀ examined by me had the 2nd antennae folded and wrinkled to a greater or less degree, even the very immature specimens from Mirzapur showing it plainly

FIGURE 13.—*Streptocephalus*. A, left 2nd antenna of young ♂ *S. simplex* from Nundy, seen from outer side. B, same, somewhat older specimen. C, left 2nd antenna of young ♂ *S. dichotomus* from Mirzapur, of about the same age as B. D, head of a very young ♀ *S. simplex* from Nundy, seen from in front. The Nundy specimens are too young to determine the subspecies.

This agrees with the statement of Alcock (1897) who described the species under the name of *Branchipus* (*Streptocephalus*) *bengalensis*, though his figure is almost the precise antithesis of his description. The 1st antennae of the ♀♀, and to a lesser extent of the ♂♂, are frequently coiled, and often hidden under the 2nd antennae. In neither sex do the 1st antennae appear segmented.

The bifurcation of the main branch of the 2nd antennae of the ♂ appears very early. A young stage is shown in Figure 13, c. (The *S. simplex* from Nundy, Figure 13, a, b, d, are not old enough to place certainly as to subspecies, except to say that they are not *echinus*. They are in all probability *S. s. simplex*.)

All the forms of *Streptocephalus* here in discussion are quite closely related to each other, but not to any other forms. If we regard the flat, unfolded 2nd antenna of the ♀ as primitive (it appears nearly universally throughout the genus), it is clear that the oldest member of the group is that closest to the African center of distribution of the genus. No *Streptocephali* are known to occur along the present land route between Arabia and India. This may be because of inadequate collecting, or the distribution may have taken place before the present arrangement of the land masses.

Key to the Species and Subspecies of the Genus Streptocephalus of the Indian Empire

1. ♂ with a complex frontal process, and strong spines on some of the abdominal segments . . . . *S. spinifer*[2]

2. ♂ with abdominal segments unarmed
   - A. Main branch of finger of 2nd antenna of ♂ bifurcate distally . . . . *S. dichotomus*
   - B. Main branch of finger of 2nd antenna of ♂ not branched
     - i. Thumb beyond thumb-notch at least as long as main branch of ♂ 2nd antenna . . . . *S. simplex longimanus*
     - ii. Thumb not over 4/5 as long as main branch of finger
       - a. Basal joints of 2nd antennae of ♂ more or less fused dorsally, obscuring frontal process . . . . *S. simplex arabicus*
       - b. Basal joints of 2nd antennae of ♂ not fused dorsally, frontal process visible from above
         - b_1. Concave edge of sickle-shaped branch of finger smooth or nearly so . . . . *S. simplex simplex*
         - b_2. Concave edge of sickle-shaped branch spiniferous . . . . . *S. simplex echinus*

Ecology and Zoogeography of the Indian Anostraca

The Anostraca as a whole are slow swimmers with no sort of protective devices or behavior. Introduced into an aquarium, they became immediate prey to any sort of fish, and when they are in company with copepods or even cladocera, the Anostraca are always the first to be eaten, usually being exterminated before any appreciable inroads have been made on the other forms. I once discovered the skeleton of a single, small fish in the dried bed of a temporary pond of considerable size which was known to have contained *Branchinecta occidentalis* the previous wet season. Outside of this one, rather circumstantial observation, I have never seen reported a single case of Anostraca and fish being found in the same waters.

Possibly in connection with this vulnerability, various devices have arisen which have the effect of preventing the co-occurrence of these phyllopods and fish. *Artemia* will only live in waters too saline for most fish to inhabit. The other forms may, in the main, be divided into 2 classes: Those with eggs that require drying to hatch, and those with eggs requiring freezing. In many temperate regions the eggs may undergo both processes without detriment. It is not known whether any species require both, or whether in any form drying can substitute for freezing or vice versa.

As a result it may be said that the Anostraca are ordinarily found in small, shallow bodies of water, usually of a temporary nature, and that there is usually only 1 generation a year.

Of the Indian anostracans it may be surmised that both *Branchinecta orientalis* (the specimens taken from Togarma Tso, 5,217 m., are from the greatest altitude I have been able

[2] Found only in Ceylon and not discussed in this paper. Cf. Gurney. Spolia Ceylanica 4 (14-15): 127, 1906.

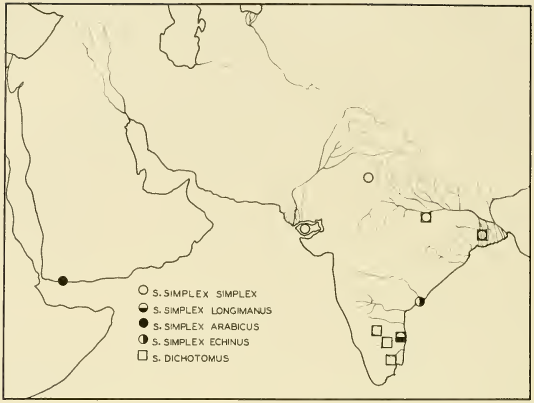

FIGURE 14.—Map of *Streptocephalus* localities.

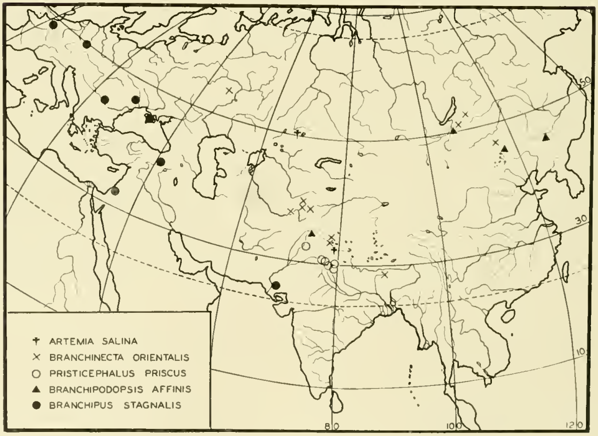

FIGURE 15.—Map of the distribution of the Indian Anostraca except *Streptocephalus*

to find reported for any Phyllopod) and *Branchipodopsis affinis* have eggs requiring freezing (though this may not be so), and certainly that the eggs of the *Branchipus* and of the *Streptocephali* require drying. The finding of *Pristicephalus* in the Sargodhar District seems to show that these eggs require drying. It is perfectly possible, of course, that this (and other forms) may have the eggs made ready for hatching by either method indiscriminately.

Since the eggs will (in most species, perhaps all) withstand long periods of drought, and since they are small and light, it might be expected that they would easily and often be transported by the feet of water birds, by the wind, or by other agencies. As a matter of fact, however, the ranges of many species are surprisingly circumscribed, even though ponds and pools offering apparently ideal conditions are to be found a short distance away. Other, perhaps related, species may be very widely distributed, with, so far as has been determined, no more efficient method of dispersal.

This curious sort of distribution may perhaps best be explained by the presence or absence of various necessary, or destructive, factors in the various environments, the different species differing, of course, in their requirements or sensitivity. Unhappily, very little is known of the particular ecological factors involved, with the exception of *Artemia* from certain regions, and since the environment of brine-pools and salterns is so special, little light is thrown upon the situation in other genera. Though there is little experimental evidence, it appears probable that temperature is a very important factor, not only in the freezing of eggs, but there is reason to suppose that there are both maximum and minimum, sharply limiting temperatures for many, if not all, species. Thus Heath (1924) has shown that hatching and the early stages of development in *Branchinecta occidentalis* may take place at lower temperatures, but that sexual maturity is only attained after the water has risen to a temperature of approximately 22°C., despite abundant food and other suitable conditions.

The Himalayan Mountain system makes a more or less sharp temperature barrier between North and South, and the higher part of the plateau, even south of the crest is, undoubtedly, for such species as *Branchipodopsis affinis* essentially similar to Manchuria and Mongolia. Whether this form is to be found in many places between the present known sites, or whether it reached the Himalayan plateau at a period colder than the present, it is impossible to say. The very occurrence of this species in the cold parts of Asia is at present not easy to explain, since all the other 11 known species of the genus are found only in the warm and dry parts of South Africa. The arrival of *Branchinecta orientalis* was probably from the North and West, where it now occurs, and in which direction other members of the genus are to be found. *Pristicephalus priscus* may be surmised to have come from the North and West also, since its closest relatives are to be found in that direction. Because of its differentiation and restricted range it would appear to have arrived at an earlier date than the other northern forms, however. *Branchipus stagnalis*, like *Streptocephalus*, probably arrived from the West, though it is odd that it has been met with only once, and it appears barely possible that it may have been a chance importation through the agency of modern man.

The localities in which the various forms of *Streptocephalus* are found are shown on the map, Figure 14. The other species are shown in Figure 15.

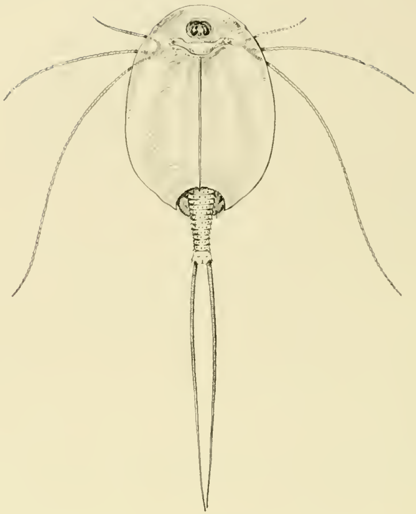

FIGURE 16.—*Apus cancriformis* ♀ from Nuriwala.

Suborder 2 NOTOSTRACA

1867 *Notostraca* Sars. Crust. d'eau douce Norv. : 5

Genus *Apus* Schaeffer

1756 *Apus* Schaeffer. Der krebsartige Kiefenfuss, etc. : 131

1803 *Triops* Schrank. Fauna Boïca 3 : 251

The correct name for this genus is by no means settled, and though *Triops* is in general use at the present in continental Europe, I believe that only *Apus* has been used by the various authors who have treated of the genus in the Indian region. The arguments for this usage are so well presented by Stebbing (1910) and Gurney (1923,1924), particularly the former, that I feel constrained to follow their usage in this paper.

Apus cancriformis Schaeffer

1756 *Apus cancriformis* Schaeffer. Der krebsartige Kiefenfuss, etc.

Locality: PUNJAB: Sargodhar District, 3 mi. South of Nuriwala. 2 ♀ ♀. 6-III-32.

Reported from: Europe, Northern Africa. Kashmir (sec. Barnard).

Carapace oval, slightly longer than broad. Nuchal organ (between the posterior margins of the compound eyes) oval as seen from above, conical as seen from the side. Number of postpedigerous segments in ♂ 6-8, in ♀ 5-8. Fourth endite of 1st leg longer than carapace. Rami of caudal furca as long as all the rest of the animal, or longer.

The 2 ♀ ♀ of the collection have 8 postpedigerous segments each—an unusually large number. The other characters agree so well, however, that there is no doubt of the correctness of the identification. (See Figure 16, drawn by Miss L. Krause.) In nothern Europe this species is generally parthenogenetic. Whether this is true in this Indian locality the collection is too small to show.

On various bases this species has been divided into a number of subspecies, but as Barnard (1929) has so clearly shown in his study of the South African forms, the diagnostic characters chosen have no taxonomic value and simply result from individual variation (Cf. also Gurney (1923)). India may or may not harbor a valid subspecies, but this can only be determined by a study of some hundreds of specimens.

Suborder 3 CONCHOSTRACA

1867 *Conchostraca* Sars. Crust. d'eau douce Norv. : 5

Family LIMNADIIDAE Sars

1896 *Limnadiidae* (part.) Sars, Fauna Norv. 1:84

Shell thin, pellucid, ovate with few and inconspicuous growth lines. Head of adult with frontal appendage. 18-32 pairs of legs, 1st and 2nd pairs in ♂ prehensile. 9th, 10th and sometimes 11th pairs of legs in ♀ ovigerous. Caudal furca claw-like.

Three not very well defined genera.

Genus *Eulimnadia* Packard-Daday

1874 *Eulimnadia* Packard. Rep. Peab. Acad. Sci. Salem. 6:55

1925 *Eulimnadia* Daday. Ann. Sci. Nat. (ser. 10) 8:145; (9:1-3 (1926))

Hinge line of shell not serrate. 18 or 20 pairs of legs. Lower distal angle of telson (last abdominal segment) produced into an acute point.

Eulimnadia margaretae n. sp.

Locality: South Arabia: Aden, 9♀♀. 7-XII-32.

Types: Peabody Museum of Yale University. Paratypes: Indian Museum, British Museum, and retained.

Description of ♀ (♂ unknown). Shell transparent, oval, highest point just anterior to the middle. Hinge line evenly arcuate. Growth lines 3 in number, the outermost extremely indistinct. Rostrum in ♀ rounded, or bluntly acute (especially in younger specimens); frontal

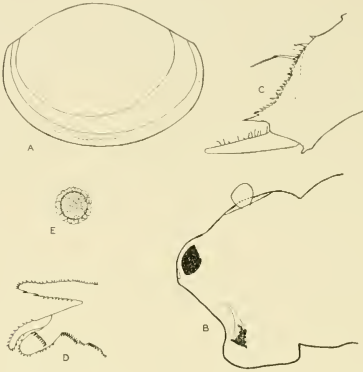

Figure 17.—**Eulimnadia margaretae.** A, shell of ♀ from left side (× 5.8). B, head of ♀ from left side (× 20.5). C, telson of ♀ from right side (× 20.5). D, distal part of left 1st leg of ♀ from behind. Bases only of the setae are shown (× 22). E, egg (× 43).

organ subglobular; posterio-ventral margin of head nearly straight, sinuous, or with a more or less sharp notch. First antennae with 6 and terminal lobes; 2nd antennae with branches of 7 and 9 segments. Twenty pairs of legs, of which pairs 10 and 11 are ovigerous. Posterior 9-13 segments bearing dorsal setae of variable number and difficult to count (setal numbers from behind forward on Type: 5?, 5?, 7?, 7, 7?, 7?, 7?, 5?, 3, 1, 1, 1, 1). Telson much worn in all specimens, with about 35 small, irregular dorsal spines, all of which are smooth; lower distal angle of telson produced into a short, rounded (possibly worn) point. Furcal claws of all specimens broken, with rounded ends; the bases of about 20 plumose setae can be made out on each claw, but most of them are broken off. Dimensions of shell: 10.4 x 7.4 mm. Ova spherical, rugose. This form does not very closely resemble any of the species described hitherto.

Family CYZICIDAE Stebbing-Barnard

1910 *Cyzicidae* (part.) Stebbing. Ann. S. Afr. Mus. 6:486

1929 *Cyzicidae* Barnard. Ann. S. Afr. Mus. 29 (1) : 253

"Shell thin, pellucid (but often rendered opaque with extraneous matter), laterally compressed, ovate in outline, with numerous and distinct growth-lines and more or less distinct surface sculpturing. Head without frontal appendage, with distinct fornix on each side extending to apex of rostrum. Rostrum unarmed, or with a minute apical spinule in the young which may persist in adult ♀, but not in adult ♂. Eyes contiguous. First antennae long with numerous lobes on anterior margin bearing sensory setae. Second antenna strong. Twenty to twenty-seven pairs of legs; 1st and 2nd pairs in ♂ prehensile, 9th and 10th pairs in ♀ ovigerous. Caudal furca claw-like. Foremost tooth on upper margin of telson larger and stronger than the following ones." (Barnard.)

Genus *Eocyzicus* Daday

1913 *Eocyzicus* Daday. Math. Termt. Ert. 31 : 567, 574 (sec. Barnard)

1915 *Eocyzicus* Daday. Ann. Sci. Nat. (ser. 9) 29: 190

With occipital angle rounded or rounded-quadrate in both sexes. Rostrum of ♀ acute, of ♂ with a less sharp angle (often obtuse).

Eocyzicus hutchinsoni n. sp.

Localities: PUNJAB: Tahsil of Kushab, Dam between Naushara and Mardwal 1 ♂ 1 ♀. 12-III-32.

PUNJAB: Tahsil of Kushab, 3 miles south on Nuriwala, Kushab-Naushara Road 2 ♀ ♀. 6-III-32.

Types: Peabody Museum of Yale University. Paratypes: British Museum, 1 retained.

Male: (Type only.) Shell ovate, umbone moderately prominent, dorsal margin straight, passing almost imperceptibly into hind margin; about 15 growth lines, outermost and innermost very faint; free margin and outer 2-3 growth lines with minute spines. Pits of shell sculpture moderately large but so shallow as to be obscure. Rostrum of ♂ acute (extreme end minutely truncated); posterior angle of rostrum rounded; anterior and posterior margins of rostrum nearly parallel. Supraorbital margin of head sinuous. First antennae with about 14 lobes; 2nd antennae with both rami of 12-14 joints; spines on anterior margins of joints smooth, or a few slightly ctenate. Twenty-two pairs of legs; inner margin of the "hand" of prehensile legs with strong notch in 1st pair, slightly sinuous in 2nd pair; "thumb" broad; spinous patch long and narrow in both pairs. Last 14 pedigerous segments armed dorsally (spine-formula from behind forward: 1, 1, 1, 1, 3?, 3, 3, 3, 3, 3, 3, 2, 1, 1). Telson with claws markedly asymmetrical, each preceded by 14 smooth, very unequal denticles, of which 1 near the middle of the row is about as large as the first. Furcal claw with 7 plumose setae on the dorsal, inner margin. Dimensions of shell: 10.6 x 6.9 mm.

Female: Shell as in ♂, but with umbones much less prominent; about 12 growth lines, the outermost very faint. Rostrum sharply acute. First antennae with about 18 lobes; 2nd antennae with both rami with 11-13 joints; spines on joints as in the ♂. Twenty-two pairs of legs; 1st pair with 6th endite extending as far as distal end of flabellum or beyond; palp

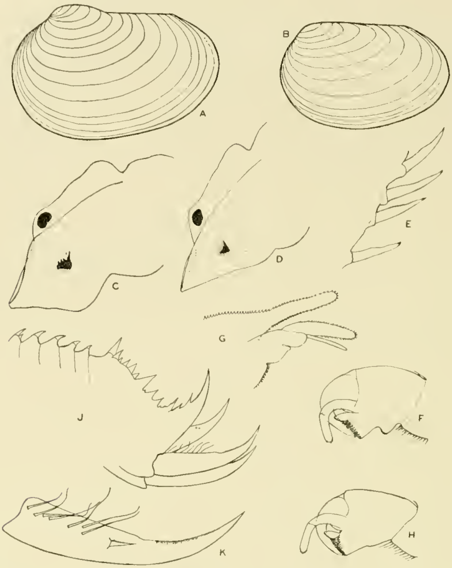

FIGURE 18.—**Eocyzicus hutchinsoni.** A, B, shells of ♂ and ♀ from left side (× 5.8). C, D, heads of ♂ and ♀ from left side (× 13.5). E, spines on anterior side of 1st joint of anterior ramus of 2nd antenna of ♀ (× 135). F, left 1st hand of ♂ from behind (× 18). G, distal part of right 1st leg of ♀ from behind. The position of some of the setae is indicated by their bases (× 21). H, left 2nd hand of ♂ from behind. (× 18). J, telson of ♂ from left side (× 22). K, right furcal claw of ♂ from left side (× 44).

of 5th endite extending nearly to end of 6th endite; 5th endite much less than half as long as 6th; 4th endite without palp; notches between endites shallow; 9th and 10th pairs of legs ovigerous. Last 15 or 16 pedigerous segments armed dorsally (formula of type, from behind forward: 3, 3, 3, 5, 5, 5, 5, 6?, 5, 5, 4?, 3, 3?, 1, 1, (1)). Telson with claws less asymmetrical than in ♂, preceded by about 26 smooth, unequal denticles, with 1 very prominent near the middle of the row. Furcal claw as in ♂. Dimensions of shell: 8.8 x 5.5 mm. Eggs rugose.

Eocyzicus deterrana n. sp.

Locality: PUNJAB: Rawalpindi District, Sohawa. About 45 ♂ ♂ ♀ ♀. 3-III-32.

Types: Peabody Museum, Yale University. Paratypes; Indian Museum; retained.

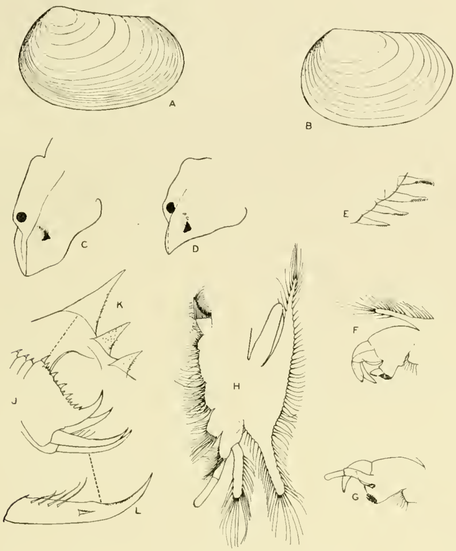

FIGURE 19.—**Eocyzicus deterrana.** A, B, shells of ♂ and ♀ from left side (× 7). C, D, heads of ♂ and ♀ from left side (× 13.5). E, spines on anterior side of 1st joints of anterior ramus of 2nd antenna of ♀ (× 135). F, G, left 1st and 2nd feet of ♂ from behind (× 18). H, left 3d leg of ♂ (× 20). J, telson of ♂ from left side (× 22). K, enlargement of part of J (× 135). L, right furcal claw of ♂ from left side (× 44).

Male: Shell ovate, umbone low; dorsal margin straight, often making a definite angle with hind margin; about 14 growth lines, the outer ones obscure and crowded; free margin and outer 3-4 growth lines with minute spines. Pits of shell sculpture small, very shallow, difficult to observe. Rostrum of ♂ acute, nearly a right angle; posterior angle of rostrum very obtuse. Supraorbital margin of head straight. First antennae with about 16 lobes; 2nd antennae with both rami of 11-12 joints; spines on anterior margin of joints smooth or ctenate. Twenty-two pairs of legs (5 specimens); inner margin of "hand" of prehensile legs with slight notch in 1st pair; nearly straight in 2nd; "thumb" square in 1st pair, slightly broader in 2nd; in both pairs base of spinous patch of thumb only slightly longer than the spines. Last 15 (about) segments armed dorsally (spine-formula of type, from behind forward: 1, 1, 3, 3, 3, 4, 4, 5, 5, 5, 5, 4, 2?, 2, 1).

Telson with claws moderately asymmetrical, each preceded by about 12 very unequal denticles, of which 2 or 3 near the middle of the row are nearly as large as the 1st; 1st (anteriormost) denticle, and some of those following, armed with very fine spinules. Furcal claw with 4 plumose setae on the dorsal, inner margin. Dimensions of shell: 6.6 x 4.0 mm.

Female: Shell as in ♂ but with umbones even less prominent; about 11 growth lines, the outer ones indistinct and crowded and the inner ones very indistinct. Rostrum acute; supraorbital margin of head sinuous. First antennae with about 14 lobes; 2nd antennae with both rami with 11-12 joints; spines on anterior margin of these joints strongly ctenate. Twenty-two pairs of legs (4 specimens); 1st pair with 6th endite extending as far as distal end of flabellum or beyond; palp of 5th endite extending nearly to end of 6th endite; 5th endite much less than half as long as 6th; 4th endite without palp; notches between endites shallow; 9th and 10th legs ovigerous. Last 14 segments of type armed dorsally (formula, from behind forward: 1, 1, 3, 3, 3, 4, 4, 5, 5, 4?, 3, 3, 1, 1). Telson with claws scarcely at all asymmetrical, preceded by about 17 unequal, mostly armed denticles (as in the ♂) of which 2 or more in the middle of the row are about the size of the first (anteriormost). Furcal claw as in the ♂. Dimensions of shell: 6.0 x 3.8 mm. Eggs rugose.

No such careful piece of work has ever been done on the genus *Eocyzicus* as Barnard (1929) has done for *Apus*, so that the extent of variation within a natural species is not known; nor is it known which of the structural details of these Conchostraca are reliable specific criteria. When such an investigation is made, it may possibly be found that one or both of the above-described species must be reduced to synonymy with others already known, but in the present state of our knowledge of the group it is probably better to describe as new any specimens about which there is reasonable doubt.

The nearest described relative to *E. hutchinsoni* is probably the wide-ranging *E. orientalis* Daday, itself very close to *E. bouvieri* Daday, which differs most conspicuously from the new species in the shape of the rostrum of the ♂, and in the presence of a well-marked palp on endite 4 of the leg 1 of the ♀. *E. deterrana* is most similar to *E. perrieri* Daday, from Tobolsk and Buchara, U. S. S. R., but the latter has only 20 pairs of legs, and the "hands" of the ♂♂ of the two species differ in shape.

Osborn Zoological Laboratory,
Yale University.

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ARTICLE VI

REPORT ON AMPHIPOD CRUSTACEA OF THE GENUS *GAMMARUS*

By Masuzo Uéno

Ôtsu Hydrobiological Station, Ôtsu, Japan

(Received February 21, 1934)

The gammarids here discussed were collected by Mr. G. Evelyn Hutchinson during the Yale North India Expedition in Kashmir, Ladak and the Tibetan borders of North India. The collection, though consisting of only one common species, *Gammarus pulex* (Linné), is highly interesting, as it enables us to ascertain the distribution of gammarids at such unusually high altitudes as 5000 meters and over, altitudes which are believed to be greater than those of any previously known localities for this species. I wish herewith to express my best thanks to Mr. G. E. Hutchinson for kindly permitting me to undertake this work and also for giving me useful information on many matters. I am greatly indebted to Prof. Kenzo Kikuchi of Tôkyô, for the use of his copy of Sars' monograph and to Dr. A. B. Martynov, Leningrad, for supplying me with Chevreux's paper.

1. Localities at which Gammarids Were Collected

The collection consisted of twenty-three bottles of specimens in spirit containing over 150 individuals.[1] As indicated in Table 1, gammarids, though common both in Kashmir and in the most elevated regions, are quite absent in the intermediate localities lying between 1600-3600 meters, a phenomenon that will be discussed in the last chapter of the present paper.

2. Description of the Species

Family: Gammaridae

Genus: *Gammarus* Fabricius

Gammarus pulex (Linné, 1758)

In all characters of specific importance, all the specimens from Kashmir and Ladak agree rather well with the descriptions and figures given by G. O. Sars (1895, pp. 503-505) and Stebbing (1906, p. 474) for the typical form of *Gammarus pulex* (Linné). There are, however, several important features to be noted peculiar to the North Indian specimens, especially those from Kashmir and the western part of Indian Tibet, north of the Ladak Range, when compared with material discussed by several authors (Chevreux 1908, Martynov 1930, Schäferna 1922, Spandl 1923 and 1924, Tattersall 1914 and 1922) who have studied the variation of certain characters of this species from different localities.

[1] Since the material was sent to Dr. Uéno a few more specimens have been found in miscellaneous collections from several localities. These additional localities are recorded in a note appended to the present paper. —*G. E. H.*

(1) The accessory flagellum of the first antenna. The number of the joints of the accessory flagellum of the first antenna is given as four by Sars (op. cit.), Stebbing (op. cit.), and Chevreux and Fage (1925), but the present specimens show considerable variation in the number of these joints; in most cases 2 or 3 and rarely only one. The specimens with typical 4-jointed accessory flagella were chiefly collected from the localities in Kashmir at altitudes between 1200-1600 m., while the specimens collected from the higher Ladak localities have usually 2-jointed flagella, rarely 3- or 4-jointed ones.

TABLE 1

List of the Localities in which the Gammarids were Collected

NOTE:—K . . . the localities in Kashmir; L . . . the localities in Indian Tibet (Ladak); the figures within brackets show the number of specimens examined.

No. of station	Locality	Altitude		Date	Remarks
		In feet	In meters		
K 1	Rampur	c. 4000	c. 1200	18-III-32	An irrigation ditch (5)
K 2	Takht-i-Sulaiman, Srinagar	c. 5200	c. 1585	20-III-32	Swamp at base of hill (8)
K 15	East of Gagirbal road	c. 5190	c. 1580	30-III-32	A closed swampy pool (5)
K 19	East of Gagirbal road	c. 5190	c. 1580	31-III-32	A closed swampy pool (4)
K 23	Nishat Bagh	c. 5200	c. 1585	7-IV-32	A stream (11)
K 24	Nishat Bagh	c. 5200	c. 1585	7-IV-32	A pond (16)
K 43*	Wular Lake	5160	1573	17-IV-32	Littoral at Kiuhnus spring (3)
Camp 9	Man (C. G.)	14008	4269	6-VII-32	Lagoon at Man by Panggong tso; townetting (2)
L 40(a)	Panggong Tso	13915	4241	29-VII-32	N. W. end (12)
L 40(b)	Panggong Tso	13915	4241	7-VII-32	N. W. end; littoral of 60 cm. (7)
L 40(c)	Panggong Tso	13915	4241	29-VII-32	N. W. end; a bottom of 31 m. collected by Ekman-Birge dredge (5)
L 49	Togom Tso	17506	5334	9-VII-32	(3)
L 52	Ororotse Tso	17381	5297	12-VII-32	Margin of the lake (4)
L 60	Kyam	c. 15500	c. 4725	21-VII-32	Pool (5)
L 72	Chushol	14228	4336	9-VIII-32	Pool by pond (6)
L 75	Tukmuru Tso	14385	4385	16-VIII-32	Smaller part of the lake (1)
L 76	Mitpal Tso	15998	4875	23-VIII-32	A vertical haul (3)
L 78†	Yaye Tso	15373	4686	11-VIII-32	(1)
L 81	Khyagar Tso	15330	4672	26-VIII-32	On anchor rope; mostly 5-10 m. depth (25)
L 82(a)	Tso-Moriri	14850	4528	30-VIII-32	At N. end, weed in estuarine water (17)
L 82(b)	Tso-Moriri	14850	4528	27-VIII-32	Vertical haul, 30-0 m. (1)
L 85	Sta-rtsak-puk Tso	14885	4536	2-IX-32	(3)

* The specimens labelled K 42.

† The localities numbered from L 78 to L 85 are located south of the Ladak Range.

(2) The form of the lower hind corners of the second and third pleon somites. With regard to this character Sars (op. cit.) writes that "last pair of epimeral plates of metasome but very little produced at the lateral corners." Stebbing (op. cit., p. 474) also describes them as "simply quadrate." On the contrary, Chevreux (1908, p. 98), who studied an Asiatic race of this species, pointed out that the lower posterior angle of the third pleon somite is prolonged and sharply pointed. A similar description is also given by Chevreux and Fage (1925, p. 254). Tattersall (1914, p. 213) also shows that the specimens of *G. pulex* from the Pamirs at an altitude of 15,600 feet have the third pleon somite with a considerably more produced and pointed lower hind angle than figured in Sars' monograph.

The present specimens from North India, especially those from the localities nos. K1-L76, have also the third pleon somites with considerably produced lower hind corners, such as is seen in those described from high alpine regions in Asia by the above-mentioned authors. In this feature the present specimens are much more allied to *Gammarus ocellatus* described by Martynov (1930) from Lake Issyk-koul in Turkestan than to the typical form of *G. pulex*. This prolongation is more marked in the specimens from the lower Kashmir localities (Plate IV, figs. 1-7) than those from the high Ladak localities (Plate IV, figs. 8-10), and the specimens from the localities L 78 to L 82 (Plate IV, figs. 11, 12) have the third pleon somite with much less produced angles which remind us of those of the typical form of *G. pulex* as figured by Sars.

The number of spinules on the lower margins of the third pleon somite is in most cases 6, but varies rather considerably from 3 or 4 to 9.

(3) The number of spinules on the last three pleon somites. In most cases 2 median dorsal and a pair of 2 lateral spinules are present on each side of both first and second pleon somites. On the last somite the median dorsal spinules are usually absent or with only a single median. The specimens of Togom Tso (L 49, the highest locality) and Ororotse Tso (L 52) have only 1 or 2 median dorsal and one pair of lateral spinules, or even none developed at all. Some examples of the arrangement of these spinules in the specimens from various localities are shown in Table 2.

(4) Telson. The telson is usually a little longer than the length of the peduncles of the third uropods, except a few cases (*e.g.*, L 81), in which the telson is nearly as long as the peduncles of the third uropods. The specimens with the former type of telson, viz., longer telsons, are very closely allied to Martynov's *Gammarus ocellatus* (loc. cit.). Both lobes of the telson are more elongated and provided more richly with setae in the specimens from the lower Kashmir localities (Plate V, figs. 1-4) than in those from the higher Ladak localities, especially from L 78-L 82 (Plate V, figs. 5-7). Thus the specimens from the last-named localities have the telson of the typical form of this species, while the form of the telson of those from the lower localities rather resembles that of *G. ocellatus*.

The telson has usually 2 or 3 terminal spines, as seen in Table 2. A single lateral spine near the base of each lobe figured by Sars is not seen in the present specimens.

(5) The inner ramus of the third uropod (Plate V, fig. 8) is usually shorter than the outer ramus, about 4/5 of the latter. The arrangement of the spines and fringes of plumose setae on both rami varies considerably in the specimens from different localities.

(6) The form and size of the second joints of the last three pereiopods are rather different not only in both sexes collected in the same locality, but also in the specimens from different localities. Generally, the specimens from the lower Kashmir localities have the pereiopods

TABLE 2

Arrangement of Spinules on the Last Three Pleon Somites and the Number of Apical Spines of Telson[2]

Locality	K 1	K 15	K 19	K 23	K 24	K 24	
Sex	?	♂	♂	?	♂	♀	
P1	1, 4, 2	2, 0, 2	2, 2, 2	2, 2, 2	2, 2, 2	2, 2, 2	
P2	2, 2, 2	2, 2, 2	2, 2, 2	2, 2, 2	2, 2, 2	2, 2, 2	
P3	1, 0, 1	2, 0, 2	2, 0, 2	2, 0, 2	2, 0, 2	3, 0, 2	
Telson	2, (0)	2, 2	2, 2	2, 2	2, 2	2, 2	
Locality	L 40*	L 40†	L 40‡	L 49	L 49	L 52	L 60
Sex	♂	♂	♂	♂	♀	♂	♂
P1	2, 2, 2	2, 2, 2	1, 2, 2	0, 0, 0	0, 0, 0	1, 1, 1	1(?), 1, 2
P2	2, 2, 2	2, 2, 2	2, 2, 2	0, 0, 0	0, 0, 0	1, 2, 1	2, 2, 2
P3	3, 0, 2	2, 0, 2	2, 0, 2	0, 0, 0	2, 0, 2	1, 1, 1	2, 0, 2
Telson	2, 1	2, 2	2, 2	–, –	1, 1	2, 1	2, 3
Locality	L 72	L 75	L 76	L 78	L 81	L 82	L 85
Sex	♂	♀	♂	♂	♂	?	? ♀
P1	0, 0, 0	2, 2, 1	1, 0, 0	2, 2, 2	1, 2, 1	2, 2, 1	1, 2, 2
P2	2, 2, 2	2, 2, 1	1, 1, 1	3, 2, 2	1, 2, 1	3, 2, 2	2, 2, 2
P3	2, 1, 2	1, 0, 1	1, 1, 1	2, 0, 1	1, 0, 1	3, 0, 2	1, 1, 2
Telson	2, 2	3, 2	broken	2, 2	3, 3	2, 2	2, 2

* N. W. end. † Littoral. ‡ Bottom at 31 m.

3-5 with narrower and more elongated second joints. The hind margins of the second joints in these limbs are much more convex in the female (Plate III, figs. 5-7) than in the male (Plate III, figs. 8, 9), but their lower hind angles are rounded in both sexes. The second joints in these limbs show a tendency to become reduced in length in the specimens from higher altitudes (Plate VI). For instance the specimens from L 49 have the last three pereiopods with the rather short second joint about 2/3 to 4/5 as wide as it is long, so that they resemble very closely those of typical *G. pulex*; their lower hind corners are somewhat produced, their hind margins more convex and the front margins often without spines or setae.

(7) The length and the number of the joints of the flagellum of the first antenna.

The length of the first antenna is nearly as long as or a little shorter than half of the body in the specimens from the high Ladak localities, but in the specimens from the lower localities it is often much shorter than half of the body. The number of joints in the first antenna shows considerable variations, as Spandl (1923 and 1924) noticed in some European forms of this species. Some examples are shown in Table 3. In larger individuals this flagellum is composed of 25-28 joints, often reaching as many as 38 joints in some large specimens from the lower localities, while the specimens from the very high localities (L 49, L 52, etc.) have flagella of a much smaller number of joints.

[2] The figures between two commas are the number of median dorsal spinules.

TABLE 3

Measurements of *Gammarus pulex* (Linné) from North India

Group	Locality	Altitude in meters	Sex	Length of body in mm.	Length of I. antenna in mm.	Number of joints of I. antenna *min.* | *max.*	Number of joints of accessory flagellum *min.* | *max.*	Number of joints of II. antenna *min.* | *max.*
I A	K 1	1200	♀	20	10	35	4	18
	K 2	1585	♀	19 – 21	11 – 12	33 – 38	2 – 4	14 – 17
	K 2	1585	♂	15 – 17	8 – 8.5	26 – 32	4 – 4	11 – 12
	K 15, 19	1580	♂	19 – 20	10 – 11	35 – 38	4 – 4	16 – 18
	K 23	c. 1585	♂	15	8.5	29	4	15
	K 23	c. 1585	♀	10	6.5	23	3	9
	K 24	c. 1585	♂	13.5	8	29	3	12
	K 24	c. 1585	♀	10	6.5	24	3	11
I B	L 40a	4241	♂	18 – 20	8 – 9	25 – 28	2 – 3	13 – 16
	L 40b	4241	♂	15 – 17	7.5 – 8	25 – 28	1 – 3	13 – 14
	L 40c	4241	♂	17 – 17	8 – 8.5	27 – 31	2 – 3	14 – 16
	Camp 9	4269	♀	16	8	28	2	11
	L 49	5450	♂	12	?	?	2	9
	L 49	5450	♀	14	4	16	2	7
	L 52	5297	♂	16 – 17.5	6.5 – 8.5	19 – 25	1 – 2	12 – 15
	L 60	4725	♂	16.5	8.5	28	4	?
	L 72	4336	♂	21	9	26 – 28	3	14 – 15
	L 72	4336	♀	16	7	?	?	?
II	L 75	4385	♀	c. 10	?	20	2	11
	L 76	4875	♂	15	6	21 – 22	2	13 – 16
	L 78	4686	♂	16	7	22	2	12
	L 81	4672	♂	17 – 17.5	6	19 – 21	2	14 – 15
	L 82	4528	a ♂	12	5.5	20	2	8
	L 82	4528	b ♂	18	9	28	2	14
	L 85	4536	♂	12	6	21	2	13

The number of the joints of the flagellum in the second antenna also fluctuates greatly, from 11 to 18, sometimes as few as 7, 8, or 9. The presence of calceoli on this antenna of the male was not detected in all of the present specimens.

(8) Some other characters. The ecologically most interesting feature is the relative size of the gill-lamallae in the specimens from different localities, particularly at different altitudes. In the individuals from the lower Kashmir localities the branchiae are relatively smaller in size than in the specimens obtained from the higher localities. Several examples of gills of the specimens of nearly same body length are shown for comparison in Plate VII. Dodds and Hisaw (1924) demonstrated the comparable fact that in swift and well-oxygenated waters the respiratory organs of some aquatic insect larvae show a tendency toward reduction.

The bodies of the specimens from the Kashmir localities and the higher districts beyond the Ladak Range have good deposits of lime and are rather hard and fragile, while those from the localities south of the Ladak Range have relatively soft bodies with poor deposits of linre. The former form has a larger body and is less hairy than the latter form, which is often provided with very rich hairs.

A similar phenomenon was also noticed when comparing the littoral and pelagic forms; the body of the latter, taken by a vertical haul, is softer and much more beautiful than the former.

* * * * *

Examining and comparing many specimens from various localities, I came to the following conclusion. In North India, both Kashmir and Ladak, there appear to be distributed at least two different races of *Gammarus pulex*, though there exist some transitional forms which are difficult to separate distinctly from one or both of them. One form, which has the shortened antennae, the elongated telson, the slenderer second joints in the pereiopods 3, 4 and 5, and the third pleon somite with considerably prolonged and pointed hind corner, is found in both lower Kashmir localities (Table 3, I A) and the higher localities in Indian Tibet north of the Ladak Range (Table 3, I B). The other form, which strongly exhibits the typical features of *G. pulex*, was collected in the localities south of the Ladak Range, within and south of the basin of the Upper Indus River (L 78 to L 85). In the intermediate districts in the Ladak Mountains south of Panggong Tso (L 75, L 76, etc.), there is found a transitional form between the above-mentioned two forms.

The first-mentioned form (Kashmir localities and L 40-L 72) is very closely allied to *Gammarus ocellatus* Martynov of Lake Issyk-koul in Turkestan, but differs from that in having smaller eyes. Although this form has some peculiar features such as the prolongation of the lower hind corner of the third pleon somite, I believe there is no reason to establish a new species for it with such characters as already discussed. In view of the great variation in some characters which are regarded as of specific importance by many authors, we would be compelled too often to create a new species or subspecies (cf. also Spandl 1923 and 1924, especially the latter paper, p. 451). Moreover, on the other hand, a comparative study of numerous specimens from different localities makes it difficult to separate them into one or more distinct species or subspecies. As in some other Crustacea, such as *Daphnia* and *Bosmina* among the Cladocera, especially pelagic forms of them, it seems quite natural that *Gammarus pulex* may also become highly differentiated into numerous races in various localities, and many forms among the species ascribed to *Gammarus* with very close relationship to *pulex* should be regarded as the local differentiates of *G. pulex*. With this in mind, I have referred all the present specimens to one common species, *G. pulex*, avoiding the use of a number of specific names for different forms. *Gammarus ocellatus* Martynov, *G. ocellatus minor* Martynov and *G. bergi* Martynov, all described from Lake Issyk-koul of Turkestan, may be thus regarded as the different races (probably subspecies) of *G. pulex* which have been developed in that locality.

Since the above was written, a paper relating to some gammarids from the western parts of Asia was published by Karaman (1934). In this paper (pp. 127-129), Karaman has described a new gammarid, *Rivulogammarus stoliczkae*, whose type-specimen was collected by Stoliczka in 1864 in the vicinity of Lake Tso-Moriri, Prov. Rupschu, Ladak. According to the original description, this new gammarid is characterized by the 3-jointed accessory flagellum of the first antennae, the rather long dactyli of pereiopods, and by the second and third pleon somites, each with pointed hind corner and provided with long setae on the lower margins, and so forth. Karaman stated that such characters as the longer dactyli and long setae on the pleon somites show that the animals may have been originated from a deep lake. The Yale North India Expedition brought back two samples of gammarids of Tso-Moriri (L 82), one being captured among the weeds of the estuarine water at the north end of the lake and the other (only one individual) obtained by a vertical haul (30-0 m.). These specimens agree rather well with the typical *Gammarus pulex* in various characters, except the third pleon somite which has a somewhat produced hind corner. The elongation of the dactylus of each pereiopod as noted by Karaman is also seen in our specimens from Tso-Moriri, not only in an animal obtained by a vertical haul, but also in many individuals collected among the littoral weeds. In the other localities, *e.g.*, Mitpal Tso (L 76), Khyagar Tso (L 81), etc., relatively longer dactyli were usually observed only in the forms obtained by vertical hauls, so that such a character seems to be peculiar to the forms of free-swimming life or of deep water inhabitants, as Karaman suggested. In other words, it must be regarded as an ecological character due to the peculiar nature of environments; it is not of specific importance.

With regard to *Rivulogammarus stoliczkae*, Karaman has pointed out no clear differential diagnosis from the other allied forms, only writing as ", so jener des *R. pulex* oder *R. balcanicus* nichts Gemeinsames" (p. 129). In some crustaceans like gammarids, which show great variations in various body parts according to difference of environment, it is a very difficult matter whether we are to recognize various forms with slightly different characters as a separate new species or to treat all different forms as variations of a single species. In regard to the various forms of gammarids from Kashmir, Ladak and Western Tibet, as already discussed in the foregoing pages, it is my present opinion that it is best to distinguish all the related forms as the peculiar local races or subspecies of *Gammarus pulex*, thus avoiding the use of one or two new specific names for those forms. As Karaman (1. c. p. 128) writes as "Oberflächlich einen *R. pulex* ähnlich," *R. stoliczkae* may also be a local race (subspecies) of the *pulex*-series of *Gammarus* (s. lat.), which has differentiated in this region of Asia. Karaman, moreover, noted that *R. stoliczkae* may belong to the oriental group of *Rivulogammarus* (l. c. p. 129).

The genus *Rivulogammarus* has been used by Karaman for certain forms of the *pulex*-series of *Gammarus*, including *pulex* itself. I have at present only very scant knowledge as to the validity of this genus, because I have been unfortunately unable to see its original description. If this genus is adopted, all the forms here concerned may be placed under it. As far as I am able to understand, it seems to me that it may be better to use the generic name *Rivulogammarus* as a subgenus of the genus *Gammarus*. In the present paper, therefore, with this in mind, I have referred all the forms to the genus *Gammarus* (s. lat.).

3. Distribution and Its Limiting Factors

A. Geographical Distribution

So far as our present knowledge goes, *Gammarus pulex* (Linné) is the commonest freshwater amphipod, being distributed over the Palaearctic region, from England to Japan and some parts of North Africa, but not found in America. In the high altitudes in Asia, Chevreux (1908) recorded this species from some parts of Turkestan, such as Lake Issyk-koul (1615 m. above the sea), the Pass of Karacolum (2000 m.), Lake Tchatyr-koul (3200 m.), etc. From the first-named lake, Martynov (1930) also recorded *G. pulex* together with two other new species and one new subspecies (see foregoing chapter). Tattersall (1914) first recorded this species in the region north of India near the western part of Tibet. He found *G. pulex* in a collection made in a pool on the summit of Killik Pass between the Northern Hunza Range and the Taghdunkash, Pamir (15,600 feet) and in pools near the banks of the Killik River. The former locality is the highest hitherto recorded as the habitat of *G. pulex*. Therefore, the discovery of this species in Togom Tso (5334 meters or 17,506 feet) on the western border of Tibet by the Yale North India Expedition may be stated to give a new record, surpassing the altitude of the Pamir locality mentioned above. The Russo-German Pamir Expedition in 1928 also collected *G. pulex* which was examined by Dr. A. B. Martynov.[3]

In the other parts of Asia, especially east of India, we have only a few records of this species. Tattersall (op. cit.) noted its occurrence in Lake Tali Fu (Erh Hai, Shan-kuan), Yunan, China, at an altitude of c. 7000 feet. In Japan *G. pulex*, first recorded by Tattersall (1922) from Lake Biwa, is common everywhere, though in the northern parts it is replaced by *G. annandalei* Tattersall which is also distributed in China (Tai-Hu, Shanghai).

As described in the foregoing chapter, the *G. pulex* of Lake Issyk-koul has some peculiar characters compared with the typical form of the species, and the specimens of the same species collected by the Yale North India Expedition resemble rather closely those from Lake Issyk-koul. It is supposed from this fact that such races of *G. pulex* are rather widely spread in the vast areas of the high alpine regions in Asia.

G. ocellatus, *G. ocellatus minor* and *G. bergi* are the representative races of the North Indian and Turkistan differentiation of *G. pulex* in Asia. The races of the typical form are distributed in the plain areas from Europe to Japan. The centre of distribution of the alpine races is not ascertained at present.

B. Distribution in Kashmir and Ladak, and Its Limiting Factors

As seen from a glance at the list of the localities in which *G. pulex* was collected (Table 1), its distribution in North India is very peculiar and interesting. The species is common in Kashmir at altitudes up to about 1600 m. It is however quite absent in the lower parts of Ladak to the east of Kashmir (1600-3800 m. above sea level), but it reappears again near the Tibetan borders at altitudes over 3800 m. It is quite common in the lakes of these high alpine regions, among which Lake Togom Tso is the highest locality, as mentioned already. I shall discuss below shortly the very interesting problem as to what factors might cause such a peculiar regional distribution.

1. *Physical and Chemical Factors*

A number of physical and chemical determinations made on waters from many localities during the expedition is summarized in the following table (Table 4).

a. Water temperature. The water temperature does not seem to limit the occurrence of *G. pulex* in the area investigated, since it ranges from 0°C. to as high as 22 C. As generally known, this species is an eurythermal ubiquitous crustacean.

[3] These specimens from Pamir differ from the typical form of the species by having somewhat larger eyes (Dr. Martynov, personal communication dated May 27, 1933).

TABLE 4

Physical and Chemical Conditions of the Waters In North India

Locality	Altitudes in meters	Water temp. °C.	Alkali reserve (Methylorange titration)	pH	*Gammarus*
1. Kashmir localities	1200-1600	11.9-19.0	0.0014-0.0017 N	8.3-9.3 (diurnal variation of K 19)	present
2. Intermediate localities..	1600-3800	7.0-19.0	0.0007-0.0036 N	7.2-8.6	absent
3. High Ladak localities..	3800-5400	0.0-22.0	0.0003-0.0610 N	7.1-9.6	present

b. Chemical factors.

i. Dissolved oxygen content. *Gammarus pulex* is a mesoxybiont (after Steinmann and Surbeck, quoted in Wundsch) which demands water rather rich in dissolved oxygen. Though I have at hand no data of the dissolved oxygen in the waters of Kashmir and Ladak, it is difficult to suppose that the dissolved oxygen may play a great part as a limiting factor. According to Dr. Hutchinson's information, Lake Khyagar Tso in Ladak had an absolute oxygen deficiency on the bottom. The gammarids in that lake seemed to be living as a free-swimming form in open water, since immense numbers of them were found settling on the anchor rope while one was making limnological observations.

ii. Salt content of water, especially calcium. The correlation between the distribution of *Gammarus* and some chemical environmental factors, especially calcium dissolved in water, is discussed by several authors (cf. also Pia 1933). Thienemann (1912) found that the gammarids in the torrents of Baumberg districts, rich in calcium, are larger in size than those found in the torrents of Sauerland, where the water is very poor in calcium. Wundsch (1915) observed in the Sieg, a branch of the Rhein, that *Gammarus pulex* entirely disappears from a biocoenosis when the calcium content of the water becomes less than 9-10 mg. per litre. Schumann (1930) writes that at least 13 mg. per litre of $CaCO_3$ is necessary for the formation of the shell of *Gammarus*, because newly ecdysized gammarids with soft bodies take up the lime for building up their shells in the state of bicarbonate from the water and then make it monocarbonate in their bodies. Since CO_2-free water can dissolve only 13 mg. per litre of $CaCO_3$, below this lime content gammarids cannot use the lime for the formation of their shells, being obliged to live as soft-bodied animals which have no external protection against osmotic action. On the contrary, Pentland (1930) concluded that the chemical composition of the water does not appear to control the distribution of *Gammarus*, the temperature of water, vegetation, and the presence of enemies alone limiting the distribution. Schlagintweit (cited by Hesse 1924) reported an interesting fact that in Ladak the Púga torrent, rich in borax, is favourable for crustaceans and fishes.

A study of the physico-chemical data relating to North Indian waters, presented above in Table 4, makes it very difficult to correlate the non-occurrence of *Gammarus* with the alkaline reserve and the pH-values of the waters in the zone between 1600 m. in Kashmir and 3800 m. in Ladak. The waters containing gammarids at high altitudes often have a lower alkaline reserve and lower pH-values than those in intermediate region where *Gammarus* does not occur. According to Schumann (op. cit.), the optimum pH of the water for *Gammarus* is about 7.2-7.8 and, when the value falls below 6.5, the water has a toxic effect upon *Gammarus*.

Besides such a chemical relation in the area of the present investigation, all of the flowing water in the intermediate region has run down from high valleys at altitudes at which the species occurs. It seems therefore very improbable that such a peculiar distribution is to be explained by chemical factors alone, though in some other parts of the world, as quoted above, calcium content of waters would play an important rôle in this respect. It must be added that *Gammarus* was found in immense numbers in Lakes Panggong Tso and Khyagar Tso in Ladak, both having water of brackish nature.

2. *Biological Factors*

The types of habitat of *G. pulex* in the area of investigation vary very much, including swampy pools covered with *Lemna*, large open-water lakes and streams with a rapid flow. There may therefore be no lack of food for *Gammarus*, although I have at present no data relating to this point. Pentland (op. cit.) is of the opinion that the food vegetation is one of the important limiting factors upon the distribution of *Gammarus*. If the source of lime upon which *Gammarus* depends should be in some plants containing calcium compounds, such as *Chara* or *Lemna*, as suggested by Schumann (op. cit.), the absence of such plants in the intermediate region in Kashmir must be considered.

Finally, there is a more important biological factor, namely natural enemies, especially fishes. On this point, Dr. Hutchinson wrote to me that "the presence or absence of fish cannot be a complete explanation for the distributions, because *Gammarus* may be taken in streams and lakes where there are many fish, as in the stream between Tangtse and Mugleb, and in Pangur Tso and Yaye Tso, and there is no very great difference between the fish fauna of the upper and intermediate zones." However, in the brackish-water-lake Khyagar Tso, *Gammarus* was found very abundantly, swimming in the open water, and in this locality its abundance is probably correlated with the complete absence of fish. Such a case was also observed in some Japanese lakes, where there was an abundance of gammarids before the introduction of trout, and Pentland (op. cit.) also writes that the presence of trout appears to control the distribution of *Gammarus*. If fish are in any way a limiting factor for *Gammarus* in North Indian localities, it is probable that the presence of genus *Schizothorax* of the family *Cyprinidae* rather than of fish in general is concerned. According to Dr. Hutchinson's statement, he observed no locality in which *Schizothorax* occurs with *Gammarus* except Wular Lake in Kashmir.

Note by the Biologist of the Expedition

Gammarus was found in several samples after the collection had been forwarded to Dr. Uéno and examined by him. These samples are enumerated below:

L 37 Between Tangtse and Mugleb, stream, alt. c. 4175 m. 26 June, 1932.
L 38 Two to three miles west of Mugleb, alt. c. 4200 m. 27 June, 1932.
L 47 Chagra, alt. 4636 m., warm spring, temp. 21.7 C. 8 July, 1932.
L 74 Pangur Tso, alt. 4329 m., margin at west end. 12 August, 1932.
L 75 Chushol, spring, alt. c. 4330 m. 12 August, 1932.

All these specimens, except those from the last locality, appear to have a prolonged and pointed hind corner to the third pleon segment and an elongate telson; the *Gammarus* from the spring at Chushol, on the other hand, exhibit indications of the characters of the specimens from the southern part of Indian Tibet, particularly in their shorter telsons. These records, therefore, confirm Dr. Uéno's findings based on the major part of the collections.

The following additional ecological evidence, moreover, supports some of Dr. Uéno's conclusions.

The oxygen content of the immediate environment of *Gammarus* in the high regions of Indian Tibet lay between 5.6 and 7.7 mgrms. per litre. In a stream at Dras, in the intermediate zone and so free from *Gammarus*, it varied from 6.2 to 6.7 mgrms. per litre; and in a swamp at Spitlug, a very favourable habitat in the intermediate zone, again without *Gammarus*, the water in contact with weed was probably supersaturated by day, though no figures relating to this locality are forthcoming.

Gravimetric analyses of the waters of some of the lakes have been made by Mr. J. A. Newlands of Hartford, Conn., and it is now possible to state that the calcium content of the *Gammarus* localities in Indian Tibet varies from 9 parts per million (Ororotse Tso) to 303 parts per million (Panggong Tso). Since the water of the former locality had the lowest alkali reserve encountered (0.0003 N.) it is safe to assume that the waters of the intermediate zone (alk. res. 0.0007 to 0.0036 N.) contained sufficient calcium to support a population of *Gammarus*.

Potamogeton pectinatus Linn. and *Ranunculus trichophýllum* Chaix (kindly determined by Dr. E. D. Merrill and his staff at the New York Botanic Garden) were the dominant species in such of the high *Gammarus* localities as contained higher plants, but more often, as at Ororotse Tso, Togom Tso, Khyagar Tso, Panggong Tso, etc., no higher vegetation occurred. Both *P. pectinatus* and *R. trichophyllum* as well as charophytes occurred in suitable localities in the intermediate zone. It is therefore clear that there is no correlation between the vegetation and the presence and absence of *Gammarus*.

Dissection has shown that the pelagic *Gammarus* of Khyagar Tso is apparently predaceous, feeding on the large, dark, slow-swimming Cladoceran *Daphniopsis*, the deep sepia brown chitin of this form being easily recognizable in considerable quantity in the faecal matter at the posterior end of the alimentary canal of *Gammarus* from a vertical haul taken in this lake. *Daphniopsis* occurred nowhere in the presence of fish (*e.g.*, Pangur Tso, Yaye Tso) though some lakes where no fish were found (Ororotse Tso, Tso-Moriri) lacked also *Daphniopsis*. In view of these findings, taken in conjunction with the results of other workers who have studied the relation of *Gammarus* to fish, quoted above by Dr. Uéno, there can be little doubt that the abundance of *Gammarus* in the closed and mineralized waters of these Central Asiatic lakes is due largely to the absence of fish, which leaves *Gammarus* unmolested on the one hand and on the other introduces no competitor for the most conspicuous source of food of these Amphipods.—*G. E. H.*

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Explanation of Plate III.

Gammarus pulex (Linné) from K 2, Takht-i-sulaiman, Srinagar, Kashmir.

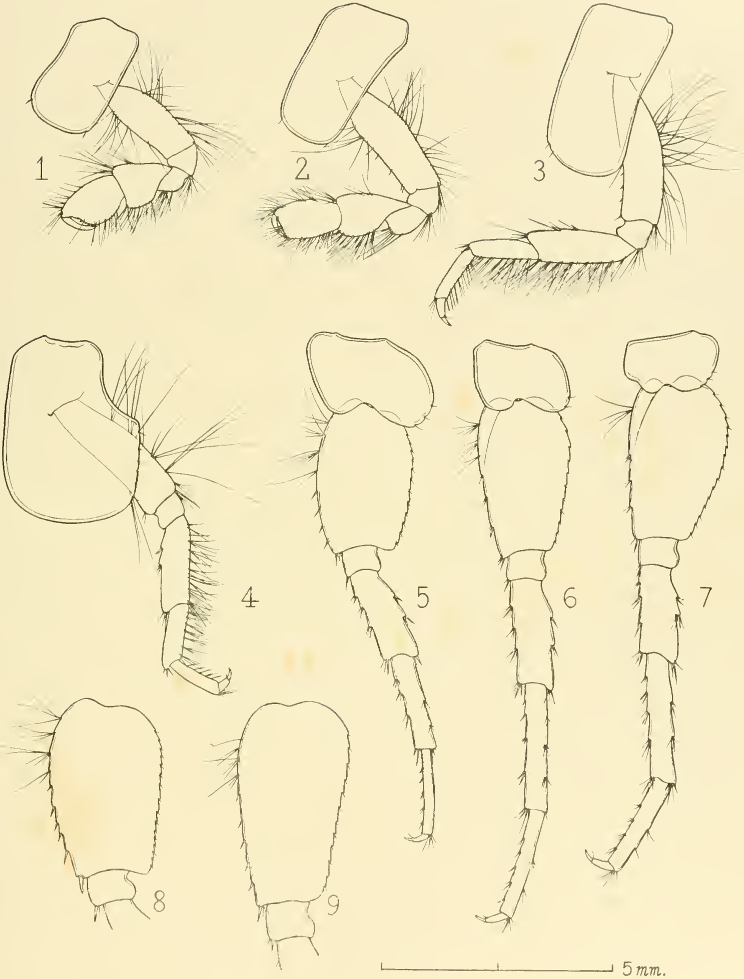
Fig. 1. Gnathopod 1. of female.

Fig. 2. Gnathopod 2. of female.

Figs. 3-7. Pereiopods 1 to 5 of female.

Fig. 8. Pereiopod 3 of male.

Fig. 9. Periopod 5 of male.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Explanation of Plate IV.

Gammarus pulex (Linné)

Epimeral plates of pleon somites

Figs. 1-3. Ep. pl. of pleon 1-3 of female, K 2. Takht-i-sulaiman, Srinagar, Kashmir.

Figs. 4, 5. Ep. pl. of pleon 2-3 of male from the same locality.

Fig. 6. Ep. pl. of pleon 3 of male, K 15, east of Gagirbal Road, Srinagar, Kashmir.

Fig. 7. Ep. pl. of pleon 3 of male, K 23, Nishat Bagh, Kashmir.

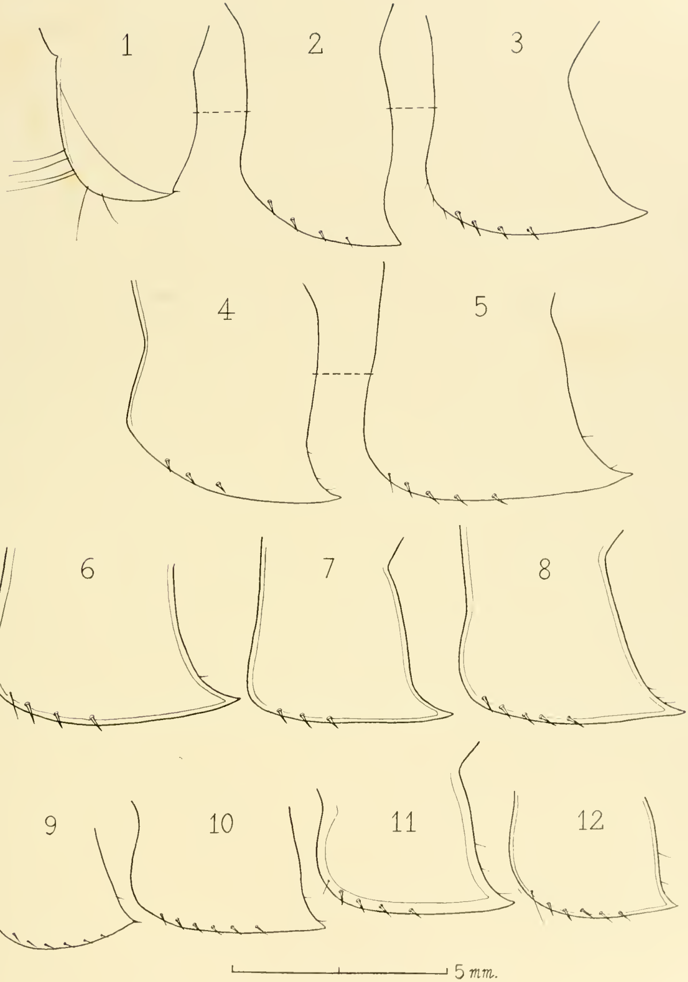
Fig. 8. Ep. pl. of pleon 3 of male, L 40, Panggong Tso.

Fig. 9. Ep. pl. of pleon 3 of male, L 49, Togom Tso.

Fig. 10. Ep. pl. of pleon 3 of male, L 76, Mitpal Tso.

Fig. 11. Ep. pl. of pleon 3 of male, L 78, Yaye Tso.

Fig. 12. Ep. pl. of pleon 3 of male, L 81, Khyagar Tso.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Explanation of Plate V.

Gammarus pulex (Linné)

Fig. 1. Dorsal part of three pleon somites and telson, K 2, Takht-i-sulaiman, Srinagar, Kashmir.

Fig. 2. Telson, dorsal view, K 19, Gagirbal, Srinagar, Kashmir.

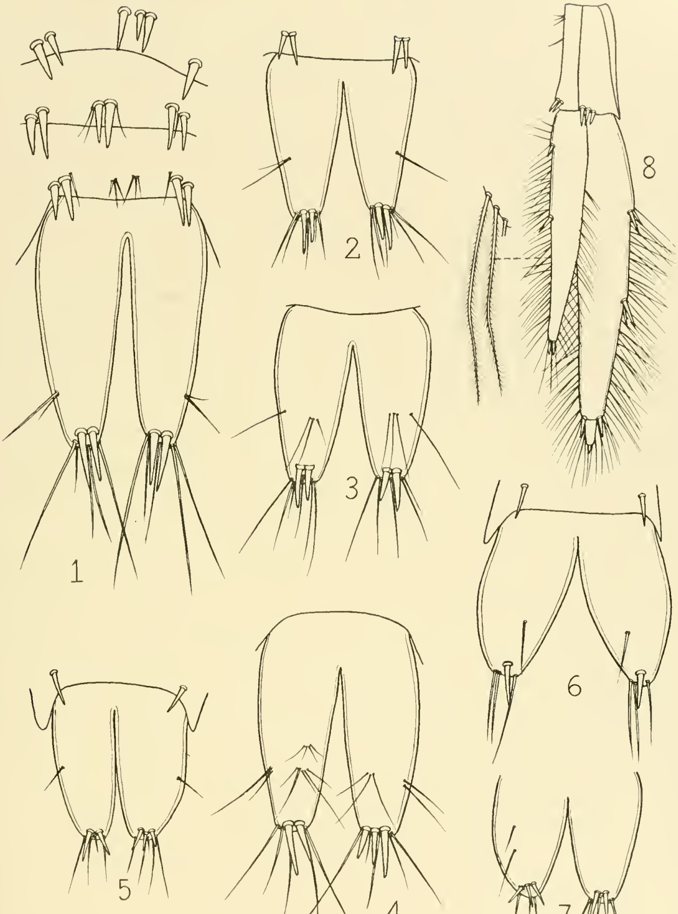
Fig. 3. Telson, dorsal view, K 23, Nishat Bagh, Kashmir, male.

Fig. 4. The same, female.

Fig. 5. Telson, dorsal view, L 78. Yaye Tso.

Figs. 6, 7. Telson, dorsal view, L 81, Khyagar Tso, male.

Fig. 8. Third uropod, K 2, Takht-i-sulaiman, Srinagar, Kashmir.



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Explanation of Plate VI.

Gammarus pulex (Linné)

Fig. 1. Last perciopod of male, L 49, Togom Tso.

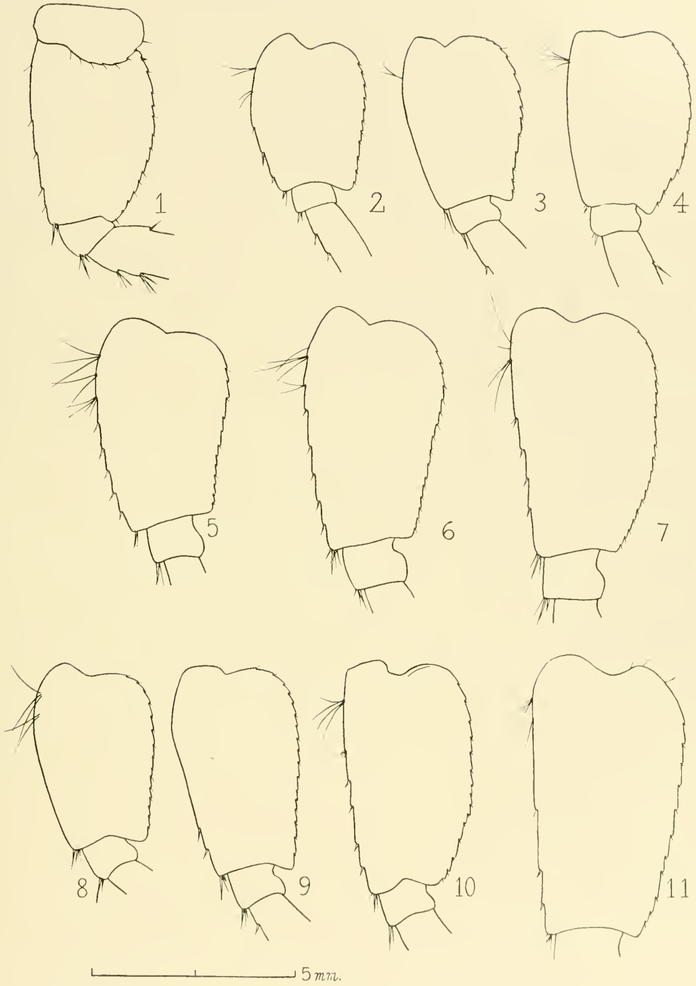
Figs. 2-4. Pereiopods 3-5 of female, L 49, Togom Tso.

Figs. 5-7. Pereiopods 3-5 of female, L 72, Chushol.

Figs. 8-9. Pereiopods 3 and 4 of male, L 81, Khyagar Tso.

Fig. 10. Pereiopod 5 of female, L 81, Khyagar Tso.

Fig. 11. Pereiopod 5 of male, L 72, Chushol.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Explanation of Plate VII.

Gammarus pulex (Linné)

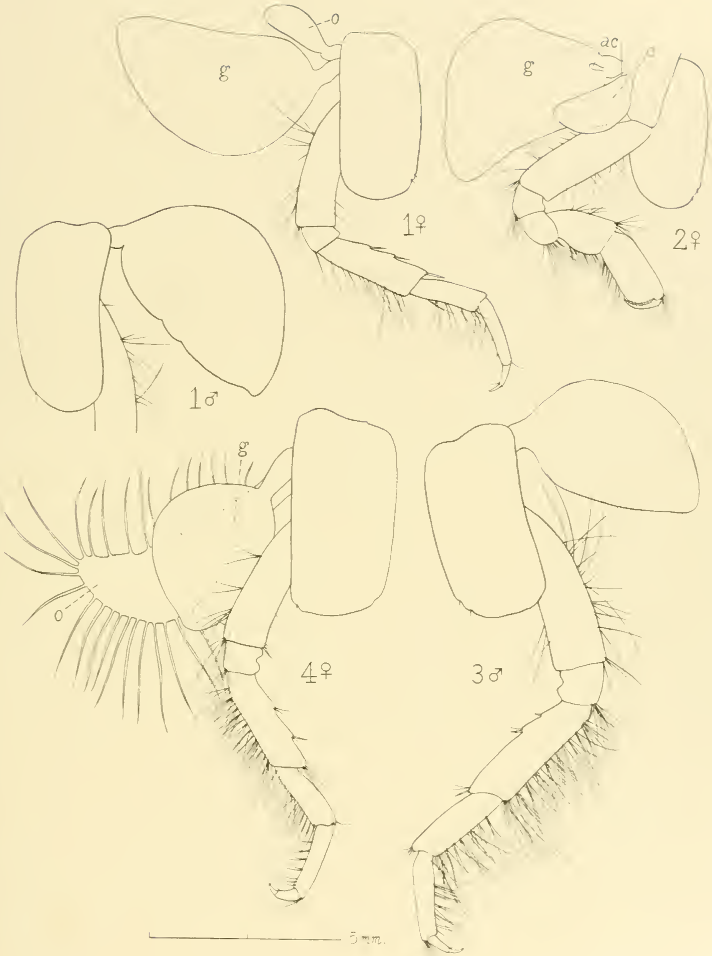
Fig. 1. Pereiopod 1 ♂ and ♀, L 49, Togom Tso.

Fig. 2. Gnathopod 2, inner, L 49, Togom Tso.

Fig. 3. Pereiopod 1 of male, K 23, Nishat Bagh, Kashmir.

Fig. 4. Pereiopod 1 of female, K 1, Rampur, Kashmir.

g. gill-lamella. *ac.* accessory gill. *o. oostegite.*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ARTICLE VII

REPORT ON HYDRACARINA

By O. Lundblad, Stockholm

(Received March 1, 1934)

During the course of the Yale North India Expedition, Mr. G. E. Hutchinson collected some water-mites, which he has asked me to work out. Because of the high altitudes at which the main part of the material was collected, only some few species are represented. Nevertheless the collection is a highly interesting one, forming a very valuable contribution to our poor knowledge of the water-mite fauna of India, and it is a great pleasure to me to offer Mr. Hutchinson my best thanks for giving me the opportunity of studying his material, which contains quite a number of forms new to science.

Family EYLAIDAE

Subfamily Eylainae

1. *Eylais hamata* Koen.

Eylais hamata Koenike, 1897, pp. 282-83
" " Piersig, 1897-1900, p. 427
" *georgei* Soar, 1901, pp. 68-69
" *longipons* Daday, 1901, pp. 94-96
Eulais hamata Piersig, 1901, p. 22
Eylais longipons Daday, 1903, pp. 359-62
" *hamata* Halbert, 1903, p. 506
Eulais marenzelleri Thon, 1905, pp. 158-62
" *hamata* Thon, 1906, pp. 15, 44-45
Eylais " Koenike, 1909, p. 16
" " Koenike, 1910, pp. 152-53
Eulais " Lundblad, 1912, pp. 59-60
Eylais " Lundblad, 1912 a, p. 222
" " Koenike, 1919, pp. 521-24
" " Soar and Williamson, 1920, pp. 110-11
" " *v. alpina* Walter, 1922, pp. 247-49
" " Soar and Williamson, 1925, pp. 59-61
" " Viets, 1921, p. 342
" " Viets, 1928, p. 10

The collection contains some few, more or less mutilated, specimens, mostly without legs and palps.

In all characters still available for study the specimens agree well with European material. The species was found for the first time in Palestine in 1895 and described from German material in 1897. Since then it has been found in many other countries, as will be seen from the foregoing list, which, however, does not complete the synonymy. Earlier authors, who did not possess our present knowledge of the great variability in the genus *Eylais*, have established new species for some slightly aberrant specimens of *E. hamata*. From Asia Minor Thon (1905) described *E. marenzelleri*, which later was withdrawn by Koenike (1910) as a

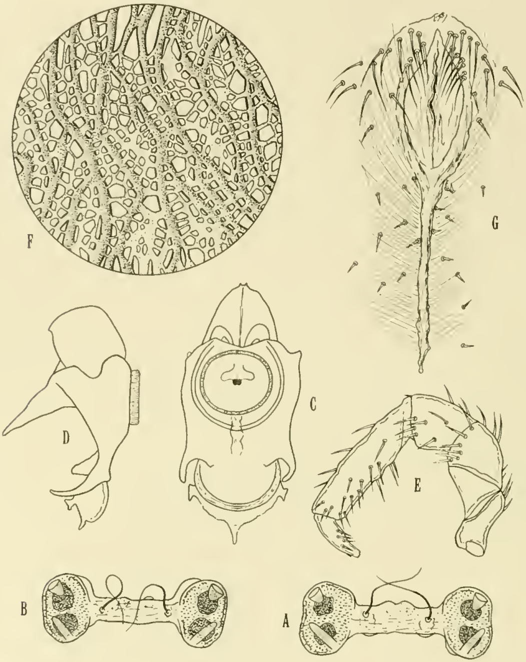

FIGURE 1.—*Eylais hamata* Koen. ♀. A, B, eyeplates; C, maxillary organ from beneath; D, from the right side; E, right palp from the inner side; F, epimeral structure; G, female genital field.

synonym of *hamata*. *E. marenzelleri* is characterized by its very long and thin eyebridge. Subsequently, in 1912, I described a nymph-form of *hamata*, having an equally thin and slender, though not especially long, eyebridge (Lundblad, 1912 a, p. 222, fig. 1) and mentioned also some adults with comparable structure. Soar in 1901 described *E. georgei*, characterized by having the intercapsular bridge curved backwards in the middle. Soar and

Williamson (1920, p. 111; 1925, p. 59) now regard this form as the same species as *E. hamata.* Lastly Daday, in the same year (1901) in his monograph on the Hungarian *Eylais-species,* published the description of a supposed new species, *E. longipons,* which almost exactly agrees with *E. georgei* Soar, having an eyebridge of the same shape. I do not hesitate in considering this form a real *hamata.* The broad and short maxillary plate, the immense overlapping pharynx with its distal hooks and the great mouth-disc indicate that both forms are identical. The third palp-segment is more conspicuously protruded than in *hamata,* but I think this character is referable to a mistake, like so many others in Daday's drawings. Walter's var. *alpina,* finally, is merely a dwarfed form of *hamata* and in all other respects quite typical.

E. hamata is an easily recognizable though rather variable species. The specific features are to be found mainly in the eyeplate, the maxillary organ, the last palp-segment and, as pointed out by Thon (1905, p. 158; 1906, p. 15, p. 45), in the structure of the epimera. The eyebridge is always very long, but length, as well as width, is variable. The maxillary organ is always broad, with a short maxillary plate, a broad and immense mouth-plate and an overlapping, hook-bearing, distally widened and rounded pharynx. The end-nails of the last palp-segment are very blunt. The epimera present a close mesh-work of chitinous balks of various thickness, quite different from those of most other species. A drawing may serve to illustrate this peculiar structure. The thicker main balks always connect the front and the hind margins (*i.e.* the longer sides) of the epimera, whereas the thinner balks run in different directions between the main balks. Lately I have drawn the attention to a somewhat similar structure in *E. mutila* Koen. (Lundblad, 1929, pp. 5-6.) In this species, however, the epimera are still more chitinized, the meshes being reduced to narrow pores, so that no balks can be distinguished. In *E. hamata* the structure of the epimera varies greatly, in some examples no distinction can be made between main balks and secondary balks, the meshes sometimes being more or less pore-like, though not so narrow as in *E. mutila.* Also the nymphs of the two species in question are distinguished by the same respective characters. In other species of *Eylais* there is no real meshwork, only main balks with some few connecting secondary balks between them being developed (cf., for instance, Thon, 1906, p. 69: *E latipons* and p. 72: *E. meridionalis.* Lundblad, 1929, Plate III, fig. 19: *E. discreta*).

Regarding all characteristics mentioned above, the present specimens are quite typical *hamata.* All examples are females. The male possesses two semicircular genital plates like most other species of the genus, whereas the female is destitute of real plates. Her genital opening is surrounded in front by a great number of long bristles. Originating from the opening there is a subdermal, suture-like, chitinous rod directed backwards. Some short and strong bristles are inserted in the skin on each side of the rod.

Locality. INDIAN TIBET: near Chushol, altitude ca. 4340 m. 14 July, 1932.

Distribution. Most European countries, Palestine, Asia Minor, Siberia. In Switzerland it is found at 2450 m. above sea level (Walter, 1922, p. 247).

2. *Eylais degenerata* Koen.

Eylais degenerata Koenike, 1897, pp. 292-93
" " Koenike, 1898, pp. 307-09
Eulais variabilis Sig Thor, 1902, pp. 450-51
" " var. *magna* Sig Thor, 1902, p. 451
" " " *intermedia* Sig Thor, 1902, p. 451
" *degenerata* Nordenskiöld, 1905, p. 2
" *pseudorimosa* Piersig, 1906, pp. 380-82
" *degenerata* Daday, 1910, p. 239
Eylais angulata Viets, 1911, pp. 155-56
" *galeata* Viets, 1911, pp. 156-57
" *angulata* Viets, 1911 a, pp. 351-54
" *degenerata galeata* Viets, 1911 a, pp. 354-57
" *consors* Szalay, 1912, pp. 70-73, 81
" *eregliensis* Szalay, 1912, pp. 73-77, 81-82
" *stagnalis* Szalay (non Halbert!), 1912, pp. 77-80, 82
" *degenerata* Viets, 1914, p. 83
" *taurica* Viets, 1914 a, p. 560
" *degenerata hispanica* Viets, 1918, pp. 19-23
" " *microstoma* Viets, 1921, pp. 419-20
" " Walter, 1922, pp. 64-65
" " *galeata* Walter, 1922, pp. 65-66
" " *microstoma* Walter, 1922, p. 66
" " *galeata Szalay*, 1926, pp. 211-12, 215
" *consors* Szalay, 1926, pp. 212-13, 216
" *taurica* Szalay, 1926, pp. 213-14, 216
" *degenerata sumatrensis* Viets, 1926, pp. 101-02
" " *asiatica* Viets, 1926 a, pp. 370-72
" *asiatica* Marshall, 1928, pp. 602-03
" *galeata* Marshall, 1928, p. 603
" *degenerata* Viets, 1930, pp. 208-09
" " *angulata* Viets, 1930, pp. 209-10

This species was originally described from Madagascar, Egypt and East Africa. Later Nordenskiöld and Walter reported it from Soudan, Viets from the Cape Province. More or less aberrant forms were described by Viets from East Africa (*angulata*, *galeata*, *microstoma*), Spain (*hispanica*), Sumatra (*sumatrensis*), and India (*asiatica*). Some of these later have been met with in other places (*angulata* in Spain by Viets, *galeata* in Hungary by Szalay and in China by Marshall, and *asiatica* in China by Marshall).[1] The forms *angulata* and *galeata* at first were looked upon as distinct species, but after some time degraded by the author himself to the rank of varieties.

Eylais degenerata is a very variable and widely distributed form that has often been misinterpreted. There seems to be no doubt that Daday and Viets are quite right in identifying Thor's *E. variabilis*, *variabilis magna* and *variabilis intermedia* from the Cape Province with the species of Koenike. The figure of the maxillary organ seems to me undisputably to confirm this opinion. For the same reason Piersig's *E. pseudorimosa* from Sumatra probably also belongs to *degenerata*, as pointed out already by Viets. Another form, *consors*, which Szalay describes from Asia Minor and which he afterwards refound in Hungary, is

[1] It seems somewhat uncertain whether the specimens mentioned by Marshall from China have been rightly identified.

regarded by Viets, with some hesitation, as being conspecific with *degenerata*. I think Viets is right in this identification and I may add that I regard also the other forms described in the same paper by Szalay as merely synonyms of *degenerata,* viz., *eregliensis* Szalay and *taurica* Viets (= *stagnalis* Szalay).[2] Both these forms are also distinguished by their characteristic

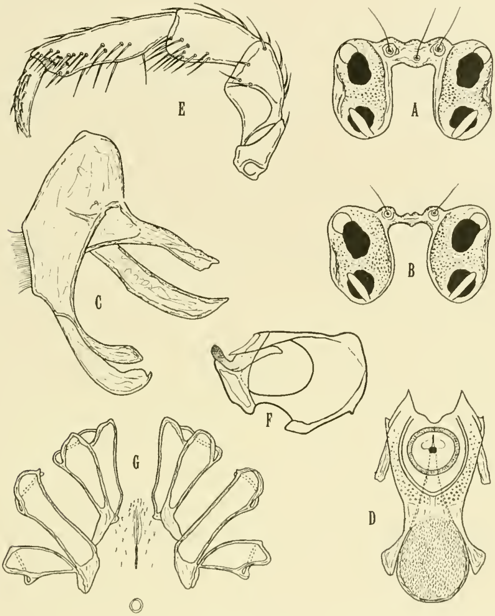

FIGURE 2.—*Eylais degenerata* Koen. A, B, eyeplates (♀); C, maxillary organ from the left side (♀); D, from beneath (♀); E, right palp from the inner side (♀); F, right mandible from the inner side (♂); G, epimera and genital field (♀).

maxillary plate and pharynx. The latter form, *taurica*, was later refound by Szalay in Hungary.

There is no other character to be relied upon in identifying *E. degenerata* but the structure of pharynx and maxillary plate (Viets, 1930, p. 209). All other characters vary, for instance, shape of eyebridge, shape and chaetotaxy of palpi, shape and width of oral disc, and length of posterior maxillary processes.

[2] Concerning the change of name, see Viets, 1914, p. 560.

In order to demonstrate the variability in the characters just mentioned the following table may be submitted of *Eylais degenerata* s. str. and allied forms.

(1) Oral disc:

wide (*degenerata*)
medium width (*consors, taurica*)
narrow (*pseudorimosa, eregliensis, microstoma*)

(2) Posterior maxillary processes:

shorter than pharynx (*degenerata, variabilis, taurica, hispanica, asiatica*)
as long as pharynx (*pseudorimosa, consors, eregliensis, microstoma, sumatrensis*)

(3) Intercapsular bridge:

V-shaped (*degenerata, angulata, sumatrensis*)
not V-shaped (all other forms)
narrow (*intermedia*)
fairly narrow (*microstoma*)
fairly wide (*magna, galeata, consors*)
wide (*variabilis, pseudorimosa, eregliensis, taurica, hispanica, asiatica*)

(4) Projection of 3rd palp-segment:

about 4 setae (*pseudorimosa*)
" 6 " (*sumatrensis*)
" 7 " (*angulata, taurica*)
" 8 " (*consors, microstoma*)
" 9 " (*degenerata, variabilis, hispanica*)
" 10 " (*asiatica*)
" 14 " (*eregliensis*)

(5) Inside of 4th palp-segment:

about 8 setae (*degenerata*: 3 spiniform, 5 pectinate)
" 10 " (*pseudorimosa*: 3 spiniform, 7 pectinate; *eregliensis, microstoma*: 5 spiniform, 5 pectinate; *taurica*: 6 spiniform, 4 pectinate; *sumatrensis*: 4 spiniform, 6 pectinate)
" 13 " (*angulata*: 10 spiniform, 3 pectinate)
" 18 " (*variabilis*: 10 spiniform, 8 pectinate; *consors*: 14 spiniform, 4 pectinate)
" 19 " (*asiatica*: 5 spiniform, 14 pectinate)
" 20 " (*hispanica*: 4 spiniform, 16 pectinate)

(6) Outside of 4th palp-segment:

about 5 setae (*pseudorimosa*: 3 spiniform, 2 pectinate)
" 9 " (*angulata*: 4 spiniform, 5 pectinate)
" 10 " (*taurica*: 6 spiniform, 4 pectinate)
" 11 " (*hispanica*: 6 spiniform, 5 pectinate; *variabilis*: 11 spiniform)
" 12 " (*consors*: 6 spiniform, 6 pectinate; *degenerata*: 4 spiniform, 8 pectinate)
" 13 " (*eregliensis*: 6 spiniform, 7 pectinate; *microstoma*: 5 spiniform, 8 pectinate)
" 19 " (*asiatica*: 5 spiniform, 14 pectinate)

(7) 4th palp-segment:

slender (*degenerata, consors*)
rather thick (*variabilis, pseudorimosa, ercgliensis, taurica, hispanica, asiatic. sumatrensis*)
thick (*microstoma*)
slender (♂) or thick (♀) (*angulata*)

From the above it will be seen that especially the palpi vary considerably. We find all stages from few to numerous bristles. It must be remembered, however, that it is often difficult not only to distinguish and to count exactly all the bristles, but especially to decide whether a bristle is feathered or not, depending upon the point of observation, *i.e.*, the position and direction of the bristle. It is obvious, therefore, that not too much stress must be laid upon statements concerning the structure of the bristles. It must also be kept in mind that it is quite an exception to find two specimens of the same species of an *Eylais*, in which the position and shape of the palp-bristles are exactly the same, at any rate in a limited collection. There is no doubt, therefore, that most species are extremely variable and that it is inappropriate to separate species by means of minute differences in the armament of the palpi, the right and left of which are often differently shaped in the same specimen. Not seldom the eyebridge is asymmetric or deformed, sometimes entirely wanting, and specimens having but one well-developed eye-capsule also have been met with (Lundblad, 1929, Plate III, fig. 26). In one of the specimens of *degenerata,* here figured, there is an unpaired extra bristle in the middle of the eybridge.

The main feature in *degenerata* is the very short maxillary plate, by which the greater part of the pharynx is laid bare. The maxillary plate is described as being coalesced with the pharynx, without leaving any suture. However, in the specimens studied by me, there seems to be a very fine, nearly invisible suture, which separates pharynx and maxillary plate from one another. This suture runs not far away from the outer oral circle, so that anyhow the maxillary plate is very short.

In the specimens before me the projection of 3rd palp-segment bears 13-14 bristles, the inner side of 4th segment 17-22, and the outer side 10-13. In the 3rd segment the specimens thus come nearest to *eregliensis,* whereas the inner side of the 4th segment resembles that of *variabilis, consors, asiatica,* or *hispanica,* the outer side that of *taurica, hispanica, variabilis, consors, degenerata,* or *eregliensis.* In the female the number of bristles on the inner side of 4th palp-segment is somewhat higher than in the male, corresponding to the condition in some other species of *Eylais* (cf. Lundblad, 1929, concerning *E. infundibulifera* and *E. discreta*). The oral disc is of medium size and the intercapsular bridge varies from narrow to wide, in both cases being rather straight.

The Kashmir specimens thus present a remarkable intermixing of characters, making it impossible to refer them to one of the "species" already described. This indicates, as far as I can see, that there is no meaning in describing forms, separated by such slight differences in number and situation of palp-bristles or in shape of intercapsular bridge, as distinct species. Such a proceeding totally neglects the great variability prevailing in the genus *Eylais.* And I think it is not even worth while to give all the different forms the rank of varieties, since it is obviously difficult to find another specimen exactly satisfying the original description in all structural details. Therefore, I regard the Kashmir specimens as being real *E. degenerata.*

The male genital opening is surrounded by two semilunar, bristle-bearing genital valves. The female has no genital plates, but some bristles are inserted in the skin between genital opening and epimera; at the anterior end of the opening the bristles are crowded, forming a group of 4-5 bristles on each side.

Localities. KASHMIR: Phashakuri (K 33) altitude c. 1585 m., in a ditch, 10 April, 1932; Phashakuri swamp (K 35), 10 April, 1932; Gagirbal Pond, Srinagar (K 36), altitude c. 1580 m., 11 April, 1932; Bakh Hajan, Jhil (K 46), altitude c. 1575 m., 19 April, 1932; Anchar Lake, S. of Bandipur, marginal swamp, altitude c. 1580 m., 6 May, 1932; PUNJAB: Sohawa, Rawalpindi dist. (P 2-3), altitude c. 528 m., 3 March, 1932; Gungrila, Rawalpindi dist. (P1), edge of shallow, weedy pool, altitude c. 525 m., 2 March, 1932.

Distribution. North, Middle and South Africa, Madagascar, Spain, Bulgaria, Hungaria, Asia Minor, Kashmir, India, Sumatra, China.

Family PROTZIIDAE

Subfamily PROTZIINAE

3. **Protziella hutchinsoni** gen. et sp. n.

Generic diagnosis. Skin papillated. Eyes in capsules. Frontal organ lying in a shield, the latter consisting of frontale, prae- and postfrontalia, dorsocentralia 1, and postocularia. Frontal organ rudimentary, but clearly visible and redoubled, divided in two lateral parts, each with a small spot of pigment. Palp chelate. Legs without swimming hairs. Claws simple, as in *Partnunia*, not split up into a number of teeth. Genital plates present, situated inside the acetabula.

At present there are four genera known within the family *Protziidae*,[3] viz., *Protzia, Partnunia, Calonyx,* and *Neocalonyx*. One of these, *Partnunia*, has simple, all the others composite claws. *Protzia* differs from *Calonyx* and *Neocalonyx* by the lack of genital plates. *Neocalonyx* differs from all other genera in the palpi not being chelate and in the skin, tending to a development of chitinous plates. The new genus comes nearest to *Partnunia*, the claws being simple, but differs remarkably from all genera by the structure of the frontal shield and the fairly well developed frontal organ, which is composed of two distinct parts. In the structure of the skin the new genus somewhat resembles *Neocalonyx*, a number of small dorsal chitinized plates or punctures being developed. If there is any closer affinity in the genital area it is impossible to say so far, since it is difficult to ascertain the structure of the genital organ in *Neocalonyx* from Walter's description, for instance, if the genital plates are situated inside or outside the acetabula.

Description of species. Length of body 983μ (♂) – 1500μ (♀). A detailed study of the structure of the skin, the presence and situation of chitinized plates and dermal glands, etc., in the family *Protziidae* has never been performed. Some years ago, however, I shortly drew attention to the fact that *Protzia eximia* has the dermal glands and dorsal bristles distributed over the skin quite after the same plan as the *Thyasinae*, for which I have drawn up a special terminology (Lundblad, 1927, pp. 210 and 221-23). According to this we find on

[3] Or five, if also *Wandesia* Schecht., known hitherto as a nymph only, belongs to the family in question.

each side an outer row of 4 lateroglandularia and an inner row of 7 dorsoglandularia. The first dorsoglandulare is also termed antenniform. Between the just-mentioned two rows there is a row of 4 chitinized shields, the dorsolateralia, and on the medial side of the dorsoglandularia we find a row of 5 other shields, the dorsocentralia. Near the frontal organ there can sometimes be distinguished two small shields on each side, viz., the prae- and post-

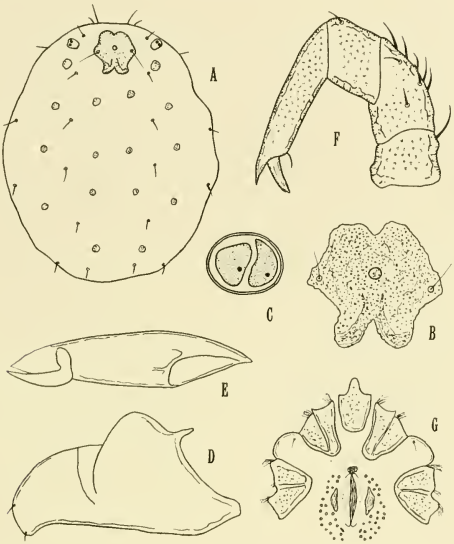

FIGURE 3.—**Protziella hutchinsoni** gen. et sp. n. A, animal from above (♀); B, frontal shield (♀); C, frontal organ (♀); D, maxillary organ from the left side (♂); E, mandible (♂). F, palp (♀); G, ventral side (♀).

frontalia, and, outside of these, two bristles on each side, the prae- and postocularia. In the *Thyasinae* there is a marked tendency to develop more or less strong and voluminous chitinized shields, which either remain isolated from one another or coalesce in a different way in different genera.

It is of considerable interest to find that the family *Protziidae* presents the same chitinized skin-elements and dermal glands as just described in the *Thyasinae*, and this fact indicates a rather close relationship between the two families. In *Protzia*, *Calonyx* and *Partnunia* there are no skin-plates developed, but according to Walter (1919) there are some in the genus *Neocalonyx*. Beyond doubt these plates are arranged after the same scheme, though Walter does not give any details. In the new genus *Protziella* the chitinized elements around the frontal organ are united into a frontal shield, which is built up from the prae- and postfrontalia, the frontale, and the dorsocentralia 1. As in so many *Thyasinae*, there are two bristles arising from the shield. These bristles are homologous with the postocularia in the *Thyasinae*. The praeocularia are inserted free in the soft skin in front of the shield. In the construction of the dorsal surface of the body the genus *Protziella* thus puts one in mind of the genera *Panisoides* and *Panisopsis* among the *Thyasinae* (cf. Lundblad, 1933, Figure 12 a and c), though in *Panisoides* and certain *Panisopsis* species some of the dorsocentralia and dorsolateralia are much more enlarged.

The shape of the frontal shield in *Protziella hutchinsoni* will be seen from the drawing. The shield is somewhat incised in front as well as behind, and the posterior margin is thickened to form a callosity, whereas the rest of the shield is fairly weakly chitinized. The postocular bristles are inserted in the lateral corners. The frontal organ is well developed and divided into two regularly shaped lateral parts, with a pigment spot in each. Such a structure we again meet with in some of the *Thyasinae*, viz., *Euthyas* and *Thyasides* (Lundblad, 1927).

♂. The maxillary organ is 278μ long. The upper side of the rostrum is convex, and the rostrum is bent downwards. The mandible (including the claw) measures 286μ in length. The length of the extensor and flexor sides of the palp-segments are (in μ):

	I	II	III	IV	V
Extensor side	71	111	54	193	39
Flexor side	46	29	54	125	32

The penultimate segment ends sharply pointed, and the second segment is provided dorsally with rather numerous bristles, whereas otherwise the palp is only poorly beset with bristles.

The anterior two pairs of legs are short and robust and, like the two posterior ones, provided with a great many strong spines, the longest of which are arranged in whorls at the distal ends of the segments 3-5. The 4th leg differs by its considerable length from the other ones, the 4th segment especially being prolonged. This segment increases in length from the first to the fourth leg; the measurements for this segment in the different legs are as follows (in μ):

1st leg: 147; 2nd leg: 182; 3rd leg: 220; 4th leg: 392.

The indifferently shaped epimera are widely separated into four groups. The anterior, projecting corners bear tufts of long, backwardly directed bristles or hairs.

The genital area occupies the region between the posterior pairs of epimera. The genital opening is 260μ long and bounded at the anterior end by a supporting, chitinized body. Another chitinous piece is to be found farther back. The genital plates are much shorter than the opening, but 121μ long, tapering towards both ends and supplied with rather few, thinly inserted bristles, most of which arise from the median border. The genital lips inside the plates are papillated, the papillae being very small and scattered. Lateral to the plates there are many acetabula, about 24 on each side. They vary somewhat in size and are not stipitate like those in most other *Protziidae*.

♀. The female does not differ essentially from the male. It is larger and the genital area has not quite the same appearance, owing to the genital lips, which are convexly swollen and much more projecting and conspicuous than in the male. They are covered by papillae, the size of which equals that of the other papillae of the skin. This sexual difference is similar to that in *Protzia* (Lundblad, 1927, p. 212), though the male in *Protziella*

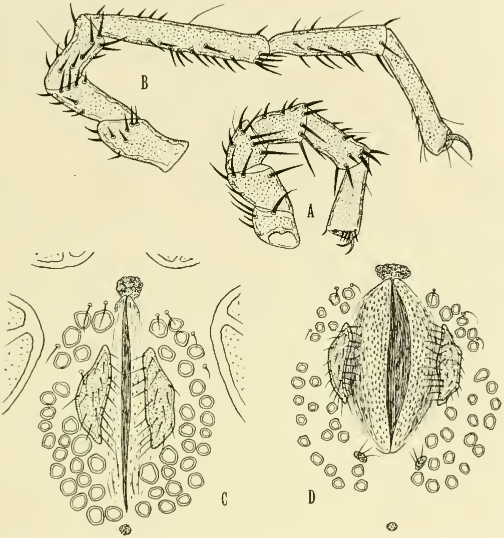

FIGURE 4.—**Protziella hutchinsoni** gen. et sp. n. A, first leg (♂); B, fourth leg (♂); C, genital organ (♂); D, genital organ (♀).

has no bristles on the genital lips. The genital plates resemble those of the other sex, as do also the acetabula, the number and shape of which also agree. As in the male there is only an anterior supporting body; another chitinous spot lies at some distance behind the genital field, free in the skin. Posterior to the genital plates there is a very small supplementary genital plate on each side, carrying some few bristles. The genital opening measures 318μ in length.[4]

[4] In the figure the male genital organ is more magnified than that of the female and thus seems to be larger, but in reality it is rather smaller.

In the male the epimeral groups are more crowded and the space between them is nearly filled up by the genital organ, whereas they are more distant in the female, leaving plenty of space between each other and the genital organ.

In both sexes some few bristles are scattered between the acetabula in the anterior part of the genital field, and the excretory opening is surrounded by a ring of chitin.

Nymph. Like the adult the nymph is recognized by the prolonged last leg. In the only specimen examined the genital organ consists of four acetabula on the right and three on the left side. Judging from the situation of the acetabula probably three acetabula on each side is the rule.

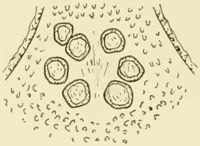

FIGURE 5.—**Protziella hutchinsoni** gen. et sp. n. Genital organ of nymph.

Locality. INDIAN TIBET: Shimsha Karbu between Dras and Kargil (K 78), 22 May, 1932, in a spring (temp. + 8°C., pH. 7.8), altitude ca. 2819 m.; springs (temp. + 7.2 C.) 4 miles from Bao, between Bao and Drugup (L 35), altitude c. 4100 m., 26 June, 1932.

Systematic affinities. The genus *Protziella* differs from all other *Protziidae* in a series of characters, viz.: (1) the strong chitinization of the dorsal surface, a well-developed frontal shield (and small dorsocentralia and dorsolateralia) being present. (2) the well-developed frontal organ, with its double spot of pigment; (3) the non-stipitate acetabula, situated outside the genital plates.

In some of these characters the genus more resembles certain members of the subfamily *Thyasinae* than the *Protziidae*. Very often the dorsal surface of the body is more or less chitinized in the *Thyasinae*, and in some genera there is, as already mentioned, a double pigment spot. The non-stipitate acetabula also gives the animal an appearance somewhat unfamiliar to a Protziid and more in correspondence with that of a Thyasin.[5] The situation of the acetabula outside instead of inside the genital plates is, however, a character unknown in both groups.

Like *Euthyas* and *Thyasides* among the *Thyasinae*—both with two spots of pigment in the frontal organ—*Protziella* seems to occupy quite an isolated position among the *Protziidae*. It has been already mentioned that in some respects—chitinization of dorsal body surface, frontal organ, non-stipitate acetabula—*Protziella* resembles certain *Thyasinae*, but probably this agreement is to be explained by convergence. However, it is impossible to deny the affinity of the *Protziidae* and the *Thyasinae* (or *Hydryphantidae*). We find another similarity between the two groups in the complicated claws which Viets recently (1929) has described in the aberrant genus *Teratothyas*, belonging to a special subfamily, *Teratothyasinae*, among the *Hydryphantidae*. The claws in that genus are said to be like those of

[5] It must be remembered, however, that according to Walter the acetabula in *Calonyx latus* are non-stipitate.

Protzia or *Calonyx, i.e.* being dilated at the apex and consisting of a main claw and some lateral teeth. It is interesting to find that we are able to draw parallel lines of development within both families (claws, frontal organ, chitinization of body). Even if some of the characters are to be regarded as being independently acquired by the two families, some others may well be of common origin. In this connection it is of a great interest to draw attention to a paper of Motas (1929) in which he has described the larva of *Calonyx brevipalpis*. His drawings, compared with the figures given by other authors and the present writer (1927), of the larvae of some *Thyasinae* and *Hydryphantinae* again reveal the fact that all these three groups undoubtedly are nearly allied to one another. However, the declaration of Motas (l. c., p. 261) that the *Protziidae* occupy an intermediate position between the *Thyasinae* and *Hydryphantinae* seems to me to require further evidence. I think it is better to join, as hitherto, the subfamilies *Thyasinae* and *Hydryphantinae* into the same family, *Hydryphantidae*, and to place the *Protziidae* in the vicinity of the *Hydryphantidae*.

4. **Calonyx montanus** sp. n.

♂. Length of body about 965μ. Skin without chitinous plates. Frontal organ very small, hardly bigger than a skin-papilla and lying some distance behind a line connecting the composite eyes. The organ looks like a rounded, circular papilla, which projects a little more over the skin-surface than do the ordinary papillae. The row of dorsoglandularia is characterized by the third dorsoglandulare having been much displaced in lateral direction, so that the distance between the two glands of that pair is distinctly longer than that between the eyes.

Length of maxillary organ 275μ. Seen from the side the rostrum is rather flat. The ventral surface projects angularly over the rest of the rostrum and the dorsal side is undulated. The mandible is 264μ long from the base to the tip of the membrane, which tapers and is sharply pointed at the end. The claw is 89μ long. The bristles on the palpi are few in number and the lengths of the palp-segments are (in μ):

	I	II	III	IV	V
Extensor side	29	93	50	150	42
Flexor side	39	35	46	79	28

The projection at the end of the fourth segment is long and slender, with the tip bent ventrally.

The bristles on the epimera are few and principally restricted to the lateral, anterior corners of the first three pairs. The first pair has a forward protruding corner, bearing about 10 rather short, stout, more or less spine-like bristles; on the second and third pairs there are about 4-5 bristles. The suture between the first and second epimera vanishes before reaching the median border. The greatest length of the anterior group of epimera is 268μ, that of the posterior group 246μ. In the third epimeron the anterior and median borders form together a continuously curved arc, not being angularly bent so as to constitute well-distinguished anterior and median borders, as in the following species.

The last segment in all legs is considerably thickened toward the distal end, which is provided with two strong claws of different lengths. Each claw consists of a central tooth of considerable length and thickness and a great number of shorter and thinner lateral teeth. These are so arranged that about 15 stand on one side, about 5 on the other side of the long tooth. Seen from the side, the last segment of the leg shows a deep incision and the upper side of the segment, which limits the incision from above, forming a long, triangular projection (see the figures for the following species). Especially the segments 3 and 4 exhibit a row of stiff bristles of middle length along the extensor side. The number of these bristles does not exceed 7. On the first leg these bristles seem to be a little shorter than on the others.

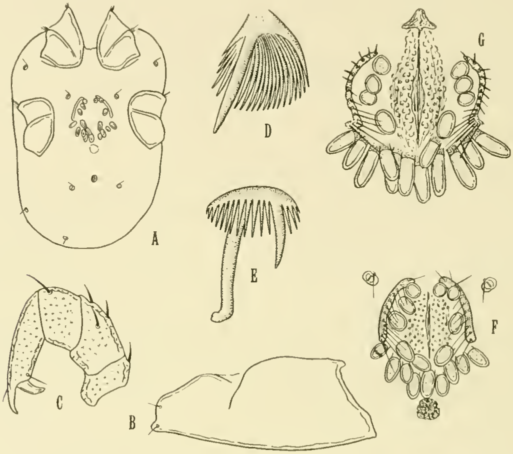

FIGURE 6. —**Calonyx montanus** sp. n. A, animal from beneath (♂); B, maxillary organ from the left side (♂); C, palp (♂); D, E, claws (♀); F, genital organ (♂); G, genital organ (♀).

The structure of the genital organ shows that the species in question is a true *Calonyx*, genital plates being present. These plates, however, are extremely poorly developed, consisting only of a narrow strip of chitin, wide enough just to support the bristles, which are inserted to the number of about 12, forming a single row. The strips are so short that only the anterior half of the genital organ is enclosed by them. Three pairs of acetabula are situated here, whilst the rest lie behind the strips. These latter acetabula are more numerous and more elongated than the others. The genital lips inside the acetabula are furnished with some very small, but rather high and well-marked papillae. Posterior to the genital organ the skin is chitinized as a small shield.

♀. The female differs, except in its larger size, very little from the male. The anteromedial border of the third epimeron is perhaps somewhat more prominently arched, forming a more distinctly marked medial border than in the other sex. There is a well-developed anterior supporting chitinous piece for the genital organ, and the genital lips are projecting and provided with big papillae all over. The posterior acetabula are more elongated than in the male and the posterior part of the genital plates seems to be bent out laterally.

Locality. INDIAN TIBET: c. 1 mile W. of Dras (K 76), altitude c. 3081 m., 21 May, 1932 (temp. 19.0°C.).

The present species differs from all hitherto described *Calonyx* species, except *C. latus,* by the claws being split up into a very large number of teeth.

5. Calonyx flagellum sp. n.

♀. A rather large species, measuring about 1550-1640μ in length. The body is broad, attaining a breadth of about 1320μ. The frontal organ is bigger than that of the foregoing species and has the shape of a distinctly marked circle. Of the dorsoglandularia only the first pair (= antenniformia) is situated anterior to the eyes, whilst the second pair lies on a line connecting the posterior margins of the eyes. In this respect the species differs from the above-described *Calonyx* species and the *Protziella* species as well, whereas the concordance with *Calonyx montanus* as to the situation of the third pair of dorsoglandularia is complete. The glandularia are characteristic, supported as they are by a very conspicuous, subcutaneous framework of chitin. This consists of three rings of different shape. In the drawing the lowest circle is black, the middle one is dotted, and the highest one, which lies immediately under the skin, is not marked in any special way. The latter embraces the fissure-shaped opening of the gland.

The maxillary organ is differently shaped, compared with that of the previous species. The rostrum especially is dissimiliar, being bent ventrally and abruptly truncated at apex, without the ventral, projecting tip, so well marked in *montanus.* The upper dorsal margin differs also in being quite straight, not undulated. The organ is 362μ long. Seen from above it is more alike in both species, though a little wider in the present one. The lengths of the palp-segments are (in μ):

	I	II	III	IV	V
Extensor side	46	132	75	196	46
Flexor side	46	36	64	96	36

The length of the mandible from the base to the tip of the mandibular membrane is 362μ and that of the claw 153μ.

As in *C. montanus* the anterior corners of the first three pairs of epimera bear bristles about equal in number to those described above. Most of those on the first pair are developed into strong, short spines. The third epimeron projects inwardly at the antero-medial corner, thus differing very much from the preceding species. The greatest lengths of the anterior and posterior groups of epimera respectively are 332 and 357μ.

The bristles, mentioned in the foregoing species as bordering in particular the extensor surface of the segments 3 and 4 in the legs are longer and more conspicuous in the present one. The claws are shaped as in *C. montanus,* but the main claw is shorter and thinner, not overlapping the side-claws so much.[6] The dorsal end of the last leg-segment is protruded as in *C. montanus.*

The genital organ resembles that of the latter species, the acetabula, however, being more numerous, about 30 in number, and much more elongated. Likewise the genital plates form a narrow strip on each side of the anterior acetabula. In some specimens there

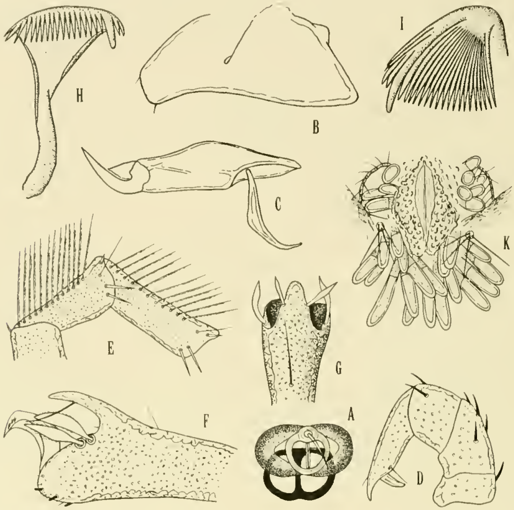

FIGURE 7.—**Calonyx flagellum** sp. n. ♀. A, supporting skeleton for a dermal gland; B, maxillary organ from the left side; C, mandible; D, palp; E, part of a leg; F, end segment of a leg seen from the right side; G, end segment of a leg seen from above (claws omitted); H, I, claws; K, genital organ.

is a small, rounded, posterior plate, bearing some bristles, which is distinctly separated from the anterior strips. Because of the bad state of preservation of the present species it is impossible to decide whether the structure mentioned holds good for all specimens. In some the spot seems to be connected, or nearly connected, with the strip, but more, well-preserved material is needed to settle this question. There are no chitinous supporting pieces before or behind the genital organ.

The male is not represented in the collection.

Locality. INDIAN TIBET: Shimsha Karbu, between Dras and Kargil (K 79), on stones in rapid stream, altitude 2819 m., 22 May, 1932.

[6] In the figures the claws are seen from a somewhat different position in the two species and thus not exactly comparable.

Family HYDRYPHANTIDAE

Subfamily Thyasinae

6. **Parathyas primitiva** sp. n.

♂. Length of body 896μ, breadth 672μ. The chitinization of the skin is less developed and more primitive than in *P. thoracata,* the sole hitherto known species of the genus. In the latter species all dorsolateralia and the last pair of the dorsocentralia are very large; in the present species, on the contrary, they are not larger than the dorsocentralia 1-4. The frontal shield has a characteristic shape; it is somewhat prolonged and truncated posteriorly. The hole for the frontal organ is well marked and fairly large. As in many *Thyas* species the fourth and fifth pairs of the dorsocentralia are widely separated from one another.

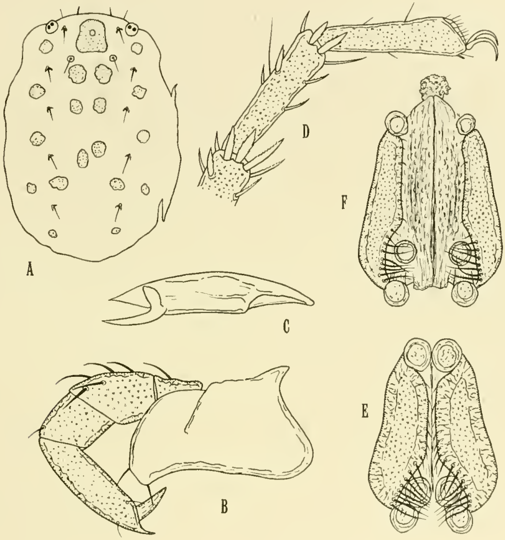

Figure 8.—**Parathyas primitiva** sp. n. A, animal from above (♂); B, maxillary organ and right palp seen from the left side (♂); C, mandible (♂); D, end segments of third leg (♀); E, genital organ (♂); F, genital organ (♀).

The maxillary organ measures 186μ in length. The rostrum is high, with a curved dorsal margin. The length of the mandible from the base to the end of the membrane is 232μ, that of the claw 71μ. The dorsal margin of the mandible is evenly curved. The measurements for the palp-segments (in μ) are as follows:

	I	II	III	IV	V
Extensor side	54	86	52	146	46
Flexor side	36	36	52	95	39

Between the second and third pairs of epimera the skin projects laterally in the shape of a triangular fold. The legs hardly display any specific characters. The spines at the distal end of the segments are finely dentated.

Genital organ of normal shape. The medial margins of the genital plates carry about 8 short and, behind these, about 8 long bristles. In front the plates are obliquely cut off, as is best seen when they are closed. Anterior and posterior to the genital organ, at the same distance, there is a chitinous, circular plate. The excretory opening is bordered at both ends by a chitinous knob.

♀. As usually, the female is larger, attaining a length of about 1170μ. Otherwise it differs from the male only in the genital organ, the anterior chitinous piece of which lies close to the genital lips, not at some distance in front of the organ. The eggs measure about 241μ in diameter.

Nymph. Length about 690μ. In the skin-plates and certain other characters it resembles the adult. The shields, however, are smaller, only the frontal shield being of corresponding size. There is no fold between the two epimeral groups. The genital organ consists of four acetabula, the two on either side being separated by a medially directed chitinized flap, broadly rounded at the tip, which carries some few hairs.

Locality. Indian Tibet: Dras (K 77), in a stream (temp. + 21.0-24.3°C.), altitude 3091 m., 21 May, 1932; C 1 mile W. of Dras (K 76), altitude 3080 m., 21 May, 1932 (temp. + 19.0°C.).

7. **Kashmirothyas hutchinsoni** gen. et sp. n.

Generic diagnosis. Colour red. Skin armoured with large shields. Right and left shields of dorsocentralia 3 and 4 united respectively into two shields. Frontal shield large, composed of frontale, prae- and postfrontalia, postocularia, dorsocentralia 1 and 2. Frontal organ non-pigmented. Eyes stalked, projecting over the sides of the body, attached to a chitinous plate, from which also the praeocular bristle arises. First pair of epimera differentiated sexually, the anterior corner being blunt in the male, acutely protruded in the female, in both sexes inwardly set with a row of long, pectinate hairs. First pair of legs with sexual differences. Genital organ with more than 3 pairs of acetabula.

Description of species. ♀. Length of body 1017μ. Skin-papillae sharply pointed, spine-like. Dorsal surface covered with large shields, the shape of which varies, as is usual in the *Thyasinae*. The frontal shield is largest. It is truncated in front and tapers gradually toward the posterior end, which is either truncated or more or less rounded. The frontal organ is not pigmented; laterally and a little posterior to it we find the two postocular bristles. The frontal shield reaches backwardly to behind the fourth pair of dorsoglandularia, thus indicating that the first and second pairs of the dorsocentralia have been absorbed. The third pair of dorsocentralia is united into a single, medial shield, as is also the fourth pair, whereas the shields of the last, fifth pair, are isolated and very large. Moreover, the dorsolateralia of the pairs 2-4 are large and easily visible, whilst the first pair is small and invisi-

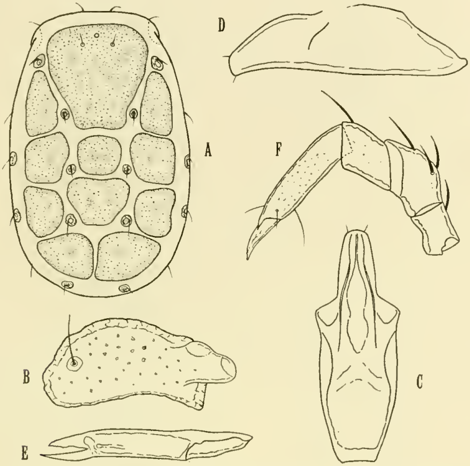

FIGURE 9.—**Kashmirothyas hutchinsoni** gen. et sp. n. A, animal from above (♂); B, eyeplate (♀); C, maxillary organ from above (♂); D, from the left side (♀); E, mandible (♂); F, palp (♂).

ble from above, lying on the sides and even partly on the underside of the body.[7] The first and third pairs of dorsoglandularia consist of a bigger plate than the others. As in *Lundbladia* the bristles of pairs 1 and 3-5 are much thicker, those of 2 and 6-7 thinner. The hair of the second pair is especially very long and delicate. The two antenniformia (= first pair of dorsoglandularia) are free, not united, but lying close up to each other. As in *Javathyas*, *Lundbladia*, and *Trichothyas* the ocularia have coalesced with the praeocularia to constitute a transverse plate. I have been unable to ascertain whether the praeocular bristle is bifid, as in *Lundbladia*, or not. I should not be surprised if it actually were, but the preparation is not clear enough to settle this. The epimeroglandulare 1 is large and triangular, as in the female of *Lundbladia*.

[7] In Figure 9 A the outline of this pair is stippled.

The shields on the ventral surface resemble those in *Lundbladia*. There is a postgenital shield of various shape, rounded or elongated, a more or less longitudinal excretale, two very large, medially incised ventralia 2, two elongated ventralia 1 and some smaller, accessory, lateral plates.

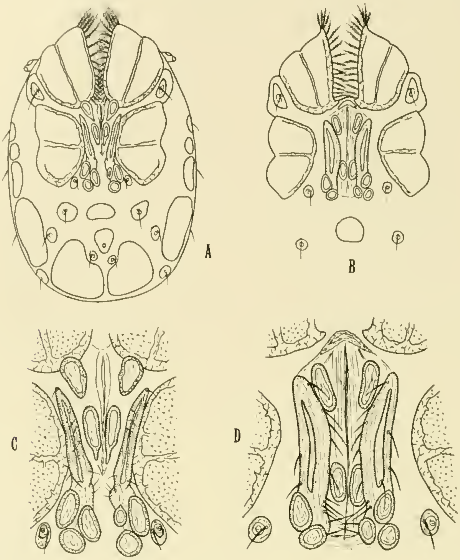

FIGURE 10.—**Kashmirothyas hutchinsoni** gen. et sp. n. A, animal from beneath (♂); B, epimera and genital field (♀); C, genital organ (♂); D, genital organ (♀).

Seen from the side the maxillary organ is rather flat, the rostrum being straight, very little bent downwards. The organ is 307μ long. The posterior margin of the maxillary plate is straight or a little concave because of the slightly projecting posterior lateral angles. The outer wall of the articular socket for the palp is angularly protruding laterally. The mandibles are elongated and narrow and the claw is fairly straight. The measurements for the palp-segments (in μ) are:

	I	II	III	IV	V
Extensor side	43	89	56	146	50
Flexor side	54	30	61	111	48

The palp is long and slender and the process of the penultimate segment thin, spine-like and much shorter than the prolonged end segment.

Epimera of usual shape. The first pair is prolonged in front, forming a very conspicuous, pointed projection. The epimera of the first pair are widely separated from each other, their inner margins being parallel, so that the maxillary bay retains the same width throughout. From the inner margins a single row of about 18 feathered bristles arises. The posterior inner corner of the first epimeron is acutely protruded inwardly. The three first

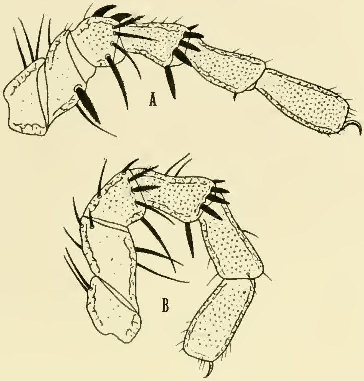

FIGURE 11.—**Kashmirothyas hutchinsoni** gen. et sp. n. A, first leg of male; B, of female, from the inner side.

legs especially are armed with strong spines, arranged in whirls at the distal end of the segments. Besides, the first leg has a long, backwardly curved, strong bristle on the ventral side of the second segment. There is also a thinner bristle on the ventral side, arising in some distance behind the spine. Such a bristle stands also at the same place on the second leg.

The genital organ is characteristic. It reaches up to the inner end of the maxillary bay and in structure it is reminiscent of that of *Trichothyas* or *Lundbladia*. However, it differs considerably from the organ of all known genera. The genital plates are long and narrow, posteriorly connected with the posterior acetabula and accordingly probably but little movable. Their interior border carries about 10, the exterior 2 bristles. The first pair of acetabula lies in front of the organ, the second is situated much farther back, posterior to the middle of the plates. Both these pairs of acetabula are much elongated and attached to low socles. Behind the plates but coalesced with them and resting upon their hindpart we find some other acetabula, more rounded in shape. Their number varies from two to four on each side. In front of the genital aperture is a chitinous transverse bolt.

♂. The male differs in many respects from the other sex, the following characters especially being worth mentioning. It is smaller, about 930μ long. The maxillary organ is somewhat narrower in the posterior part. The epimeral groups lie closer together, the first epimeron is rounded apically and the bristles along the medial border have longer feathers. Also at the base the first epimeron is broadly rounded, without the slightest trace of the hook-like projection of the female. The maxillary bay decreases in width posteriorly, and the epimera of the first pair are brought closer together than in the other sex, pressing the maxillary organ out of position in a dorsal direction. The first epimeroglandulare is hardly smaller than in the female (cf. *Lundbladia*).

The anterior pair of legs presents very striking differences. They are distinctly shortened, particularly in the basal segments and resemble very much the same leg in *Lundbladia*. Whilst the female possesses a long and strong bristle on the ventral side of the second segment, the male has this bristle developed into a thick spine. On the dorsal margin of the following segment the male has two curved, strong spines, just as in *Lundbladia*. On the other hand, I am unable to find the angular swelling, described in *Lundbladia,* on the outer side of the second segment of the first leg. Consequently the leg in question is not distorted as in the genus just mentioned.

In the genital organ the sexual differences are very conspicuous. It fills completely the space between the four groups of epimera, which allow the genital structures very little space. The first pair of acetabula, for instance, overlaps the posterior ends of the first pair of epimera. Obviously, through the pressure against the epimera, these acetabula have altered their shape from elongated to more rounded, being even bluntly distended in front, as if they had been pressed together. As in the other sex, anterior and median acetabula are attached to socles. The second pair is not placed posterior to the middle of the genital plates as in the female, but has been pressed forward until somewhat in front of the suture between the third and fourth pairs of epimera. The posterior acetabula, however, have retained the same position. The genital plates are narrower and have thinner bristles. Their lateral margins are partly overlapping the borders of the epimera.

Locality. KASHMIR: Stream W. of Sonamarg (K 71), altitude 2590 m. (temp. + 7.0 C.), 19 May, 1932. INDIAN TIBET: Shimsha Karbu, between Dras and Kargil (K 78), altitude 2819 m., in a spring (temp. + 8 C., pH. 7.8), 22 May, 1932.

Systematic affinities. The above described, very interesting genus is nearest related to *Trichothyas* and *Lundbladia,* with which it has many characters in common.

Such characters are:

(1) composition of frontal shield
(2) non-pigmented frontal organ
(3) right and left elements of third and fourth pairs of doscocentralia united to form two medial shields
(4) eyes stalked and lying in a shield together with the praeocularia
(5) the same sexual differences in the first pair of epimera
(6) the same sexual differences in the maxillary organ
(7) the same sexual differences in the situation of the second pair of acetabula
(8) principally the same sexual differences in the first pair of legs

The most important difference is to be found in the genital organ, which comes nearest to that of *Lundbladia.* Especially the males of the two genera are very much alike, whilst the females differ particularly in the shape of the posterior part of the genital plates. Moreover, both sexes differ in having a greater number of acetabula.

In some of the characters mentioned *Kashmirothyas* also resembles the genus *Javathyas* and belongs undoubtedly to the same group of genera as *Javathyas*, *Trichothyas*, and *Lundbladia*. It has, therefore, to be looked upon as a ramification from the same tribe as these genera, mainly differing in the multiplication of the acetabula (cf. Lundblad, 1933).

Family HYDRACHNIDAE

Subfamily HYDRACHNINAE

8. *Hydrachna* (*Diplohydrachna*) *conjecta* Koen.

Hydrachna	*conjecta*	Koenike, 1895, pp. 145-46
"	*Koenikei*	Sig Thor, 1898, pp. 7-8
"	"	Sig Thor, 1899, pp. 17-18
"	*conjecta*	Piersig, 1897-1900, Plate L, fig. 177 a-f
"	"	Piersig, 1901, pp. 47-48
"	"	Koenike, 1904, pp. 29-33
"	"	+ *Koenikei* Koenike, 1908, p. 263
Hydrarachna	"	Koenike, 1909, p. 43
"	"	*dissecta* Viets, 1911, a, pp. 343-46
"	"	Halbert, 1911, pp. 12-13
Hydrachna	*koenikei*	Sig Thor, 1916, pp. 14-18, figs. 15-16
Hydrarachna	*conjecta*	Lundblad, 1920, pp. 169-70
"	"	Soar and Williamson, 1925, pp. 175-78
Hydrachna	"	Viets, 1928, p. 15
"	"	Lundblad, 1929, pp. 18-23

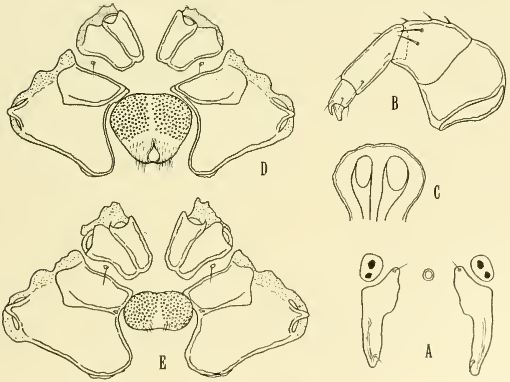

FIGURE 12.—*Hydrachna conjecta* Koen. A, eyes and dorsal plates (♀); B, left palp from the outer side (♀); C, stigma (♀); D, epimera and genital organ (♂); E, epimera and genital organ (♀).

This species, which Koenike described from a nymph, and of which Viets later described another nymph under the name of *H. conjecta dissecta*, is a very variable species, as already shown by me in two papers (1920 and 1929), to which I may refer here. For the sake of completeness I give some drawings here from the India Expedition material, including a figure showing the shape of the stigma. In all details the specimens agree well with European material of this well-known species.

Localities. KASHMIR: Srinagar, Gagirbal, closed swamp (K 19), altitude c. 1580 m., 9-11 April, 1932; Phashakuri (K 34) altitude c. 1585 m., 7 May, 1932; Shadipur (K 40), altitude c. 1582 m., 13 April, 1932 (nymphs).

Distribution. Many European countries, Palestine, Kashmir.

Family HYGROBATIDAE

Subfamily HYGROBATINAE

9. **Megapus proximalis** sp. n.

♀. Length of body 880μ. Skin without any distinct structure, except two poorly developed chitinous plates far back on the dorsal side. The glandularia are also chitinized, as usual, and can be seen as small, circular spots.

The palps constitute the most striking character of the species. As always in this genus the penultimate segment is supplied with a strong, lateral spine on the inner side. In the new species, however, this spine is placed near the base instead of in or beyond the middle of the segment. Characteristic of the species are also two very long bristles, attached to the ventral side near the base. At the point from where these bristles arise the segment is distinctly swollen and the whole segment is curved, turning the concave side ventrally. The last segment is unusually short. The penultimate segment carries a number of fine hairs near the dorsal side. The measurements for the palp-segments are (in μ):

	I	II	III*	IV	V
Extensor side	43	107	93	134	32
Flexor side	32	53	61	113	32

The mandible (including the claw) is 286μ long. The rostrum of the maxillary organ is short.

The epimera are not very characteristic. The posterior group projects triangularly toward the middle of the ventral body surface. The first leg again shows remarkable features, the last segment being unusually short, measuring but 114μ in length. It is strongly curved. The penultimate segment is supplied with the usual two spines of different shape and size and the long, curved bristle.

* The measurements of the third segment are from its inner side.

The genital opening is 243μ long and equipped at both ends with chitinized supporting bodies. The acetabula, three in number on each side, are arranged in a curve. The diameter of the egg is 175μ.

Locality. Indian Tibet: Shimsha Karbu, between Dras and Kargil (K 78), altitude 2819 m., in a spring (temp. + 8°C., pH. 7.8), 22 May, 1932.

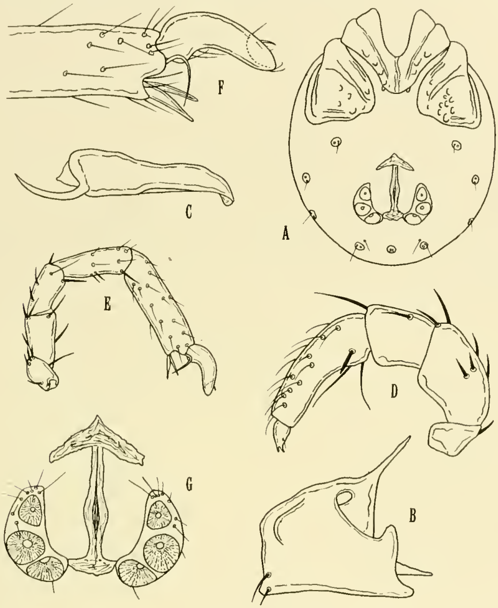

Figure 13.—**Megapus proximalis** sp. n. ♀. A, animal from beneath; B, maxillary organ from the left side; C, mandible; D, right palp from the inner side; E, first leg; F, end segments of first leg; G, genital organ.

Subfamily Acercinae

10. *Acercus ornatus* C. L. Koch

Tiphys ornatus C. L. Koch, 1835, 5, fig. 20
Acercus " C. L. Koch, 1842, p. 24
Piona ornata Piersig, 1897-1900, pp. 143-48
Laminipes ornatus Piersig, 1901, p. 202
Acercus " Koenike, 1909, p. 106
" " Soar and Williamson, 1929, pp. 16-19

Unfortunately the male sex is not represented in the collection, so the determination is not quite to be relied upon. The females, however, agree exactly with European females of *Acercus ornatus.*

Locality. Kashmir: Phashakuri, S. of Pampur (K 35), altitude 1585 m., 10 May, 1932.

Distribution. Most European countries, Algeria, Kamschatka, Kashmir.

Comparative Notes on the Distribution of the Watermite Fauna at Higher Elevation

The watermite fauna occurring at high altitudes is very little known, except in the Alps. In spite of this it may be of some interest to compare here the faunae of certain elevated districts.

If we begin with the Alps and consider only the species living over a height of 1800 meters we can group them in the following way. The distributional data are taken from Walter (1922 b).

List of the Watermites of the Alps (Above 1800 m.)[8]

1800-2000 m.

Protzia distincta
Partnunia angusta
Limnochares holosericea
Hydryphantes spinipes
Dartia borneri
Megapus nodipalpis
" *loricatus*
Lebertia cognata
" " *sevocata*
" *lineata*
" *dubia*
Lebertia aspera
" *extendens*
" *cuneifera*
" *giardinai*
Gnaphiscus setosus
Pionacercus leuckarti
Feltria zschokkei
Aturus clinitus
Arrhenurus conicus
" *maculator*
" *neumani*

2000-2200 m.

Hydrovolzia placophora
Protzia alpina
Calonyx rotundus
Sperchon mutilus
" *squamosus*
" *longirostris*
Panisus bazettae
Panisopsis curvifrons
Zschokkea oblonga
Megapus vaginalis
Lebertia subtilis
" *robusta*
Feltria menzeli
" *setigera*
" *rubra*
Piona carnea
Brachypoda versicolor

[8] Of course most of the species occur also beneath 1800 m. For instance, the figures 1800-2000 mean that the highest level at which the species here enumerated are found lies somewhere between 1800 and 2000 m.

2200-2400 m.

Partnunia steinamanni
Sperchon brevirostris
" *glandulosus*
" *denticulatus*
Panisus michaeli
Limnesia fulgida
Hygrobates longipalpis
Rivobates norvegicus
Lebertia rufipes impennata
" *pavesii*
" *maglioi*
" *zermattensis*

2400-2600 m.

Protzia invalvaris
Eylais hamata
" *extendens*
Lebertia rufipes
Lebertia tuberosa
" *zschokkei*
Feltria minuta
" *nussbaumi*

2600-2800 m.

Lebertia porosa

The above list shows us that the watermite fauna of the Alps is a rich one. Above 1800 meters there still live no less than 60 species and varieties.

In Norway Thor (1901) has studied the watermite fauna in the mountains. He was unable to find watermites above 1200 meters. Thor mentions the following species:

List of the Watermites of Norway (Above 900 m.)

900-1000 m.

Teutonia primaria
Lebertia insignis
Piona coccinoides
Acercus lutescens

1200 m.

Sperchon brevirostris
" *lineatus*
" *multiplicatus*
" *squamosus*
Hygrobates foreli
Megapus nodipalpis
Aturus scaber
Feltria minuta

In Sweden the watermites reach no higher than in Norway. In the mountains of North Sweden I have collected a great many mites but most of them have not been determined as yet. I have not found any mites there at higher elevation than 1112 meters. At present I am able to list the following species only:

List of the Watermites of Sweden (Above 900 m.)

900-1000 m.

Sperchon squamosus
Teutonia subalpina

1000-About 1100 m.

Zschokkea oblonga
Piona coccinoides
Pionacercus leuckarti
Hygrobates foreli
Gnaphiscus setosus
Neobrachypoda ekmani
Arrhenurus subarcticus

Lastly we shall list the watermites of Mount Elgon in equatorial Africa. Mt. Elgon is the only tropical mountain of which the watermite fauna has been studied. The following species have been found (Lundblad, 1927a):

List of the Watermites of Mt. Elgon (Above 1800 m.)

1800-1900 m.

Sperchon fenestratus

1900-2400 m.

Hygrobates lovéni	*Megapus splendidus superbus*
Hygrobatopsis levipalpis	*Octomegapus minutissimus*
Hygrobatomegapus spathuliferus	*Atractides jucundus*
Megapus linearis	" *bryki*
" *ugandensis*	

2400-3200 m.

Hydrachna eldoretica	*Megapus splendidus*
Hygrobates elgonensis	*Atractides lemnius*

3200-3300 m.

Hygrobates laceratus	*Megapus affinis*

3300-4200 m.

Sperchon elgonensis	*Piona angulata*

Unfortunately we can by no means say that the watermite fauna is well known at higher altitudes either in Sweden, Norway, or on Mt. Elgon. Probably, however, there are but few species to be added to the Scandinavian fauna. Our highest mountains do not rise much above 2000 meters, and they are always isolated summits. Our highest plateaus are hardly higher than 1000 m. Their area is very extended in Sweden, but is much split up into smaller, isolated districts, the area of each measuring at the utmost some 10 square kilometers. When following a certain level—for instance, that of 700 m.—from South to North, we would find, however, that the number of species to be enumerated as living above or at this level would diminish very rapidly. This indicates that the mites are not restricted to a special elevation but that the temperature of the waters—or other circumstances, for instance, the presence of food or hosts—determines their distribution. It is, therefore, of little interest to state the vertical distribution of a species unless we at the same time report the latitude at which the species was found.

Consequently we find quite a number of watermites on Mt. Elgon even above 2000 meters, viz., 16 species, whilst there are no species in Sweden above 1100 meters. Undoubtedly the fauna of Mt. Elgon, being at present superficially known, contains at least the same number of undiscovered species as those already described.

The species of Kashmir may be arranged in the following way:

List of the Watermites of Kashmir (Above 1000 m.)

1500-1600 m.

Eylais degenerata	*Acercus ornatus*
Hydrachna conjecta	

1600-2800 m.

Calonyx flagellum	*Megapus proximalis*
Kashmirothyas hutchinsoni	

2800-3000 m.

Calonyx montanus	*Parathyas primitiva*

3000-4100 m.

Protziella hutchinsoni

4100-4300 m.

Eylais hamata

It is difficult to decide at what height the corresponding zoogeographical limits run in North Sweden, in the Alps and on Mt. Elgon, so far as the watermite fauna is concerned. A personal knowledge of all three districts would be necessary in order to settle this. However, I think we can use preliminarily the uppermost limit of the forest as an indicator of the climate.[9] On Mt. Elgon this limit runs at an altitude of about 3400 meters, in North Sweden at 400-900 meters, sinking considerably from South to North. In the Alps the forest-limit is situated at about 1900 meters (1800 m. along the northern and 2000 m. at the southern border). In the part of the Kashmir Valley studied by the Yale Expedition the forest-limit, according to information in writing from Dr. Hutchinson, is situated between 3000 and 3500 meters. Within this depression, *i.e.*, southwest of the main Himalayan range, in the Srinagar region, at a height of about 1500-1700 meters, the winter is not severe at all, but most localities there are likely frozen in parts of January and February, whereas the summer temperature must be high. The species found in stagnant waters there are *Eylais degenerata*, *Hydrachna conjecta*, and *Acercus ornatus*. The water temperature varied between 13.0-23.2°C.

The expedition crossed the range at the Zoji-La pass at 3528 meters, where many kilometers of snow were found along the road in the middle of May. On the southwestern slopes of the range before the expedition reached the pass only one species, *Kashmirothyas hutchinsoni*, was collected, in streams at Sonamarg at 2590 meters. The climate here is undoubtedly more rigorous, with lower temperatures, than in the Kashmir basin. Once over

[9] It is clear, however, that this limit is a very rough one, owing to the fact that distribution of water animals depends upon the temperature of the water, which does not always correspond to that of the air nor is it a simple exponent of the height above the sea level. At the same level different bodies of water often present quite different temperatures.

the pass the forest disappears entirely even below 3000 m., the whole of Indian Tibet being arid or semi-arid. The winters must be very severe, though with little snow, but certain springs remain open all through the winter. This may be true of the spring at Shimsha Karbu at 2819 meters, where *Protziella hutchinsoni*, *Kashmirothyas hutchinsoni* and *Megapus proximalis* live at a temperature of 8.0°C. However, some of the small streams in this district are heated up relatively high by day, to over 20°C., and cool off to around 8.0°C. at night, owing to the rarity of the atmosphere. In such a stream *Parathyas primitiva* was collected at Dras at about 3100 meters in a temperature of 19.0-24.3 C., and *Calonyx montanus* in 19.0°C. At Bao, at an altitude of 4100 meters, *Protziella hutchinsoni* was found in 7.2 C. in a spring. For *Calonyx flagellum*, found only in a rapid stream at Shimsha Karbu at an altitude of 2819 meters, there are no temperature records. It may be mentioned also that *Kashmirothyas hutchinsoni*, besides in the above reported spring, was collected in a stream at Sonamarg, altitude 2590 meters, in 7.0 C. Lastly *Eylais hamata* was taken in ponds at Chushol, near the Tibet frontier, at an altitude of about 4340 meters. Unfortunately there are no precise temperature data available in this case, but the ponds in question very likely freeze completely solid during the winter. It is rather strange to find that this mite, which lives even at the level of the sea, is able to thrive at such a height. But we have noticed already that *Eylais hamata* is one of those species which forces its way farthest up the Alps, where it lives above the forest limit. The ponds at Chushol are the highest records for mites in this region, and in the world, and though there were a number of ponds at still much higher altitudes, no mites were found therein. It is a matter of interest that the species from the highest locality is a widely distributed one and not an exclusively mountain form. Thus only two species, *Eylais hamata* and *Protziella hutchinsoni*, extend their range above the forest limit as defined on the eastern slopes of the Kashmir Valley, while two more species, *Calonyx montanus* and *Parathyas primitiva*, just reach this limit.[10] It is likely that still more species do so though they have hitherto escaped discovery.

The watermite fauna of the Western Himalayas appears, in the present state of our knowledge, to be much less rich than that of other districts enjoying a somewhat similar climate, either in the far North or at high elevations in temperate or tropical countries. It is difficult to decide with absolute certainty whether this difference is due to the Western Himalayan fauna being less well known, or to actual poverty of species. One would expect not only a greater assemblage of endemic cold-water forms, but also a greater number of lowland species in the Kashmir Valley.

It is not advisable to give any detailed opinion as to the composition and immigration of the watermite fauna of Kashmir, owing to the poverty of the data at present available, founded as they are on but a few months' collecting. But even if we postulate the occurrence of more species, the fauna seems to be very poor. The reason for this is probably that mountain barriers have prevented the mites from spreading. The most characteristic highland forms, such as *Protziella* and *Kashmirothyas*, are probably endemic and of ancient, perhaps preglacial, origin, while the other element in the fauna comprises such easily distributed species as *Eylais hamata* and *E. degenerata*; the immigration of this latter element is presumably still occurring, though more slowly than in most other parts of the world.

[10] But in the Dras basin where they occur the country is too arid to support forest, though at this altitude on the opposite side of the Zoji-La about 35 miles to the west there are numerous trees.—*G. E. H.*

If we compare the Scandinavian mountain watermite fauna, living above the forest limit, with that of the Alps, we see that the Alpine fauna is much richer, consisting of 60 species, as against 18 in Scandinavia. This, moreover, is true not only of the watermites but of other groups, such as the insects. One of the reasons for this richness is that the Alps are surrounded by a much more abundant fauna and have received immigrants from many different directions. Tropical mountains also will probably be found to have a rich fauna, though experience on Mt. Elgon hardly supports this contention, for but two species were found there above the forest belt. It must, however, be remembered that the fauna at the top of this mountain has not been at all thoroughly studied.

Considering the favorable situation of Kashmir, in the middle of a large continent, bounded to the North by the enormous palaearctic area and to the South by the tropical Indian region with its luxuriant fauna, one should expect to meet a rather rich assemblage of watermites there, comparable to that of the Alps. This is not the case, however, and consequently there must be some special causes preventing the development of such a fauna. Probably the main obstacle is to be found in the high Himalayan ranges, which most of the mites are unable to force and by which the Kashmir upland is isolated from the surrounding districts.

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ARTICLE VIII

REPORT ON TERRESTRIAL FAMILIES OF HEMIPTERA-HETEROPTERA

By G. Evelyn Hutchinson

Biologist, Yale North India Expedition

The present paper is based on the collection of terrestrial Heteroptera made during the course of the Yale North India Expedition in Indian Tibet and the borders of Tibet proper in 1932. My very best thanks are due to Dr. Hellmut de Terra for the opportunity to make collections and observations in the little known territory traversed by the expedition and for his continued interest in the progress of the work after the return of the expedition. In a later paper I hope to discuss in detail the ecology and zoogeography of the various elements which compose the fauna of the highest inhabited zones of the Himalaya and Karakorum. I believe that it will be possible to correlate many of Dr. de Terra's geological findings with the results of such zoogeographic studies. Meanwhile a short zoogeographical account of the fauna of the highest localities is appended to the present contribution.

The taxonomic work here reported was begun at the British Museum in January, 1934. While working in London I received invaluable help from Mr. W. E. China, who is in charge of the unrivalled collections of Hemiptera at South Kensington. Mr. China spared himself no trouble in assisting me, and any merit that the present paper may possess is largely due to him. My thanks are also due to my friend Prof. A. Petrunkevitch for help with the Russian literature, and to Dr. E. D. Merrill and the staff of the New York Botanical Garden for determining specimens of food-plants.

The only previous work dealing with the Heteroptera of the region under discussion is Distant's report (1879) on the collections made by Stoliczka during the Second Yarkand Mission. Most of the Heteroptera in these collections were obtained at Murree and in the vicinity of Yarkand, but among terrestrial species *Lamprodema brevicolle* Fieb. is recorded from between Tangtse and Chagra (altitude c. 4, 200 m.) in Indian Tibet. The specimen was determined by Edward Saunders and is presumably correctly named. The species is not represented in the present collection.

In Oshanin's catalogue (1912) several Heteroptera are recorded from Ladak, apparently on the authority of Horvath (1889), who enumerated a number of species collected by Pauli "in itinere suo e provincia Ladak in provinciam Pendshab." Since this collection contained a number of large brightly colored forms, some of which are known from other parts of the western Himalayas at comparatively low altitudes, it seems reasonable from the available data to suppose that the collection was made either in Kulu or in the Kashmir depression. As the present material consists exclusively of specimens from considerable altitudes, and contains no species present in Horvath's collection, the latter is not further discussed.

The material collected by the Yale North India Expedition comprises 76 specimens, representing thirteen species, of which one, a species of *Stictopleura*, is represented only by a female and a nymph; in the absence of a male it seems unwise to attempt a specific determination. Of the remaining twelve species, four appear to be already known, while two new genera, eight new species and one new subspecies are here described for the first time. It has also been necessary in the course of the work to re-examine some of the criteria used in the separation of the subfamilies and tribes of the *Lygaeidae*, and to study rather closely certain members of the genus *Nysius* allied to *N. ericae* (Schill.). The results of these studies are set out in the appropriate places below. All species in any way associated with aquatic localities will be described in a later paper.

In general Oshanin's catalogue (1912) has been followed as to nomenclature and classification. Bibliographic references are given for all specific names not included in that work, but otherwise only to papers to which actual reference is made in the text. A representative set of all species, including the types of those here described, has been incorporated in the collections of the Peabody Museum, Yale University; a first set of duplicates has been sent to Mr. China for the collections of the British Museum.

Family PENTATOMIDAE

Subfamily Scutellerinae

Tribe Odontotarsaria

1. **Phimodera rupshuensis** sp. n.

Widely oval (Plate VIII, fig. 1), holotype 1.44 times as long as wide; moderately convex, opaque, covered with short, sparse pale pubescence; head, save for the raised parts of the jugae and clypeus and the regions at the bases of the eyes, pronotum, scutellum and exposed portions of the elytra, punctured, the distance between the punctures very irregular, averaging rather more than their diameter, under surface punctured but more sparsely so.

Color. Pale greyish yellow, puncturation black, head black, a narrow area round the eyes, jugae particularly in their raised part, and base of the clypeus largely yellow, a large spot on the anterior margin of the pronotum, and the base of the scutellum black; basal joints of antennae brown, the first and second narrowly yellow apically, terminal two joints black; anterior femora with a black ventral stripe and a less well defined posterior stripe fusing with the black puncturation dorsally, intermediate and posterior femora with black postero-ventral stripes, tibiae black apically and basally, on the dorsal surface the dark markings forming a stripe interrupted in its middle third, first and distal half of third tarsal joints dark brown.

Head. In front view (Plate VIII, fig. 2), about one-sixth longer than interocular width, subparallel and hardly constricted in front of the eyes, juga with outer angle widely rounded, anterior margin lightly curved from the external to the sub-obtuse inner angle, inner part of the juga in its basal half somewhat raised and encroaching on the clypeus; clypeus anteriorly subacute and projecting beyond juga, carinate in its anterior part, carina depressed posteriorly, becoming obsolete opposite the elevated part of the juga, vertex behind clypeus somewhat elevated. Ocelli separated from eye by a space subequal to the maximum diameter of the eye and rather greater than its width. Bucculae subprominent below clypeus, obtusely rounded behind (Plate VIII, fig. 3).

Antennae with first and second joints subequal, half as long again as third, fourth twice as long as the latter, fifth just over half as long again as fourth (0.27, 0.27, 0.18, 0.36, 0.58 mm.).

Rostrum reaching to posterior coxae.

Pronotum just over twice as wide as long (3.35, 1.53 mm.), with anterior margin evenly concave when seen from in front and practically straight when viewed from above, posterior margin almost straight centrally, laterally bent forward to the rounded posterior angles, lateral margins emarginate behind the subrectangular anterior angles, disc with a central impunctate carina, which in its posterior third is fragmented to form two irregular tubercles, and with a transverse depression, obsolete centrally, in front of which are two raised areas divided by transverse V-shaped depressions (probably apodeme bases) and falling off abruptly toward the lateral margins.

Scutellum with a longitudinal central carina, reaching to just beyond its centre. (The specimen also shows two folds running obliquely from the anterior angles to behind the middle of the disc, but these appear to be due to an injury that has also removed the right elytron and so buckled the scutellum on that side as to make measurement impossible.)

Marginal abdominal tubercles but moderately prominent (Plate VIII, fig. 4).

Length 4.8 m.; breadth 3.35 m.

INDIAN TIBET: 1 ♂ (*type*) Peldo-le, near N. end of Tso Moriri, altitude 4529 m. (14,855 ft.), among roots of short grass.

This species, as is indicated by its subparallel head, subrectangular anterior pronotal angles and the coloration of its antennae, clearly belongs in the fourth cohort of the key in Reuter's monograph of the genus (1908). It differs from the species placed in that group in its small size, unarmed trochanters, less conspicuous marginal tubercles, and apparently in the somewhat elevated center of the vertex behind the clypeus.

P. reuteri Kiritshenko (1910), the only species described since Reuter's monograph, belongs to first cohort. The present species appears to be the smallest member of the genus.

Family COREIDAE

Subfamily CORIZINAE

2. *Stictopleura* sp.

INDIAN TIBET: 1 ♀ and 1 nymph, between Tsak-shang and Tsak-ra, road from Tso Moriri to Tso Kar, altitude 4570 m. (c. 15,000 ft.), 1 Sept., 1932.

The single adult before me is a female in not very good condition. It is most closely allied to *nysioides* Kiritshenko, but since the genus contains several very similar species and since these probably cannot be satisfactorily determined without a study of the ♂ genitalia the present specimen is best left unnamed.

Family LYGAEIDAE

Subfamily Lygaeinae

Tribe Orsillaria

3. *Nysius ericae* (Schill.)

The sixteen specimens of *Nysius* in the collection present so much diversity that at first it seemed as though several rather distinct species were represented. Before attempting to elucidate the present collection it appeared advisable to examine rather minutely certain of the described Palaearctic species. In particular, since Evans (1929) had shown that in discriminating between certain Australian species, the parameres of the male provide valuable characters, special attention was paid to these structures. As a result of these studies it became clear that all the Yale North India Expedition material was referable to *N. ericae* (Schill.), though it has seemed desirable to describe as a subspecies a rather distinct form from very high altitudes.

The Palaearctic species of *Nysius* have been studied by Horvath (1890) whose valuable key provides a satisfactory basis for further work. In this key a group of species of the restricted sub-genus *Nysius* (now to be regarded as a genus, cf. Evans, 1929) are characterised by having no well-marked pale longitudinal ruga on the scutellum and by the bucculae being distinctly lowered posteriorly and not quite reaching the posterior margin of the ventral surface of the head. This group includes *thymi* (Wolff), *ericae* (Schill.) and its var. *obscuratus* Horv., *cymoides* Spin., *graminicola* (Klti.), and *groenlandicus* (Zell.), the latter form, which Lindroth (1931) regards as a synonym of *obscuratus* Horv., being excluded by Horvath on geographical grounds. As pointed out below, *groenlandicus,* which is found in the N. of Europe and Iceland as well as in the Nearctic region, though undoubtedly a subspecies of *ericae*, differs in several characters from *obscuratus*. This group, which may be known as the *thymi*-group, appears to include most of the species described from the tropical regions of the world, but with the exception of the Australasian and African species described by Evans very few of these species can be recognised from descriptions alone. It seems therefore desirable to put on record the following notes, which, though they relate only to three of the most closely allied Palaearctic forms, may help to stabilise our conception of this difficult group of species and provide a point of reference for workers studying tropical and sub-tropical species.

a. *N. thymi* (Wolff). This species is distinguished externally by its oblong-ovate shape, the posterior corial margin being rounded and ampliate (Plate VIII, fig. 7). The genital segment of the male is black and the longitudinal veins of the corium are brown or blackish. According to Horvath the vertex is destitute of a pale immaculate basal spot, but this is actually often very feebly developed. Horvath also states that the ante-apical black line on the pronotum is oblique, curved forward and interrupted centrally. This refers to a pair of marks, of essentially the same form in all the species, presumably the bases of thoracic apodemes, which are black and surrounded by a dark suffusion. In *ericae*, however, this suffusion generally forms a straight uninterrupted transverse band so that the forward curve of the apodeme bases is less easily distinguishable.

The genitalia of two specimens from Britain were examined, one from Polzeath, Cornwall, the other from Kidwelly, Carmarthen. The parameres in lateral view (Plate VIII, fig. 14) are distinctly angulate dorsally, the angulation not being emarginate, and the ventral margin distinctly flanged. In dorsal view (Plate VIII, fig. 15) the angulate prominence hardly projects over the inner margin of the base of the shaft.

b. *N. ericae ericae* (Schill.). The typical subspecies of *ericae* is much narrower than *thymi*, the corial margins less ampliate, though very slightly curved from the widest point towards the membrane (Plate VIII, fig. 8). The genital segment is black and the corial nerves infuscated, but the basal immaculate spot on the vertex is much more strongly developed and the antiapical apodeme bases of the pronotum are normally included in a straight unbroken transverse band. Material from North America (North Haven, Conn.) appears to differ in no respect from a ♂ from Marburg, Germany, determined by Horvath and in the British Museum collection.

The genitalia were studied in two specimens from North Haven. The dorsal angle of the parameres is very prominent, setose, and distinctly emarginate, the ventral flange is obsolete (Plate VIII, fig. 16). In dorsal view the angular prominence projects over the inner margin of the base of the shaft (Plate VIII, fig. 17).

c. *N. e. obscuratus* Horvath. I have been unable to examine an authenticated specimen of this form. Horvath's (1899) description is as follows: Articulo primo antennarum, saepe etiam basi articuli secundi, femoribusque nigris, femoribus feminae interdum pallidis, nigro-maculatis; pronoto posterius fusco, angulis posticis maculaque parva media postica pallidioribus; hemelytris griseo-fuscibus, interstitiis vernarum corii fusconebulosis; ventre feminae magnam partem nigro; statura sexuum conformi. ♂. ♀. Long, 4¼-4½ mill.

Apart from its size the first male from Renka-le appears to agree with this form but its smallness indicates a transition to *ericae ericae*. The genitalia are quite typical.

N. e. obscuratus was originally recorded from Turkestan, Siberia and China; in Ekblom's map it is indicated as co-occurring with the typical subspecies throughout its entire Central Asiatic range, but it is clear from Horvath (1904) and Kiritshenko (1931a) that it is the only form found in the Tian-shan and in the Pamirs so that it may justifiably be given subspecific status.

d. *N. e. groenlandicus* (Zett). Lindroth (1931) synonymises this form with *obscuratus*. In *groenlandicus*, however, the corial margin has a peculiar shape well marked in a series of ♀♀ in the British Museum collection and also in a ♂ from Kugsuk, Godthaab Fjord, West Greenland, collected by Major Hingston and kindly sent me by Professor G. D. H. Carpenter of Oxford (Plate VIII, fig. 9). In *N. e. ericae* and in the Renka-le specimen, discussed above under *N. e. obscuratus*, the corial margin is slightly and very gently rounded from the straight basal part to the region of maximum dilatation, while in *groenlandicus* the dilatation is more sudden so that in this region the corial margin appears almost obtusely angulate. Moreover, in *groenlandicus* the pale portion of the elytra is more transparent than in the other forms so that when compared with *obscuratus* the color pattern of the former shows much more contrast than that of the latter. Ekblom (1931) records the Lapland form of *ericae* as *obscuratus* without description, and without indicating any Icelandic or Greenlandic records on his map. In the absence of specimens from this region it is not possible to settle the matter finally but it seems more reasonable at present to refer all these boreal forms to *groenlandicus*. It is clear from Ekblom's map that the latter subspecies, as here understood, is separated from the other forms by a wide intervening subboreal zone in which the species is absent.

The parameres of the West Greenland specimen are identical in shape with those of the North Haven specimens, though the angular prominence is a little more setose, a character that varies in parameres of insects from the same locality in Indian Tibet. There can be no doubt therefore that *groenlandicus* is rightly referred to this species.

e. *N. graminicola* (Klti.). This species is easily distinguished by its coloration from the preceding, for the longitudinal veins of the corium are hardly, if at all, infuscated and the general coloration is paler. In shape *graminicola* is more elongate than *thymi*, but the corial margins are posteriorly more strongly and more regularly rounded than in *ericae*. The pronotum is without a transverse black band obscuring the bases of the apodemes, which are at most surrounded with an interrupted black suffusion. The vertical margin spot is very feebly developed.

The genitalia of a specimen from Porto d'Ischia, on the island of Ischia, Italy, were studied. The dorsal angle is very feebly emarginate and the ventral keel moderately developed (Plate VIII, figs. 20, 21).

It is clear from the above that *thymi*, *ericae*, and *graminicola*, three very closely allied but adequately defined species, all show differences in their genitalia, while the various forms here grouped under *ericae* show no such differences, thus justifying the present arrangement. I have not been able to examine the genitalia of *cymoides*, a most distinct species with very long subparallel elytra.

The material collected by the Yale North India Expedition was obtained from five localities, as enumerated below. Measurements and notes on the individual specimens are also set out in Table I. It will be seen that the material from the lowest locality is practically identical in form and color with typical *N. e. ericae*, while from the highest a rather distinct new form was obtained which is described below as *alticola* subsp. n. From the intermediate localities series were obtained which appear to combine the characters of all the Central Asiatic forms known, viz., *ericae* s. str., *obscuratus* and *alticola*.

A. Leh. 1 ♂ Residency Garden. 19 Sept., 1932, altitude 3506 m. Parameres typical of species. This specimen may be considered as a very slightly atypical member of *N. e. ericae* (Plate VIII, fig. 10).

B. Tsak-shang, N. of Tso Moriri. 2 ♀♀. 31 Aug., 1932, altitude 4872 m. These specimens are comparable to some of the ♀♀ from the next locality; they are probably nearer to *N. e. ericae* than any other form.

C. Renka-le, between Mitpal Tso and Yaye Tso. 3 ♂♂, 5 ♀♀. 18 Aug., 1932, altitude 5156 m. The specimens numbered 1 and 2 are very close to *obscuratus*. The third ♂ is practically typical *e. ericae*, though very small. Specimen 2 (Plate VIII, fig. 11) is slightly wider than the others, so approaching *alticola*. The females are rather variable in width, but none show the coloration of *obscuratus*.

D. Kyang-La, Koh Lungpa valley. 2 ♂♂. 9 July, 1932, altitude 5100-5200 m. These two specimens are both here referred to *alticola*; the darker one is rather similar to

TABLE I

Dimensions of and remarks on specimens of *Nysius* examined.

Locality	Sex	Length	Breadth	$\frac{L}{B}$ Ratio	Departure from Normal Coloration	Posterior Pronotal Angles
N. ericae						
LEH alt. 3506 m.	1 ♂	3.45	1.11	3.12	Femora black with testaceous apices	Very slightly reduced
TSAK-SHANG alt. 4872 m.	1 ♀	3.75	1.38	2.71	Femoral spots confluent	Slightly reduced
	2 ♀	4.25	1.56	2.72	Femoral spots confluent	Slightly reduced
RENKA-LE alt. 5156 m.	1 ♂	3.28	1.09	3.00	Femora save apices, pronotum largely, and inner part of elytra, very dark	Almost normal
	2 ♂	3.52	1.27	2.86	As above	Almost normal
	3 ♂	3.28	1.11	2.96	Femoral spots confluent	Slightly reduced
	4 ♀	3.88	1.34	2.89	Femoral spots strongly confluent	Slightly reduced
	5 ♀	3.82	1.40	2.73	Practically typical	Slightly reduced
	6 ♀	3.96	1.54	2.60	Femora black with pale apices	Slightly reduced
	7 ♀	4.00	1.42	2.82	Femoral spots somewhat confluent	Slightly reduced
	8 ♀	3.96	1.49	2.66	As above	Slightly reduced
KYANG-LA alt. 5100-5200 m. subsp. *alticola*	1 ♂	3.09	1.13	2.74	Femora black save at apex, pronotum very dark, elytra suffused with brown	Considerably reduced
	2 ♂	2.97	1.13	2.64	As above but lighter	As above
OROROTSE TSO alt. 5297 m. subsp. *alticola*	1 ♂	3.20	1.24	2.58	Femora black save apically, elytra and pronotum suffused with brown	Much reduced
	2 ♀	3.38	1.42	2.38	As above but some pale maculation on femora	As above
	3 ♀	3.65	1.45	2.50	As above but rather paler	As above
NORTH HAVEN, CONN., U.S.A. subsp. *ericae*	1 ♂	3.48	1.16	3.00		
EAST GREENLAND subsp. *groenlandicus*	1 ♂	4.15	1.42	2.92	Femora, inner part of elytra and most of pronotum black, outer part of elytra hyaline	Unreduced
N. thymi						
KIDWELLY, WALES	1 ♂	4.07	1.49	2.72		
N. graminicola						
ISCHIA	1 ♂	4.62	1.49	3.10		

the wide dark specimen from the previous locality, but the latter is larger, proportionately a little narrower, and has more prominent pronotal angles.

E. Ororotse Tso. 1 ♂, 2 ♀♀. 11 July, 1932, altitude 5297 m. These specimens (Plate VIII, figs. 12, 13) are very broad and have the posterior pronotal angles much reduced so that the posterior border is but little reflexed and the sides are straight. In color they are less dark than the *obscuratus* form from Renka-le. The present specimens constitute the typical series of *alticola* subsp. n., primarily characterised by its small size, wide form which is comparable to that of *thymi* rather than to *cricae* s. str., and straight lateral pronotal margins.

Nysius ericae **alticola** subsp. n.

♂ Robust (Plate VIII, fig. 12); dorsal surface covered with fine short adpressed hairs.

Color. Head black, mottled with testaceous yellow on the clypeus and juga, and with a conspicuous smooth spot on the posterior margin yellow; antennae dark brown, ventral surface of first joint and proximal half of first joint, save the extreme base, yellowish; bucculae grey. Pronotum yellowish-grey, with heavily black puncturation, save in the posterior angles and a spot on the posterior margin; transverse black line on the anterior part of the pronotal disc complete centrally and turned forward laterally; scutellum black. Dorsal surfaces of all femora black, save at their apices which are testaceous; anterior femora black ventrally save for the testaceous apices, intermediate and posterior femora testaceous ventrally, heavily spotted with black, tibiae testaceous with black spots apically, first tarsal joints testaceous darkening distally to brown, second joints brown, third joints black. Elytra opaque, yellowish-grey, with the inner margin of the clavus obscurely darkened, lateral margins of corium very narrowly black, indefinitely mottled with black along the outer corial vein (sub-costa) and less conspicuously on the disc, membrane hyaline with a large black spot on its corial border fading to brown at the edges and just invading the posterior angle of the corium. Thorax beneath black, posterior borders of pleurae and edges of articulations of legs yellowish-grey, outer part of lip of scent-gland yellowish. Abdomen black, with yellowish mottling on the edge of the connexivum.

Head about one-sixth narrower than the pronotum posteriorly; eyes relatively small, vertex moderately flat in profile, bucculae not quite reaching the posterior margin of the ventral surface of the head, slightly lowered in their posterior half and more abruptly terminated opposite the apex of the first rostral joint. First joint of antenna but little surpassing the apex of the head; second joint twice as long as first and very slightly shorter than the pronotum; third joint three-fourths the length of the second; and fourth joint slightly longer than the third (0.29, 0.58, 0.44, 0.51 mm.).

Pronotum trapeziform and moderately transverse, sides straight, posterior angles not prominent, posterior margin but little deflexed, transverse black lines on anterior part of disc incomplete centrally and turned forward laterally. Scutellum sub-equal in length to pronotum and about as long as its basal breadth.

Apex of abdomen not covered by elytra. Wings developed.

Genitalia as in the typical subspecies (Plate VIII, figs. 18, 19).

♀ Somewhat broader than the male (Plate VIII, fig. 13). Yellow mottling of the clypeus extending back throughout the central region of the vertex. Antennae entirely black. Elytra just surpassing the apex of the abdomen. Otherwise as male in non-sexual characters.

Length ♂, 3.20 mm. (holotype); ♀, 3.38 mm. (allotype), 3.65 mm. (paratype).

INDIAN TIBET. ♂ (*holotype*), 2 ♀♀ (*allotype* and *paratype*) L 52, Ororotse Tso, altitude 5297 m. (17,381 ft.), near margin of lake, among short sparse grass in company with *Chlamydatus pachycerus* Kiritsh. 11 July, 1932; 2 ♂♂ L 48, Kyang-La, altitude 5100-5200 m. (16,700-17,100 ft.), among short sparse grass with *Pegaeophyton* prob. *scapifolium* Marq. and Skan., in company with *C. pachycerus*, 9 July, 1932.

In form this subspecies in its most extreme facies differs very widely from *N. e. ericae*, departing as much from the latter in its proportions as does *N. thymi* (cf. Table I). Were it not for the existence of intermediate specimens and the identity of the genitalia throughout the entire series it would have been regarded as a very distinct species. Though the feeble development of the posterior pronotal angles suggests brachyptery, the wings appear to be as well developed as in the North Haven specimens of the typical subspecies.

Key to the Subspecies of Nysius ericae (*Schill.*), *applicable primarily to Male Specimens*

1. About three times (♂ 2.92-3.12) as long as wide, lateral margins of the pronotum sinuate, posterior angles subprominent 2

Less than two and three-quarters (♂ 2.58-2.74) times as long as wide, lateral margins of pronotum straight, posterior angles reduced ....*N. e.* **alticola** subsp. n.

Koh massif, Chang Chenmo Range, from over 5100 m.

2. Posterior part of pronotum, femora and intervenal spaces of corium widely suffused with blackish-brown 3

Posterior part of pronotum and intervenal spaces of corium testaceous, femora testaceous with black spots ....*N. e. ericae* (Schill.)

Palaearctic from France to Siberia but absent in Britain, Scandinavia, Northern Germany and Northern Russia; Nearctic throughout U. S. A. and Southern Canada; locally wholly or in part replaced by other subspecies.

3. Corium evenly rounded to its maximum width, pale parts of elytra opaque....... *N. e. obscuratus* Horv.

Central Asia from the Caspian to China, in part replacing *N. e. ericae*.

Corium suddenly expanded to its maximum width, pale parts of elytra hyaline....... *N. e. groenlandicus* (Zett.)

Lapland, Greenland, Iceland and Arctic and Sub-arctic America.

Subfamily Oxycareninae

4. *Microplax hissariensis* Kiritshenko

M. hissariensis Kiritshenko (1913).

Indian Tibet 1 ♀. Between Tsak-shang and Tsak-ra, road from Tso Moriri to Tso Kar, altitude c. 4570 m. (c. 15,000 ft.), 1 September, 1932.

. The single specimen which is here identified with *M. hissariensis* appears to agree in all essential points with the original description of this very distinct species. The only slight differences concern the coloration of the elytra, which seems to be more intense in the specimen now before me, the dark marks on the corial nerves appearing to extend outward farther onto the disc of the corium than is indicated in the original description, while the black base of the clavus fades to brown with black punctures apically. Since but a single specimen is known it seems unwise to describe the present form as a subspecies.

M. hissariensis is, as Kiritshenko points out, sharply distinguished from its congeners by its larger size (4.0-4.2 mm. in typical series, 3.94 mm. in the present specimen), the entirely black antennae, and the brown-black apical corial angle (Plate VIII, fig. 5). The typical series was taken in northern Buchara.

5. *Bianchiella adelungi* Reuter

Indian Tibet. 1 ♀ Igu, in the Indus Valley above Leh, on the bark on *Populus* sp., altitude 3417 m. (11,210 ft.).

The single brachypterous specimen obtained was one of several observed, but extremely difficult to capture owing to the rapidity of their movements. It has been compared with material determined by Kiritshenko in the British Museum and appears to be identical. Since this remarkable form has not been figured, a drawing is given in Plate VIII, fig. 6. The species is known from Siberia, Mongolia and Northern China (Oshanin, 1912) but curiously enough appears to be unrecorded from Russian Turkestan; a second species (*B. sarmatica* Kiritshenko, 1926) is, however, known from European Russia.

Subfamily Aphaninae

Tribe Gonionotaria

6. **Emblethis horvathiana** sp. n.

Ovate subparallel and rather robust, 2.25 times as long as wide.

Color, dark greyish-yellow heavily punctured with black, antennae and legs darker than head pronotum scutellum and elytra, eyes brown, apical joint of antennae, ocular margin of head, base of scutellum showing through the pronotum and some irregular spots joining punctures on the disc of the pronotum and the scutellum, black; thorax below black, margins of coxal articulations greyish-yellow, abdomen beneath brownish, darkening to piceous along the midline.

Head with eyes, seen from above, twice as wide as long (1.20, 0.58 mm.), antenniferous tubercles acutely rounded in lateral view, antennae 1.11 times as long as the maximum width of the pronotum, basal joint sub-cylindrical, just over twice as long as wide (0.15 mm.), second joint just over twice as long as the first, third joint just over two-thirds as long as the second, fourth subequal to the latter (0.33, 0.76, 0.55, 0.74 mm.); basal three joints richly setose, the setae being slightly shorter than the maximum diameter of the first joint, apical joint with a few setae basally and with fine short hairs throughout; rostrum long, reaching almost to the center of the posterior coxae, second joint very slightly longer than the first, third subequal to second, fourth subequal to first.

Pronotum trapeziform (Plate X, fig. 1), not greatly narrowed anteriorly, rather under twice as wide as long (2.15, 1.16 mm.), sides moderately explanate, anterior margin slightly, evenly and roundly excavate, lateral margins neither reflexed or marginated, slightly converging anteriorly from just before the posterior angles, slightly emarginate behind middle, with about eight setae on their anterior portion, including the anterior angles.

Scutellum equal in length to the pronotum and basally slightly wider than its length (1.34, 1.16 mm.). Mesosternum with well-developed and closely approximated tubercles, disc of metasternum not very conspicuously impressed.

Elytra nearly reaching the apex of the abdomen.

Posterior tibia a little shorter than the posterior width of the pronotum, and just over twice as long as the basal tarsal joint, the latter two and a half times as long as the subequal second and third joints together, claws two-fifths as long as one of the latter (2.00, 0.91, 0.18, 0.18, 0.07 mm.).

Length ♀ (*type*) 5.45, breadth 2.43 mm.

Indian Tibet. 2 ♀♀ (*type* and *paratype*). L 77a. Renka-le, altitude 5136 m. (16,917 ft.), between Mitpal Tso and Yaye Tso, on grassy bank in valley, 18 Aug., 1932.

In the paratype the anterior margin of the pronotum is practically straight centrally and the elytra reach to the apex of the abdomen, the two specimens otherwise agree and are undoubtedly conspecific.

E. horvathiana is perhaps more closely allied to *E. verbasci*, than to any other species of the genus known to me. It differs conspicuously in having much more setose antennae, the fourth joints of which are subequal to the second, rather less explanate lateral pronotal margins, in being narrower and in its dark greyish coloration. At first I believed my material was to be referred to *brevicornis* Horv., but, on seeing a drawing of one of the present specimens, Dr. Horvath pointed out to me that in my species the form of the pronotum and antennae are very different. In *brevicornis* the lateral margins of the former are quite straight and converge more markedly anteriorly, while the fourth joint of the antenna is very much shorter than in the present species. I am greatly indebted to Dr. Horvath for calling my attention to these points and have much pleasure in associating this high-altitude species with his name.

Dolmacoris[1] gen. n.

Head bearing conspicuous bristles, ocelli set well on vertex, close to the inner margins of the eyes; antennae with first three joints and the extreme base of the fourth with well-

[1] Tibetan *sGrol-ma*, pronounced Dolma, the most popular goddess of the lamaistic pantheon, better known by the Sanskrit name of Tara. The specific name is in honor of my friend Dr. Hellmut de Terra, leader of the Yale North India Expedition.

developed bristles; bucculae well developed; rostrum short reaching but to the posterior margin of the prosternum; apex of second joint reaching but to the base of the head, the first joint the longest; sides of pronotum slightly explanate, pronotal disc with two large raised circular areas, and an ill-defined longitudinal carina; sutures between third and fourth and between fourth and fifth abdominal sternites almost straight, reaching almost to the connexivum where they become fragmented and obscure; glandular patches on fourth sternite apparently absent; abdominal spiracles all ventral save that of the fourth segment which is situated dorsally on the connexivum; anterior femora incrassated but unarmed, well-developed tarsal aroliae absent. Genotype: — **D. deterrana** sp. n.

7. **Dolmacoris deterrana** sp. n.

Color. Dull greyish-yellow, somewhat suffused with orange, eyes and ocelli reddish brown, punctures and bases of bristles very dark brown or black, posterior smooth part of vertex and central carina of pronotum slightly paler, elytra with two large tubercles reddish, abdomen dorsally obscurely mottled with brown, anterior margin of connexival portion of tergites and a small transverse stripe on the same on tergites five, six, and seven, black; abdomen ventrally black mottled with greyish-yellow laterally, antennae and legs greyish-yellow with large black spots at the bristle bases, fourth antennal joint uniformly blackish brown, femora with heavy black puncturation, apices of tarsi somewhat darkened.

Head. Dorsal surface, save for two areas immediately around the ocelli, a median area on the extreme posterior part of the vertex and the anterior three-quarters of the ventral surface lateral to the bucculae, coarsely and irregularly punctured; anterior and postero-central part of head dorsally with conspicuous sparsely set bristles, two being set on the labrum; width of head with eyes greater than length seen from above (0.98, 0.76 mm.); clypeus very distinctly separated by furrows from the jugae; antenniferous tubercles well developed, downwardly directed in lateral view (Plate IX, fig. 3), and giving the preocular part of the head a very slightly constricted outline in front of the eyes; eyes very large and subpedunculate, situated behind the middle of the head; bucculae well developed and elevated, somewhat divergent, reaching practically to the posterior margin of the head, suddenly and obliquely lowered in the posterior eighth of the latter; rostrum short reaching but to the posterior margin of the prosternum, the first joint the longest, about one and one-half times as long as the second, which reaches to about the posterior margin of the head, the third subequal to the second and slightly longer than the fourth (Plate IX, fig. 5). Antennae rather short, basal joint cylindrical, reaching about to the apex of the head and stouter than the others, three basal joints and base of the fourth with strong bristles which are a little longer than the diameter of the second joint, the latter joint twice as long as the first, and just under twice as long as the third which is just under half the length of the fourth (0.25, 0.47, 0.22, 0.45 mm.).

Thorax. Pronotum (Plate IX, fig. 1) subequal in length to the head and one and two-thirds times as wide as long (1.18, 0.72 mm.), anteriorly narrower and posteriorly wider than the head, subtrapeziform, with all sides slightly and widely emarginate, anteriorly with an ill-defined collar behind which the lateral margins are slightly explanate, forming a cariniform expansion which is impunctate above and bears a row of five short bristles just within the margin; disc with a few short bristles and two large circular raised areas with central depressions, behind which are a pair of ill-defined tubercles, between each raised area and continued behind between the tubercles a very ill-defined longitudinal carina. Propleuron punctured, its posterior margin distally bent back towards the posterior angle of the prothorax. Prosternum with a wide well-defined longitudinal rostral depression, the sides of which are raised posteriorly against the articulation of the anterior coxae, anterior part of prosternum forming a distinct collar which is coarsely punctured. Apertures of metathoracic scent-glands small and set a little obliquely, their margins hardly elevated. Legs with numerous well-developed bristles throughout. Anterior coxa with an inwardly projecting lamelliform tooth; anterior femur moderately incrassated, its maximum diameter being about twice that of the femora of the other legs, subequal in length to the anterior tibia; the latter slightly expanded apically, twice as long as the tarsus (0.84, 0.90 mm.), first tarsal joint twice the second which is about two-thirds the length of the third and equal in length to the claws (0.16, 0.09, 0.13, 0.09 mm.). Intermediate coxa acutely angulate interno-posteriorly but not produced into a definite tooth, femur subequal in length to tibia; the latter twice as long as the tarsi (0.84, 0.44 mm.), first tarsal joint three times as long as second, second about two-thirds as long as third and equal in length to the claws (0.18, 0.09, 0.16, 0.07 mm.). Posterior coxa obtusely angulate interno-posteriorly, femur very slightly shorter than tibia; the latter twice as long as the tarsus (1.24, 0.62 mm.), first tarsal joint equal in length to the others together, third one and two-thirds as long as second, claws a little shorter than the latter (0.29, 0.11, 0.18, 0.07 mm.). No aroliae can be made out on any tarsi.

Elytra (brachypterous) covering the proximal half of the abdomen; widely expanded in their proximal quarter so as to cover the base of the connexivum, in their distal three-fourths slightly narrowed exposing the connexivum; posteriorly obliquely truncate; claval vein (*cubitus*) well developed and tuberculate, inner corial vein (*media*) more or less obsolete, represented by a feebly developed carina bearing a single minute tubercle; *subcosta* + *radius* well developed, dividing behind the middle of the elytra to form two large tubercles, with the inner, more anterior, one of which, the inner corial vein appears to fuse, three longitudinal tuberculate carinae behind the tubercles apparently represent the subcosta, radius and media freely approaching the posterior margin of the elytron.

Abdomen. Broad, depressed centrally, coarsely and irregularly punctate, sutures between sternites two and three, three and four, and four and five, almost straight, very slightly turned forward at their distal ends, especially in the case of that between three and four, the latter and that between four and five not quite reaching the connexivum and irregularly fragmented at the ends; all spiracles small, those of the fourth segment dorsal, the rest ventral (Plate IX, fig. 2); opaque glandular patches not developed on the fourth or any other sternite; fourth and fifth tergites with their posterior margins produced backwards as obtuse angle, each angle enclosing a well-marked tubercle, the two tubercles subequal in size and rugose.

♂ Seventh abdominal tergite evenly rounded behind, posterior margin of sternite straight (Plate IX, fig. 8); genitalia as in most *Aphaninae*, with a long spiral vesica (cf. Singh-Pruthi 1925), basal plates moderately large (Plate IX, fig. 6), parameres dilated sub-basally, narrower and slightly bent apically (Plate IX, fig. 7).

♀ Seventh abdominal tergite with a wide, deep semicircular emargination in its posterior border, seventh sternite cleft throughout. Eighth tergite with posterior margin sharply emarginate in the extreme centre. Gonapophyses unarmed (Plate IX, fig. 4).

Length ♂ (*holotype*) 4.15 mm., breadth 2.05 mm.

Length ♀ (*allotype*) 4.55 mm., breadth 2.15 mm.

Indian Tibet. 2 ♂♂ (*holotype* and *paratype*), 5 ♀♀ (*allotype* and *paratypes*). L 63, between Nying-ri and Chungang La, altitude 5100-5300 m. (16,800-17,400 ft.), under and between sparsely distributed plants of *Artemisia minor* Jacq., in company with *Tibetocoris margaretae* gen. n., sp. n., and Psyllids, on which forms it probably feeds, 18-19 July, 1932. The male paratype was taken on a slope just above the summit of the Chungang La, altitude 17,397 ft., on the boundary between Indian Tibet and Tibet proper.

In spite of its unarmoured femora and straight abdominal sternal sutures this remarkable insect is referred to the Aphanine tribe *Gonionotaria* on account of the disposition of the bristles on its head and antennae, and the position of the abdominal spiracles. *Dolmacoris* is clearly allied to *Diomphalus* Fieb., which also has straight abdominal sternal sutures, very similar brachypterous elytra, no conspicuous tarsal aroliae (Fieber, 1864, T. I., fig. IV f.) and a small spur on the anterior coxa. The structure of the rostrum, which in *Diomphalus* reaches to beyond the middle of the mesosternum, with a basal joint reaching almost to the base of the head, constitutes the most striking generic character of *Dolmacoris*. The short antennae and trapezoidal pronotum suggest comparison rather with the little known Transbaikalian *Diomphalus annulicornis* Jak., than with *D. hispidulus* Fieb., but Jakovleff (1889) makes no mention of his species differing from *hispidulus* in the structure of its rostrum so that it is presumably correctly placed in *Diomphalus*. *Dolmacoris* appears to have larger eyes than either species of *Diomphalus* and in the latter genus the anterior femora appear to bear spurs; the shape of the pronotal bosses probably furnishes a further generic character.

In the course of examining *Dolmacoris* it became apparent that no adequate information was available as to the position of the abdominal spiracles in the various tribes of the *Aphaninae* as well as in certain of the other subfamilies of the *Lygaeidae*. Mr. W. E. China most kindly offered to make preparations from representative species of each tribe of the *Aphaninae*, using as far as possible the typical genera and also of representatives of a number of other subfamilies. The results of these studies Mr. China most generously asked me to incorporate in the present paper (Table II). A few words may therefore be appropriately devoted to the problems of the classification of the *Lygaeidae* raised by these data. Omitting the *Aphaninae* it is clear that while there is a general progression from a dorsal to a ventral position when the subfamilies are considered in the order currently used in systematic works, yet this progression is not as regular as would appear from the keys that have been published, as, for instance, those given by Stal (1872) or in the excellent work of Barbour (1917, 1918). The following points require comment:

1. The *Lygaeinae* and *Cyminae* are generally stated to have entirely dorsal spiracles; this appears to be essentially correct, though the spiracles on the seventh segment of *Cymus* are almost lateral, being situated dorsally on the conjunctival membrane between the connexivum and the sternite.

2. The *Henestarinae* are omitted from Barbour's key as the subfamily is unrepresented in the Nearctic Region. If it is to be included with the *Blissinae* and *Geocorinae*, as is done by Stal (1872), the key character defining this group of subfamilies must be emended

TABLE II

Position of Abdominal Spiracles in *Lygaeidae*

Species	Segment 2	3	4	5	6	7
Lygaeinae						
Lygaeus pandurus	D	D	D	D	D	D
Chauliopinae						
Chauliops bisontula	D	D	D	D	D	D
Cyminae						
Cymus claviculatus	D	D	D	D	D	D–L
Metrarginae						
Metrarga (Nesocryptias) villosa	D	D	D	D	D	D
Geocorinae						
Geocoris limbatus	D	D	D	D	D	V
Henestarinae						
Henestaris laticeps	V	D	D	D	V	V
Blissinae						
Blissus leucopterus	D	D	D	V	V	V
Artheneinae						
Chilacis typhae	D	V	V	V	V	V
Oxycareninae						
Oxycarenus hyalinipennis	D	V	V	V	V	V
Heterogastrinae						
Heterogaster urticae	V	V	V	V	V	V
Pachygronthinae						
Pachygrontha antennata	V	V	V	V	V	V
Aphaninae-Cleradaria						
Clerada apicicornis	V–L	V	V	V	V	V
Myodocharia						
Orthaea pallicornis	D	D	D	V	V	V
Rhyparochromaria						
Rhyparochromus chiragra	V	D–L	D	V	V	V
Plinthisus brevipennis	V	V	V	V	V	V
Aphanaria						
Aphanus vulgaris	V	D	D	V	V	V
Gonionotaria						
Gonionotus marginipunctatus	V	V	D	V	V	V
Ischnopeza pallipes	V	V	D	V	V	V
Dolmacoris deterrana	V	V	D	V	V	V
Lethaearia						
Lethaeus longirostris	V	V	V	V	V	V

D = dorsal, V = ventral, D–L = dorsal on conjunctival membrane, V–L = ventral on conjunctival membrane.

to "all of the abdominal spiracles not situated ventrally, at least those of the third and fourth segments dorsal"; for, as is indicated in the table, the spiracles on the second segment of *Henestaris* are ventral, so that the original statement that at most only the last three spiracles are ventral is incorrect.

3. In the *Heterogastrinae*, *Pachygronthinae*, *Artheneinae* and *Oxycareninae* all the spiracles are usually said to be ventral. In *Oxycarenus* and *Chilacis*, however, those of the second segment are dorsal. The emended key character defining this group of subfamilies should therefore run "all or at least the five posterior abdominal spiracles situated ventrally."

4. In the *Chauliopinae* and *Metrarginae*, subfamilies not examined by Stal or Barbour, all the abdominal spiracles are dorsal. The *Metrarginae* were stated by Kirkaldy (1902), in erecting the subfamily, to be allied to the *Cyminae*, but to have the last three abdominal spiracles placed ventrally. Later he concluded (1908) that the subfamily was more probably allied to the *Oxycareninae*. It is probable that Kirkaldy mistook three prominent pairs of trichobothria for ventrally placed spiracles in uncleared material. In reality the affinities of this peculiar Hawaiian subfamily with the *Cyminae* are great, the chief differential character being that in the *Metrarginae*, unlike any other member of the family, the hamus of the alar areole is "continuous, extending from the vena subtensa upwards to the upper vein" (Kirkaldy, 1902).

5. The *Aphaninae* (*Rhyparochrominae*) have never been separated on spiracular characters and show great diversity in this respect. The Myodocharian arrangement as exemplified by *Orthaea* is similar to that obtaining in the *Blissinae*, while in the *Lethaearia* and in *Plinthisus* an entirely ventral arrangement is found as in the *Heterogastrinae* and *Pachygronthinae*, and an almost identical pattern is found in *Clerada*. On the other hand the arrangements with the spiracles of the third and fourth segments alone dorsal or dorso-lateral as in *Aphanus* and *Rhyparochromus*, or with only those of the fourth segment dorsal as exemplified by the *Gonionotaria*, are not found outside the *Aphaninae*. In conclusion it would seem that although the position of the spiracles may be of great value in the construction of artificial keys and in determining the relationships of individual genera and tribes, too much stress must not be laid on so variable a character in determining the natural subdivisons of the family.

Family ANTHOCORIDAE

Tribe Anthocoraria

8. **Ectemnus paradoxus** sp. n.

Color. Head, pronotum, scutellum and ventral surface black; eyes and ocelli dark vinous; first antennal joint black, second yellow with a little black basally and the extreme apex greyish-black, third yellow, narrowly black apically, fourth black, slightly paler basally. Elytra with fine sparse pale golden pubescence, clavus brown, its inner margin paler and outer margin darker than the disc, corium and embolium basally lacteous, apically piceous, extreme apex of corio-embolial suture, in the neighbourhood of the anterior margin, hyaline, cuneus piceous black, membrane opaque lacteous with a large central and a still larger sub-apical spot greyish-black, the areas around and between the spots luteous; femora black, tibiae pale testaceous, their apices somewhat darker, tarsi greyish-black.

Head elongate (Plate X, fig. 3), just under one and a half times as long (0.53 mm.) as width, with eyes (0.36 mm.), anterior margin of eye inserted very slightly behind middle of lateral margin, head somewhat constricted in front of insertion of antennae and also before the posterior margin; rostrum reaching to posterior margin of anterior coxae; first antennal joint reaching just to apex of head, second three and a third times the length of the first, third twice the length of the first and very slightly shorter than fourth (0.11, 0.40, 0.24, 0.27 mm.), second joint slightly thickened baso-apically, third and fourth hardly narrower than the middle of the third.

Pronotum twice as wide posteriorly (0.73 mm.) as long (0.36 mm.) with a very distinct apical collar less than half the posterior width (0.31 mm.) and marked transverse impression, disc finely rugose and covered with very fine short pale hairs, lateral margins sinuate, somewhat raised and marginate, posterior angles sub-acute, directed backward and not projecting laterally.

Scutellum slightly shorter than pronotum, and one and a half times as wide (0.44 mm.) as long (0.29 mm.), disc with sparse, very short fine pale hairs, little raised anteriorly, remotely punctate and nitid, slightly depressed before apex which is rugulose.

Prosternum rugose, its disc flattened centrally, posterior margin produced to form an acute xyphus between the anterior coxae.

Mesosternum nitid, very finely and regularly rugulose, posterior margin narrowly emarginate, disc with a fine groove running forward from the emargination and becoming obsolete anteriorly.

Metasternum transverse, between the widely separated posterior coxae, but little raised, coarsely and irregularly rugose, posterior margin truncate.

Orifice of metathoracic scent-gland straight, produced rather prominently at the outer end (Plate X, fig. 7).

Tibiae of all legs but little longer than femora (ant. 0.51, 0.55; inter. 0.51, 0.55; post. 0.80, 0.87 mm.).

Elytra and wings macropterous, the latter without a hamus (Plate X, fig. 6).

Abdomen distinctly surpassed by the elytra.

♂ Left paramere short, broad and semicircular (Plate X, fig. 8), right paramere vestigial. Length 2.55 mm., breadth 0.80 mm.

Indian Tibet. 3 ♂♂ (*holotype* and *paratypes*) Igu, in the Indus Valley above Leh, on the bark of *Populus* sp.; altitude 3417 m. (11,210 ft.), Sept., 1932.

The present species is anomalous in that it lacks the hamus of the wing cell, a character which would remove it from the *Anthocoraria* and place it in the *Lyctocoraria* as defined by Poppius (1909). *Ectemnus paradoxus*, however, runs down perfectly to its genus in the key to the *Anthocoraria* given by this author, if once its membership in that tribe be admitted. Apart from the absence of the hamus it appears to be an entirely normal member of its genus. If, therefore, it is to be removed from the *Anthocoraria*, a new genus of the *Lyctocoraria* must be defined, isolated from all the other members of that tribe, and differing only from the Anthocorarian genus *Ectemnus* in the single character under discussion. This is clearly an unsatisfactory proceeding and the present species is therefore described as an *Ectemnus*. It is clear that the value of the presence and position of a hamus as a major taxonomic character is dubious, but I am not in a position to revise the tribal characters of the *Anthocoridae*, nor to provide any new distinction between the two tribes. It may be pointed out that China (1933) also appears to be somewhat doubtful of the value of hamal characters for this purpose.

The genus *Ectemnus* at present contains four species. *E. longirostris* Horv. from the Balkans is sharply distinguished by its rostrum which reaches to the intermediate coxae. Of the remaining species the widespread Palaearctic *E. reduvinus* (H.-Sch.) is an insect of very different facies from *paradoxus*; it is usually brachypterous and the head and pronotum are ferrugineous brown. *E. parilis* Horv. is known only in the brachypterous state, the head and anterior part of the pronotum are black as in *paradoxus*, but the posterior part of the latter fades to ferrugineous, and the whole of the fourth, the apical half of the third and all of the second antennal joint save a yellow ring are black. *E. pictipennis* Esaki (1931) a macropterous species from Japan, in which, as in *paradoxus*, the head and pronotum are entirely black, differs from the latter, as is clear from Esaki's excellent description and figure, in having the fourth antennal joint yellow, the sides of the pronotum straight and the head unconstricted behind the eyes.

The species nearest geographically to *paradoxus* is *reduvinus*, which is recorded by Oshanin (1889, 1912) from Russian Turkestan, but it is possible that *Galchana* Distant (1910) is a synonym of *Ectemnus*, though the type and only species, *G. humeralis* from Simla, is clearly distinguished by its pointed posterior pronotal angles from *E. paradoxus*.

9. **Anthocoris gyalpo**[2] sp. n.

Moderately broad and robust, 2.85 times as long as wide.

Head, antennae, basal half of rostrum, pronotum, scutellum, dorsum abdominis and ventral surface black; apex of penultimate joint of rostrum testaceous, ultimate joint brown, posterior part of metapleuron behind scent-gland and apex of abdomen beneath, obscurely testaceous; legs testaceous, the bases of the coxae piceous, extreme bases of femora and tibiae slightly darkened, dorsal surface of anterior femora slightly infuscated subapically, posterior femora darkened along the posterior margin, tarsi brown, all these markings obscure, the legs being without any definite spots or annulations; elytra pale testaceous brown, practically unmarked, the base and internal margin of the clavus, the corial veins and the apex of the cuneus being very slightly darker, membrane grey, infuscated subapically.

Head with a few pale hairs anteriorly, one and a sixth times as long as wide (0.60, 0.51 mm.), suddenly and then more gradually narrowed in front of the eyes, postocular region constricted, antennae longer (1.44 mm.) than the length of the head and pronotum together (1.07 mm.), first joint not reaching the apex of the head, second joint subequal in length to the width of the head and eyes, and half as long again as the third which is subequal in length to the fourth (0.15, 0.55, 0.36, 0.38 mm.); second joint about half as thick basally as subapically, where it is very slightly thicker than the first joint, all joints clothed with fine pale hairs which are subequal in length to or a little shorter than the maximum thickness of the second joint, hairs more abundant and more closely adpressed on the apical half of the fourth joint; rostrum reaching to just beyond the centre of the anterior coxae, its first visible joint (damaged in unique type) apparently not quite reaching to the insertion of the antennae; second joint about twice as long as third (0.25, 0.47 mm.).

[2] Tibetan *rGyal-po*, a king; the garden in which the unique holotype was taken formerly surrounded a pavilion or summer residence of the Gyal-po of Leh.

Pronotum (Plate X, fig. 2) covered with fine short pale hairs, its maximum width about two and a quarter times the median length (1.06, 0.47 mm.), anterior collar moderately well developed, its width (0.38 mm.) just over one-third the maximum width of the pronotum, lateral margins immarginate feebly rounded from the collar and quite straight throughout the greater part of their length, posterior angles obtusely pointed, disc strongly rugose, save a longitudinally impressed raised transverse area immediately in front of the transverse fovea, which is set in the middle of the mid-line of the pronotum and occupies more than one-third of the width of the pronotum at that level, posterior part of disc with traces of a longitudinal central depression, posterior margin widely emarginate before the base of the scutellum. Scutellum covered with fine short pale hairs, longer (0.62 mm.) than the pronotum and about one and a quarter times as wide (0.77 mm.) as long, with a well-marked transverse fovea behind the middle, anteriorly somewhat swollen and remotely punctate, apex somewhat rugose.

Prosternum with its posterior margin somewhat marginated, except centrally where it is produced backwards as a short xyphus between the anterior coxae, its disc somewhat rugose, with an indistinct transverse carina behind the middle.

Mesosternum smooth, its posterior margin rounded and centrally a little emarginate, disc with a fine longitudinal groove running forward from the emargination almost to the anterior coxae.

Metasternum rounded posteriorly and elevated.

Orifices of metathoracic scent-glands curved slightly forward externally and with a very fine carina running forward from the outer end of the orifice (Plate X, fig. 4).

Legs with fine pale hairs on all joints, slightly sparser than those of the antennae, tibiae slightly incrassated apically, anterior femur very slightly shorter than the tibia, which is just over three times the length of the tarsus, the latter just under three times the length of the curved claws (0.73, 0.80, 0.25, 0.09 mm.), intermediate femur very slightly shorter than the tibia, which is just under three times the length of the tarsus, the latter just over three times the length of the curved claws (0.76, 0.84, 0.31, 0.09 mm.), posterior femur about five-sixths the length of the tibia, which is a little over three and a half times the length of the tarsus, the later about three times the length of the straight claws (1.02, 1.20, 0.33, 0.11), last tarsal joint of each leg just over half the length of the tarsus.

Elytra surpassing the apex of the abdomen, covered with fine short pale hairs, coarsely but obscurely punctured and sub-nitid throughout, cuneus entirely behind the apex of clavus, its marginal length (0.62 mm.) about three-fifths that of the embolium (1.16 mm.), embolial margins straight and subparallel, all membranal veins save the outer one more or less obsolete.

♂. Left paramere narrow, sickle-shaped, and angulate (Plate X, fig. 5).

Length 3.52 mm., maximum breadth 1.24 mm.

INDIAN TIBET. ♂ (*holotype*) Leh, Residency Garden, apparently blown from *Populus* sp., 19 September, 1932.

The present species, in its rostrum, metasternum, odoriferous glands, cuneus and pronotum agrees sufficiently well with *Anthocoris* to be included in that genus. It differs from its previously described congenus in its almost unicolorous elytra which are perhaps more clearly punctate than usual in *Anthocoris*. *A. gyalpo* appears to belong to that section of the genus in which the antennae are longer than the head and pronotum together, of which *A. sylvestris* (Linn.) is the best known member, but is easily distinguished from var. *nigri-*

cornis (Fieb.) of this species by its almost uniform elytral coloration and curved orifice of the odoriferous gland. From the other species included in this section it is also distinguished by the different proportions of the antennal joints. Poppius (1909) has described two members of this group, viz., *annulipes* and *indicus* from Darjeeling, but these appear to be normally coloured members of the genus with black or annulated femora (*vide* Distant, 1909, figs. 166, 167). The almost complete suppression of all but the outer membranal veins suggests *Compsobiella* Poppius (1909) but the present species shows none of the other characters of this Central African insect and a somewhat similar reduction is found in the species of the *sylvestris* group.

Family MIRIDAE

Subfamily Dicyphinae

Tribe Dicypharia

10. **Dicyphus physochlaenae** sp. n.

Head black, the inner border of the eyes margined with yellow which spreads out towards the central black area of the vertex from the postero-internal angle of the eye, centre of frons with a longitudinal yellow stripe which spreads anteriorly to the bases of the antennae, vertex with two submarginal yellow spots posteriorly (Plate X, fig. 9). Pronotum grey, with a transverse stripe across the calli and subapical fossa piceous black, the stripe interrupted by a longitudinally elongated yellow spot between the calli but uninterrupted more anteriorly, grey part behind median fossa with an anterior median yellow spot narrowly connected with the spot between the calli, outer part of calli marked with brownish yellow. Scutellum black, basal angles narrowly orange, apical half of margins with greyish yellow vittae which become obsolete towards the posterior angle. Ventral surface black. Antennae with first joint black, very narrowly greyish yellow at the extreme base and apex, second joint black, very narrowly greyish yellow at the base and with a conspicuous yellow band occupying its central quarter, third joint black, a little paler basally, fourth joint brown. Rostrum yellow, base of second and third and whole of fourth joint black. Coxae yellow with black bases, femora yellow heavily spotted with black, dorsally tibiae yellow with the extreme base brown and with about five brown (anterior) or black (intermediate and posterior) spots on the postero-dorsal part of the proximal third, first and second tarsal joints yellow and the third black; all tibiae armed with fine black spines. Elytra hyaline, greyish, with the apex of the cuneus piceous, membrane very transparent, greyish, its nerves yellowish grey suffused with brown.

Head transverse, rather less than one and a half times as wide as long (0.60 mm., 0.44 mm.), evenly rounded and little produced anteriorly above clypeus, the latter in lateral view with its anterior margin straight ventrally, in its dorsal third rather suddenly rounded to meet its dorsal suture with the frons, gula longer than bucculae and slightly sinuate.

Antennae fairly thick, first joint surpassing apex of head by about three-quarters of its length, and about two-thirds the length of the head from above, second joint twice as long as the first, third joint just over two-thirds the length of the second, fourth about two-thirds the length of the third, second joint distally about twice as thick as proximally, but throughout slightly narrower than the first (head length 0.44 mm., antennae 0.25, 0.51, 0.36, 0.25 mm.).

Rostrum not quite reaching the middle of the intermediate coxae, first joint hardly surpassing the base of the head.

Pronotum anteriorly about three-quarters of the width of the head, posteriorly about one and three-quarters times as wide as head, two and one-third times as wide as the anterior breadth and twice as wide as long (head width 0.60 mm., pronotum, anterior width 0.45 mm., posterior width 1.02 mm., length 0.1 mm.), anterior collar well marked, its anterior margin very slightly sinuate, calli well marked, subconfluent centrally, posterior transverse fossa central, sides but little sinuate, posterior margin widely and deeply emarginate, posterior part of disc rather feebly rugose.

Elytra long, their length from the insertion to the level of the apex being five times the median length of the pronotum, and two and one-third times their greatest width, outer margin slightly explanate centrally. Anterior coxae reaching to the middle of the mesosternum, posterior tibia (1.58 mm.) 2.66 times as long as the width of the head and eyes, third tarsal joints of all legs slightly shorter than second.

♂ Left paramere as in Plate X, figs. 11, 12.

♂ (*holotype*) length 3.53 mm., breadth 1.13 mm.

♀ (*allotype*) length 3.75 mm., breadth 1.20 mm.

Indian Tibet. 2 ♂♂, 4 ♀♀ (*holotype, allotype* and *paratypes*) L 67. Dambuguru, altitude 4603 m. (15,100 ft.), on *Physochlaena praealta* Hook. (Solenaceae), 31 July, 1932.

In the coloration of the head and legs this species closely resembles *D. orientalis* Reut. from Turkestan; it may ultimately have to be treated as a subspecies or form of that species. The posterior tibia is, however, proportionately shorter than is indicated in Reuter's description (1884) of *orientalis* and the coloration of the antenna is comparable to that of the widespread western Palaearctic species *D. annulatus* (Wolff.). In the latter species the black spots extend throughout the intermediate and posterior tibiae at the bases of the black spines. *D. montanus* Poppius (1912) from the Alexander Mts. is another closely allied species which, however, appears to have a longer basal antennal joint ("nur wenig kürzer als der Kopf von ober gesehen") and to have a rather different color pattern on the vertex.

These forms are all clearly closely allied and the coloration, which has been chiefly used in separating them, is undoubtedly variable. It is hoped that the present figures of the parameres of *D. physochlaenae* will make it possible for other workers to decide whether the present form is specifically distinct. There can meanwhile be little doubt of its Central Asiatic affinities.

11. Dicyphus sengge[3] sp. n.

Head yellow, posterior margin black, centre of vertex with a large V-shaped black mark which tends to become somewhat diffuse at its posterior apical end (Plate X, fig. 10). Pronotum grey, with a transverse stripe across the calli black, centrally interrupted by a longitudinal yellow vitta, outer margin of calli yellowish, posterior part of pronotum grey. Scutellum black, basal angles dull orange, apical two-thirds of margins with broad greyish yellow vittae which do not quite reach the apical angle. Ventral surface brownish. Antennae with basal joint black, its apex very narrowly whitish, second joint yellow with the extreme base and apical third black, third joint black, fourth joint piceous black. Rostrum

[3] Tibetan *Seng-ge*, a lion, the setose angle of the left paramere being suggestive of a mane.

brownish yellow, fourth joint black. Legs very pale greyish yellow, bases of coxae blackish, femora with small brown spots, tibiae immaculate, third tarsal joints black; tibiae with numerous fine black spines which do not arise from spots. Elytra hyaline grey throughout, apices of corial nerves suffused with black, covered throughout, but most strongly in the lateral (anterior) region with fine black hairs.

Head transverse, rather more than one and a half times as wide as long (0.60 mm., 0.37 mm.), evenly rounded and hardly produced anteriorly over the clypeus, the latter in lateral view with its anterior margin straight ventrally; bucculae shorter than gula.

Antennae moderately thick, the first joint surpassing the apex of the head by about three-quarters of its length, and about two-thirds the length of the vertex seen from above, second joint two and two-thirds times as long as first, third just under three-fourths as long as the second and fourth about three-fifths as long as third (0.25, 0.65, 0.45, 0.27 mm.).

Rostrum apparently reaching just beyond middle of intermediate coxae (somewhat damaged in unique type), basal joint distinctly shorter than head.

Pronotum anteriorly about four-fifths as wide as head with eyes, posteriorly about one and four-fifths as wide as the head, just over twice the anterior breadth and just over twice as wide as long (head width 0.60 mm., pronotum, anterior width 0.49 mm., posterior width 1.03 mm., length 0.49 mm.), anterior collar well marked, its anterior margin very slightly sinuate, calli well marked, subconfluent centrally, posterior transverse fossa lying just anterior to center, sides rather sinuate, posterior margin widely emarginate, posterior part of disc feebly rugose.

Elytra about six times as long as pronotum, and just over twice their greatest width, outer margin very slightly explanate. Anterior coxae reaching to middle of mesosternum, posterior tibiae (1.64 mm.) 2.75 times as long as width of head and eyes, third tarsal joints subequal to second.

♂ Left paramere as in Plate X, fig. 13, with very long hairs on the basal part of the shaft, and a small triangular projection, situated more apically than the corresponding projection in the preceding species and directed upwards.

Length ♂ (*type*) 3.69 mm., breadth 1.23 mm.

INDIAN TIBET. 1 ♂ (*type*) L 37, between Tangtse and Mugleb, altitude c. 4175 m., among grasses, 27 June, 1932.

This species is very close to the preceding, differing in the different coloration of the head, the more sinuate lateral margins of the pronotum and in the left paramere. Both species are allied to the above-mentioned Central Asiatic species and to *annulatus*. From the latter species *D. sengge* differs in the coloration of the head and tibiae, from *orientalis* in the coloration of the head and antennae, from *montanus* in the short basal joint of the latter.

Subfamily PLAGIOGNATHINAE

Tribe Plagiognatharia

12. *Chlamydatus pachycerus* Kiritsh.

C. pachycerus Kiritshenko. 1931.

INDIAN TIBET. 1 ♂ macr., 3 ♀ ♀ brachypt. L 33, Shakya La, south slope c. 5200 m. (c. 17,000 ft.), air temp. in shade 7.2 C. "jumping about in sun around moss and grass," 25

June, 1932. 3 ♀ ♀ brachypt. L 48 Kyang La, among sparse grass and *Pegaeophyton* prob. *scapifolium* Marq. and Skan., altitude 5100-5334 m. (16,800-17,500 ft.), 9 July, 1932. 1 ♂ macropt., 1 ♀ brachypt. Ororotse Tso, altitude 5297 m. (17,381 ft.). 11 July. 1932. 2 ♂ ♂ macropt., 3 ♀ ♀ brachypt. L 54a, north side of Marsimik La, altitude c. 5300 m. (17,400 ft.), grassy place, 16 July, 1932. 1 ♂ macropt., 1 ♀ brachypt. Kyam, altitude 4733 m. (15,530 ft.), grassy place, 20 July, 1932. 3 ♂ ♂, 1 ♀ all macropt. Nyagtzu, altitude 4671 m. (15,324 ft.), grassy place, 30 July, 1932; 1 ♂ macropt. Peldo-le, north end of Tso Moriri, altitude 4529 m. (14,835 ft.), mixed vegetation with grasses dominant, 31 Aug., 1932. 1 ♀ brachypt. Tsak-shang, 31 Aug., 1932.

This species was described from material taken between 13,500 and 16,500 feet in southern Tibet by Major R. W. G. Hingston on the Third Mount Everest Expedition. According to Kiritshenko both sexes may be brachypterous ("Hemelytra—magis minusve abbreviata"), while only males may be macropterous. In the present collection all the males and a single female appear to be macropterous. Hingston, at his highest locality, notes that the species was "common at the entrance to tunnels of mouse-hares"; in spite of much observation on this point I never found the slightest trace of such an association. Since short grass is the only plant, common to every locality, on the vegetation of which I have notes, there can be little doubt that this species is graminivorous.

Tibetocoris gen. n.

Elongate, clothed above with long irregular sparse, pale pubescence, which is somewhat tomentose on the head.

Head (Plate X, figs. 14, 15, 16) from above but little produced anteriorly, facial angle subrectangular, clypeus moderately prominent, wide, very slightly depressed dorsally, slightly compressed ventrally, subparallel in lateral view, dorsal suture indistinct, lying just above a line drawn across the insertions of the antennae, bucculae moderately well developed, gula distinct, rostrum reaching almost to the apex of the intermediate coxae, anterior joint short and thick, but little surpassing the posterior margin of the head, vertex unimpressed, its posterior margin convexly rounded centrally and feebly marginate laterally, eyes large, ommatidia granuliform, interocular distance less than twice the dorsal width of an eye, in lateral view eye elongate; loro-genal suture distinct; frons and anterior part of vertex feebly striate on each side. First antennal joint surpassing the head by about half its length. Pronotum very transverse, just over twice as wide as long, anterior border centrally emarginate, posterior margin very widely and lightly sinuate, lateral margins straight, anterior callosities poorly developed. Proxyphus flat, its margins obscurely marginate; mesosternum reaching a little beyond the apex of the anterior coxae, its posterior border emarginate centrally.

Tibiae with fine black spinous bristles; pseudarolia narrow, connate throughout its entire length, reaching about to the centre of the evenly and lightly curved claw, basal tooth obtuse, aroliae very fine, bristle-like and subparallel (Plate X, fig. 17). Hamus of wing cell arising opposite the base of the vena decurrens. *Genotype*: **T. margaretae** sp. n.

13. Tibetocoris margaretae sp. n.

Head, pronotum, scutellum and elytra clothed above with long irregular sparse pale pubescence, which is somewhat tomentose on the head; and with a few black hairs on the elytra. Pale greyish white, tinged with yellowish green, vertex near eyes minutely transversely striate with brown, pronotum, scutellum, elytra, and distal third of femora with minute brown spots, antennae greyish brown, basal joint paler, tarsi brown becoming almost black apically, mesosternum and apical joint of rostrum black, abdomen greenish grey. First joint of antenna with two subapical black bristles, second joint narrow proximally, somewhat widened apically but throughout narrower than the first, third and fourth subequal in width, and slightly narrower than the proximal end of the second; second joint just under three times as long as the first; third joint about three-fifths as long as the second and fourth three-fifths the third (0.33, 0.95, 0.58, 0.33 mm.).

Anterior femur with three conspicuous subapical and three small apical bristles, tibia with about nine black bristles; the tibia one and one-third times as long as the femur and twice the length of the tarsus (0.80, 0.98, 0.51 mm.), the tarsal joints overlapping at their articulations, the second a little longer than the first and a little shorter than the third which is twice as long as the claws (0.15, 0.18, 0.22, 0.11 mm.).

Intermediate femur with two apical and one conspicuous subapical bristle tibia with about 16 bristles, tibia just over one and one-third times the length of the femur and two and a half times the tarsus (0.90, 1.24, 0.51 mm.), second tarsal joint twice as long as first, third just longer than second and more than twice as long as claws (0.12, 0.24, 0.25, 0.11 mm.). Posterior femur with two conspicuous subapical bristles, tibia with about 16 bristles, tibia about one and a half times as long as femur and three times as long as the tarsus (1.34, 2.04, 0.69 mm.), second tarsal joint two and a half times as long as the first and slightly longer than the third which is just over twice as long as the claws (0.15, 0.36, 0.33, 0.15 mm.).

♂ Right paramere hook-shaped (Plate X, fig. 18), left paramere styliform (Plate X, fig. 19).

Length 3.75 mm., breadth 1.27 mm.

Indian Tibet. 5 ♂♂, L 57, Slope of mountain on south side of the valley of the Chang-chenmo River, near Pamzal, altitude c. 5220-5270 m. (c. 17,000-17,300 ft.), on *Artemisia minor* Jacq., 18 July, 1932. 3 ♂♂ (*type* and *paratypes*) L 62a, Nying-ri c. 5120 m. (c. 16,800 ft.), on *Artemisia minor* Jacq., 26 July, 1932. 6 ♂♂ L 63 Chungang La, just above top of pass which constitutes the boundary of India and the independent territories of Tibet, altitude 5305 m. (17,400 ft.), on *Artemisia minor* Jacq., 19 July, 1932. 1 ♂, 77 Kakstet La, altitude c. 5360 m. (c. 17,600 ft.), on *Artemisia minor* Jacq., 18 August, 1932.

The present genus is probably most closely allied to *Tuptonia* Reuter, from which it differs mainly in the longer pseudarolia. This character, if the feeble markings on the femora be neglected, would bring the genus into the neighbourhood of *Asciodema* in Reuter's key (1884); *Asciodema*, however, differs markedly from *Tibetocoris* in the structure of the head and legs. The specimens are all somewhat teneral and the prosternum therefore tends to be distorted, but in the best preserved of them it shows no trace whatever of being convex, in this rather resembling the series of genera originally separated by Reuter as the division *Oncotylaria*.

Zoogeographical Notes on the Heteropterous Fauna of High Altitudes

The zoogeographical problems raised by the present collection center around the existence of a number of endemic species, some belonging even to endemic genera, at high altitudes in a mountainous region which was undoubtedly subjected to intense glaciation during the Quaternary Ice Age.

Prior to the present investigation the highest recorded locality at which Heteropterous bugs had been collected was Rongbuk in South Tibet, where at an altitude of 16,500 ft. Hingston obtained much of his material of *Chlamydatus pachycerus* (Kiritshenko, 1931b). A hitherto unrecorded nymph of *Nysius* was also obtained by the same investigator at an altitude of 17,000 ft. In the Yale North India Expedition collections the following four species are represented from still greater elevations:

Nysius ericae alticola subsp. n., up to 5297 m. (17,381 ft.)
Dolmacoris deterrana gen. n., sp. n., up to 5300 m. (17,400 ft.)
Chlamydatus pachycerus Kiritsh., up to 5334 m. (17,500 ft.)
Tibetocoris margaretae gen. n., sp. n., up to c. 5360 m. (17,600 ft.)

These four species fall into two ecological and zoogeographical groups. *N. e. alticola* and *C. pachycerus* occur among grasses and small herbaceous plants, mostly *Cruciferae,* the dominant members of the mesophytic high-altitude vegetation. Both are probably widely distributed in the Himalayan and Karakorum ranges wherever the appropriate flora is developed, for, as has been pointed out, *C. pachycerus* and an undetermined species of *Nysius* are known from but slightly lower localities in the Everest region. It is also of interest to note, that of the three free-living species of Heteroptera inhabiting Greenland, two (cf. China, 1934) belong to the genera *Nysius* and *Chlamydatus.* It is therefore very probable that, during the Quaternary Glaciation, both these genera, and perhaps no others, could survive in the highest zone of vegetation, in the immediate vicinity of the ice. *D. deterrana* and *T. margaretae,* on the other hand, are apparently confined to a drier type of habitat, where the dominant plant is *Artemisia minor* Jacq. Both species belong to monotypic genera most closely related to groups that reach their highest development in Central Asia. The well-defined generic characters of *Dolmacoris* make it most improbable that it is a recent immigrant to the western Tibetan Plateau and strongly suggests that the fauna of the present region of xerophytic vegetation in this region has survived the Quaternary Glaciation in unglaciated parts of Western Central Tibet under semi-arid conditions.

The Pamirs are the only mountains of Central Asia of which the Heteropterous fauna is at all well known. Here from heights of over 4,000 m. Kiritshenko (1931a) records 27 species of which three belong to the *Acanthiidae,* not treated in the present paper. Of the 24 truly terrestrial Heteroptera of the High Pamir only two are endemic species. Omitting three forms only recorded from the Indus valley from localities lying below 4,000 m. and in each case associated with poplar trees which do not grow above this height, the number of species at present known from Indian Tibet is 11. If to these are added two extremely doubtful records, a nymph of *Psallus* sp. (Dambu-guru) and *Teratocoris* sp. (Tukung, S. of the Panggong Tso), which I noted but of which no specimens were found when the collections were unpacked, the total number of species is increased to thirteen, just over half the number recorded from the High Pamir. Of these, however, six appear to be endemic to Indian Tibet and one to Indian Tibet and the Southern Himalaya. Moreover, it is probable that were a male of the species of *Stictopleura* obtained available, this too would be found to be an endemic species. It therefore appears that at least half the species of the region are peculiar to the Himalayan and Karakorum ranges, and that the High Pamir though richer in species is much poorer in peculiar forms. This is probably to be explained by the fact that, while in the Pamirs after the Quaternary Glaciation a number of routes for recolonisation were open (Reinig, 1932), putting the high regions into easy communication with the richest Heteropterous fauna in the Palaearctic region (cf. Kiritshenko, 1931 a), in Indian Tibet the only migration routes were from the North over extensive mountain ranges and deserts, from the humid south and west where the Sub-Himalayan and Kashmirian forest fauna is apparently ecologically unsuited to penetrate into very elevated and semi-arid regions, and from the east where a restricted pre-glacial high-altitude fauna may have survived in the less glaciated parts of western Tibet proper. The material available suggests that certain forms such as *Nysius ericae obscuratus* and *Microplax hissariensis* belong to a Central Asiatic element that has entered by the northern route, while the endemic genera and perhaps some or all of the endemic species represent a migration from hypothetically unglaciated regions of the Tibetan plateau, where a fauna of undoubted Central Asiatic origin survived and differentiated at a time when the greater part of the Karakorum and Western Himalaya were heavily glaciated and quite uninhabitable. Without some such hypothesis it seems impossible to explain the large proportion of endemic forms in a region that has suffered so much glaciation in relatively recent times.

Osborn Zoological Laboratory,
Yale University,
July 18, 1934.

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Explanation of Plate VIII.

Fig. 1. **Phimodera rupshuensis** sp. n.

Fig. 2. **P. rupshuensis,** anterior aspect of head.

Fig. 3. **P. rupshuensis,** ventral aspect of head.

Fig. 4. **P. rupshuensis,** anterior part of connexivum.

Fig. 5. *Microplax hissariensis* Kiritsh.

Fig. 6. *Bianchiella adelungi* Reut.

Fig. 7. *Nysius thymi* (Wolff). ♂, Kidwelly, Britain.

Fig. 8. *N. ericae ericae* (Schill.). ♂, North Haven, Connecticut.

Fig. 9. *N. ericae groenlandicus* (Zett.). ♂, East Greenland.

Fig. 10. *N. ericae ericae* (Schill.). ♂, Leh.

Fig. 11. *N. ericae* aff. *obscuratus* Horv. ♂, Renka-le.

Fig. 12. *N. ericae* **alticola** subsp. n. ♂, *holotype,* Ororotse Tso.

Fig. 13. *N. ericae* **alticola** subsp. n. ♀, *allotype,* Ororotse Tso.

Fig. 14. *N. thymi* (Wolff). ♂, lateral aspect of paramere, Kidwelly.

Fig. 15. The same, dorsal view.

Fig. 16. *N. ericae ericae* (Schill.). ♂, lateral aspect of paramere, North Haven.

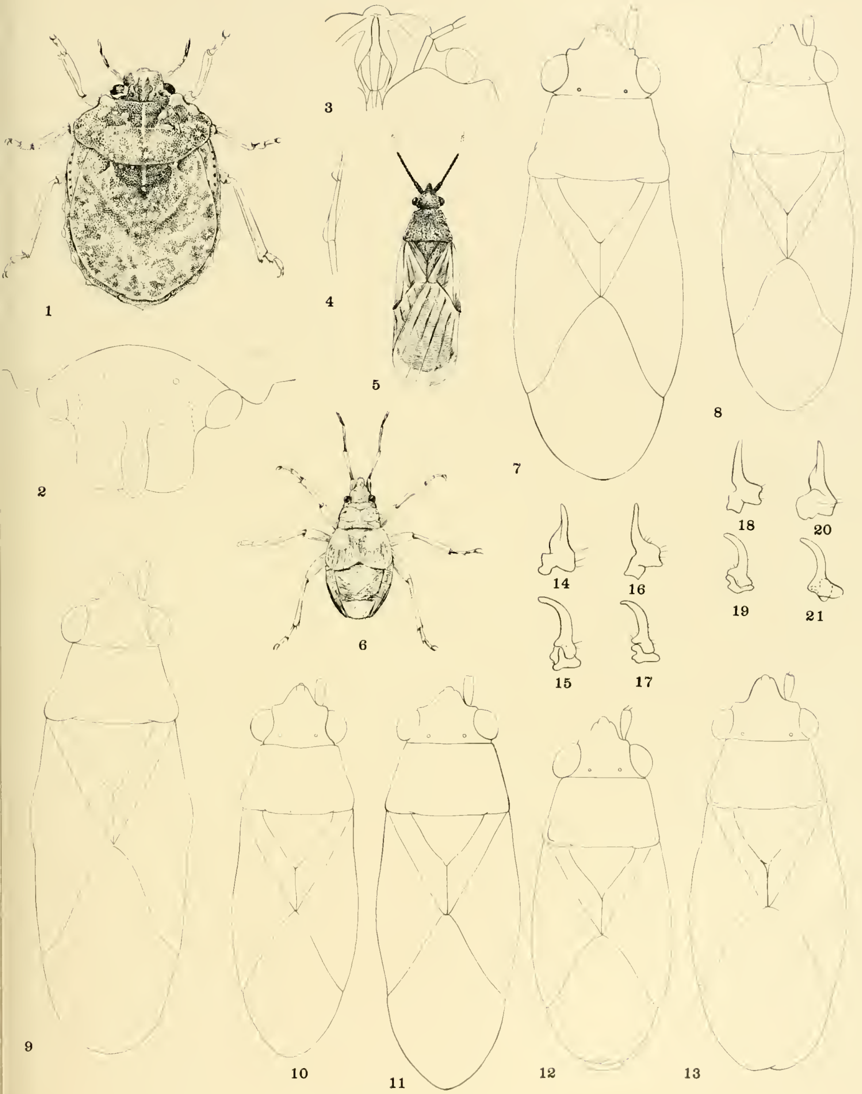
Fig. 17. The same, dorsal view.

Fig. 18. *N. ericae* **alticola** subsp. n. ♂, holotype, lateral aspect of paramere.

Fig. 19. The same, dorsal view.

Fig. 20. *N. graminicola* (Klti.). ♂, lateral aspect of paramere, Porto d'Ischia, Italy.

Fig. 21. The same, dorsal view.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Explanation of Plate IX.

Dolmacoris deterrana gen. n., sp. n.

Fig. 1. Dorsal aspect of ♂.

Fig. 2. Lateral margin of abdominal sternites 2-7 and connexivum of tergites 2-4, partially detached, to show arrangement of spiracles.

Fig. 3. Lateral aspect of head.

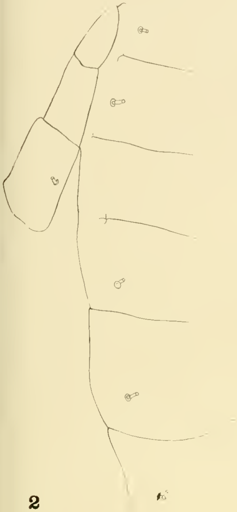
Fig. 4. Gonapophyses of ♀.

Fig. 5. Ventral aspect of head and prothorax.

Fig. 6. Genitalia of ♂, dorsal aspect. (W. E China *del.*) *bp. br.* basal plate bridge, *bp.* basal plates, *ejr.* ejaculatory reservoirs, *phs.* phallosoma, *cnj.* conjunctiva, *vs.* vesica, *gnp.* gonopore, *pr.* paramere.

Fig. 7. Paramere of ♂.

Fig. 8. Seventh abdominal segment of ♂, ventral aspect.



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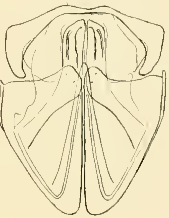

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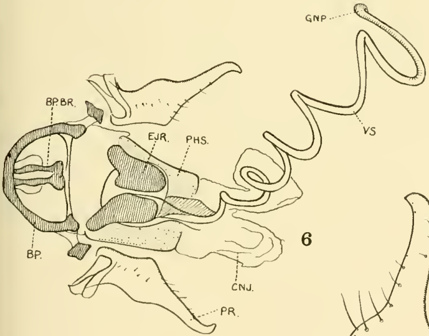

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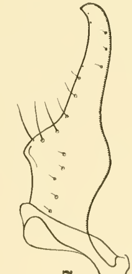

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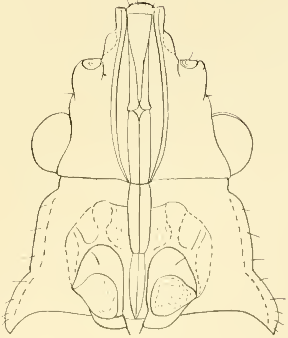

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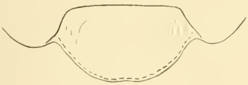

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Explanation of Plate X.

Fig. 1. **Emblethis horvathiana** sp. n. Head and pronotum of type.

Fig. 2. **Anthocoris gyalpo** sp. n. Head and pronotum of type.

Fig. 3. **Ectemnus paradoxus** sp. n. Head and pronotum of type.

Fig. 4. **Anthocoris gyalpo** sp. n. Aperture of metathoracic scent-gland.

Fig. 5. **A. gyalpo** sp. n. Left paramere.

Fig. 6. **Ectemnus paradoxus** sp. n. Wing cell.

Fig. 7. **Ectemnus paradoxus** sp. n. Aperture of metathoracic scent-gland.

Fig. 8. **E. paradoxus** sp. n. Left paramere.

Fig. 9. **Dicyphus physochlaenae** sp. n. Head of holotype.

Fig. 10. **D. sengge** sp. n. Head of type.

Figs. 11 and 12. **D. physochlaenae** sp. n. Left paramere.

Fig. 13. **D. sengge** sp. n. Left paramere.

Fig. 14. **Tibetocoris margaretae** gen. n., sp. n. Dorsal aspect of head and pronotum.

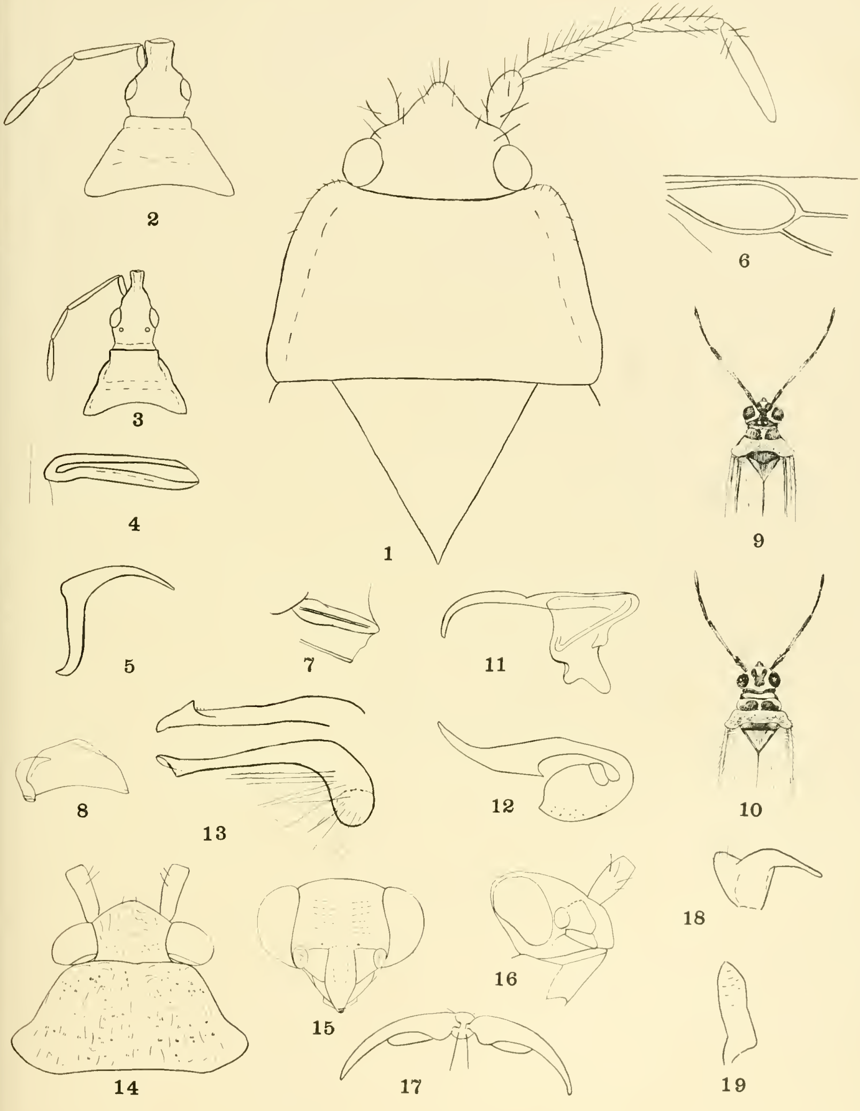
Fig. 15. **T. margaretae** gen. n., sp. n. Anterior aspect of head.

Fig. 16. **T. margaretae** gen. n., sp. n. Lateral aspect of head.

Fig. 17. **T. margaretae** gen. n., sp. n. Claws, aroliae and pseudaroliae.

Fig. 18. **T. margaretae** gen. n., sp. n. Right paramere.

Fig. 19. **T. margaretae** gen. n., sp. n. Left paramere.



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ARTICLE IX

REPORT ON ROTATORIA

By W. T. Edmondson and G. E. Hutchinson

I. INTRODUCTION

Tow-nettings and other samples containing rotifers were obtained by the Yale North India Expedition in fifty-two localities in the Punjab and Northwest Frontier Province (4), the Kashmir basin (15), Indian Tibet and the extreme western part of Tibet proper (24) and the Nilgiri Hills (9). From these collections we have succeeded in determining ninety-nine species excluding a few doubtful forms. No new species were discovered, though it has been necessary to bestow one specific and two varietal names. This paucity of new forms is probably due to the fact that the collections were made for the most part in alkaline waters at moderate or low temperatures. The great number of new species recently obtained from acid waters by Myers (1931-4) is well known; moreover it is probable that truly tropical waters will be found to yield a number of remarkable new species when they are more adequately known. At the same time as the work reported in this paper was in progress one of us had the opportunity to examine a small collection from somewhat alkaline waters at temperatures between 25.9-29.2° C. from the Island of Hispaniola, in which, though but thirty-six forms were obtained, three of these represented very distinct new species (Edmondson, 1934).

In preparing this report we have had invaluable assistance from Mr. Frank J. Myers, who has confirmed a number of doubtful identifications and placed his great knowledge of the group at our disposal whenever difficulties have arisen. Mr. Elbert H. Ahlstrom has most kindly examined our material of the genus *Brachionus* and his determinations have been included in the lists of species. He has also made several useful comments on species of other genera. Dr. J. Wiszniewski has most kindly studied our material of the very interesting species that he has recently described as *Pedalia bulgarica* Wiszn. To these investigators our sincerest thanks are due. We are extremely grateful to Professor Alexander Petrunkevitch and Professor George Vernadsky for translating various descriptions in Russian and Polish. We are also indebted to Dr. E. D. Merrill and the staff of the New York Botanical Garden for determinations of water plants.

The types of the new forms described, and as far as possible a representative set of slides of the known species encountered, will be deposited in the Peabody Museum of Natural History of Yale University. A second set of slides will be forwarded to Mr. Myers for incorporation in the collection of the American Museum of Natural History.

II. LIST OF LOCALITIES

P. *Localities in the Punjab and Northwest Frontier Province.*

P 2. Sohawa, Jhelum district, altitude c. 528 m.

Large dam near village. Marginal vegetation chiefly a narrow-leaved *Potamogeton* and charophytes. Temp. 10.45 a. m. (overcast) 16.2° C., 4.30 p. m. (bright sunlight) 21.2° C. 3 March, 1932. P 2. (6) from open water between weeds, P 2. (7) from among weeds.

P 3 Sohawa, Jhelum district, altitude c. 528 m.
Small pond, about 2 × 5 m. and 50 cms. deep, in swampy stream-bed just below P 2. Temp. 11.25 a. m. 17° C. 3 March, 1932.

P 6. Sohawa, Jhelum district, altitude c. 528 m.
Pond about 18 × 18 m., shallow, very turbid, *Juncus* in centre suggests that it is temporary. Temp. 3.45 p. m. 26.5°C. 3 March, 1932.

P 13. Haripur, Abbotabad district, Northwest Frontier Province, altitude c. 550 m.
Small and presumably very transient puddle by roadside, about 2-3 × 1 m., and 10 cms. deep. Masses of filamentous algae. 17 March, 1932.

K. *Localities in the Kashmir Valley.*

K 4. Srinagar, altitude c. 1585 m.
Small pond by office of Fish and Game Commission. Very turbid and tending to polysaprobic condition. 21 March, 1932.

K 8. Swamp at Gagirbal, Srinagar, at lower end of Lokut Dal lake, altitude c. 1580 m.
Limnanthemum nymphaeoides dominant plant. Diurnal temp. range, 6 April, 1932, 15.3-19.0° C.; pH range, 8.0-8.4. 5 April, 3 May, 1932.

K 19. Swamp at Gagirbal, Srinagar, altitude c. 1580 m.
Cut off from lower end of Lokut Dal by an embankment.
Dominant plant *Ranunculus trichophyllum.* Temp. range 6 April, 1932, 13.2-23.0° C., pH range 8.3-9.3. 5 April, 3 May, 1932.

K 21. Lokut Dal Lake, Srinagar, altitude 1582 m.
Shallow lake, about 1.3 m. deep, entirely carpeted with vegetation, *Potamogeton lucens* being dominant, with *P. amphibium,* and *Limnanthemum nymphaeoides* at the margin. Temp. range, 6 April, 15.85-18.12° C.; pH range 8.2-8.5. 5 April, 1932.

K 21a. Floating garden at side of west side of Lokut Dal, altitude 1582 m.
These are artificially constructed swamps, formed by anchoring masses of decaying vegetation on sticks at the edge of the lake. Tomatoes and other vegetables are cultivated on the islands so obtained. Small pools are cut off from the edge of the main lake in this way and in one of these collections were made 8 May, 1932. A full ecological account of stations K 8, K 19, K 21 and K 21a is in preparation and will appear in a later paper in this series.

K 24. Nishat Bagh, altitude c. 1585 m.
Small artificial pond, 8 m. in diameter and about 50 cms. deep, muddy and with undetermined *Myriophyllum*-like plant. 7 April, 1932.

K 26. Sundar Khun, altitude 1582 m.

A small lake flowing into the swamps in which lie the two Dal Lakes. Max. depth 5 m. *Potamogeton lucens, P. pectinatus, Ceratophyllum demersum* and charophytes, the whole floor of the lake being carpeted with vegetation. Surface temp. 19.4, pH 8.5. 2 May, 1932.

K 35. Phashakuri, near Pampur, altitude c. 1585 m.

A very large swamp in which the dominant plants are *Potamogeton crispus* and *Limnanthemum nymphaeoides*. Temp. 7 May, 1932, 19.1°C.; pH, 10 April, 1932, 9.3, 7 May, 1932, 9.6. Collections 10 April, 7 May, 1932.

K 43. Wular Lake, altitude 1573 m.

Large shallow lake, max. depth 6 m. but mostly under 3 m. Collections are from plankton samples taken on the western side of the lake, April, 1932. Surface temp. 15.5-19.0°C., pH 8.9-9.0.

K 46. Bakh Hajan, altitude 1584 m.

Large swamp of "jhil," between K 43 and K 48, mostly about 30 cms. deep, with much *Ranunculus trichophyllum* and *Marsilia* sp. pH 8.5. 17 April, 1932.

K 48. Manasbal Lake, altitude 1584 m.

Lake with a maximum depth of 12.7 m. Surface temp. 19.85°C., pH 8.8. Collections 21 April, 1932, K 48 (1) epilimnetic plankton 7-0 m., K 48 (2) hypolimnetic plankton 10-7 m.

K 51. Bod Dal Lake, altitude 1582 m.

Shallow lake; max. depth 4.0 m., but mostly under 2 m. deep with beds of *Potamogeton crispus*, etc. Temp. surface 16.4; pH 8.5. 1 May, 1932.

K 68. Sonamarg, altitude c. 2620 m.

Pond about a mile west of rest house, 20 x 10 m. and about 50 cms. deep. Masses of filamentous algae. Temp. 9.00 a. m. 10°C., pH 7.0. 19 May, 1932.

K 69. Sonamarg, altitude c. 2620 m.

Similar pond near K 68 with fresher looking algae. Temp. 9.30 a. m., 13.2, pH 7.6+. 19 May, 1932.

L. *Localities in Indian Tibet (Ladak, Rupshu, etc.) and Tibet Proper.*

L 2. Mulbe, road from Kargil to Leh, altitude 3200 m.

Small pool behind Gonpa rock. About 4 m. in diameter, 50 cm. deep. Filamentous algae. Temp. 8.30 p. m. 7.0°C.; pH 8.0. 27 May, 1932.

L 4. Spring below Photho-la, pass on road to Leh, between Mulbe and Lamayuru, altitude c. 3960 m. 28 May, 1932.

L 10. Khalatse, on road to Leh, altitude 2957 m.

Small pond. 30 May, 1932.

L 14. Ŝpithug, on the Indus south of Leh, altitude 3270 m.
Pool in a swampy meadow, *Potamogeton pectinatus*, *Utricularia* sp. charophytes, etc. pH 8.0. 4 June, 1932.

L 16. Spithug, altitude 3270 m.
Pool a little south of L 16, vegetation similar but *Ranunculus trichophyllum* also present. Temp. 1 p. m., 28.7° C. 9 June, 1932.

L 32. Zung-lung, below Shakya-la, altitude 4224 m.
Algal growth in stream, temp. 2.30 p. m., 5.2, pH 7.9. 24 June, 1932.

L 39. Tsar Tso, between Mugleb and Panggong Tso, altitude 4252.
Small shallow lake, lacking outlet, about 400 m. in diameter, almost completely full of a water-plant, probably *P. pectinatus*. Temp. 5 cms. below surface at edge, 10 a. m., 12.5° C.; pH 9.3. 28 June, 1932.

L 40b. Lagoon 2 at west end of Panggong Tso, altitude 4241 m.
A long narrow pond shut off from the lake by a bar of sand and shingle. Brackish, chloride, 0.249 grms. per litre. 30 June, 1932.

L 47. Lung-yun, above Chagra, Northwest of Panggong Tso, altitude 4977 m.
Pools in swampy ground. 9 July, 1932.

L 49. Togom Tso, northwest of Panggong Tso, altitude 5334 m.
9 July, 1932. This and the next two localities are discussed in detail below.

L 50. Togarma Tso, northwest of Panggong Tso in the Ko-lungpa valley, altitude 5217 m.
10 July, 1932.

L 52. Ororotse Tso, just south of Chang-chenmo River, altitude 5297 m. 12 July, 1932.

L 60. Kyam, Chang-chenmo valley, altitude c. 4725 m.
Largest of several pools fed by non-thermal spring below terrace. 21 July, 1932.

L 61. Kyam, Chang-chenmo valley, 24 July, 1932.
Pond in swampy hummock ground, about 5 m. in diameter, with *Ranunculus trichophyllum*.

L 71a. Tso Nyak, Tibet, altitude c. 4250 m.
Visited by two Ladakis, Tzewang Tashi and Sonam Tergas, who made littoral tow-nettings in the western part of the lake. Though the water of the lake drains into Panggong Tso it is probably slightly mineralised; a sample brought back to camp had a pH value of 8.9. 12 August, 1932.

L 74. Pangur Tso, Tibet, altitude 4329 m.
Large lake lacking outlet studied at the west end, where the maximum depth was 9.5 m. Littoral vegetation abundant, not flowering but probably *P. pectinatus*. Temp. 14.1-15.1, pH 9.6+. Collections 14 August, 1932.
L 74 (1) marginal, L 74 (2) open-water plankton.

L 72. Chushol, S. of Panggong Tso, altitude 4491 m.
Large pond south of village. 9 August, 1932.

L 72a. Chushol, S. of Panggong Tso, altitude c. 4491 m.
Small pool by L 72. 9 August, 1932.

L 73. Chushol, S. of Panggong Tso, altitude c. 4330.
Pond with large spherical algal colonies, N. of village. 10 August, 1932.

L 76. Mitpal Tso, between Chushol and the Indus Valley, altitude 4875 m.
Small lake lacking outlet, max. depth 24 m. Plankton from middle of lake, surface temp. 12.49° C., pH 9.1. 17 August, 1932.

L 78. Yaye Tso, draining into Indus, altitude 4686 m.
Small lake, max. depth 18.1 m. Plankton from middle of lake, surface temp. 14.19 C., pH 8.7. 19 August, 1932.

L 82. Tso Moriri, Rupshu, altitude 4528 m.
Very large lake, with a max. depth probably in excess of 50 m. Plankton from northern part of lake, temp. surface 11.73, pH 9.0. 28 August, 1932.

L 82a. Estuary at Peldo-le, northern end of Tso Moriri, altitude 4528 m.
Temp. 14.9° C. Water much fresher than in lake. Considerable amounts of waterweed, presumably P. *pectinatus.*

L 85. Sta-rtsak-puk Tso, Rupshu, altitude 4536 m.
Small very shallow freshwater lake flowing into the salt lake Tso Kar. 4 September, 1932.

L 86. Tso Kar. Rupshu.
Shallow salt lake, about 2 m. deep, chloride 11.66 gms. per litre, pH 8.9. 5 September, 1932.

L 86a. Pool by Tso Kar, Rupshu, altitude 4527 m.
Slightly brackish pool by salt lake, chloride .078 gms. per litre, pH 9.2. 5 September, 1932.

N. *Localities in the Nilgiri Hills, Madras Presidency.*

N 2. Ootacamund, altitude c. 2255 m.
Pond on Marimund Rd., about 50 m. in diameter, blue waterlilies and *Utricularia.* Temp. 16.1-17.0 C., pH 6.6. 7 November, 1932.

N 3. Ootacamund, altitude c. 2255 m.
Small pond in swamp above N 2, about 13 m. across, temp. 16.5. 7 November, 1932.

N 5. Ootacamund, altitude c. 2201 m.
Lake near the town, very turbid owing to recent rains, small amount of blue waterlily. Temp. 17.5, pH 6.6. 8 November, 1932.

N 6. Ootacamund, altitude c. 2280 m.
Pond at fourth milestone on Connemara Rd., about 2 x 3 m. and 20 cms. deep, in swampy ground, temp. 22.7 C., pH 6.3. 9 November, 1932.

N 8. Ootacamund, altitude c. 2195 m.
Pond about 15 × 6 m. and 1 m. deep, on Pykara Rd., beyond cemetery, temp. 21.3 C., pH 7.3. 10 November, 1932.

N 13. "Umbrella Tree" near Ootacamund, altitude c. 2316 m. Small pool in swamp, 2 x 1.5 m. and c. 60 cms. deep. Utricularia and filamentous algae. Temp. midday, 22.1 C., pH 6.1. 18 November, 1932.

N 15. Ootacamund, altitude c. 2195 m.
Pool 3 × 8 m. and 1 m. deep, full of a lanceolate-leaved Potamogeton, pH 6.4. 13 November, 1932.

N 17. Ootacamund, altitude c. 2316 m.
Dam towards Government House, c. 30 × 70 m., temp. 13.7 C., pH 6.3. 15 November, 1932.

N 20. Pykara, altitude c. 2133 m.
Littoral plankton from large artificial lake. Temp. 19.5 C., pH 6.8. 16 November, 1932.

III. ENUMERATION OF SPECIES

In general Harring's Synopsis has been accepted as indicating the standard nomenclature, save in a few cases where later investigators have found it necessary to modify his terminology.

The symbol c. after a station number indicates that the species in question was common, vc. that it was very common; in all other cases it may be assumed that but a few individuals were found.

Actinurus neptunius Ehrenberg, P 2 (7) c., P 3, K 48.

Anuraeopsis fissa (Gosse), P 2 (6, 7).

Ascomorpha eucaudis Perty, K 35, K 51.

A. saltans Bartsch, L 72.

A. sp. L 13.

Asplanchna brightwelli Gosse, K 26, K 35, K 43 vc., K 51, L 14, L 16, N 20.

A. priodonta Gosse, K 8, K 21, K 43, K 48 vc., K 51.

Asplanchnopus multiceps Schrank, L 73.

Bdelloids, indet., P 2 (7), K 8, K 19, K 21a, K 24, K 35, K 46, K 51, L 2, L 4, L 13, L 14, L 32, L 47, L 49, L 60, L 71a, L 72, L 72a, L 73, L 82a, L 86a, N 2, N 3, N 5, N 8, N 15.

Brachionus angularis Gosse, P 2, K 43.

B. calyciflorus Pallas, P 2, K 19, K 35, K 43 vc., K 51c.

B. capsuliflorus Pallas, P 2 f. *quadridentatus* Hermann, L 71a f. *rhenanus* Lauterborn, L 74 f. *cluniorbicularis* Skorikov, f. *enzii* Francé and transitional forms, L 86a f. *enzii* Francé.

B. furculatus Thorpe, K 4 (form).

B. plicatilis Müller, L 40b vc., L 71a vc., L 86 c. L 86a.
B. quadratus Rousselet (= ? *leydigii* Cohn), P 6.
B. sericus Rousselet, K 4.
Cephalodella catellina (Müller), ? K 35, L 74 (1) vc. f. **ahlstromi** n.
C. exigua (Gosse), ? P 2 (7), ? P 6, K 35.
C. forficula Ehrenberg, P 2 (6), P 6.
C. gibba (Ehrenberg), K 8, K 21, K 21a, K 35, K 44, K 51, L 16, L 72, L 73, L 74, L 86a.
C. panarista Myers, P 2 (6).
Cephalodella wiszniewskii n. n. L 86a.
C. sp. P 2, K 4, K 35, K 44, K 51, L 74, N 13.
Collotheca campanulata (Dobie) K 8.
Colurella bicuspidata (Ehrenberg) P 2 (6, 7), P 3, K 8, K 21, K 21a, K 35, L 14, L 74, N 5, N 8.
C. colurus (Ehrenberg), K 35.
Conochilus hippocrepis (Schrank), K 21.
Cupelopagis vorax (Leidy) L 21.
Dicranophorus myriophylli (Harring) L 72.
Diurella brachyura (Gosse), P 2 (7).
D. cavia (Gosse), L 14, L 16.
D. stylata Eyferth, N 2, N 19.
D. weberi Jennings P 2 (7), K 8, K 19, K 21, K 21a, K 34, L 14, L 16, L 73.
Eosphora najas Ehrenberg, L 60.
Epiphanes brachionus (Ehrenberg), L 51.
E. senta (Müller) K 4, K 8, K 34.
Euchlanis alata Voronkov ? P 2 (7).
E. (*Dapidia*) *deflexa* Gosse, K 8, K 34, K 51.
E. dilatata Ehrenberg P 2 (6, 7), P 13, K 8, K 19, K 21a, K 34c, K 46c, K 51c, K 68, K 69, L 14c, L 16c, L 39, L 73.
E. meneta Myers P 3, K 21a, K 24, K 35, K 51, L 14, L 16, L 60, L 72.
E. parva Rousselet, P 2 (6, 7), P 3, K 21a, K 24, K 34, K 46, K 51c, L 14c, L 61, L 73, L 82a.
E. triquetra Ehrenberg P 2 (7).
Filinia longiseta (Ehrenberg) P 2, K 43, K 46, K 48 (2) vc., K 51, L 16, L 49c, N 2, N 5.
F. terminalis (Plate) N 2, N 5.
Floscularia conifera (Hudson) ? K 8.
Flosculariid, indet. P 2 (7).
Gastropus hyptopus (Ehrenberg) K 4.
Itura aurita (Ehrenberg) P 2 (7), P 3, L 86a.
Keratella cochlearis (Gosse) K 8, K 24, (f. *cochlearis* c, f. *carinata* (Levander) one specimen) K 48 (1, 2) vc., K 51, L 52, L 76 vc., L 78.
K. quadrata (Müller) f. *divergens* (Voigt) with transitions to f. *quadrata* K 8, K 24, K 35c, 46c, K 48, N 5, N 6, N 10, N 17, N 20, f. *frenzeli* (Eckstein) K 26 vc., f. *quadrata* and f. *testudo* L 76c, f. *quadrata*, short spines trans. ad *divergens* L 82, the same with f. **valgoides** n. L 71a.
K. valga (Ehrenberg) f. *valga*, P 2 (6), f. *tropica* Apstein P 2 (6), N 5, f. *tropica-asymmetrica* Barrois and Daday K 43, f. *tropica-monstrosa* Barrois and Daday K 43c.
Lecane aculeata Jakubski, P 3.

L. flexilis (Gosse), N 5.
L. hornemanni (Ehrenberg) K 19.
L. luna (Müller) P 2 (6, 7), P 3, K 8, K 21, K 26, K 34, L 14, L 16c, L 71a, L 73c.
L. ohioensis (Herrick) P 2 (7).
L. papuana (Murray), P 2 (6, 7)c.
Lepadella acuminata (Ehrenberg) N 5, N 15.
L. ovalis (Müller) K 24, L 73.
L. patella (Müller), P 2 (6, 7), vc., P 3, P 6, K 19, K 21, K 21a, K 35 vc., K 43, K 51, L 13, L 14, L 16, L 61, L 74 (1), L 86a.
L. rhomboides (Gosse), P 2, N 5.
L. triptera Ehrenberg, P 2 (6), K 24, K 35, N 13.
Lophocaris oxysternon (Gosse), P 2 (6, 7), L 86a.
L. salpina (Ehrenberg) P 2 (6).
Monostyla bulla (Gosse) P 2 (6, 7) vc., P 3 vc., K 8, K 19, K 21a, K 35, L 14, L 16, N 2, N 5, N 13, N 15.
M. closterocerca Schmarda, P 2 (6), P 2 (7) vc., P 3c, P 6, K 8, K 19, K 21, K 21a, K 24, K 35, K 43, K 46, K 51c, L 14, L 72, N 5, N 8, N 15.
M. crenata Harring, P 2 (7), K 8, K 21a, K 35, N 6.
M. hamata Stokes, P 2 (7), K 19, K 21a, K 35, N 5.
M. lunaris (Ehrenberg) K 21, L 72.
M. quadridentata (Ehrenberg) K 19, K 21, K 35 vc., K 43, K 51.
M. stenroosi Meissner P 3.
Mytilina mucronata (Müller) P 2 (7), K 8, K 19, K 21, K 35, vc., K 43, K 51.
M. trigona (Gosse) L 61, L 72 (long form).
M. ventralis (Ehrenberg) P 2 (6, 7) f. *ventralis* and f. *brevispina* Ehrenberg, K 8 long post. spines, K 21a, long post. spines, K 34 c. f. *ventralis* and f. *brevispina*, K 48, f. *brevispina*, L 16 f. *brevispina*.
Notholca striata (Müller), K 51, K 60, L 71a, L 73, L 74, L 86a, all reduced f. *striata* (= *scaphula* Stewart).
Notommata copeus Ehrenberg L 16.
N. epaxia Harring and Myers, P 2 (7), L 86a.
N. tripus Ehrenberg, P 2 (7).
Notommatids, indet. K 24, K 35, K 51, L 10, L 14, L 72, L 72a.
Pedalia bulgarica Wiszniewski L 50, L 73, L 74 (2).
P. mira (Hudson) K 19, N 5.
Polyarthra euryptera Wierzejski K 48 vc.
P. trigla Ehrenberg P 2 (6), K 8, K 19, K 21 c., K 24 vc., K 43 vc., K 78, K 85 vc.
Platyias patulus (Müller), K 34, N 5.
P. quadricornis (Ehrenberg), K 8, L 14.
Pompholyx sulcata Hudson, L 82a vc.
Proales decipiens (Ehrenberg), P 2 (6).
Ptygura sp., K 46.
Scaridium longicaudum (Müller), P 2 (6, 7), P 3.
Squatinella mutica (Ehrenberg), P 2 (7), L 76.
Synchaeta littoralis Rousselet, ? K 51.
S. oblonga Ehrenberg, K 51.

S. pectinata Ehrenberg, K 8, K 19, K 21, K 21a, K 26, K 43, K 46, K 48 (1) vc., K 51 c., N 5.
S. stylata Wierzejski, K 43 c., N 5.
S. tavina Hood, K 43, ? L 72.
S. tremula (Müller), P 2 (6, 7), K 43 c., K 51, ? N 19.
S. sp., K 35, L 14.
Testudinella incisa (Ternetz), N 2, N 8, N 13.
T. mucronata (Gosse), K 35.
T. patina (Hermann), P 2 (6, 7), P 3, K 8, f. *patina* and f. *intermediata* Anderson, K 19, K 21, K 24, f. *intermedia*, K 35 c., K 51.
Trichocerca cristata Harring, P 2 (7).
T. cylindrica (Imhof), K 43.
T. elongata (Gosse), K 8, K 21, K 21a, K 26, K 51.
T. iernis (Gosse), K 8.
T. longiseta (Schrank), K 19, K 35, L 14, L 16, L 72.
T. rattus (Müller), P 2 (6, 7) c., P 3, K 8, K 21, K 35, K 69, L 14, L 16.
T. scipio (Gosse), P 2 (7).
Trichotria pocillum (Müller), K 19, K 21, K 51, L 14, L 16, L 72, L 73.
T. tetractis (Ehreberg), P 2 (7), K 8, K 19, K 21, K 21a, K 46, L 72a, L 73, N 5, N 8.

IV. TAXONOMIC AND ZOOGEOGRAPHICAL NOTES

1. *Cephalodella catellina* (Müller).[1] Several allies of this species, distinguished primarily by the relative length and shape of the toes, appear to exist. There can be little doubt that the form figured by Ehrenberg, who gives the first recognisable illustration of the species (1838, T. LV, fig. iii) is the same as that figured by Hudson and Gosse (1889, Plate XIX, fig. 10a) and by Harring and Myers (1924, Plate XXVII, fig. 3). If Ehrenberg's reference of his *Diglena catellina* to *Cercaria catellina* Müller determines the significance of the latter, which otherwise would be quite unrecognisable, it is clear that the form of the species with long slender straight toes about one-sixth of the total length must be regarded as typical.

On the other hand Weber has figured, as *Diglena catellina* a form which is not only somewhat larger than the typical form as figured by Harring and Myers, but has a proportionately shorter and basally much broader toe. Though this form is perhaps less widespread than the true *C. catellina*, it apparently is found in the New World as well as in the Old, for Mr. Myers informs us (*in litt.*) "after our paper was published, . . . Harring found both forms of *C. catellina* and it was at that time decided that we should have described both."

[1] After the present paper had gone to press, we saw, through the kindness of Mr. Myers, part of the proof of a paper by Dr. Wiszniewski, in which this species is discussed. Dr. Wiszniewski has shown that *catellina* Weber differs from *catellina* Harring and Myers, not only in shape and in the form of the toe, but in possessing salivary glands. These structures appear to be present in our volvocicolous form and absent in f. *ahlstromi*. We have attempted, with a minimum alteration of our text, to bring our arrangement into line with that of Dr. Wiszniewski. We find it impossible, however, to agree with him that the true *catellina* is the species figured by Weber, but have much pleasure in associating the name of this distinguished Polish investigator with such an interesting species. Were it not for the fact that *catellina* is the genotype of *Cephalodella*, it would probably be better to discard the name and use for the form figured by Harring and Myers, the new name introduced by Dr. Wiszniewski. The posterior position of the foot in Müller's figure makes it certain that whatever species he may have had before him, it was not either of the present forms.

We have obtained a single specimen of this form from sample L 86a, and believe it to be sufficiently distinct to merit recognition; we therefore propose the name **C. wiszniewskii** n. n.

In addition to these forms, two other very close allies of the species have been described. *Diglena volvocicola* Zavadovski (1916), for which the author proposed, should it prove to be but a variety, the unnecessary alternative *D. catellina parasitica* (*nec Pleurotrocha parasitica* Jennings = *C. parasitica* Harring and Myers), is a form living in colonies of *Volvox*. We have unfortunately been unable to obtain the original description, but according to Harring and Myers the figures that accompany it do not show "any differences that might be considered of specific value. Some physiological dissimilarities are described, the most striking one being the parasitism of the animal in Volvox colonies." Hutchinson, Pickford and Schuurman (1932) record from inside colonies of *Volvox* in two shallow fresh-water pans a form determined by them as *C. catellina*. Re-examination of some of this material shows that it represents a form of *Cephalodella* in some respects intermediate between *C. catellina* and *C. wiszniewskii*, resembling the former in the narrow base of the toe in proportion to its length, and the latter on the other hand in the concavity of its anterior margin, though this is more marked in the volvocicolous form.

Recently de Beauchamp (1932) has described a very large form with a short curved toe from the plankton of Lake Elmenteita in Kenya. This form he regards as a species *Cephalodella elmenteita* because the preserved specimens on which it was based lacked the characteristic eye-spots of *C. catellina*. We have, however, been unable to observe eye-spots in any specimens of forms of *C. catellina* preserved in formalin and then cleared in glycerine, and therefore believe the difference to be illusionary. Moreover, in the marginal sample from the alkaline Pangur Tso we have obtained a form of *C. catellina* which has toes which though straight show a basal constriction as in *C. elmenteita*. Our Pangur Tso form, therefore, seems in one of its characters to be transitional to de Beauchamp's species. For this Pangur Tso form with its basally constricted toe, we propose the name f. *ahlstromi*, Mr. Ahlstrom who observed some specimens of the form in a tube of *Brachionus* material having pointed out to us the desirability of examining the form more closely. Mr. Ahlstrom believes the Pangur Tso form to have a shorter and in preserved specimens more plicated head than is normal, but we are not convinced that these differences are not entirely due to preservation. Intergrades between f. *catellina* and f. *ahlstromi* appear to occur, for of three specimens of *catellina* from Los Angeles, California (det. Myers), kindly lent us for study by the American Museum of Natural History, two specimens have a typical toe, and the third a definitely constricted toe as in *ahlstromi*, the toe in this specimen is however slightly longer (body 120μ, toe 21μ) than in the latter form, in this resembling the specimens of f. *catellina* with which it occurred.

The various forms of *C. catellina* may be tabulated as follows:

C. catellina (Müller). Length $110\text{-}135\mu$, toe $20\text{-}25\mu$, about one-fifth or one-sixth of the total length, long, narrow, anterior margin practically straight, widest at the practically unconstricted base. (Figure 1 c.)

f. **ahlstromi** n. Length $95\text{-}112\mu$, toe $15\text{-}18\eta$, just under one-sixth of the total length, long, narrow, slightly concave both anteriorly and posteriorly, straight, basally constricted and widest distinctly distally to base. (Figure 1 d.)

C. wiszniewskii n. n. Length 190 (*type*), 100-140μ (Weber), toe 21μ, about one-ninth of the total length, short, wide basally, anterior margin very slightly concave, widest at the unconstricted base. (Figure 1 a.)

f. *volvocicola* (Zavadovski). Length 126μ, toe 19μ, about one-seventh of the total length, moderately narrow basally, anterior border strongly concave, widest at the practically unconstricted base. (Figure 1 b.)

C. elmenteita de Beauchamp. Length 210μ, toe (from figure) 18μ, short, narrow, strongly curved, the anterior border concave, the posterior convex, basally constricted and widest distinctly distally to base. (Figure 1 e.)

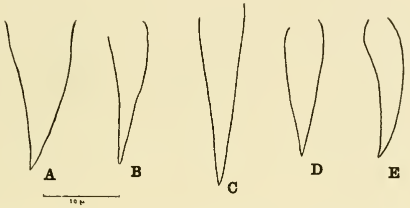

FIGURE 1.—External aspect of left toe of A, **C. wiszniewskii** n. n.; B, *C. w.* f. *volvocicola* (Zavadovski); C, *C. catellina* (Müller); D, *C. c.* f. **ahlstromi** n.; E, *C. elmenteita* de Beauchamp, redrawn from de Beauchamp.

The trophi are essentially similar in all these forms, the characteristic asymmetrical development of a tooth on the distal edge of the right ramus is particularly well marked in South African specimens of f. *volvocicola* and in the East African *C. elmenteita.*

2. *Filinia longiseta* (Ehrenberg) and *F. terminalis* (Plate). In plankton samples from the lake at Ootacamund two forms of *Filinia* are not uncommon. One of these is a typical limnetic form of *F. longiseta,* the other is a form with a small very narrow spindle-shaped body and completely terminal insertion of the posterior seta. No intermediates occur between the two forms in these samples. The form with the terminal insertion of the posterior seta was met with in South Africa by Hutchinson, Pickford and Schuurman. Some of their material was kindly examined by Mr. D. Bryce, who pointed out that this form is referable to *F. terminalis* (Plate), a species which has been rarely found in Europe and which was placed in the synonymy of *F. longiseta* by Harring. Unfortunately Plate (1886) gives no figures but there is no reason to doubt that Mr. Bryce's determination is correct and as the two forms are frequently found together in South Africa as well as in the Ootacamund locality, without any intermediate forms occurring, there seems no reason why *F. terminalis* should not be accorded specific rank. The species may be easily recognised by its small narrow spindle-shaped body and by the insertion of the posterior seta (Figure 2c) as pointed out above.

It is probable that the chief reason for the almost universal failure to recognise *F. terminalis* is to be found in the great variability of the distance between the posterior end of the body and the insertion of the posterior seta in *F. longiseta*. Slominski (1926) has shown that in Europe this species exhibits a considerable amount of cyclomorphosis and that, in the autumn and winter, forms occur in which the distance between the posterior end and the insertion of the seta is reduced to 7μ, these forms are called *terminalis* by Slominski who consequently regards the latter as but a form of *longiseta*. It is however to be noted that his measurements show that these winter "*terminalis*" forms are actually shorter and wider than the summer forms in which the insertion of the seta is markedly ventral. It is

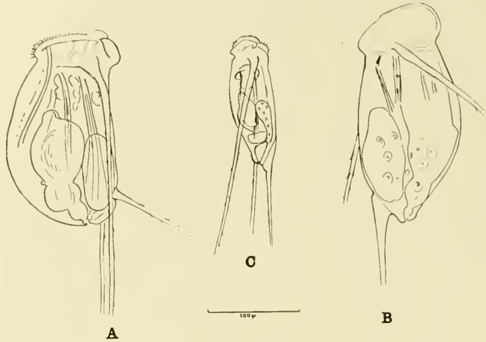

FIGURE 2.—A, *Filinia longiseta* (Ehrenberg), Ootacamund Lake, N 5; B, *F. longiseta* Togom Tso, L 49; C, *F. terminalis* (Plate), Ootacamund Lake, N 5.

clear therefore that our form, which we believe to be the true *terminalis*, is a quite different organism to Slominski's form with a sub-terminal insertion.

Our material from Kashmir (Wular Lake and the hypolimnion of L. Manasbal) and from the ice-covered Togom Tso in Indian Tibet has a terminal or sub-terminal insertion (Figure 2 b), while from the Ootacamund Lake the specimens have a typical ventral insertion. Measurements of specimens taken at random from these localities are given in Table I. It will be seen that normally *longiseta* has a body about twice as long as deep, while in *terminalis* the body is about two and a half times as long as deep. The material of the former from Togom Tso however is about as proportionately long as *terminalis* but comparison of the figures of the two forms will show (Figure 2 b, c) that even such elongate specimens of *longiseta* retain a more gibbous dorsal profile than is found in *terminalis*; moreover Slominski's data, as pointed out above, indicate that elongate forms of *longiseta* are only found in populations of very large specimens, having a much greater total length than *terminalis*, so that they do not constitute a real transition between the two species. On the basis of the relative length of the anterior setae our Togom Tso specimens may be considered as typical *longiseta,* while our other specimens are transitional to f. *limnetica* (Zacharias) :

TABLE I

(All dimensions in μ)

	Length	Dorso-ventral Depth	R. Ant. Seta	L. Ant. Seta	Post. Seta	Distance between insertion of post. seta and apex of body
Filinia longiseta						
Togom Tso	230	90	480	455	360	8
Togom Tso	240	100	475	490	395	4
Wular Lake	138	79	400	380	262	1
Wular Lake	133	71	410	410	290	0
Wular Lake	146	71	420	...	237	8
Wular Lake	142	71	382	390	233	4
L. Manasbal	150	83	420	380	325	4
L. Manasbal	150	83	450	450	325	4
Ootacamund	171	83	590	590	341	21
Ootacamund	208	100	595	595	305	25
Filinia terminalis						
Ootacamund	138	54	342	300	242	0
Ootacamund	138	50	330	330	262	0
Ootacamund	142	58	308	333	242	0

3. *Keratella quadrata* (Müller) and *Keratella valga* (Ehrenberg). In spite of the valuable contributions of Hartmann (1918) and others, there still appears to be considerable uncertainty as to the status and correct designation of the various forms included by Harring (1913) under *K. quadrata* (Müller). After examining extensive material from South Africa and India we are fully convinced of the correctness of the contention that two species, *K. quadrata* (= *aculeata* Ehrenb.) and *K. valga,* are to be recognised. Moreover, the nomenclature of these two species in their typical forms raises no difficulties.

Anuraea aculeata Ehrenberg (1832) is expressly stated by its describer (1838) to be identical with *Brachionus quadratus* Müller. Ehrenberg's best figure (1838, T. LXII, fig. xiv, 1) may therefore be taken in conjunction with those of Müller (1786, T. XLIX, figs. 12, 13) as defining the typical form of *quadrata.* The posterior margin of the lorica in Ehrenberg's figure, measured across the outer margins of the bases of the posterior spines, is wider than the anterior margin similarly measured across the bases of the antero-lateral spines. The posterior spines are parallel (Müller) or very slightly divergent, about two-fifths as long (Ehrenberg) or half as long (Müller) as the lorica. Both reticular and punctate sculpture are clearly indicated by Ehrenberg. Müller's figure is so unsatisfactory that in fixing the typical form it is best to abide by the excellent illustration given by Ehrenberg, save that it is convenient to regard typical *quadrata* as having practically parallel posterior spines, as is indicated by Müller.

Anuraea valga Ehrenberg (1834) may be regarded as typically represented by Ehrenberg's best figure (1838, T. LXII, fig. xv, 1), which shows a form in which the posterior width of the lorica is distinctly narrower than the anterior. The right spine is about one-third, the left one-quarter of the length of the lorica. Reticulate and punctate sculpture are both clearly indicated.

In examining as much material and as many illustrations as are available to us we have rarely had any difficulty in assigning individuals or illustrations to one or the other species. It is true that in a few figures of European specimens (*e.g.* Virieux 1916, fig. 46, Wesenberg-Lund, 1930, Plate VII, figs. 8, 26, and 46) the anterior and posterior borders are equal or the former very slightly longer than the latter. But such specimens do not appear to show the pronounced narrowing of *valga* and it must be remembered that a very minute error in drawing on the part of an observer not studying the dimensions in question would produce just such differences as found in some of these figures. Fadeev (1927) used the relation between the anterior and posterior widths of the lorica to separate *tropica* Apstein from the other forms of *K. quadrata* (s. lat.), apparently understanding by Apstein's name what we here regard as *K. valga*. Within these species the use of misapplied varietal terms appears to have led to considerable confusion. Thus in his monumental work on the cyclical phenomena in rotifers Wesenberg-Lund (1930) objects to certain of Hartmann's conclusions as to the production of *valga* forms from resting eggs. But it is clear from a study of Wesenberg-Lund's figures that what this author calls *valga* is a form of *quadrata* (s. s.) while Hartmann's observations on this point referred primarily to the true *K. valva* (Ehrenberg). Since such confusion is bound to result from the present unsatisfactory state of the varietal nomenclature of these two species we have attempted to standardise as far as possible the names of the various forms, introducing a minimum of new names and adhering to the principle of priority. Though the latter is not binding in such cases, it would appear to provide the best method of determining the relative merits of two synonyms, and the neglect of the principle in the past has led authors to create new varietal names without an adequate study of the literature so that the form of *valga* with a single posterior spine has been provided with at least three and probably four names.

Keratella quadrata (Müller).

Krätzschmar (1908, 1913), Hartmann (1918) and Wesenberg-Lund (1930) have studied the morphological cycle in this species. Normally the first generations from sexual eggs are composed of forms with long divergent spines (f. *divergens* Voigt); these later give place to forms with shorter more parallel spines (f. *quadrata* Müller). Later one (f. **valgoides** n.) or both spines (f. *curvicornis* Ehrenberg) are lost and at such periods sexual reproduction is stated to occur. The amount of cyclomorphosis is very variable in different localities but in general this species exhibits a cycle of reduction. In a few cases an initial elongation of the spines has been observed and in a series called by Hartmann "*A. aculeata-valga*," but consisting of apparently morphologically normal reduced forms of *K. quadrata*, the cycle begins with *curvicornis*, to which the addition of one minute papilliform spine produces the form named by Jakubski (1915) *irregularis,* and two minute spines *testudo* Ehrenberg.

In general the two posterior spines of *quadrata* are subequal in length, but in certain forms unequal spines apparently indicate a transition from *divergens* (right spine) to *quadrata* (left spine). Fadeev has figured as *valga* a specimen of *quadrata* with unequal subparallel

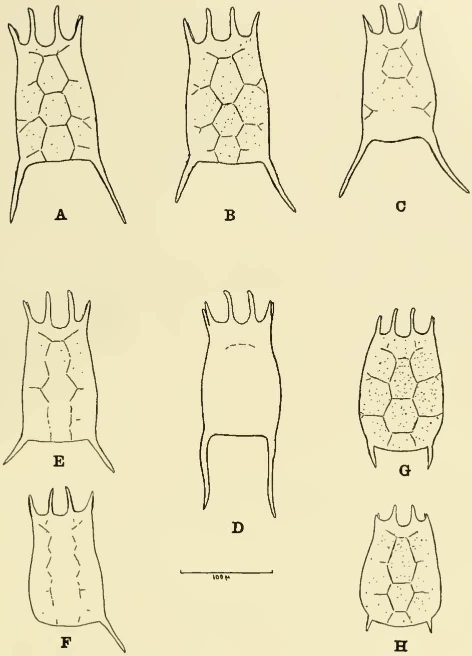

FIGURE 3.—*Keratella quadrata* (Müller), dorsal aspect of lorica of A, B, f. *divergens* (Voigt) Phashakuri, K 35; C, f. *divergens* Ootacamund Lake N 5; D, f. *frenzeli* (Eckstein), Sundar Khun, K 26; E, f. *quadrata* trans. ad *divergens*, Tso Nyak, L 71a; F, f. **valgoides** n, Tso Nyak, L 71a; G, f. *quadrata*, Mitpal Tso, L 76; H, f. *testudo* (Ehrenberg), Mitpal Tso, L 76.

spines but this may best be regarded as a transition to *valgoides*, though Wesenberg-Lund's figures and our collection from Tso Nyak indicate that the latter form may probably appear in a *quadrata* population without intermediate forms with unequal spines. The following names are probably sufficient to describe the chief members of the cycle and to designate the varieties present in single collections.

Keratella quadrata (Müller).

Diagnosis: Six anterior spines, reticulate sculpture forming a median series of undivided hexagons, maximum breadth of lorica slightly greater than the posterior breadth, the latter greater than the anterior breadth, two posterior spines which are usually subequal, or one asymmetrically placed spine, or without spines.

f. *platei* (Jägerskiöld). Posterior spines long, strongly divergent basally, bent round so that apically they lie at right angles to the long axis of the body. An exuberant development of f. *divergens* from the Baltic.

f. *divergens* (Voigt). Posterior spines long, more than half the length of the lorica (excluding anterior spines), subequal and strongly divergent, reticulate and punctate sculpture well developed. Syn. var. *longispina* Thiébaud (1911).

f. *frenzeli* (Eckstein). Posterior spines more than half the length of the lorica. Subequal and somewhat sinuate, but with parallel axes. Sculpture practically absent.

f. *quadrata* (Müller). Posterior spines about half the length of the lorica, subequal, and subparallel, reticulate and punctate sculpture well developed.

f. *testudo* (Ehrenberg). Posterior spines short, about one-seventh of the length of the lorica, often somewhat divergent. Punctate and reticulate sculpture both present.

f. *brevispina* (Gosse). Posterior spines short and equal as in *testudo*, often somewhat divergent. Punctate sculpture absent.

f. *valgoides* f. n. Right posterior spine well developed, left absent. Punctate sculpture absent. Syn. *valga* Fadeev 1927, p. p. Wesenberg-Lund 1930 etc., nec. Ehrenberg.

f. *irregularis* (Jakubski). One posterior spine (right in typical figure) absent, the other represented by a minute papilla.

f. *curvicornis* (Ehrenberg). No posterior spines, punctate sculpture absent.

Of the other forms described and probably referable to this species, *Anuraea squamula* Ehrenberg is clearly a very reduced *curvicornis* without reticulate sculpture. However, it is very doubtful that this is really the same as *Brachionus squamula* Müller, the anterior spines of which suggest a very round reduced form of *Notholca striata*, in all probability the use of this name is superfluous. *A. falculata* Ehrenberg and *A. quadridentata* Ehrenberg are doubtful forms which probably need not be recognised.

In the Nilgiri Hills and in most localities in Kashmir (Figure 3 a, b) moderately developed forms that have rather divergent spines and may be regarded as transitional between the typical form and f. *divergens* are common. Well-developed examples (Figure 3 c) of the latter are found in the Ootacamund Lake (N 5). In Sundar Khun (K 26), however, a very well developed unsculptured form with long parallel posterior spines, which may be referred to f. *frenzeli*, is abundant (Figure 3 d). No reduced forms were found in any samples from these regions.

In the high lakes of Indian Tibet *quadrata* forms with moderately long spines, which in the specimens from Tso Moriri and Tso Nyak in Tibet are fairly divergent (Figure 3 e), are found. In Tso Nyak the reduced f. *valgoides* (Figure 3 f) also occurs sporadically, while in Mitpal Tso a form (Figure 3 h) referable to f. *testudo* is found though less commonly than is f. *quadrata*. The specimens from Tso Nyak, and to a less degree from Tso Moriri, are feebly sculptured, while the Mitpal Tso form which is rather wide and gibbous dorsally has well developed sculpture and slightly convergent posterior spines. It is probably unwise to attempt to correlate the occurrence of reduced forms in these cold elevated lakes with ecological conditions without more knowledge of the seasonal cycle, but their occurrence may be of significance.

The occurrence of *K. quadrata* in the Nilgiris is of interest for the species is probably absent in most truly tropical waters, occurring only within the tropics in elevated localities under temperate conditions such as are afforded by the aquatic habitats around Ootacamund.

Keratella valga (Ehrenberg).

In true *K. valga* the cycle (Klausener 1908, Hartmann 1918) appears to involve primarily the addition of spines. The initial phase in the most complete cases is the form called by Klausener *K. curvicornis* f. *brehmi.* This form is figured as being somewhat longer than *K. quadrata* f. *curvicornis.* In certain irregularities in the line of the posterior margin of this figure there is, moreover, perhaps a hint of the position of the spine bases, demarkating a typical *valga* posterior margin, though this may be accidental. Fadeev (1927) has described and figured as f. *aspina* a comparable form which is certainly clearly referable to *valga* on the shape of the posterior margin alone without having to take into account the other members of the cycle. An essentially similar elongate form (Figure 4 a) was recorded from South Africa by Hutchinson and by Hutchinson, Pickford and Schuurman (1932) as curvicornis. Klausener distinguished f. *brehmi* from *curvicornis* by the fact that the antero-median spines do not diverge in the former. This character is probably too variable and in general does not separate *valga* from *quadrata.* It must be admitted that the two species must often be hard to separate in their most reduced forms.

In Hartmann's studies of this species the most exuberant form was one in which the two posterior spines are subequal. This form seems to be the one figured by Schmarda (1850, Plate IV, fig. III) as *A. longicornis* but it has doubtless been regarded by other authors as *aculeata* (*i.e. quadrata* s. s.).

Apstein has described another exuberant form from Ceylon as *tropica.* This form is characterised by the very long and unequal posterior spines, the left being about two-fifths the length of the lorica without the anterior spines, the right about six-sevenths of this length. This form, in spite of Hartmann's statement that it agrees well with his form of May, 1915 (f. *valga*), differs from his figure of the latter in which the right spine is hardly more than one-half the length of the lorica. It is clear from the work of Tschugunoff (1922) and Fadeev (1927) that forms essentially similar to *tropica* are common in South Russia, and Skorikov as long ago as 1896 figured (T. VIII, fig. 29) such a form from near Kharkov. Jakubski (1915) has figured a monospinous *tropica* form from Poland and in South Africa, Hutchinson (1930) and Hutchinson, Pickford and Schuurman (1932) found *tropica* to be the only common form of *valga.*

In all probability the most developed form of *valga* varies from place to place, and if f. *valga* and f. *longicornis* represent the highest development in some European localities, *tropica* probably does the same in Ceylon, S. Russia, South Africa and Kashmir. The names proposed for forms of *valga* in which the left spine is very reduced or absent may be used in conjunction with the name *tropica* in localities where the right spine is very elongate, and where these reductions occur, *e.g., K. valga* f. *tropica-asymmetrica* and *K. valga* f. *tropica-monstrosa.*

The following terms may then be applied to designate the forms of *K. valga.*

Keratella valga (Ehrenberg).

Diagnosis: six anterior spines, reticulate sculpture forming a medial series of undivided hexagons, maximum breadth of lorica very distinctly greater than the posterior breadth, the latter much less than the anterior breadth, two posterior spines which are usually unequal, or one asymmetrically placed spine, or without spines.

f. *valga* (Ehrenberg). Posterior spines well developed, rather short, unequal, the right typically one-third and the left one-fourth of the length of the lorica. Punctate and reticulate sculpture both present.

f. *asymmetrica* (Barrois and Daday). Right posterior spine well developed, typically about half as long as the lorica, left spine rudimentary. Punctate and reticulate sculpture both present. Syn. f. *heterospina* Klausener (1908) p. p.

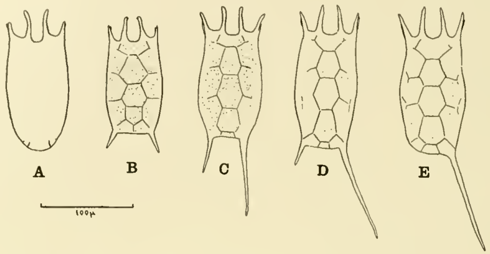

FIGURE 4.—*Keratella valga* (Ehrenberg), dorsal aspect of lorica of A, f. *aspina* (Fadeev) Weltevreden West, Tvl. S. Africa; B, f. *valga*, Sohawa, P 2; C, f. *tropica* (Apstein) Ootacamund, N 5; D, f. *tropica-asymmetrica* Apstein-Barrois and Daday, Wular Lake, K 43; E, f. *tropica-monstrosa* Apstein-Barrois and Daday, Wular Lake, K 43.

f. *monstrosa* (Barrois and Daday). Right posterior spine well developed, typically about half as long as the lorica, left spine absent. Reticulate and punctate sculpture well developed.

Syn. ? var. *dumasi* Richard (no figure or indication if this is really a form of *valga*)
var. *asymmetrica* Daday *nec.* Barrois and Daday
f. *monospina* Klausener (1908)
f. *monospina* Fadeev (1927) = *tropica-monstrosa*

f. *longicornis* (Schmarda). Both posterior spines well developed and practically equal, typically about three-fifths as long as the lorica, reticulate and punctate sculpture both well developed, as indicated in Schmarda's typical figure, or the latter reduced (Hartmann, 1918, Figure 76).

f. *tropica* Apstein. Right spine very long, typically about six-sevenths of the length of the lorica, left spine much shorter but well developed, about two-fifths as long as the lorica. Reticulate sculpture developed, punctate often reduced.

f. *reducta* Fadeev. Right posterior spine alone developed, short, about one-fourth of the length of the lorica (typical figure may be taken as Fadeev, 1927, T. 2, fig. 12), punctate sculpture absent, reticulate very reduced.

f. *brehmi* Klausener. Both posterior spines absent, reticulate sculpture present (Brehm and Zederbauer, 1904, fig. 1), punctate apparently absent.

f. *aspina* Fadeev. Both posterior spines absent, reticulate sculpture almost and punctate entirely absent.

If Fadeev is correct, in South Russia *aspina* is to be regarded as the extreme reduced phase of *tropica*, i.e. *tropica-brehmi*, and *reducta* an intermediate between *tropica-monstrosa* and this extreme reduced phase. More knowledge is clearly needed of the cyclomorphosis of *tropica* forms before it is certain that the extreme reduction in sculpture noticed in *aspina* is really characteristic of this series of forms. In the only South African locality that has been followed throughout an entire year, Florida Lake, near Johannesburg (Schuurman, 1932), the species appears stable, but a spineless unsculptured form which we would refer to *aspina* is recorded from certain shallow pans, as has been already indicated. In the present collections a single specimen which may be referrd to *tropica* (Figure 4) occurred in the plankton of the lake at Ootacamund, in which *K. quadrata* f. *divergens* was abundant. A few very similar specimens occurred in the pond at Sohawa designated as P 2, where a single short subequal spined form with a pentagonal posterior polygon (Figure 4) here referred to f. *valga* was also obtained. Both the Sohawa and Ootacamund *K. valga* f. *tropica* have well-developed punctate as well as reticulate sculpture. In Wular Lake a very long spined form which may be referred to *tropica-monstrosa* (Figure 4) was not uncommon and in the same locality a very few specimens of f. *tropica-asymmetrica* were also obtained (Figure 4). The punctate sculpture in these Kashmir specimens is considerably reduced.

It is clear from Jakubski's (1916) record and from some of Klausener's data that the asymmetric condition does not always involve reduction of the left, but sometimes also of the right spine. It is highly probable that truly dextral and sinistral forms may occur, with a concomitant difference in the sense of their spiral swimming movements. Such a possibility is of great biological interest and would merit close attention on the part of any worker to whom living material is available.

Certain names applied to forms of *K. quadrata* and *K. valga* or included under the former species by Harring remain to be considered.

Anuraea scutata Thorpe (1891) from Brisbane appears to be allied to *K. valga* f. *asymmetrica* but such sculpture as is indicated seems to show the median cariniform arrangement of the mid-dorsal reticular partitions characteristic of *K. cochlearis* (Gosse). The dorsal surface is said to be markedly gibbous in lateral view. In view of the doubt raised by the sculpturing the name *scutata* Thorpe is best suppressed unless an animal identical with the figure remains to be rediscovered.

Anuraea procurva Thorpe (1891) from the Island of Ascension is in form nearer to *quadrata* than *valga* but is distinctly asymmetric in its posterior spines. In side view the lorica is seen to be bent forward, particularly in its ventral part, in a most peculiar manner. This form is probably best retained as a somewhat doubtful species under the name of *Keratella procurva* (Thorpe).

Anuraea stipitata var. *Wartmanni* Asper and Heuscher (1889) is another problematic form but there seems no reason to treat it as a synonym of *K. quadrata* f. *curvicornis*, as is done by Weber (1898).

TABLE II

(All dimensions in μ)

	Length	Max. Breadth	Ant. Breadth	Post. Breadth	R. Post. Spine	L. Post. Spine	Median Ant. Spine	Dorsolat. Spine
K. quadrata								
SUNDAR KHUN								
f. *frenzeli*	134	96	77	92	125	108	38	29
“	121	100	75	92	100	83	46	29
“	129	104	79	96	133	134	33	27
“	142	98	79	94	108	117	42	25
PHASHAKURI								
trans. ad								
f. *divergens*	132	92	75	90	83	79	38	25
“	138	96	75	92	75	58	38	25
OOTACAMUND								
f. *divergens*	116	79	58	73	75	67	33	21
“	121	83	60	77	79	71	29	25
TSO MORIRI								
trans. ad								
f. *divergens*	121	92	67	79	46	42	25	21
“	121	94	69	83	42	40	33	21
TSO NYAK								
trans. ad								
f. *divergens*	125	90	67	77	48	46	38	29
f. *valgoides*	118	90	69	77	54	0	33	25
MITPAL TSO								
f. *quadrata*	121	96	67	75	42	38	25	17
“	125	96	69	75	42	38	25	21
f. *testudo*	108	90	63	71	17	17	25	10
K. valga								
OOTACAMUND								
f. *tropica*	112	71	58	46	85	42	25	21
SOHAWA								
f. *valga*	100	67	58	46	23	19	23	17
f. *tropica*	116	75	67	50	75	21	27	23
WULAR LAKE								
f. *tropica-asymmetrica* ..	129	71	60	50	108	25	29	25
f. *tropica-monstrosa*	138	77	58	54	120	0	25	29
“	131	68	54	46	108	0	29	29
BANAGHER PAN 2, TRANSVAAL.								
f. *tropica*	104	79	68	54	96	54	37	21
FRISCHGEWAAGD, TRANSVAAL.								
f. *tropica*	102	90	75	50	108	50	46	31
WELTEVREDEN WEST, TRANSVAAL.								
f. *aspina*	106	73	60	c. 42	0	0	31	17

Anuraea aculeata var. *cochlearis* Voigt is, according to Carlin-Nilsson (1934), identical with *K. paludosa* (Lucks).

Two forms recently described by Athanassopoulos (1930) as *Anuraea aculeata* var. *graeca* and var. *conica*, both appear to belong to the genus *Brachionus*, in the figures of both forms what appears to be a foot-shield is indicated; the former is apparently *B. capsuliflorus* f. *quadridentatus* Hermann, the latter bears some resemblance to *B. satanicus* Rousselet.

FIGURE 5.—Map of the world showing the distribution of *Lecane papuana* (Murray) in relation to the mean annual isotherms for 15° C.

In Table II measurements of specimens of the two species under discussion, from various localities in India, Tibet and in South Africa are given.

4. *Lecane papuana* (Murray). This species was originally described from New Guinea. Harring and Myers (1926) record it from Panama, Guatemala and Polk County, Florida, and Ahlstrom (Myers in litt.) has also taken it at Miami in Florida. Tarnogradsky (1930) reports the species from the North Caucasus and Wiszniewski (1931) from near Valencia, Spain. Hutchinson, Pickford and Schuurman (1932) met with it rather frequently in a number of localities in the Transvaal. In the present collection it occurred at Sohawa in the Punjab. If these records are plotted on a map of the world (Figure 5) on which the mean annual isotherms for 15° C. are drawn, it is seen that they fall on or within these isotherms, while the countries whose rotatorian fauna is best known lie for the most part outside them. There can be little doubt, therefore, that the present species is a subtropicopolitan form, providing what appears to be the most conspicuous case of such a distribution yet recorded among the Rotatoria.

V. ROTATORIA PREVIOUSLY RECORDED FROM INDIA AND TIBET

In the present section we have collected together all the previous Indian and Tibetan records of Rotatoria, and have revised these lists in accordance with the now generally accepted nomenclature of Harring (1913). All species of doubtful validity have been omitted.

The earliest Indian list is that of Anderson (1889) who studied the rotifers in the vicinity of Calcutta. The following list of thirty-seven species comprises all those recorded by him, the nomenclature being standardized as indicated above.

Collotheca ornata (Ehrenberg)
C. campanulata (Dobie)
C. ambigua (Hudson)
C. tenuilobata (Anderson)
**Floscularia ringens* (Schrank)
Limnias ceratophylli Schrank
L. melicerta Weisse
Beauchampia crucigera (Dutrochet)
Ptygura stephanion (Anderson)
Sinantherina socialis (Linnaeus)
Philodina citrina Ehrenberg
Rotaria rotatoria (Pallas)
R. macroceros (Gosse)
R. mento (Anderson)
Actinurus ovatus Anderson
**Notommata tripus* Ehrenberg
**Cephalodella forficula* (Ehrenberg)
Monommata orbis (Müller)
Dicranophorus forcipatus Müller
Diurella tigris (Müller)
**Scaridium longicaudum* Ehrenberg
Squatinella tridentata (Fresenius)
**Mytilina ventralis* (Ehrenberg)
**M. ventralis brevispina* (Ehrenberg)
Euchlanis macrura Ehrenberg
**Lecane luna* (Ehrenberg)
Monostyla cornuta (Müller)
**M. quadridentata* Ehrenberg
**M. bulla* Gosse
Colurella caudata (Ehrenberg)
**Lepadella ovalis* (Ehrenberg)
**L. triptera* (Ehrenberg)
L. ehrebergii (Perty)
**Testudinella patina* form *intermedia* (Anderson)
**Brachionus capsuliflorus* Pallas
Brachionus urceolaris Ehrenberg
**Platyias patulus* (Müller)
**P. quadricornis* (Ehrenberg)

The species preceded by an asterisk are to be regarded as wide spread, having occurred in our collections also.

Murray (1906) has listed the following rotifers from the slopes of the Himalayas between altitudes of 2000 and 8000 feet (610 and 2440 m.). Most of these rotifers are Bdelloids, which is to be expected since the collections were made in moss.

Philodina indica Murray
P. squamosa Murray
P. citrina Ehrenberg
P. brevipes Murray
P. flaviceps Bryce
P. vorax Janson
P. laticeps Murray
Habrotrocha perforata (Murray)
H. angusticollis (Murray)
H. angusticollis attenuata (Murray)
H. nodosa (Murray)
H. aspera Bryce
H. lata Bryce
H. leitgebii (Zelinka)
H. microcephala (Murray)
Macrotrachela formosa (Murray)
M. quadricornifera Milne
M. papillosa Thompson
M. multispinosa Thompson
M. plicata (Bryce)
M. habita (Bryce)
M. bullata (Murray)
M. musculosa Milne
Rotaria sordida (Western)
R. sordida fimbriata (Western)
R. rotatoria (Pallas)
Adincta vaga (Davis)
Proales quadrangularis (Glasscott)
Squatinella tenella (Bryce)
Colurella adriatica (Ehrenberg)
Monostyla lunaris (Ehrenberg)
Brachionus urceolaris Ehrenberg

Our Kashmir stations are comparable in altitude to Murray's localities, but since our collections were made with a tow-net, his list is of no value for comparison.

The rotifers of Southern Tibet have been studied by Stewart (1908), who collected 17 species, including five that he described as new, from the neighbourhood of Gyantse, at altitudes between 13,000 ft. and 14,000 ft., *i.e.* approximately 4000 m. and 4270 m. Of the five new species *Mastigocerca auchinleckii* Stewart is synonymised by Harring (1913) with *Trichocerca longiseta* (Schrank) and *Salpina shape* Stewart with *Mytilina ventralis brevispina* (Ehrenb.). *Rotifer tridentatus* Stewart is considered unrecognisable by Harring as is *Cathypna amban* Stewart by Harring and Myers (1926). *Notholca scaphula* Stewart, omitted through an oversight by Harring, is an obvious synonym of *N. striata* (Müller). The Tibetan list is further reduced by the union of *Proales gibba* Ehrenb. and *Diaschiza semiaperta* Gosse under the name of *Cephalodella auriculata* (Müller) (Harring and Myers, 1924). The following list, therefore, gives all the valid species recorded by Stewart:

Philodina erythophthalma Ehrenb.
P. roseola Ehrenb.
P. citrina Ehrenb.
Notommata aurita (Müller)
**N. copeus* Ehrenb.
Cephalodella auriculata (Müller)
**C. catellina* (Müller)
C. exigua (Gosse)
Scaridium longicaudum (Müller)
**Trichocerca longiseta* (Schrank)
**Trichotria pocillum* (Müller)
**Mytilina ventralis brevispina* (Ehrenberg)
**Euchlanis dilatata* Ehrenberg
**Notholca striata* (Müller)

An asterisk indicates that the species in question was obtained also from our collections from Western Tibet.

Anderson's and Murray's lists alone refer to territory which is within the boundaries of the Indian Empire. Taken together sixty-seven species are recorded by these two authors, of these, sixteen were found in our collections. In the latter, therefore, eighty-three species are found, not hitherto recorded from India, and the total Indian list is brought up to one hundred and fifty. When it is remembered that Ahlstrom (1933) has recorded one hundred and nineteen species from a single embayment of Lake Erie, it becomes clear that the Rotatoria of India are still extremely little known and offer a promising field for further investigation.

VI. THE ROTATORIAN FAUNA OF HIGH ALTITUDES

The only previous collection of Rotatoria from the higher parts of the Himalaya is that described by Stewart, whose recognisable species are enumerated above. No other collection from over 4000 m. appears to have been hitherto reported. Smirnov (1930) has enumerated 14 species and 2 varieties from the Pamirs but his collection was made apparently between 3700 and 3900 m.

In our material 42 determinable species are recorded from 18 separate localities in Indian Tibet between 3500 and 5334 m., while from 12 localities in Kashmir, lying between 1580 and 2667 m. we record 58 species. It would appear, therefore, that a slight decrease in number of species occurs in passing from the lower to the higher localities. Further analysis brings this out much more clearly. Of the 42 species recorded from Indian Tibet 33 were found in 9 localities (of which 3 were alkaline) below 4500 m. and 22 species were confined to this zone. The 9 localities lying above 4500 m. may best be considered in three groups.

4500-4600 (3 localities)

Brachionus plicatilis
B. capsuliflorus f. *enzii*
Cephalodella gibba
C. wiszniewskii
Itura aurita
Keratella quadrata
Lophocaris oxysternon
Notholca striata
Notommata epaxia
Polyarthra trigla
Pompholyx sulcata

4600-5000 m. (3 localities)

Eosphora najas
Euchlanis meneta
E. parva
Keratella quadrata
K. cochlearis
Lepadella patella
Mytilina trigona
Notholca striata
Polyarthra trigla
Squatinella mutica

5000-5334 m. (3 localities)

Filinia longiseta
Keratella cochlearis
Pedalia bulgarica

It would seem that the increasing rigor of the environment with increasing altitude plays a considerable part in reducing the rotatorian fauna but that in the region studied the limiting factors do not become very intense until an altitude of about 5000 m. is attained. The localities above that altitude may therefore be profitably examined more closely.

Togarma Tso, altitude 5217 m. (Figure 6).

Three small ponds lie close together in the wide valley that ends to the North in the pass called Ororotse La, above the Ororotse Tso. The smallest pond is about 30 m. long, 15 m. wide and 30 cms. deep. Both the largest and smallest ponds yielded *Pedalia bulgarica,* but no other rotifers were obtained. The water at 11.00 a. m., 10 July, 1932, had a temperature of 16.2° C. but during the night probably fell to about freezing point. The chloride content was less than 0.0005 N., the alkali reserve (methyl orange titration) 0.0012 N. and the pH 8.9. In the largest of these ponds an abundant copepod and cladoceran fauna occurred, and much *Spirogyra,* forming brick-red masses, but no other rotifers were obtained in tow-nettings. The poverty of the rotatorian fauna is emphasized by the fact that these ponds superficially resemble the ponds at Chushol from which a considerable number of species are recorded.

Ororotse Tso, altitude 5297 m.

FIGURE 6.—The group of ponds known collectively as Togarma Tso. The localities for *Pedalia bulgarica* are the small pond indicated by the arrow, and the large central pond.

FIGURE 7.—Togom Tso.

This lake is a small fresh-water lake in a "kar" at the head of a small tributary of the Chang-chenmo River. The lake has a maximum determined depth of 14 m. When visited 11-13 July, 1932, it was covered by a sheet of ice with a maximum thickness of about 1 m. which was melting around the edges and from below. Most of the water was at about 4.0°C., falling to 1.25 below the surface of the ice. A single specimen of *Keratella cochlearis* was noted in a vertical haul made from 13.5 to the surface. An extended study of the lake will be given in a later paper.

Togom Tso, altitude 5334 m. (Figure 7).

This very small lake, lying between Togarma Tso and Chagra, was visited on the afternoon of 9 July, 1932, when it was found to be almost entirely covered with ice. A small belt of free water at the edge varied in temperature from 0°C. against the ice to 9.5°C. at the extreme margin. A few specimens of undeterminable bdelloids, one perhaps *Dissotrocha aculeata* var. *tuberculata*, and of *Filinia longiseta*, were obtained in this marginal water. The chloride content of the latter was less than 0.00005 N., the alkali reserve 0.0003 N., the pH 7.3.

Although many lakes in the western part of Tibet apparently lie at about the altitude of these three it is doubtful if any habitats capable of supporting planktonic or other swimming rotifers exist much above 5500 m. On the other hand, Heinis (1910) has shown that in the Alps the muscicolous fauna extends to 4000 m. so that it is reasonable to suppose that bdelloid rotifers exist in the Himalaya at altitudes of over 6000 m.

In considering the limiting factors determining the existence of organisms at very high altitudes, it is clear that many which apply to terrestrial plants and animals cannot affect aquatic forms. Thus terrestrial organisms may theoretically be limited by low temperature, low oxygen tension, perhaps intense ultra-violet radiation, low CO_2 tension in the case of plants and some animals with a complex respiratory mechanism, and in the case of animals deficiency in food supply. As will be pointed out in a later paper the oxygen tensions in the high-altitude lakes examined, owing to their coldness, lie within the values frequently found in surface waters in low-lying temperate countries. The penetration of ultra-violet light into water is slight (cf. Carter and Beadle, 1930, and some unpublished observations made on this expedition). It may be of importance in the surface layers of water at high altitudes, but much less so than in the case of terrestrial habitats. The available CO_2 content of natural waters is largely regulated by the quantity of alkali carbonate in the water, while so far as the food supply of animals is concerned, evidence available as to the productivity of Ororotse Tso suggests that this lake compares favourably with lakes at much lower altitudes (Hutchinson 1933). It seems, therefore, that temperature is the most important limiting factor in the ecology of the high-altitude members of such a group as the Rotatoria.

Sufficient is known of the high-altitude rotatorian fauna of Europe to justify some comparison between that fauna and the present collection. From the monumental work of Zschokke (1900), the papers of Brehm and Zederbauer (1904) on the Tyrol and Monti (1906) on the Italian Alps and from the catalogue of Swiss Rotatoria by Weber and Montet (1918), it is possible to prepare lists of the rotifers of the Central European Alps. Zschokke indeed gives such a list of 65 valid, fully determined species from over 1450 m., and by inclusion of later records this list is raised to 108. The limits chosen by Zschokke, however, include the upper part of the forested zone; if only the region above the forest line, from 1700 m. upward, be considered, the list is reduced to 89 species. Such a list has indeed been given by Pesta (1929) in his valuable work on the high mountain lakes of the Alps, but since it is in need of a few minor corrections, is not according to the standard nomenclature now universally used and is not arranged by zones, it seems desirable to present the data critically in full. The altitude after the name of each species gives the highest station recorded. No species is given in a lower zone if it also occurs in a higher zone.

2700-4000 m. (nival zone)
- *Adineta vaga* 3800
- *Macrotrachela ehrenbergi* 3000
- *Mniobia magna* 4000
- *M. scarlatina* 4000
- *Pleuretra alpium* 4000 m.

2300-2700 m. (subnival zone)
- *Asplanchna priodonta* 2453 m.
- *Brachionus urceus* 2350
- *Cephalodella gibba* 2340
- *Chromogaster ovalis* 2306
- *Conochilus unicornis* 2359
- *Dicranophorus forcipatus* 2600
- (*Diurella* sp. 2375)
- *Euchlanis dilatata* 2630
- *Filinia longiseta* 2400
- *Habrotrocha torquata* 2686
- *K. q. valga* 2350
- *Lepadella patella* 2400
- *Macrotrachela plicata* 2440
- *Monommata longiseta* 2344
- *Monostyla lunaris* 2600
- *Notholca longispina* 2640
- *N. striata* 2600
- *Pedalia bulgarica* ? 2630 (2200 in Bulgaria, Wiszniewski, 1933)
- *Philodina citrina* 2600
- *P. erythophthalma* 2445
- *Polyarthra trigla* 2600
- *Proalinopsis caudatus* 2313
- *Rotaria citrina* 2445
- *R. rotatoria* 2550
- *Synchaeta pectinata* 2307
- *Trichocerca carinata* 2350
- (*Trichocerca* sp. 2640)

1700-2300 m. (alpine zone)
- *Adineta gracilis* 2028
- *Brachionus calyciflorus* 2000
- *Cephalodella auriculata* c. 2000
- *C. eva* 1938
- *Collotheca ornata* 1810
- *C. deflexa* 2000
- *C. uncinata* 2144
- *C. wiszniewskii* 1825
- *Dicranophorus uncinatus* 2028

Dissotrocha aculeata 1796
D. macrostyla 2048
Diurella sejunctipes 1874
D. tigris c. 2000
Embata parasitica 2189
Epiphanes brachionus 1725
E. senta 2093
Eosphora najas 2102
Eothinia elongata 2102
Euchlanis macrura 2144
E. triquetra 2048
Floscularia melicerta 2100
F. ringens 2000
Gastropus stylifer 1920
Habrotrocha angusticollis 2000
H. bidens 2100
H. munda 2087
Keratella cochlearis 2189
K. quadrata f. *quadrata* 2270
K. serrulata 2189
Lecane luna 2189
Lepadella ovalis 2000
Macrotrachela multispinosa 1900
Mniobia symbiotica 1950
Mytilina mucronata spinigera 1782
M. mutica c. 2000
M. ventralis brevispina 2200
Notholca foliacea 2102
Notommata aurita 2189
N. pachyura 2102
N. tripus 2000
Philodina roseola 2200
P. vorax 2000
Pleurotrocha petromyzon 2000
Proales decipiens 2000
Ptygura crystallina 2000
Rhinoglena frontalis 1800
Rotaria macrura c. 2000
R. sordida 20000
R. tardigrada 1938
Squatinella mutica 2000
Stephanoceros fimbriatus 2144
Testudinella patina 2000
Trichotria pocillum 1815
Trichocerca longiseta 1934
T. rattus 2189

Zschokke (1900) in his analysis of his earlier list brings out clearly a limitation of the number of species with increase in altitude, which limitation is supported by the later list, given above. In the nival zone only muscicolous bdelloids occur, no rotifers being recorded from the few lakes above 2700 m. that have been studied biologically in the Alps. Nine species are, however, known to occur between 2600 and 2700 m. Zschokke gives a little evidence that the limitation of the algal flora in the higher lakes is one of the factors involved, but considerably more data are required to substantiate this.

It appears clear from the results of all investigators that the commonest pelagic and semipelagic rotifers of the high Alpine ponds and lakes are *Conochilus unicornis, Euchlanis dilatata, Notholca longispina* and *Polyarthra trigla*. Zschokke concludes that the Alpine rotatorian fauna is composed of widely distributed common species, a fact further emphasized by the list reproduced above. *Pedalia bulgarica* appears to be the only exception to this generalisation.

In no other part of the world have any relevant data been assembled. All the lakes studied at high altitudes in N. America appear to be below the timberline. Bryce (1931) records 13 species from the sacred lake on Mt. Zaquala in Abyssinia at an altitude of 2700 m. (9000 ft.), but this locality clearly enjoys a temperate climate, and the same is true of Lake Titicaca at an altitude of 3800 m. (12,500 ft.), from which Murray (1913) obtained 33 species.

In comparing our list with that of the Rotatoria of the central European Alps it is necessary to establish some sort of correlation between the ecological zonation in the two areas. This raises considerable difficulties owing to the fact that the whole of Indian Tibet enjoys a semi-arid climate and within the Himalayan front-range no true forest occurs.

The nival zone begins in the region studied at about 6000 m. Above 5000 m. larger lakes such as Ororotse Tso and Togom Tso apparently remain frozen for almost, if not quite, the entire year. It is probably correct to regard the zone lying between 5000 and 6000 m. as the equivalent of the upper part of the subnival zone of the Alps. Thickets of *Salix* sp. exist in sheltered valleys, such as the Nyagtsu valley North of the Panggong Tso, up to 4600 m., but such rare and isolated thickets can hardly be regarded as representing the upper limits of the forest zone of the Alps. Cultivation is carried on up to 4524 m. at Phobrang, northwest of Panggong Tso and up to about 4540 m. at Korzok on the shore of Tso Moriri. The fields at the latter settlement are probably the highest cultivated land in the world, but Francke (1914) gives evidence of former higher cultivation in this region. It must, however, be remembered that owing to the poverty of the country and the isolation of its communities agriculture is carried on under circumstances that would be economically unremunerative in Europe. It seems, therefore, reasonable to suppose that the Alpine zone of the Alps is represented by the zone above 4500 m. though its upper limit is uncertain.

In comparing our list with that of the Alps the data from above 1700 m. may therefore be legitimately used, but the bdelloids and the attached forms (except *Conochilus*) must be omitted, as our methods of study inevitably preclude their recognition. If this omission be made, the Alpine list is found to consist of 58 species, or just under three times the number recorded from the supposedly corresponding zones in Indian Tibet. When it is remembered that the Alpine list is the result of over fifty years' work by several investigators while our list represents but a single season's collecting by one individual, it becomes probable that the rotatorian fauna of Indian Tibet is at least as rich as that of the higher zones of the mountains of Central Europe.

Of the 21 species recorded in our list, 11 species are found in the Alps above 1700 m. and 7 species above 2300 m. Unfortunately these numbers are small; an attempt was made to determine if there is any correlation between the maximum altitude records of these species in the Alps and in Indian Tibet; the value of the correlation coefficient obtained, viz., 0.19, is quite without significance when derived from eleven pairs of observations. While it is clear that there are considerable similarities between the two faunae, evidence not susceptible to statistical treatment strongly indicates that there are also differences between them, for it is to be noted that of the four commonest Alpine free-swimming rotifers only one, *Polyarthra trigla*, occurs in our list for over 4500 m., and that *Notholca longispina*, perhaps the commonest Alpine species, and *Conochilus unicornis*, were found nowhere in the regions studied.

With the exception of *Pedalia bulgarica*, all the species that we record have previously been found at about sea-level in widely distant countries, and in general our list supports Zschokke's conclusion that the Alpine rotatoria are predominantly eurytopic species of immense vertical and horizontal distribution. Bearing in mind the differences that we have just noted between the fauna of the Alps and that of Indian Tibet, it is safe to conclude that the rotifer fauna of very elevated waters represents, with the single exception of *P. bulgarica*, a remnant of the common, and in general eurytopic, fauna widely distributed throughout the earth, but that the composition of this remnant differs from place to place, such differences being perhaps in part due to chance and in part due to ecological factors, of which latter the occurrence of *Brachionus plicatilis* provides an extreme example.

Pedalia bulgarica has been mentioned so often throughout this discussion that a few words as to its ecology may be appropriate. The species was met with in three localities.

As indicated above, a number of well-preserved specimens were obtained from two of the Togarma Tso ponds; these were determined by Dr. Wiszniewski. A single specimen was obtained in one of a similar series of ponds at Chushol (altitude 4336 m.) and several very poorly preserved specimens from the open water of Pangur Tso (altitude 4329 m.) were found to be undoubtedly referable to this species on account of the absence of posterior appendices and the six teeth of the uncus. None of these waters were very cold at the time when the material was collected. At Togarma Tso there was undoubtedly a great diurnal variation in temperature, but in Pangur Tso, the temperature lay between 15.1°C., (surface) and 14.2°C. (9 meters) on 13 August and 14.1°C. (surface) and 13.8 C. (9 meters) on 14 August, so that in this locality the species must be continually exposed to a moderate temperature of about 14°C. in the summer. The record of the species in Pangur Tso is also of interest as indicating that it is tolerant of considerable alkalinity (alkali reserve 0.0610 N., chloride 0.022 N., pH c. 9.6). These facts are of interest as indicating that this species, the only recorded alpobiont rotifer, is more tolerant of diverse conditions than might be expected.

Osborn Zoological Laboratory of Yale University,
23 July, 1934.

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ARTICLE X

UEBER EINEN LAND-ISOPODEN AUS LADAK

(55. Isopoden-Aufsatz)

By K. W. Verhoeff (Pasing bei München)

With 7 Text-Figures

(Received November 8, 1934)

Die mir in sechs Tuben von 6 Fundplätzen durch Herrn Prof. G. E. Hutchinson freudlichst übermittelten *Isopoda-terrestria* aus dem nordwestlichen Indien gehören alle zu der einzigen, im Folgenden besprochenen *Protracheoniscus*-Art.

Hinsichtlich dieser Gattung *Protracheoniscus* möchte ich aber zunächst Folgendes hervorheben: In meinem 22. Isopoden-Aufsatz "Zur Kenntnis der Entwickelung der Trachealsysteme und über die Gattungen *Porcellio* und *Tracheoniscus*" (SitzBer. Ges. Naturf. Fr., Berlin, 1917, N.3 S. 195-223.) habe ich nicht nur eine neue Umschreibung dieser Gattungen besonders auf Grund der Atmungsorgane gegeben, sondern auch mehrere Untergattungen beider begründet. Unter den Untergattungen von *Tracheoniscus* befindet sich auch *Protracheoniscus*, eine Gruppe, welche jedoch später ebenfalls um so mehr als eigene Gattung betrachtet werden musste, da sich die Notwendigkeit ergab sie selbst wieder in Untergattungen zu teilen.

Dies geschah in meinem 42 Isopoden-Aufsatz, über Isopoden aus Turkestan (Zool. Anzeiger, Leipzig 1930, Bd 91. H. 5/8 S. 101-125.) wo ich nicht nur die Beziehungen von *Protracheoniscus* und *Nagara* behandelt, sondern auch auf S. 105 die beiden Untergattungen *Protracheoniscus* s. str. und *Mongoloniscus* unterschieden habe. Während *Mongoloniscus* für Ostasien charakteristisch ist, stellt *Protracheoniscus die artenreichste und überhaupt* hervorstechendste Isopoden-Gruppe der *mittleren Länder Asiens* vor. Aus Turkestan habe ich allein 7 Arten nachgewiesen. Aus mehreren im letzten Jahrzehnt erschienenen Aufsätzen wissen wir jetzt auch, dass *Protracheoniscus* für den Südosten *Europas* bezeichnend ist und dass die *westlichsten* Vorposten der Gattung fast genau in der Mitte Deutschlands stehen, so namentlich der bekannte *politus* Koch, Verh. Die oekologischen Ansprüche der einzelnen Arten sind ausserordentlich verschieden und ebenso die Grössen der Areale. Es giebt wärmebedürftige, mediterrane Arten von geringer Verbreitung einerseits, aber andererseits auch weiter verbreitete und weniger empfindliche Arten, wie z. B. den *asiaticus* Ulj.

Jedenfalls kennen wir aber in Europa keine Art, welche in den Gebirgen besonders hoch ansteigt, z. B. oberhalb 1500 m. ist meines Wissens in Europa nie ein *Protracheoniscus* beobachtet worden. Aber auch aus Asien waren bisher Vorkommnisse von bedeutender Höhe nicht bekannt. Um so mehr hat es mich überrascht, dass die im Folgenden beschriebene Art in Nordindien in Höhen lebt, in welchen es in Europa überhaupt gar keine Isopoden giebt. In den mitteleuropäischen Alpen sind schon bei 2000 m. Höhe in vielen Gebirgen keine Isopoden mehr anzutreffen, im Gegensatz zu den klimatisch viel widerstandsfähigeren Chilopoden und Diplopoden.

Die starke Vertretung der Gattung *Protracheoniscus* in Asien, wobei aber zweifellos die weitaus meisten Arten noch unbekannt sind, ferner die Tatsache, dass sowohl die Untergattung *Mongoloniscus* als auch die nahe verwandte Gattung *Desertoniscus* Verh. (ebenfalls im 42. Aufsatz beschrieben) in Asien heimaten, während entsprechende verwandte Gruppen in Europa (und andern Continenten) nicht bekannt sind und schliesslich das extreme hohe Vorkommen des **Pr. nivalis**, sind in Einklang stehende Erscheinungen, welch dafür sprechen, *dass Asien die Urheimat von* Protracheoniscus *ist.*

Protracheoniscus (Protracheoniscus) nivalis n. sp.

♀ 11-14 mm., ♂ 12 mm. lang. Rücken grau bis braunschwarz.

Von allen bekannten *Protracheoniscus*—Arten unterscheidet sich die vorliegende schon äusserlich.

1. Durch die Stirnleisten, welche zwischen dem Mittelteil derselben und den Seitenlappen fast einen *stumpfen Winkel* bilden (während sie sonst hier einfach gebogen sind),
2. Durch den Hinterrand an den 1. Pereion-Epimeren, welcher ganz *gerade* streicht (während er sonst bogig verläuft),
3. Zeigen die 1. Pleopoden des ♂ (Abb. 1 und 3) nach Exopodit und Endopodit eine recht eigentümliche Beschaffenheit.

Rücken mehr oder weniger glänzend, Antennen von typischer Länge, die beiden Geisselglieder gleich lang, oder das terminale etwas (bis 1/3) kürzer, 3 Glied am Ende vorn und hinten mit kleinem Zahn, 4 und 5 deutlich gefurcht. An den 3 gliedrigen, sehr kleinen Antennulen (Abb. 6) das mit mehreren Sinnesstäbchen besetzte Englied nur halb so lang wie das mittlere und dieses etwas schmäler und wenig kürzer wie das Grundglied. Letzteres springt am Ende innen etwas gerundet vor.

Ocellen in vier Reihen stehend. Die Seitenlappen des Kopfes gross, fast halbkreisförmig, ihr Endrand um etwa ¾ der Länge des Ocellenhaufens von diesem entfernt. Stirnleiste in der Mitte mit stumpfen Winkel vorragend.

Exopodite der 1 Maxillen mit 4 derberen und 5 feineren Zännchen, von den 4 derberen einer viel kürzer als die andern. 2 Maxillen am Ende tief eingesschnitten in zwei fast gleich breite Lappen, deren äusserer nackt und deren innerer fein behaart und gestreift ist.

Die Kieferfüsse (Abb. 7) sind durchaus nach dem bekannten *Porcellioniden*-Typus gebaut, ihre 3-gliedrigen Taster, wie überhaupt die ganzen Kieferfüsse zeigen kaum etwas Besonderes gegenüber denen der Verwandten, stimmen auch fast ganz überein mit denen von *Desertoniscus* (Abb. 17 in meinem 42. Aufsatze) doch ist hier bei *Desertoniscus* das 3 Tasterglied schlanker und zugleich nicht deutlich abgegrenzt.

Der Rücken erscheint (unter der Lupe) feinpunktirt. Auf den Epimeren des Pereion zeigt sich eine schwache aber deutliche *Körnelung*. Noduli laterales am 1.-4. Pereiontergit viel höher stehend als am 5.-7. Am. 1. Tergit, wo die Noduli zugleich etwas grubig vertieft liegen, sind sie vom Seitenrand 1½ mal weiter als vom Hinterrand entfernt, am 3 Tergit vom Seitenrand doppelt so weit wie vom Hinterrand entfernt, am 4 Tergit 3 mal so weit. Am 5-7 Tergite stehen also die Noduli dem Seitenrand viel näher und zwar sind sie am 5. und 6. Tergit vom Seiten- und Hinterrand gleich weit entfernt, am 7 vom Seitenrand 1½ mal weiter als vom Hinterrand.

In den Punkten der genannten Punktirung sitzen über den ganzen Rücken zerstreut kurze und sehr feine Borsten, die sich (mikroskopisch) als einfach erweisen.

Pleon ohne Körnelung. Das im dreieckigen Spitzenteil grubig eingedrückte Telson reicht bis zum Hinterrand der Uropoden-Propodite. An den Rändern der Epimeren münden Drüsen und zwar stehen an den 1 Pereion-Epimeren die Drüsenporen in einer Längsreihe hinter den abgerundeten Vorderecken. An den 7. Epimeren sah ich 5-7 Drüsenporen in einer Langsreihe im mittleren Gebiet, dicht neben dem Seitenrande.

Am 7 Beinpaar des ♂ ist das Ischiopodit unten bogig ausgehöhlt, kurz beborstet, besitzt oben in der Endhälfte eine im Bogen angeordnete Reihe von 7 Stachelborsten. Meropodit am Ende oben und unten mit je drei Stachelborsten, Carpopodit unten mit drei stufigen Absetzungen und 7-8 Stachelborsten.

Von sehr charakteristichem Bau sind die 1. Pleopoden des ♂. Die gerade nach hinten gestreckten und allmählig verschmälerten 1. Endopodite (Abb. 3) laufen in einen fast dreieckigen, am Ende abgerundeten Endzipfel aus. Die äussere Basis dieses Endzipfels tritt nach aussen *eckig* vor und vor dieser Ecke mündet die Spermarinne (*x.*). An der immeren Basis ist der Innerrand unterbrochen (*at.*). Hinter dieser Unterbrechung zeigt sich eine kurze Wimperreihe und vor ihr ist der Rand mit äusserst feinen und kurzen Spitzchen Besetzt.

Trachealsysteme treten, wie bei allen *Protracheoniscus*, an den 1.-5. Exopoditen auf. Die 1. und 2. Exopodite sind pigmentlos, die 3.-5. von zahlreichen verzweigten Pigmentzellen durchsetzt, (Abb. 4.).

Die 1. Exopodite des ♂ (Abb. 1.) sind hinten breit abgerundet, innen gerundet, aussen hinten gerade abgeschrägt, während vorn der Aussenrand in einen abgerundeten *Lappen vorspringt*, an dessen hinterer Basis das Trachealsystem mündet. Hinter dieser Mündung bemerkt man innen neben dem Schrägrande eine Trachealfeldleiste, deren Hinterende undeutlich.

An den 2. Exopoditen des ♂, welche am Hinterrande aussen eine Reihe kräftiger Borsten tragen, befindet sich mitten im Trachelfeld eine stumpfwinkelige, ziemlich tiefe Einbuchtung (*tf*, Abb. 2.) und auch die Trachealfeldleiste ist stumpfwinkelig eingebuchtet. Die 2. Exopodite werden von ihrem Endopodit, welches im Endteil sehr dünn ist und spitz ausläuft, nur wenig überragt.

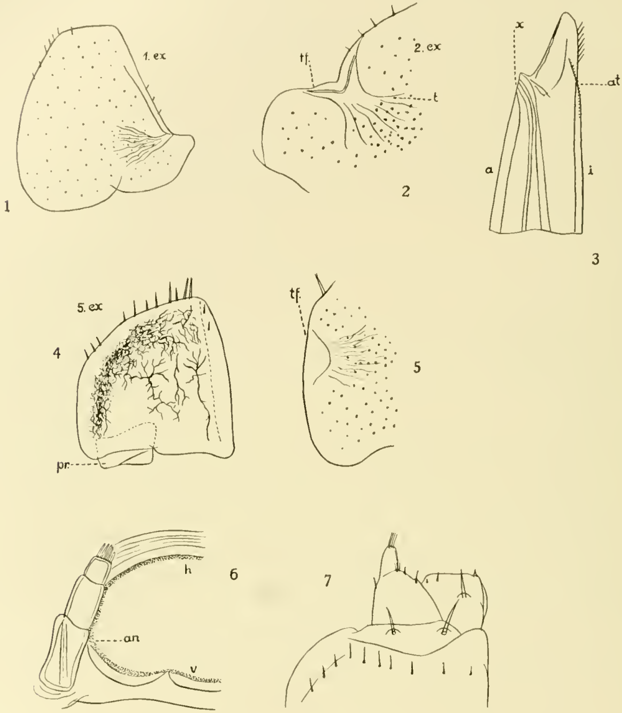
Den stärksten Borstenbesatz und zwar am Hinterrande besitzen die 5. Exopodite des ♂ (Abb. 4) welche vorn quer abgestutzt, aussen und hinten zugerundet und innen fast gerade nach hinten streichen. Ueber dem Innenrande zeigt sich die bekannte, taschenartige Einsenkung. Die Trachealysteme (Abb. 5.) münden am vorderen Aussenrande etwas vor der Mitte und sind an den 5. Exopoditen am schwächsten entwickelt.

Vorkommen. Die in etwa 14 Stück vorliegende Art ist auch in zwei Jugendlichen vertreten und im obersten Indusgebiet an folgenden Orten gesammelt worden:

L. 20 Hemis Gonpa, unter Steinen, 12–VI–1932. c. 3660 m.
L. 31 Lhabaps, unter Steinen, 22–VI–1932. 3614 m.
L. 32 Zung-Lung, Tangyartal unter Steinen, 24–VI–1932. 4224 m.
L. 68 Zwischen Anzurma und Dambu-guru, 1–VIII–1932. c. 4725 m.
L. 72 Tokung, bei Panggong Tso, 8–VIII–1932. c. 4250 m.

L. 68 und L. 72 befinden sich zu beiden Seiten des Panggong Tso. Ausserdem liegen noch vor von Tso Nyak in Tibet Tzewang Tashi und Sonam Tergas 12-viii-1932 durch auffallende Weichheit ausgezeichnet 2 ♀♀. Ein ♀ mit Marsupium wurde nicht beobachtet.

Anmerkung: Vielleicht handelt es sich bei diesen Tieren um zwei Rassen, deren eine schmäler und heller und deren andere breiter und dunkler ist. Dies lässt sich jedoch nur an zahlreicheren Objecten entscheiden als mir vorgelegen haben. Wie es scheint ist der *Tracheoniscus nivalis* die am *höchsten* lebende *Isopoden*-Art, welche bisher auf unsere Erde beobachtet worden ist.



FIGURES 1-7. **Protracheoniscus (Protracheoniscus) nivalis** n. sp. 1, Ein 1. Pleopodenexopodit des ♂, von unten gesehen, × 56. 2, Aüsserer Abschnitt eines 2. Pleopodenexopodit des ♂, *t*, Tracheen, *tf*, Trachealfeld. × 125. 3, Endteil eines 1. Pleopodenendopodit des ♂, Ansicht von unten, *i*, Innen- *a*, Aussenrand, *x*, Mündung der Spermarinne, × 125. 4, Ein 5. Pleopodenexopodit des ♂ von unten gesehen, *pr*, Propodit, × 56. 5, Aüsserer Teil desselben mit dem Trachealfeld (*tf*), × 125. 6, Linke Antennule (*an*) und der angrenzende Teil der Gelenkgrube der linken Antenne, *v*, Vorder- *h*, Hinterrand, × 125. 7, Endteile des rechten Kieferfusses, Ansicht von unten, × 125.

ARTICLE XI

REPORT ON HIRUDINEA

By J. Percy Moore

(Received December 15, 1934)

The collection of leeches is very small, consisting of ten lots representing three species. One of these came from the Nilgiri Hills in Madras Presidency and two from Kashmir, one being a new record for that state. All are from moderate elevations and the absence of land leeches is worthy of note.

Theromyzon sexoculata (Moore)

Protoclepsine sexoculata Moore, 1898.
Theromyzon sexoculata Moore, 1924.
"   " Harding, 1927.
? *Protoclepsis meyeri* Livanow, 1902.

This species is new to Kashmir, though it was previously known from India, having been recorded from Manipur (Moore, 1924); the type is from Bering Island (Moore, 1898). Livanow considered *T. sexoculata* (unfortunately so named) identical with a species known from Russia, Sweden and France, to which he gave the new name of *T. meyeri.* Externally the resemblance, in respect to annulation, eyes, genital orifices and color, is close. The only difference noted on the Manipur specimens was that the second annulus (*a3*) of somite XXVI was differentiated only at the margins, as is also the case in the Kashmir specimens. Somite III is triannulate on all specimens. But a series of sections which this material permitted definitely establishes the distinction between the Indian form and *T. meyeri.* The gonopores are similar in position (♂ XI/XII, ♀ XII *a2/a3*) but the two oviducts are united beneath the nerve cord into a slender, tubular vagina which runs vertically to the ♀ orifice, exactly as in *T. tessellata*, as contrasted with *T. meyeri* in which there is no such common vagina. The condition of the oviducts in the original *T. sexoculata* is unknown, as it could not be determined from the single very poorly preserved type specimen. It is not improbable that the south Asiatic species will eventually prove to be distinct from *T. sexoculata* but present evidence gives no ground for separation.

The color of the present specimens is largely faded but all retain at least traces of the six series of metameric yellow spots and in addition a moderate number of similar but unsegmental spots. One specimen has a dark band on each side of the buccal ring, wide laterally and tapering to a point medially. The dark green, contracted chromatophores are conspicuous and on the venter of one specimen form dark rings about the sensillae which appear to the naked eye as black dots. On complete somites *a3* is constantly somewhat larger than the other annuli but there is no indication of subdivision. Ventrally throughout the length, and dorsally at both ends, the intersegmental furrows are conspicuously deeper than the others and *a2/a3* is deeper than *a1/a2*.

All four specimens (K34 Nos. 691 and 698) were taken at Phashakuri, near Pampur, Kashmir, May 7, 1932, at an altitude of 5200 ft.

Erpobdella octoculata (Linn.)

Hirudo octoculata Linnaeus, 1758.
Erpobdella octoculata Moore, 1924.
" " Moore, 1927.

This widely distributed Eurasiatic species is very common in the lakes and ponds of Kashmir. It was fully discussed in my 1924 paper. It is the best represented species in this collection but all specimens are small. The gonopores are normally separated by 3 annuli, the ♂ in or immediately behind the furrow XII *b1/b2* and the ♀ constantly in XII *b5/b6* but the ♂ may shift caudad as far as the middle of *b2* in which case it is only 2½ annuli anterior to the ♀ pore. One specimen has two ♂ pores in XII *b2* and XIII *b2* respectively.

K 15 and 19 Gagirbal, Srinagar, Kashmir, swampy pond east of road, altitude 5190 ft., No. 703, 707; K 24, Nishat Bagh, pond, April 7, altitude 5200 ft., No. 651; K 42, Wular Lake, April 18, alt. 5180 ft., dredged, No. 763, depth 1.5–2 m., No. 765, depth 1.0 m.; K 61, Gund, Sind Valley, May 17, altitude 6824 ft., under stones on muddy bottom of small stream.

Foraminobdella heptamerata Kaburaki

Foraminobdella heptamerata Kaburaki, 1921.
" " Moore, 1927.

This interesting and little known species is represented by four poorly preserved specimens N. 8 (No. 834, 849) taken in ponds on Pykara Road near Ootacamund, Nilgiri Hills, Madras, November 10, 1932, altitude 7200 ft. The specimens measure from 23. × 4. to 42. × 5.3 mm. All have the gastropore of large size; this structure, the gonopores and the annulation are as described in 1927 from the type, at that time unique, which also came from the Nilgiri District. In January, 1931, I was fortunate in finding several populous colonies of this species in the lake at Ootacamund and was able to study its mode of life and to secure material from which an anatomical description will be published in another connection. Its favorite habitat is in the little gravelly deltas at the mouths of streams emptying into the lake. Here it is found under stones especially just above water level and when exposed disappears quickly into the gravel and silt. It is as muscular, hard and slippery as an eel, very difficult to hold and with its pointed head and slender form an adept burrower. When placed in water a current may be seen to issue periodically from the gastropore and when removed to the air a fine jet of water was sometimes ejected from it a distance of several inches. In life the color is a dull or bright red or pink according to size and contents of stomach. The food consists chiefly of tubificid oligochaetes.

Full references to all of the papers cited in the synonymy appear in the bibliographies of Harding and Moore, Fauna of British India. Hirudinea. London, 1927.

ARTICLE XII

HOCHASIATISCHE BINNENSEESEDIMENTE

By G. Lundqvist

With 1 Plate and 5 Text-Figures
(Received February 8, 1935)

Vorwort

In einigen älteren Arbeiten, besonders von 1927, habe ich die Auffassung verfochten, dass die Einsammlung von Bodenproben in Seen mit der grössten Genauigkeit und von dem Forscher, der dieselben bearbeiten wird (Lundqvist 1927), ausgeführt werden muss. Weiterhin muss man, um den Typus eines Sees feststellen zu können, eine persönliche Erfahrung desselben haben, denn in dem Typus ist eine Mannigfaltigkeit unbedeutender und unbeschreibbarer Faktoren vorhanden. Es scheint deshalb inkonsequent, dass ich die Bearbeitung der Bodenproben von "The Yale North India Expedition, 1932," die mir von Dr. H. de Terra und Dr. G. E. Hutchinson freundlichst angeboten wurde, übernommen habe. Anderseits aber war die Möglichkeit, Sedimente aus den höchst gelegenen limnologisch untersuchten Binnengewässern der Erde zu sehen, gar zu verlockend. Ich möchte darum den erwähnten Forschern für ihr freundliches Anerbieten meinen besten Dank aussprechen. Ganz besonders möchte ich Dr. Hutchinson für die örtlichen Observationen über die verschiedenen Seen, die er mir bereitwillig geliefert hat, danken. Ich bin ihm und Dr. de Terra auch dankbar für das Durchlesen der Korrektur, das ich infolge drucktechnischer Umstände leider nicht selbst ausführen konnte.

Von denen, die mir im übrigen geholfen haben, möchte ich Dr. H. Thomasson, der die Diatoméenbestimmungen ausgeführt hat, zuerst nennen. Weiter hat Dr. S. Thunmark das Desmidiéenmaterial durchmustert. Dr. G. Assarsson hat die Wasseranalysen, die mir von Dr. Hutchinson zur Disposition gestellt wurden, durchgerechnet und mit mir diskutiert. Schliesslich habe ich den Vorteil gehabt, mit Dr. R. Melin und Dr. C. J. Östman über die Klimafragen sprechen zu können. Besonderen Dank schulde ich deshalb auch diesen fünf Forschern.

Schon hier dürfte erwähnt werden, dass die Lokalitätsnamen dieser Gegenden in ganz verschiedener Weise geschrieben werden. Ich habe selbstverständlich die Namen der Berichte der Yale-Expedition benutzt (de Terra 1934). Daneben habe ich aber die Seenamen angeführt, die auf solchen bekannten Karten wie z. B. denjenigen von Hedin (1909) und Dainelli (1922) gebraucht worden sind. Eine mehr systematische Prüfung und Vergleichung von Karten der vorliegenden Gebiete von ortographischen Gesichtspunkten aus habe ich selbstverständlich nicht versucht.

Um ein Missverständnis zu vermeiden, hat jeder See seine Nummer erhalten, und diese ist sowohl in den Text als auf die Karten eingesetzt worden.

Über die Disposition der folgenden Arbeit sei nur angeführt, dass einerseits das Material (also die deskriptiven Kapitel) andererseits, die mehr theoretischen Kapitel und die

Rückblicke für sich stehen. Das Hauptgewicht ist auf das erstere gelegt, da die Sedimente dieser Gegenden bisjetzt ganz unbekannt waren. Darum dürfte hier jedes Detail von Interesse sein können.

Methodische Bemerkungen

Die Proben sind mit dem Ekman-Birge-Bodengreifer eingesammelt worden. Nur in einigen Seen (Son Sakesar Kahar, Lokut Dal Lake und Wular Lake) wurde das Rohrlot von Naumann benutzt. Die Proben, die mit dem Bodengreifer genommen wurden, sind ja betreffs ihrer Lage in Verhältnis zu der Sediment oberfläche nicht so gut Lockalisiert wie die ubrigen, und das Material ist auch zusammengerührt und heterogen geworden. Man kann darum in solchen Proben Klumpen aus Gyttja mit ganz verschiedener mikrobiologischer Zusammensetzung finden. Die äusserst genauen Methoden, mit denen die Proben bearbeitet wurden, sind deshalb oft nicht nötig gewesen. Ich möchte daher die Aufmerksamkeit darauf richten, dass hier in hohem Grade der Ausspruch von Hagen gilt: "Der Mangel an mathematischer Bildung gibt sich durch nichts so auffallend zu erkennen, wie durch masslose Schärfe im Zahlenrechnen." Damit möchte ich also auch hervorheben, dass die Frequenzzahlen, die für die Diatoméen oder Strukturelemente angeführt werden, nicht so exakt, wie sie im Druck erscheinen, aufzufassen sind.

Über die Observationen an Ort und Stelle ist auch zu bemerken, dass die Farbe des Sees nach dem Masstab von Forel-Ule (Ule 1892) und diejenige des Wassers nach dem Platina-Chlorid-Masstab der U. S. Geological Survey (Leighton 1905) bestimmt worden sind. Die natürlichen Farben der Sedimente sind schwer festzustellen, da sämtliche Proben, die nicht getrocknet sind, in Spiritus oder Formalin fixiert sind.

Die Bearbeitung der Proben im Laboratorium ist mit einigen Erweiterungen nach Lundqvist, 1927, ausgeführt worden. Ich habe mich also nicht mit eingetrockneten Proben beschäftigt. Die Eintrocknung verursacht bei den Kolloiden, feinerem Detritus u. a. den Verlust sowohl ihres Aussehens als auch ihres Volumens. Dadurch wird also das Volumenverhältnis zwischen organogenem und minerogenem Material verändert. Die Strukturanalyse ist durch Rechnung der verschiedenen Bestandteile unter dem Netzokular von Leitz in 1 mm.^{3} von der gefeuchteten Probe ausgeführt worden. Bei dieser Analyse kann es ganz schwierig sein, das feinkörnige minerogene Material und Feindetritus von einander zu unterscheiden. Ich habe darum verschiedene Färbungsmittel probiert, um eines zu finden, das das minerogene Material unbedeckt und farblos lässt. Das beste der probierten Mittel ist ein gewöhnlicher Anilinfarbenstift (vgl. Naumann 1918). Nach chemischer Methode kann man dieses feinkörnige Material, besonders den Tonschlamm, erreichen. Die methodische Schwäche besteht darin, dass man hierbei in der Summe des unorganischen Materials auch die Diatoméen und die anderen Kieselskelette bekommt. Es ist daher meines Erachtens vom mikrobiologischem Gesichtspunkte aus mehr anzuraten, die Proben mikroskopisch zu untersuchen. Wünscht man aber den Charakter der Sedimente von rein chemischem Gesichtspunkt aus herauszufinden, ist es eine ganz andere Frage.

Die mikrobiologischen Untersuchungen sind ebenfalls auf 1 mm.^{3}-Proben ausgeführt worden. In den mehr eingehenden Diatoméenanalysen, von H. Thomasson, werden die Resultate in Prozentzahlen vorgelegt, wobei die Prozente der Summe der nicht kolonienbildenden Individuen ausgerechnet sind. Ausnahmen bilden z. B. *Melosira arenaria* und *Cyclotella*, dagegen weder *Melosira granulata* etc. noch *Fragilaria*.

Auf diese jetzt oben beschriebene Weise sind auch die Proben mit der "Trockenprobe," der "HCl-Probe" und der "Tuschprobe" untersucht worden. Die Trockenprobe ist ein einfaches Hilfsmittel, um eine ungefähre Vorstellung des Dygehalts in den Sedimenten zu vermitteln: je dyreicher dieselben sind, um so mehr braunschwarz werden sie in trockenem Zustand. In den vorliegenden humusarmen Gebieten ist die Probe jedoch von untergeordnetem Interesse. Die HCl-Probe beabsichtigt die Angabe, einer ungefähren Auffassung des relativen Karbonatgehalts. Auf etwa 1 mm.^{3} des Sediments wird ein Tropfen HCl (etwa 10%-ig) getropft und das Schäumen wird beobachtet. Für die Bestimmung desselben habe ich eine 5-gradige Skala benutzt nach dem Prinzip: 0 = kein Schäumen, 5 = sehr starkes Schäumen. Die Anwendung ist sehr einfach und weitere Beschreibung unnötig. Die Tuschprobe gibt eine recht gute Vorstellung des Gehalts an Algenschleim im Feindetritus. Diese Probe ist schon früher, besonders in der algologischen Literatur, mehrmals beschrieben worden.

Schliesslich möchte ich hier auch hervorheben, dass ich auf das Zusammenbringen von Data über die Naturverhältnisse viel Zeit verwendet habe. Denn für das Verstehen der Biologie eines Sees ist es viel wichtiger, dass man die Umgebungen und das Milieu des Sees beherrscht, als dass man z. B. sämtliche Arten einer besonderen Tier-oder Pflanzengruppe, die darin lebt, kennt.

Das Material, das über die Naturverhältnisse dieser Gegenden vorliegt, ist ebenso gross als auch schwer zu überblicken. Diese Gebiete sind klassischer Boden sowohl von dem Gesichtspunkte der indischen Naturforschung aus als auch aus limnologisch klassischer Boden. Hier wanderten die Brüder Schlagintweit schon Mitte des vorigen Jahrhunderts und untersuchten auch die Seen. Selbstverständlich waren ihre Methoden äusserst primitiv; in einer Hinsicht aber waren diese Forscher ihrer Zeit voran: sie machten relativ genaue Observationen über die Transparenz und Farbe der Seen. Es dürfte lohnen aus der Vergessenheit gerettet zu werden, dass sie im Ladak- und Kashmirsee die Sichttiefe durch Messen der Tiefe bestimmten, bei der ein Zylinder aus Carrara-Marmor unsichtbar wurde. Für die Farbenbestimmungen benutzten sie ebenfalls ein grosses Glasprisma, das man unter der Wasserfläche drehte, bis die stärkste Farbe erhalten wurde (Schlagintweit 1871 [74] S. 170).

Einige Bodenproben der asiatischen Seen von reinem Sediment-gesichtspunkt aus scheinen jedoch vorher nicht genommen worden zu sein, obgleich einige "Schlammproben" auf Diatoméen hin bearbeitet worden sind. Ich möchte in diesem Zusammenhang Meister (1932, S. 2) anführen: "Es fehlten also bis jetzt Proben vom Grunde stehender Gewässer, die erfahrungsgemäss die reichste Ausbeute liefern. Wenn einmal richtiges Benthos zur Untersuchung gelangt, werden sicherlich noch viele neue Formen bekannt." Aus den in vorliegender Arbeit untersuchten Proben scheint es jedoch, als ob Meisters Prophezeiung nicht Stich halten würde.

Die hier untersuchten Seen liegen in drei Gebieten: Salt Range im Punjab, dem Kashmirtal und Ladak im westlichen Tibet (Text-figure 1 und 2). Ich werde versuchen, über jedes dieser drei Gebiete eine kurze Naturbeschreibung zu liefern.

Salt Range

Die Salt Range ist ein O-W-licher Komplex von Gebirgsketten zwischen Indus und Jhelam im Punjab. Gegen S besitzt das Gebiet einen starken Abfall; gegen N ist es aber nicht so scharf abgegrenzt. Das Seegebiet liegt auf einer schwach kupierten Hochebene

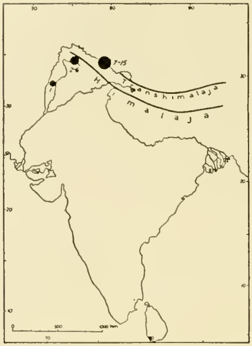


FIGURE 1. Die Seen der drei Untersuchungsgebiete: Nr. 1 Salt Range (Son Sakesar Kahar), Nr. 2-6 Kashmir und Nr. 7-15 Ladak.

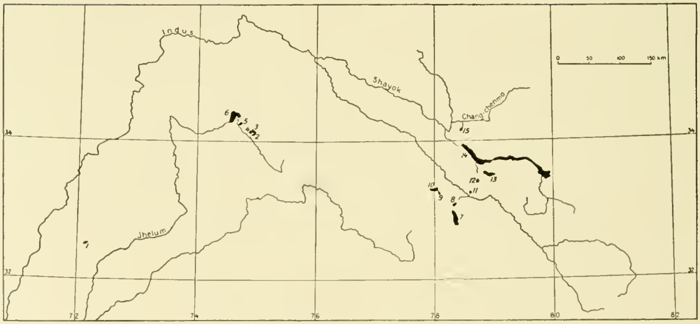


FIGURE 2. Die untersuchten Seen: 1 = Son Sakesar Kahar, 2 = Lokut Dal Lake, 3 = Bod Dal Lake, 4 = Sundar Khun, 5 = Manasbal Lake, 6 = Wular Lake, 7 = Tso Moriri, 8 = Khyagar Tso, 9 = Startak-puk Tso, 10 = Tso Kar, 11 = Yaye Tso, 12 = Mitpal Tso, 13 = Pangur Tso, 14 = Panggong Tso und 15 = Ororotse Tso.

zwischen zwei der Gebirgsrücken. Der höchste Punkt ist Sakesar, 1500 m. u. M. Der Berggrund besteht hauptsächlich aus Nummuliten-Kalkstein. Gegen S gibt es auch Karbon-Kalksteine und kleine Partien von Jura-Gesteinen. Die Kalksteine liegen gewöhnlich unbedeckt und kleinhügelig in O-W Richtung ausgestreckt. Die Bodenarten nehmen hauptsächlich die Senken zwischen den Rücken ein und sind in grosser Ausdehnung kultiviert. Die Waldvegetation dieser Zentralpartie der Salt Range ist ganz unbeträchtlich und nur aus einigen verkümmerten *Hyperanthera* und *Bombax heptaphyllum* zusammengesetzt (Fleming 1853, S. 237). Übrigens wird die höhere Vegetation von Fleming (S. 238) als "a low bush jungle, formed in great part of *Dodonaea Burmanniana* (Sunhetta) and *Adhatoda vassica* (Behikkur)" bezeichnet. Die letzteren sind für das Gebiet sehr charakteristisch. Das Klima ist demjenigen von Kashmir ähnlich. Während der warmen Zeit ist die Hitze ganz drückend; aus einer Angabe von Fleming (1853, S. 229) geht hervor, dass er darum Mitte April wegen der Hitze mit seiner Untersuchung aufhören musste, wodurch die Arbeit ein halbes Jahr verzögert wurde. Die Winde blasen in der Salt Range während dieser Zeit von OSO und während der kalten Zeit von W. (Harwood 1926). Die Niederschlagsmenge erreicht 250-500 mm. (Schott 1933).

1. *Son Sakesar Kahar*

(ca 750 m. ü. M.)

Wynne (1878) auf der Karte: Son Sukesur Kahur, im Text auch Samandar genannt.

Das Zuflussgebiet umfasst einen Teil der Hochebene Son in den höchsten Partien der Salt Range. Die Topographie ist teilweise stark zerschnitten; die Höhenunterschiede zwischen Gipfeln und Talböden erreichen höchstens 700-800 m. Der Berggrund besteht am See aus Kalksteinkonglomeraten und Sandsteinen, oberem und unterem Pleistozän angehörend. Die Hochgebirgsabhänge bestehen hauptsächlich aus flinsteinhaltigen eozänen Kalksteinen. Die Bodenarten sind in der Nähe des Sees vor allem alte Salzablagerungen. Die Vegetation der Umgebung des Sees ist als Macchien charakterisiert worden, ein Begriff der jedoch heterogen ist. In der Nähe des Sees liegen die kleinen Dörfer Chitta, Uchhali u. a. Das Zufliessen scheint nicht so stark zu sein, einen Abfluss gibt es nicht.

Das Seebecken ist seicht, deshalb wechseln Grösse und Wassertiefe mit den Niederschlägen (Wynne 1878 S. 46). Die grösste mir bekannte Tiefe ist 8.8 m. Die Farbe des Sees, die man nicht nach Forel-Ule bestimmen konnte, ist, auf Grund einer grossen Menge von *Microcystis roseo-persicinus* gräulich-hellrot. Über die Farbe spricht mir Hutchinson in einem Briefe: "Later in the year, according to Dr. Pruthi, this alga disappears and the only plankton that he discovered consisted of *Diaptomus salinus.* The lake was still pink, as this crustacean is a reddish species. The inhabitants maintain that the lake is always pink, except in the late autumn when it may be whitish. I am not very clear whether this is true, but it is possible that the calcium carbonate deposits represent a whitish phase occurring annually at a time when a good deal of sediment is washed into the lake."

Das Wasser ist in ökologischer Beziehung extrem salzig. Die Cl-Menge ist 34400 mg/l. Die Summe von Alkalisalzen 73050 und SO_4 17176 mg/l. Auch die Karbonatmenge ist ungewöhnlich hoch: 1276 mg/l (vgl. die Tabelle).

Der Boden. Hierüber liegen folgende briefliche Angaben von Dr. Hutchinson vor: "The bottom of Son Sakesar Kahar is very peculiar, consisting, I suspect, largely of ferrous sulphide in which there seem to be thin bands of white material, probably calcium carbonate." Drei Bodenproben, von 8.8 m., aus einer etwa 6 cm. langen Schlammwurst, mit dem Rohrlot von Naumann heraufgeholt, sind untersucht worden. Zwei von ihnen gehören dem schwarzen sulfidreichen Sediment, die dritte einer weissen dazwischen liegenden 2 cm. unter der Sedimentflache befindlichen Schicht an. Gewöhnlich scheint es, als ob die schwarzen Sedimentschichten etwa 2 cm. und die weissen < ½ cm. dick wären. In trocknem Zustand ist die Farbe der Oberflächenprobe dunkelgrau und die der unteren Probe gelblich-dunkelgrau. Die weissen Schichten verändern sich beim Eintrocknen nicht. Die HCl-Probe gab eine starke Reaktion (2 und 3) von sämtlichen Proben.

Strukturanalyse.

Probe	Grobdetritus	Feindetritus	Mineralkörner	Ca-Schlamm	Pyrit	Chitin
Ca 1 cm. u. B.	<1%	71%	12%	12%	2%	3%
" 2 " " "	2%	20%	6%	64%	...	8%
" 5 " " "	...	67%	18%	13%	<1%	1%

Der Feindetritus ist in den schwarzen Schichten hyalin, in den oberen Schichten dagegen reich an grauen oder karotingefärbten Klumpen; er ist körnig und flockig und enthält eine reichliche Menge kleiner bazillenähnlicher Körper, etwa ½ × 1 μ. Die Tuschprobe zeigt 10-20% von Algenschleim, mit bestimmtem Mehrgewicht in der unteren Probe. Die Mineralkörner sind gut abgerundet oder stark splitterig, 15 μ oder weniger. Der Feindetritus ist in den weissen Schichten hellgelb und reich an abgerundeten Körnern, die zum Teil eventuell minerogen sind. Die Mineralkörner sind hier 15-25 μ, sehr gut abgerundet, oder 5-15 μ, gut abgerundet und stark lichtbrechend. Sie bestehen mit Gewissheit aus Karbonat, nach Dr. Assarsson gewöhnlich aus Kalziumkarbonat. Auch Eisenkarbonatkörner kommen vor, obwohl es nicht möglich war, die Proportion derselben festzustellen. Die Karbonatkörner unterscheiden sich von den "Mineralkörnern" (Quarz, Feldspat, Glimmer und anderen nicht ausgefällten Mineralien) durch die hohe Lichtbrechung und den Glanz und die Ebenenheit ohne Splitterigkeit der Fläche. Die Karbonatkörner sitzen wie Trauben auf den Feindetritusklümpchen. Auf dem Grobdetritus sind die Karbonatkörner grösser und etwas kantig, sind aber doch recht gut abgerundet. Das Pyrit ist gewöhnlich kugelförmig und klumpenweise angesammelt. Die schwarzen Sedimente sind kalkreiche Feindetritusgyttja, die weissen chitinreiche Kalkgyttja.

Mikrofossilienanalyse. Unter den Diatoméen gibt es nur ein Fragment von *Cymbella aspera* in der oberen Probe. Daneben sind *Cosmarium sp.* und andere Chlorophycéenreste angezeichnet. An Pollen findet man "*Picea*," unter denen ein 180 μ grosses Exemplar, "*Salix*," "Chenopodiacéen-pollen," einen *Quercus*-ähnlichen Pollen und einige, die einen hellen *Fagus*-Pollen ähnlich sind. Was die Quantitat betrifft, so kommen nur ein paar von jedem Pollen auf den $mm.^3$ Dies alles gilt nur für die dunklen Schichten. Die weissen Schichten sind beinahe steril, nur ein *Chitinen*-fragment, möglicherweise von einem Rotatorien-Ei, ist angetroffen worden.

Mikrobiologisch sind die Angaben dieser Sedimente ziemlich dürftig; sie deuten vielleicht an, dass der See biologisch zu einer Wüste umgewandelt wurde, ein Schluss, der jedoch von den Feldbeobachtungen widerlegt wird.

Zusammenfassung: Son Sakesar Kahar ist ein seichter See mit einem sehr Cl- und SO_4-reichen Wasser, die Lagenfolge ist geschichtet, die zwei Sedimenttypen der Schichtenreihe sind kalkreiche Feindetritusgyttja und chitinreiche Kalkgyttja ohne Mikrofossilien. Mikrobiologisch herrschen *Microcystis roseo-persicinus* und *Diaptomus salinus* vor.

Kashmir

Das Kashmir-Gebiet ist ein etwa 7 × 11 Meilen breites Tal, scharf abgegrenzt von den Abhängen der umgebenden Gebirgszüge. Das Gebiet war früher von einem Süsswassersee eingenommen, wovon noch zerstreut liegende Sedimente mit Süsswassermuscheln zeugen. Der Berggrund besteht aus Sandsteinen, Quarziten u. ä des Panjal-Systems, Kalksteinen des Karbon, Perm und Trias und im Norden aus andesitischem Trapp (Lydekker 1883). Die Bodenarten der Talebene sind muschelreiche Karewa-Sedimente, diejenigen der Abhänge besonders gegen unten—Moräne oder warwiger Ton (Sörlin 1927). Das Flachland ist mit Reisfeldern und Obstgärten schön bewachsen. Der Boden ist so stark ausgenützt worden, dass man im "Srinagar-See" (ich bin nicht ganz sicher, welcher dem Srinagar naheliegende See damit bezeichnet wird) Gärten auf Flössen angelegt hat. Diese bestehen aus Schilf, Zweigen usw., sind mit Erde bedeckt und fliessen auf ledernen Luftsäcken, das ganze wird durch in den Seeboden eingetriebene Stämme befestigt (Schlagintweit 1871, S. 411). An Bäumen stellt man Platanen, Pappeln und Walnussbäume fest. Die umgebenden Abhänge sind mit Nadelwäldern von z. B. *Abies Webbiana, Picea Morinda, Pinus longifolia, P. Peuce* und *Taxus baccata* (Sörlin, briefliche Mitteilung) bewachsen. Es sind daher hauptsächlich die gegen N exponierten, also die nicht von der Sonne trockengelegten Seiten, die so bewachsen sind. Hinter den Wäldern erheben sich in der Ferne die schneebekleideten Alpengipfel. Das Klima des Kashmirgebiets ist ein warm gemässigtes Regenklima von warmem und wintertrockenem Typus (Köppen auf der Karte in Supan-Obst 1927). Die heftigen Sommerregen im Juli verursachen ein kräftiges Schneeschmelzen im Hochgebirge, also eine Alpenfluss, das die Flüsse sehr schwer zu passieren macht (Schlagintweit 1871, S. 466). Im Winter wird das Klima durch heftige, kalte Luftströmungen von den Hochgebirgen her verschlechtert. Die jährliche Niederschlagsmenge beträgt etwa 1000 mm. (Schott 1933). Die Winde scheinen während dieser kalten Jahreszeit von WNW, während der Monsunzeit aber von OSO und auch etwa von NNO zu kommen (Harwood 1926). Doch sei hier bemerkt, dass die Topographie einen grossen Einfluss auf die örtlichen Windrichtungen ausübt.

2. *Lokut Dal Lake*

(1582 m. ü. M.)

Die Grösse des Wassergebiets ist schwierig zu bestimmen; es scheint jedoch recht gering zu sein. Der Berggrund, der zwar nicht entblösst vorkommt, besteht aus einem andesitischen Trapp, der dem Panjalsystem angehört (Lydekker 1883). Die Bodenarten sind pleistozener Ton aus der Karewa-Serie (de Terra, brieflich). Der See liegt auf dem ebenen, zum Teil versumpften Talboden; im Osten steigen die Gebirge steil empor. Die Vegetation rings um den See besteht aus *Salix* und *Populus* und im Osten aus Nadelwäldern. Das Wassergebiet zum grossen Teil bebaut. Das Zufliessen ist aus Bod Dal; der Abfluss geht südwestwärts bei Srinagar vorbei.

Die Tiefe des Sees ist gering, 1-2 m. Die Farbe des Sees ist nach Forel-Ule etwa XIV und diejenige des Wassers am Abfluss 15 mg. Pt/1. Die Secchi-Scheibe ist am Boden gut sichtbar; der pH-Wert ist 8.2-8.5. Der ökologische Standard ist süss wie in den naheliegenden Seen. Chemische Analysen liegen von "Bod Dal" vor. Jedenfalls sind die Analysen sicher für sämtliche Seen der Srinagar-Gegend repräsentativ. Die Summe der Alkalisalze beträgt 0 mg/l. Die Cl-Menge ist 1.6 und der Karbonatgehalt 65 mg/l. Die einzige Beziehung, in der sich das Wasser dieses Sees von dem der übrigen untersuchten unterscheidet, ist der relativ hohe Überschuss an Na_2CO_3: 14 mg/l.

Der Boden ist zum grossen Teil mit *Potamogeton* bewachsen und enthält eine arme *Limnaea*-Fauna. Übrigens wachsen hier sowohl rote *Lotus*-Blumen zu Tausenden als auch *Trapa* (Sörlin 1927). Die Oberflächenschicht ist braun-grau und enthält Schneckenschalen; das konsolidierte Sediment ist hellbraun-grau und enthält nur wenige Schalenreste. Die Grenze zwischen den erwähnten Schichten wird durch eine dünne graue Schicht markiert, es war jedoch nicht möglich, sie von den umgebenden zu separieren. Nur die Oberflächenschicht ist untersucht worden. Die Probe ist in trockenem Zustand dunkelgrau. Die HCl-Probe gab keine Reaktion (0).

Strukturanalyse. Grobdetritus 54%, Feindetritus 33%, Mineralkörner 2%, Chitinreste 10%, Kalkschlamm < 1% und Diatoméen und Pyritkugeln < 1%. Der Grobdetritus stammt event. aus *Potamogeton* her. Der Feindetritus ist hyalingelblich und relativ grob; mit Immersion sieht man rundliche Körner und vereinzelte bazillenähnliche Körper $1 \times 4\,\mu$. Die Tuschprobe zeigt < 10% Algenschleim. Die Mineralkörner sind abgerundet und etwa $25\,\mu$ oder $5\text{-}10\,\mu$. Die Chitinreste bestehen im allgemeinen aus *Bosmina*. Das Sediment ist eine chitinreiche Grobdetritusgyttja.

Mikrofossilienanalyse. Die Diatoméen sind die wichtigsten der Mikrofossilien. Unter ihnen dominiert *Gomphonema intricatum*, 31% oder beinahe 50 St. pro mm.^{3} Danach folgen *Cymbella parva* 15% und *Epithemia zebra* var. *porcellus* 14%, d. i. mehr als 20 St. pro mm.^{3} Unter den übrigen Mikrofossilien bemerkt man besonders Spongien-nadeln, 22 St. pro mm.^{3} Es kommen auch *Pediastrum duplex* (*4 St.*), *Euastrum* sp., *Cosmarium* sp., *Gloiotrichia* u. a. vor. Die Chitinreste sind zum grossen Teil *Bosmina*-Schilde. Unter den Pollen gibt es "*Pinus*," "*Picea*" und "*Quercus*," von dem ersten 3 St., von den übrigen 2 St. pro mm.^{3} Ein Rückblick zeigt eine ausserordentlich reiche Mikrobiologie. Von den Diatoméen gibt es 28 Formen; 77% dieser Flora gehören zu den Süsswasserarten und 23% sind fakultativ Süss- und Brackwasserformen. Die meisten, 90%, sind Aufwuchsformen. Typische Planktonformen kommen nicht vor.

Zusammenfassung. Lokut Dal Lake ist ein seichter, sehr vegetationsreicher See mit süssem Wasser und ohne besonderen Charakter; das Sediment ist eine chitinreiche Grobdetritusgyttja mit zahlreichen Diatoméen, besonders Süsswasser-Aufwuchsformen.

3. *Bod Dal Lake*

(1582 m. ü. M.)

Dainelli (1922) auf der Karte: Dal.

Das Wassergebiet umfasst ein grösseres, gegen NO 3-4000 m. hoch gelegenes Bergland und den darunter liegenden Talboden. Der Berggrund im Hochgebirgsgebiet besteht aus andesitischem Trapp (Lydekker 1883). Die Bodenarten sind nach de Terra Sand und Ton aus der Karewa-Serie; zum grossen Teil sind sie versumpft. Die höhere Vegetation der Umgebungen besteht aus *Salix* und *Populus* und auf den Höhen im O aus Nadelwäldern. Grosse Areale rings um den See sind bebaut. Das Zufliessen von dem Gebirge im O dürfte beträchtlich sein; das Abfliessen ist auch recht effektiv.

Der See hat wenigstens im W. eine Tiefe von etwa 4 m. Die Farbe des Sees ist Forel-Ule XV und die des Wassers 10 mg. Pt/l. Die Sichttiefe ist 1.2 m. und der pH-Wert 8.5. Der ökologische Standard ist süss; chemisch dürfte derselbe mit demjenigen von Lokut Dal Lake übereinstimmen.

Der Boden ist mit einem dunkelgrauen, in trockenem Zustand grauen Schlamm bedeckt. Eine Probe davon (von etwa 4 m.) ist untersucht worden. Das Material, mit dem Ekman-Birge-Bodengreifer heraufgeholt, ist jedoch sehr heterogen. So kommen in einer Probe wenige Diatoméen, in einer anderen zahlreiche vor. Die Produktionsziffern, die hier unten angeführt werden, haben darum nur einen ziemlich relativen Wert. Die HCl-Probe gab keine Reaktion (0).

Strukturanalyse: Feindetritus 68%, Mineralkörner 29% und Diatoméen 3%. Der Feindetritus ist hyalin-gelblich und recht grobkörnig; die Bestandteile sind abgerundet oder bilden zahlreiche bazillenähnliche Körper, $1 \times 3\,\mu$. Die Tuschprobe zeigt nur sehr wenig Algenschleim. Die Mineralkörner sind gewöhnlich $< 10\,\mu$; es gibt aber auch solche bis $25\,\mu$; sämtliche sind abgerundet. Das Sediment ist eine diatoméenreiche Schluffgyttja.

Mikrofossilienanalyse. Dominierend sind die Diatoméen, obleich, wie schon oben erwähnt wurde, die Mengen verschiedener Präparate ziemlich variieren. Am zahlreichsten Scheint *Melosira granulata* mit var. *angustissima*, zusammen 9% oder beinahe 500 St. pro mm.³ vorkommen. Dann folgen *Cymbella parva* 12%, *C. ventricosa* 11% und *Navicula rhynchocephala* var. *rostellata* 12%. Im übrigen wird auf die Tabelle 3 hingewiesen. Nur ein "*Picea*"-Pollen pro mm.³ ist festgestellt worden.

Eine Zusammenfassung der Mikrofossilien zeigt 64 Diatoméenformen, die höchste Anzahl in den untersuchten Seen. Die meisten sind Süsswasserformen, daneben eine Brackwasserform, *Navicula pygmaea*, und eine Art, die hauptsächlich in Salzwasser lebt, *Navicula salinarum*, sind auch angetroffen worden. Prozentuell sind die beiden letzteren untergeordnet, die typischen Süsswasserformen sind aber nur 62%. Unter den Milieutypen dominieren Aufwuchsformen mit 85%; daneben kommen auch u. a. 3% (+16%) Planktonformen vor.

Zusammenfassung: Bod Dal Lake ist ein seichter, vegetationsreicher See mit süssem Wasser; das Sediment ist eine diatoméenreiche Schluffgyttja mit zahlreichen Süsswasser-Aufwuchsdiatoméen und auch ein paar Brackwassertypen.

4. *Sundar Khun*

(1582 m. ü. M.)

Das Wassergebiet ist dasselbe wie das für Bod Dal Lake beschriebene, da der See in unmittelbarer Nähe davon liegt. Die Sand- und Tonflachländer sind mit Gebüschen von *Salix* und von *Populus* und *Platanus* bewachsen. Der Zufluss dürfte zum grössten Teil durch den Abfluss aus Bod Dal Lake gebildet werden.

Der See ist etwa 5 m. tief und der Boden ist mit einem für den Bodengreifer undurchlässigen *Chara*-Teppich bewachsen. Die Farbe des Sees ist Forel-Ule XII-XIII. Die Secchi-Scheibe ist unter Bodenvegetation auf 3 m. sichtbar; der pH-Wert ist 8.5. Der ökologische Standard ist süss; in chemischer Beziehung dürfte das Wasser dem von Bod Dal Lake ziemlich ähnlich sein.

Der Boden besteht aus einem bräunlich-grauen, in trockenem Zustand grauen Sediment von sehr heterogener Beschaffenheit. Die HCl-Probe gab keine Reaktion (0).

Strukturanalyse: Grobdetritus 23%, Feindetritus 56%, Mineralkörner 10%, Pyrit 2%, Chitinreste 4% und Diatoméen 5%. Der Grobdetritus ist aus *Chara* und aus Phanerogamen (*Ceratophyllum ?*) gebildet. Der Feindetritus ist hyalingelblich, feinkörnig-flockig und enthält nur vereinzelte bazillenförmige Körper, $1 \times 2\,\mu$. Die Tuschprobe zeigt etwa 10-20% Algenschleim. Die Mineralkörner sind 2-10 μ und abgerundet. Die Chitinreste sind zum grössten Teil *Bosmina*-Schalen. Das Sediment ist eine diatoméenreiche Grobdetritusgyttja.

Mikrofossilienanalyse. Die Diatoméen dominieren, aber auch die Desmidiéen, und Spongiennadeln kommen relativ zahlreich vor. Unter den ersteren bemerkt man *Cymbella*-Arten, zum grossen Teil *C. parva* 9%, *Gomphonema intricatum* 18%, *Nitzschia amphibia* 12% und *Fragilaria construens* 20%. *Epithemia* wird von *E. sorex* 5%, *E. turgida* 7% und *E. zebra* var. *porcellus* 4% repräsentiert. In einigen Präparaten sind diese Arten so zahlreich, dass es z. B. von *E. zebra* > 60 und von *E. sorex* 20 St. pro $mm.^3$ konstatiert wurden. Das Sediment ist aber, wie schon hervorgehoben wurde, sehr heterogen, was selbstverständlich auch in den Zahlen ausgedrückt werden kann. Von den Spongien-nadeln kann man 15 St. und von den Kopfschilden von *Bosmina* 4-5 St. pro $mm.^3$ finden. Pollen von "*Salix*," "*Picea*," "*Pinus*" und "*Quercus*" kommen mit 1-2 St. pro $mm.^3$ vor.

Eine Zusammenfassung der Diatoméen gibt 44 Arten usw., wovon die meisten Süsswasserformen sind. 12 St. leben auch im Brackwasser. Von der ganzen Diatoméen-Flora machen die typischen Süsswasserformen 71% aus. 88% sind Aufwuchsformen und 3% Planktonformen.

Zusammenfassung. Sundar Khun ist ein kleiner, seichter, vegetationsreicher See mit süssem Wasser; das Sediment ist eine diatoméenreiche Grobdetritusgyttja mit Süsswasser-Aufwuchsdiatoméen.

5. *Manasbal Lake*

(1584 m. ü. M.)

Das Zuflussgebiet ist recht schwer zu bestimmen, da der See auf dem Flachlande am Fuss der Hochgebirge liegt. Das Flachland ist aus Sand und Ton der Karewa-Serie aufgebaut; im Hochgebirge im Norden steht andesitischer Trapp an (Lydekker 1883). Die höhere Vegetation der Umgebung des Sees besteht aus *Salix* und *Populus*, wo der Boden nicht bebaut ist; an den Abhängen im Norden wachsen Nadelwälder. Das Zufliessen scheint nach der Karte von Dainelli (Taf. CL XII) unterirdisch zu gehen; der Abfluss geht in den Jhelum und dann in den Wular Lake.

Der See ist etwa 15 m. tief (Lydekker 1883).[1] Die Farbe desselben ist Forel-Ule X und diejenige des Wassers 10 mg. Pt/l. Die Sichttiefe ist 4 m. und der pH-Wert 8.5. Der ökologische Standard ist süss. Die Cl-Menge ist 1.8 mg/l und die Summe der Alkalisalze 23 mg/l. Der Karbonatgehalt ist 113 mg/l.

Der Boden ist von einem beinahe schwarzen, in trockenem Zustand grauen Sediment mit hellbraunem Oberflächenlager bedeckt, das nach den Angaben reich an grobem Pflanzendetritus ist. In der sehr heterogenen Probe von 12 m. Tiefe, die ich untersucht habe, ist jedoch dieser Grobdetritus sehr untergeordnet. Die HCl-Probe gab keine Reaktion (0). Übrigens konnten 13 Tubificiden pro $m.^2$ festgestellt werden.

Die Strukturanalyse eines dunklen und festen Gyttjaklumps gab; Grobdetritus < 1%,

[1] Eighty-eight soundings in all parts of the lake failed to disclose any depth greater than 12.8 m.—G. E. H.

Feindetritus 75%, Mineralkorner 18% und Diatoméen 7%. Der Feindetritus ist hyalingelblich, flockig, nur ein wenig körnig und enthält nur vereinzelte bazillenförmige Körper, $1 \times 3\,\mu$. Die Tuschprobe zeigt etwa 10% Algenschleim. Die Mineralkörner sind splitterig oder etwas abgerundet, gewöhnlich $< 10\,\mu$, aber auch einzelne bis $50\,\mu$ sind wahrgenommen worden. Das Sediment ist eine diatoméenreich Feindetritusgyttja.

Mikrofossilienanalyse. Die Diatoméen dominieren und unter ihnen besonders *Cyclotella comta* 14%, *Cocconeis placentula* mit var. *lineata* 15% und *Cymbella parva* 13%. Am zahlreichsten kommt jedoch *Synedra acus* v. *angustissima*, 300% (ausserhalb der Summe berechnet) vor. Dieser Wert entspricht 1140 St. pro mm.^{3} Die *Epithemia*-Arten machen zusammen 10% oder beinahe 40 St. pro mm.^{3} aus. Ausser Diatoméen gibt es kleine Desmidiéen der Gattungen *Cosmarium, Spondylosium* und *Staurastrum.* Zwei Pollen von "*Picea*" und "*Quercus*" pro mm.^{3} sind auch konstatiert worden.

Die Diatoméen bestehen aus 46 Formen, von denen 26 typische Süsswasser- und 3 Brackwasserformen sind. 80% sind Aufwuchsformen und 14% Planktonformen, dazu kommen aber 300% *Synedra acus* v. *angustissima*, die hier in der Summe nicht mitgerechnet sind, um die anderen Formen nicht ganz zu überglänzen.

Zusammenfassung. Manasbal Lake ist ein mitteltiefer Süsswassersee; das Sediment ist eine diatoméenreiche Feindetritusgyttja mit Süsswasser-diatoméen von Aufwuchs-und Planktontypus; auch einige Brackwasserformen kommen vor.

6. *Wular Lake*

(1573 m. ü. M.)

Das Wassereinzugsgebiet besteht aus dem grössten Teil des Kashmirbeckens und ist also ausserordentlich gross. Im S und O von dem See ist das Land sehr niedrig und eben, im N und W aber reichen die hohen Gebirge (> 3000 m. ü. M.) beinahe an den See. Der Berggrund besteht hauptsächlich aus Sedimenten des Panjal-Systems (Sandsteinen, Konglomeraten und Quarziten). In der Nähe des Flachlands steht andersitischer Trapp an. Die Quellen der nordöstlichen Zuflüsse finden sich in Formationen alt- und jung-paläozoischen Alters bei denen Schiefer und Kalke vorwiegen. Das Flachland rings um den See besteht aus einem sandigen Karewa-Ton. In der unmittelbaren Nähe des Sees gibt es Torfablagerungen (Lydekker 1883 S. 332). Die Umgebungen sind mit *Salix* und *Populus* bewachsen oder bebaut. An den Abhängen im N und O wachsen Nadelwälder. Das Zufliessen muss ganz bedeutend sein, da der See ein Sammelbecken für einen grossen Teil des Kashmirtals ist. Bemerkenswert ist, dass viele der fliessenden Gewässer nicht bis im den See reichen, sondern in den umgebenden Torfböden enden.[2] Dies deutet darauf hin, dass sie nur während der Hochwasserzeit des Jahres wasserführend sind (vgl. die Karte, Taf. CL XII von Dainelli 1922). Der Abfluss geht gegen SW durch den Jhelum.

Die Tiefe des Sees beträgt wenigstens 5 m. Die Farbe des Sees ist Forel-Ule XVI und die des Wassers 30 mg. Pt/l. Die Sichttiefe ist 1.5 m. und pH-Wert 9.0. Der ökologische Standard ist süss. Die Cl-Menge ist 1.7 mg/l, der Überschuss an $Mg\ Cl_2$ 2.3 mg/l. Die Summe der Alkalisalze beträgt 18 mg/l. In chemischer Beziehung schliesst sich dieses

[2] Two well-defined and probably numerous smaller channels now conduct the Jhelum water into the lake. G. E. H.

Wasser sehr gut den anderen, im Wassergebiet von Jhelam weiter aufwärts liegenden Seen an.

Der Boden ist mit *Lotus* und *Trapa* bewachsen (Sörlin, briefliche Mitteilung), und im Schlamm ist *Tubifex* allgemein. Das Sediment ist oberflächlich locker, braun-grau und von einer dunkelgrauen, festen Gyttja unterlagert. Die Proben, von 4 und 5 m. sind mit dem Rohrlot von Naumann aufgenommen. Die untersuchten Proben von 5 m. sind aus der Schlammwurst von 0-1 cm. und 6-12 cm. herausgenommen. Beide sind in trockenem Zustand grau und die HCl-Proben derselben geben keine Reaktion (0).

Strukturanalysen zeigen, dass die Zusammensetzungen der beiden Proben mit einander annähernd übereinstimmen; unter folgenden Ziffern beziehen sich die ersten auf die Oberflächenprobe: Feindetritus 70-69%, Mineralkörner 28-29% und Diatoméen 2-2%. Der Feindetritus ist hyalin, ganz grob und enthält abgerundete Körner, 2-5 μ in Diam., und bazillenähnliche Körper, $1 \times 2\,\mu$. Die Tuschprobe zeigt sehr wenig Algenschleim. Die Mineralkörner sind kleine Splitter und grössere, ganz abgerundete Körner; gewöhnlich sind sie $< 10\,\mu$. Das Sediment ist eine diatoméenreiche Schluffgyttja.

Mikrofossilienanalysen haben eine sehr grosse Verschiedenheit der beiden Proben gezeigt, besonders hinsichtlich der absoluten Mengen der *Melosira*-Zellen. In der oberen Probe gibt es annähernd 500 St., in der unteren dagegen etwa 1150 St. pro mm.^{3} Die entsprechenden Prozentwerte sind 105 und 126% (ausser der Summe). Sie gehören *Melosira distans* v. *alpigena*, *M. granulata* mit v. *angustissima*. Übrigens gibt es in der oberen Probe 16% *Gomphonema intricatum* v. *dichotoma*, was in der unteren Probe fehlt. Dagegen sind die Epithemien der unteren Probe zahlreich. Die Prozentsumme ist hier 20%, in der oberen Probe 4%. Ausser Diatoméen gibt es Pollen von "*Picea*," "*Pinus*" und "*Salix*," von jedem ein oder zwei pro mm.^{3}

Die mikrobiologische Veränderung, die die beiden Proben angeben, enthält einen Widerspruch. In der unteren Probe sind die Süsswasserformen 48% (+129%), in der oberen 73% (+107%). Die fakultativen Süss- und Brackwassertypen sind resp. 43% und 20% (+6%) und die reinen Brackwasser oder Salzwasserformen 2% und 4%. Trotz des fraglichen Verhältnisses zeigen die Proben aufwärts meiner Meinung nach ein Abnehmen des Salzgehalts. Die Aufwuchsformen sind zu einer Zunahme aufwärts—von 75% bis 82%—geneigt. Dieses kann auf eine Vermehrung der Vegetation des Sees hindeuten, kann aber auch nur blosser Zufall sein.

Zusammenfassung. Wular Lake ist ein relative grosser, aber seichter, vegetationsreicher Süsswassersee. Das Sediment ist eine diatoméenreiche Schluffgyttja mit Süsswasserdiatoméen, besonders von Aufwuchstypus; auch Brackwasserformen kommen vor.

Ladak

(Plate XI, Figure 4)

Ladak ist ein sehr stark zerschnittenes Hochgebirgsbebiet in der Fortsetzung des Transhimalaya und Himalaya und wird von dem oberen Indus durchflossen. Das südliche Ladak setzt sich geologische aus zwei Haupt-Granitmassiven zusämen, die von metamorphen paläozoischen Komplexen umraümt sind. In der umgegend des Panggong-Sees stehen vergneisste Schiefer, Grünsteine, marmorisierte Kalke und Granite an. Die Seeufer sind ortlich von quartären Moränen und interglazialen Seetonen eingeraümt. Am Südabhang der Ladak-

Kette, in der Umgebung der Seen Yaye- und Mitpal-Tso erscheinen eozäne bis oberkretazische Sandsteine und ältere Quarzite (de Terra, brieflich). Die Vegetationsverhältnisse des Gebiets sind sehr arm selig: im allgemeinen gibt es nur Tamarisken und Xerophyten oder nicht einmal die geringste Vegetation. Das Klima ist ein Tundren-Klima (Köppen auf der Karte in Supan—Obst 1927) mit < 250 mm. Niederschlag per Jahr (Nordisk Världsatlas 1926).[3] Die Stürme sind zeitweise unerhört heftig und reissen grosse Mengen des Bodenmaterials mit sich in die Luft. Die Temperatur ist sehr niedrig, und die Seen sind darum nur in einem kurzen Teil des Jahres eisfrei. Über Ororotse Tso z. B. schreibt Hutchinson (1933): "When visited on July 11, 1932, Ororotse Tso was still covered with ice save at the extreme edge, and it seems doubtful if it ever becomes entirely clear." Nach diesen kurzen Angaben über die Seen könnte man vermuten, dass sie vollständig wüstenähnlich wären, eine Annahme, die im folgenden jedoch widerlegt wird.

7. *Tso Moriri*

(4528 m. ü. M.)

Hedin (1909): Tschamomeril Lake.

Das Zuflussgebiet ist relativ gross unregelmässig zerschnitten und umfasst auch Gebirge von > 6300 m. Meereshöhe. Der Berggrund besteht aus Graniten und Kalkschiefern; die Bodenarten sind pleistozener Ton, Sand und Schotter. Die Umgebung des Sees ist beinahe steril, nur mit einigen Gräsern und Xerophyten bewachsen. Unter anderm konstatiert man hier *Caragana versicolor* (Schlagintweit 1874, S. 126). Ein Dörfchen mit kleinen, bebauten Feldern liegt am westlichen Ufer. Die Zuflüsse sind wasserreich; der grösste Zufluss ist der Yan, der—wie mehrere andere—von Schneefeldern und kleinen Gletschern im Hochgebirge im Westen kommt. Auf der Karte Taf. CXXV von Dainelli (1922) weist der See auch einen grossen Zufluss von dem grossen Haupttal im Süden auf. Abfluss fehlt.

Der See ist im allgemeinen 30-60 m. tief; die grösste bekannte Tiefe ist 74.7 m. in der Nähe des Ufers, in einer Bucht im SO. Die Farbe des Sees ist Forel-Ule V und die des Wassers < 5 mg. Pt/l. Die Sichttiefe ist 9 m. und der pH-Wert 9.0. Der ökologische Standard ist brackig. Die Cl-Menge ist 22 mg/l und ein Uberschuss an $MgCl_2$ von 30 mg/l kommt vor. Die SO_4-Menge ist für die Brackwasserseen von Ladak relativ gering: 517 mg/l; Mg SO_4 ist 199 mg/l (Überschuss). Auch die Summe der Alkalisalze ist niedrig: 788 mg/l.

Der Boden. Zwei Proben, beide von derselben Stelle, 48 m. u. Wfl., sind untersucht worden. Das Sediment ist hell graugrün, in getrocknetem Zustand hellgrau. Die HCl-Probe hat eine sehr starke Reaktion (4) gezeigt.

Die Strukturanalyse der Proben gab: Feindetritus (hyalin-graulich) 43% und mineralkörner 57%. Mikrofossilien u. s. w. also $< 1\%$. Der Feindetritus scheint unter Immersion flockig, allgemein hyalin, in dickeren Klumpen aber gelblich; darin finden sich einzelne bazillenähnliche Körper, $\frac{1}{2} \times 2\,\mu$, die sicher keine Mineralkörner sind. Die Mineralkörner sind allgemein 10-40 μ, am häufigsten sehr scharfkantig und splitterig. 10-15% der Körner—ein ungewöhnlich grosser Teil—bestehen aus dunklen Mineralien. Das Sediment ist ein gyttjiger Feinsand.

[3] At Leh, the nearest station to the lakes, the mean annual precipitation is 81 mm. (Smithsonian Misc. Coll. 79, p. 271).—G. E. H.

Mikrofossilienanalyse. Die Mikrofossilien bestehen nur aus Diatoméen, von denen 89% *Cyclotella antiqua* (178 St. pro mm.^{3}) sind. Es folgt *Diploneis elliptica* mit 6% (12 St. pro mm.^{3})

An Diatoméenformen unterscheidet man 10 St., von denen 6 St. fakultativ in süssem und brackigem Wasser leben. Von der ganzen Flora sind jedoch 89% typische Süsswasserformen, die zu den Plankton-oder Bodentypen gehören.

Zusammenfassung. Tso Moriri ist ein grosser, vegetationsarmer Brackwassersee; die Cl- und SO_4-Mengen sind relativ klein; das Sediment ist ein kalkreicher, gyttjiger Feinsand mit besonders planktischen Süsswasserdiatoméen; Brackwassertypen wurden nicht angetroffen.

8. *Khyagar Tso*

(4672 m. ü. M.)

Dainelli (1922): Tso Tasancurù.

Das Zuflussgebiet ist klein, da der See in einer Berggrube liegt, die im Süden an Tso Moriri grenzt. Das Gebiet aus Graniten und Schiefern besteht, die mit pleistozänem Ton und Sand bedeckt sind. Die Topographie ist stark zerschnitten, da der Höhenunterschied des kleinen Gebiets etwa 1350 m. beträgt. Der Boden ist fast steril, nur einige Xerophyten kommen vor. Die Zuflusse sind kurz und steil; der grösste kommt von den Schneefeldern im westlichen Teil des Gebietes. Abfluss fehlt.

Die grösste bekannte Tiefe des Sees ist 20.2 m.; höhere Vegetation kommt nicht vor. Die Farbe des Sees ist Forel-Ule VIII und die des Wassers 5 mg. Pt/l. Die Sichttiefe ist 3 m. und der pH-Wert 9.5. Der ökologische Standard ist brackig. Die Cl-Menge ist 257 und die SO_4-Menge 2069 mg/l. Der Karbonatgehalt ist relativ hoch; 525 mg/l. Der Überschuss an Na_2 CO_3 beträgt 824 mg/l. Der Berggrund des Wassersystems scheint aber kalkfrei zu sein. Die Summe der Alkalisalze ist 3784 mg/l. Dieser Wert trägt ebenfalls dazu bei, die Ahnlichkeit dieses Wassers mit dem von Pangur Tso zu erhöhen.

Der Boden. Das Sediment ist auf 21 m. grauschwarz; nach Heraufholen wird es ein wenig rötlich, in getrocknetem Zustand gräulich-hellrot. Die HCl-Probe hat keine Reaktion gezeigt (0). Der Siebrest ist beinahe nur *Gammarus*-Chitin. Das Tiefwasser ist reich an freiem H_2S.

Strukturanalyse: Feindetritus (gräulich-hyalin) 93%, Mineralkörner 6%, Chitinenreste 1%. Der Feindetritus scheint unter Immersion körnig-flockig, gelblich-hyalin und enthält vereinzelte, $\frac{1}{2} \times 1$-$2\,\mu$ grosse Partien. Die Mineralkörner sind gewöhnlich etwa $20\,\mu$; man findet aber auch einzelne Körner bis $100\,\mu$ gross. Sie sind abgerundet, zuweilen aber scharfkantig. Die Chitinreste sind graubraun, quadratförmig liniiert, beinahe sicher aus *Gammarus.* Andere limnische Mikrofossilien, auch Diatoméen, sind nicht angetroffen worden. Dagegen sind "*Picea*"-Pollen 1 St. und "*Salix*"-Pollen 2 St. pro mm.^{3} beobachtet worden. Diese Pollenkörner sind genau von demselben Typus wie die in den Kashmir-Proben gefundenen. Das Sediment ist eine Feindetritusgyttja oder—besser gesagt—Algengyttja, trotz der Abwesenheit deutlicher Algenstruktur passt dieser Name besser.

Die Mikrofossilienanalysen deuten darauf hin, dass der See völlig steril ist. Die Gyttja stammt aber, wie gesagt, zum grossen Teil aus Algenschleim, weshalb es recht wahrscheinlich ist, dass der See reich an Myxophycéen ist oder—richtiger—gewesen ist.[4] Die Sedimentprobe ist ganz sicher nicht rezent.

Zusammenfassung. Khyagar Tso ist ein kleiner Brackwassersee mit relativ hohen Cl- und SO_4-Mengen und auch relativ hohen Karbonatgehalt; das Sediment ist eine Feindetritusgyttja mit reichlich Algenschleim; Mikrofossilien sind nicht angetroffen worden.

9. *Sta-rtsak-puk Tso*

(4536 m. ü. M.)

Dainelli (1922): Tso-Ciùm.

Das Zuflussgebiet ist im Verhältnis zum Areal des Sees relativ gross. Es weist grosse Höhenunterschiede auf und zwar besonders im NO (etwa 1460 m.); der grösste Teil aber ist aussergewöhnlich flach. Die Bergarten sind schieferige Granite und die Bodenarten Schotter und Ton. Das Zufliessen ist relativ reichlich, der Abfluss im N geht in den Tso Kar. Die grösste Tiefe ist etwa 1½ m. Der Boden ist mit einem dichten Teppich von Blütenpflanzen bewachsen. Die Sichttiefe ist 1.5 m. und der pH-Wert 9.6. Der ökologische Standard des Wassers ist süss. Chemische Analysen fehlen.

Der Boden. Eine Probe von 1.5 m. ist untersucht worden. In getrocknetem Zustand ist das Sediment grau. Die HCl-Probe zeigte keine Reaktion (0).

Strukturanalyse: Grobdetritus 7%, Feindetritus 36%, Mineralkörner 55%, Diatoméen 1%, *Merismopedia* etwa 1%. Der Grobdetritus ist unbestimmbar, dürfte aber aus den Blütenpflanzen des Sees stammen. Der Feindetritus scheint unter Immersion grobflockig, gelblich und enthält vereinzelte kleine, bazillenförmige Körper, $\frac{1}{4} \times 1\,\mu$. Die Tuschprobe zeigte keinen Algenschleim. Die Mineralkörner sind 5-20 μ, aber auch Körner 50-60 μ gross erscheinen; sie sind immer sehr splitterig und scharfkantig. Das Sediment ist ein gyttjiger Schluff.

Die *Mikrofossilien.* Quantitativ und qualitativ dominieren die Diatoméen in den Mikrofossilien. Am zahlreichsten sind *Epithemia zebra* (34%) und *Navicula rhynchocephala* var. *rostellata* (14%). Daneben kommen *Fragilaria brevistriata* (9%) und *F. pinnata* (6%) vor, beide nicht in der Summe mitgerechnet. Überhaupt dominieren die Aufwuchsformen. Übrigens sei bemerkt, dass *Rhoicosphenia* in < 1% vorkommt.

Die Anzahl pro mm.[3] ist z. B. für: *Epithemia zebra* 75 St., *Caloneis silicula* 20 St., *Cymatopleura solea* 4 St., und *Merismopedia*-Kolonien sind etwa 20 pro mm.[3] Ausserdem bemerkt man vereinzelte "*Picea*"-Pollen.

Die Diatoméenformen umfassen hier 21 St. Unter diesen leben 12 St. in sowohl süssem als auch brackigem Wasser. Sie machen 71% (+15%) der ganzen Flora aus. 79% sind Aufwuchsformen und 11% (+9%) Bodenformen.

Zusammenfassung. Sta-rtsak-puk Tso ist ein kleiner, relativ vegetationsreicher Süsswassersee; das Sediment ist ein gyttjiger Schluff mit recht zahlreichen Aufwuchsdiatoméen, von denen die meisten fakultative Süss- und Brackwasserformen sind; typische Brackwasserformen wurden nicht angetroffen.

[4] Myxophyceae and Chlorophyceae are very abundant in the plankton. At 12 m. the water contained 5000 cells and colonies per cc., the highest number encountered in Indian Tibet.

10. *Tso Kar*

(4527 m. ü. M.)

Hedin (1909): Tsokr Tschumo Lake; Dainelli (1922): Tso Cemmo.

Das Zuflussgebiet ist gross und umfasst auch dasjenige von Sta-rtsak-puk Tso. Die beiden Seen liegen in einem ausgedehnten und flachen Gebiet, von hohen und steilen Bergen umrandet. Nur wenige Schneefelder, z. B. die auf Rukchen im W und W von Shing-buk La im NW, sind beständig. Die Bergarten sind schieferige Granite und die Bodenarten Ton und Schotter, die letzterer in Terrassen. Der See ist von salzigem Flachland umgeben, das im S grasbewachsen ist, sonst aber nur Xerophytenvegetation aufweist. Der Zufluss scheint ganz unbeträchtlich zu sein. Am wichtigsten ist das Wasser aus dem Sta-rtsak-puk Tso und aus einem Bach aus Shing-buk La. Die meisten fliessenden Gewässer trocknen schon aus, wenn sie in das Flachland erreichen.

Die Tiefe des Sees ist etwa 2 m. und die Farbe Forel-Ule VIII. Die Sichttiefe ist mehr als 2 m. und der pH-Wert 8.9. Der ökologische Standard ist sehr salzig. Die Cl-Menge ist 11662 mg/l und ein Überschuss an $Mg\ Cl_2$ von 9960 mg/l kommt vor. Daneben bemerkt man einen extremen Gehalt an SO_4: 35075 mg/l, es ist dies der höchste Wert in diesen Seen. Der Karbonatgehalt ist 1633 mg/l und die Summe von Alkalisalzen 61140 mg/l. Hinsichtlich des Wassertypus steht also dieser See Son Sakesar Kahar am nächsten.

Der Boden. Eine Probe von 2 m. ist untersucht worden. In getrocknetem Zustand ist sie grauweiss. Die HCl-Probe gab eine starke Reaktion (3).

Strukturanalyse: Grobdetritus 1%, Feindetritus 70%, Mineralkörner 19%, Chitin 10%. Der Feindetritus ist hyalin, körnig-flockig, aber reich an kleinen bazillenförmigen Körpern, $\frac{1}{4}$-1 $\mu \times$ 1-4 μ gross. Die Tusch probe zeigte nur wenig Algenschleim. Im Präparat scheint aber mehr enthalten zu sein, da die Kalklümpchen beinahe denselben farblosen Eindruck geben. Die Mineralkörner sind 10-60 μ, gerundet und nur selten etwas scharfkantig. Die Chitinreste bestehen aus hyalinen Stückchen, möglicherweise von Raupenhaut und Cladocerenextremitäten herstammend. Wahrscheinlich stammen sie von *Artemia* her, der wichtigsten Komponente der Fauna. Andere Mikrofossilien, auch Diatoméen, sind nicht angetroffen worden. Das Sediment ist eine chitinreiche Feindetritusgyttja. Mikrobiologisch ist der See eine Wüste.

Zusammenfassung. Tso Kar ist ein steriler, relativ grosser See mit einem extremen Gehalt an Cl und SO_4; auch der Karbonatgehalt ist hoch; das Sediment ist eine chitinreiche Feindetritusgyttja, die im übrigen steril und kalkreich ist.

11. *Yaye Tso*

(4686 m. ü. M.)

Dainelli (1922): Ichi Tso.

Das Zuflussgebiet ist im Verhältnis zum Areal des Sees ziemlich gross. Im N grenzt es an das des Mitpal Tso. Es ist sehr stark zerschnitten, und die hohen Gebirgsabhänge fallen beinahe an das Seeufer. Die Bergarten sind Sandstein, Mergel, Konglomerate und Granite. Die Gegend ist ausserordentlich steril; im Norden findet sich eine sparsame Vegetation von Gräsern und Xerophyten. Im Talstrich, etwa 10 km. NNO von dem See, liegt das Dorf Pialung. Das Zufliessen ist im Verhältnis zum Areal des Sees sehr reichlich, weshalb der Wasseraustausch sehr schnell von statten gehen muss. Der See fliesst in den nahgelegenen Indus ab.

Die grösste Tiefe des Sees ist 18 m. und die Farbe Forel-Ule X. Die Farbe des Wassers ist < 5 mg. Pt/l. Die Sichttiefe ist 4 m. und der pH-Wert 8.2. Der ökologische Standard ist süss. Die Cl-Menge ist nur 1 mg/l, es ist dies der niedrigste Wert in den vorliegenden Seen. Die Summe der Alkalisalze ist nur 15 mg/l. Der Karbonatgehalt ist 63 mg/l, wobei noch ein Überschuss an Na_2 CO_3 von 25 mg/l vorkommt. Der allgemeine Typus dieses Wassers ist dem der Srinagar-Seen am ähnlichsten.

Der Boden. Eine Sedimentprobe von 18 m. ist untersucht worden. In getrocknetem Zustand ist dieselbe grau. Die HCl-Probe gab kein Reaktion (0).

Strukturanalyse: Grobdetritus 1%, Feindetritus (graugrün) 88%, Mineralkörner 5%, Diatoméen 6%, Pyrit und Chitin < 1%. Der Feindetritus scheint unter Immersion gelblich, grobkörnig und sehr reich and bazillenähnlichen, ½-1 μ ×2-4 μ grossen Körpern. Die Tuschprobe zeigt keinen Algenschleim. Die Mineralkörner sind 10-20 μ, gerundet oder ebenso häufig splitterig. Das Sediment ist eine diatoméenreiche Feindetritusgyttja.

Bei den *Mikrofossilien* dominieren die Diatoméen und unter diesen ihrerseits *Cyclotella comta*, 73%. Daneben finden sich *Campylodiscus noricus* 3%, *Gyrosigma attenuatum* und *G. kützingi, beide* 2%, zuletzt *Melosira arenaria* 1%. Von *Cyclotella comta* kommen etwa 1960 St. pro mm.^{3} vor; die Anzahl variiert jedoch etwas in der heterogenen Probe. Von den übrigen Mikrofossilien sind "*Picea*-" und "Chenopodiacé"-Pollen als etwa 2 St. pro mm.^{3} angezeichnet.

In mikrobiologischer Beziehung weist dieser See einen für die Ladak-Seen ausserordentlichen Reichtum auf. An Diatoméenformen wurden 34 St. gerechnet und unter diesen sind 12 St. fakultative Süss- und Brackwasserformen. Von der ganzen Flora machen diese Formen 9% aus. Die Aufwuchsformen sind 11(+1)% und die Bodenformen 13 (+3)% aus.

Zusammenfassung. Yaye Tso ist ein kleiner hochalpiner Süsswassersee mit etwas Karbonatgehalt; das Sediment ist eine diatoméenreiche Feindetritusgyttja mit Süsswasser-Planktondiatoméen. Brackwasserformen sind nicht angetroffen worden. Mikrobiologisch scheint der See sehr üppig zu sein.

12. *Mitpal Tso*

(4875 m. ü. M.)

Dainelli (1922): Mirpa Tso.

Das kleine Zuflussgebiet liegt zwischen dem des Yaye Tso und Panggong Tso. Es ist ein einheitliches Becken, von mehr als 6000 m. hohen Gipfeln umgeben. Die Gesteine sind Granite und kristalline Schiefer, die Bodenarten pleistozäner Sand und Schotter. Das Gebiet ist fast ganz steril; nur eine arme Xerophytenvegetation gedeiht. Die Zuflüsse sind kurze, reissende Bäche von den Höhen rings umher, zum Teil Abflüsse der Schneefelder im SO. Ein Abfluss des Sees fehlt.

Die grösste Tiefe ist 23 m. die Farbe des Sees Forel-Ule XI und die des Wassers < 5 mg. Pt/l. Die Sichttiefe ist 7 m. der pH-Wert ist 9.1. Der ökologische Standard ist brackig. Die Cl-Menge ist 82 mg/l und ein Überschuss an $Mg\ Cl_2$ von 110 mg/l kommt vor. Die SO_4-Menge beträgt 625 und die Summe der Alkalisalze 1011 mg/l, der Karbonatgehalt

364 mg/l. Trotz grosser Verschiedenheiten scheint dieses Wasser betr. des allgemeinen Typus dem von Tso Moriri am nächsten zu stehen.

Der Boden. Eine Probe aus der grössten Tiefe, 23 m. ist untersucht worden. In getrocknetem Zustand ist sie hellgrau. Die HCl-Probe gab eine schwache Reaktion (1).

Strukturanalyse: Grobdetritus 3%, Feindetritus (hyalinhellgrau) 90% und Mineralkörner 7%. Der Feindetritus scheint unter Immersion hyalin und grobkörnig. Er ist reich an hyalinen, unregelmässigen, abgerundeten, 4 μ grossen Körnern, und ein wenig stachelig. Unsicher ist jedoch, ob diese Körner organischen oder minerogenen Ursprungs sind. Bazillenähnliche Körper sind nicht beobachtet worden. Die Tuschprobe zeigt keinen Algenschleim. Die Mineralkörner sind etwas abgerundet und meistens 15 μ gross; vereinzelte grössere sind indessen konstatiert worden. Das Sediment ist eine Feindetritusgyttja.

Mikrofossilienanalyse: Die Mikrofossilien werden von *Cocconeis placentula* var. *lineata* 52%, *Diploneis elliptica* 22%, *Amphora ovalis* 11% und *Melosira arenaria* 10% dominiert. Die *Cocconeis*-Anzahl pro mm.^{3} beträgt etwa 50 St.; unter diesen sind aber mehrere so stark destruiert, dass nur die Randpartie zurückgeblieben ist und wie ein schwarzer Ring hervortritt. Dasselbe gilt übrigens auch für *Diploneis.* Von *Melosira arenaria* kommen 10 St. pro mm.^{3} vor.

Von übrigen Mikrofossilien kommen nur 2 Pollenarten: Chenopodiacé-Pollen und eine Art, die dem *Quercus* ähnlich ist, aber wahrscheinlich von einem *Populus* stammt, vo.

An Diatoméenformen kommen 8 St. vor, von denen 4 typische Süsswasserformen sind. 87% der Flora sind fakultative Süss- und Brackwassertypen; es ist dieser höchste Wert in den untersuchten Seen. Die Aufwuchsformen betragen 55% und die Bodenformen 33%. Ausserdem kommen hier 1% Planktonformen (*Cyclotella comta*) vor.

Zusammenfassung. Mitpal Tso ist ein kleiner Brackwassersee mit einer durchschnittlichen Menge von Cl, SO_4 und Karbonaten; das Sediment ist eine schwach kalkige Feindetritusgyttja mit sehr zahlreichen Diatoméen, von denen die meisten in Süss—resp. Brackwasser als Aufwuchs—oder Bodenformen leben; es wurden keine Brackwasserformen angetroffen.

13. *Pangur Tso*

(4329 m. ü. M.)

Es ist mir nicht möglich gewesen das Zuflussgebiet zu bestimmen: auf der Karte der Yale-Expedition ist das Gebiet im O nicht kartiert, auf den Karten von Hedin (1909) und Dainelli (1922) ist die Abgrenzung sehr unbestimmt. Das fragliche Gebiet scheint jedoch relativ gross und stark zerschnitten zu sein. Im Westen liegt ein Flachland gegen Tsakalungpa. Der Berggrund besteht in den bekannten Teilen aus kristallinen Schiefern und Kalksteinen; die Bodenarten sind pleistocäne, schneckenhaltige Tone. Die Vegetation besteht aus spärlichen Gräsern an den Ufern und einigen xerophytischen Kräutern. Die Zuflüsse kommen in den bekannten Teilen aus dem Hochgebirge im S. Die Bäche von den nördlichen Höhen erreichen den See nicht. Der Abfluss ist ganz unbeträchtlich.

Die grösste bekannte Tiefe ist im NW etwa 10 m. Über den ganzen untersuchten Boden verbreitet sich eine höhere Vegetation (*Potamogeton*). Die Farbe des Sees ist Forel-Ule VI und die des Wassers < 5 mg. Pt/l. Die Sichttiefe ist 8.5 m. und der pH-Wert 9.6. Der ökologische Standard ist brackig. Die Cl-Menge beträgt 629 und die von SO_4 1316 mg/l.

Der Karbonatgehalt ist 842 mg/l; $Na_2 CO_3$ zeigt einen Überschuss von 1936 mg/l. Die Summe der Alkalisalze beträgt 3180 mg/l. Der allgemeine Typus des Wassers ist dem von Khyagar Tso am ähnlichsten.

Der Boden. Es gibt nur zwei Proben dieses grossen Sees und beide stammen von derselben Stelle, 9.5 m. u. Wfl. Ob sie aus demselben Niveau in der Lagerfolge herrühren oder nicht, ist mir unbekannt. Es scheint mir aber sehr glaublich, dass die eine (Feld-Nr. 58) mehr oberflächlich ist, die andere dagegen unmittelbar unter der Sedimentfläche genommen wurde. Beide Proben sind nun von einer hellen rotgelben Farbe; es ist aber unmöglich, die natürliche Farbe zu bestimmen. In getrocknetem Zustand sind die Proben graulich rotweiss. Die HCl-Probe gab eine recht starke Reaktion (3). Die Feldnoten geben nur Siebreste von *Potamogeton* an. Die Konsistenz ist stark elastisch und makroskopisch scheint das Sediment eine Algengyttja zu sein.

Strukturanalyse der beiden Proben

	Obere Probe	Fertiges Sediment
Grobdetritus	< 1%	....
Feindetritus	95%	87%
Mineralkorner	2%	6%
Oscillatoria	2%	1%
Diatomeen	1%	1%
Ostrakodenschalen	....	5%
Chitinreste	< 1%	....

Charakteristisch ist also der Feindetritus. Er scheint ganz homogen zu sein. Die Tuschprobe aber zeigt, dass etwa 90% der Detritusmenge Algenschleim sind. Der Feindetritus erscheint unter Immersion vollkommen hyalin, sehr feinkörnig und besteht aus 1 μ grossen rundlichen und auch etwa 1×4 μ grossen bazillenähnlichen Körpern. Die Mineralkörner sind 1 μ oder etwa 15 μ; vereinzelte sind doch 100 μ. Daneben sieht man 2×4 μ grosse eirunde Körper. Mineralogisch besteht das Material aus Quarz. Die erwähnten kleinen Körner, die eine starke Lichtbrechung besitzen und durch Milchsäure leicht zu lösen sind, bestehen wahrscheinlich aus Kalziumkarbonat. Ihre Frequenz ist—auf Grund ihrer unbeträchtlichen Grösse und ihrer Ähnlichkeit mit körnigeren Partien von Feindetritus—schwierig festzustellen. *Oscillatoria* bilden allerdings nicht so grosse Volumenprozente, ihre Frequenz ist aber 200-250 St. pro $mm.^3$, was sehr bedeutend ist. Das Sediment ist eine typische Algengyttja.

Die Mikrofossilienanalyse hat gezeigt, dass unter den Diatoméen *Anomoeoneis polygramma* (79%) dominieren und danach *Epithemia zebra* var. *porcellus* (18%), beide in dem konsolidierten Sediment. Die absoluten Werte betragen 34-40 St. *Anomoeoneis* und 15-25 St. *Epithemia* pro $mm.^3$ Es ist bemerkenswert, dass so hohe Frequenzen nicht besser mit der Strukturanalyse ausgedrückt werden. Dieses beruht darauf an, dass oftmals von den ganz grossen Diatoméenschalen vielfach nicht mehr als die Raphe übrig geblieben ist, die anderen Teile sind ganz aufgelöst worden. Dieses Verhältnis ist betreffs gewisser kalkreicherer Sedimente nicht selten. Von den übrigen Mikrofossilien ist nur *Quadrula subglobosa* (20 St. pro $mm.^3$) in dem konsolidierten Sedimente hervorzuheben.

In mikrobiologischer Beziehung wird der See durch die ausserordentlich starke Spezialisierung charakterisiert: 2 Arten—*Anomoeoneis polygramma* und *Oscillatoria*—dominieren vollständig. Die letztere Art dürfte der wichtigste Sedimentproduzent sein, denn beinahe die ganze Feindetritusmenge besteht aus Algenschleim. Unter Diatoméen gibt es nur 4 Arten, von denen eine oder 79% der ganzen Diatoméenflora eine Brackwasserform (und Bodenform) ist.

Zusammenfassung. Pangur Tso ist ein ziemlich grosser Brackwassersee mit etwas *Potamogeten*; das Wasser ist besonders reich an Cl, SO_4 und Karbonaten; charakteristisch ist ein hoher $Na_2 CO_3$-Überschuss; das Sediment ist eine sehr kalkreiche Algengyttja mit einer stark spezialisierten Mikroflora von hauptsächlich *Anomoeoneis polygramma* und *Oscillatoria*, die erstere Art ist eine Brackwasser-Bodenform.

14. *Panggong Tso*

(4241 m. ü. M.)

Schlagintweit (1874): Tschomagnalari; Dainelli (1922): Pancòng-Tso.

Das Zuflussgebiet ist auf der Karte der Yale-Expedition im Osten nicht abgeschlossen; nach älteren Untersuchungen (Huntington 1906, Hedin 1909) wissen wir aber, dass der See der letzte einer Reihe ist, die etwa unter 81° Greenwich-Länge (in der Nähe von Jai-Tonghok auf der Karte Hedins) beginnt. Das Gebiet, das jedenfalls sehr gross ist, ist ein tektonisches Becken (de Terra 1934) und zeigt grosse topographische Verschiedenheiten. Die Gipfel erreichen > 6600 m.; besonders im Norden sind sie mit Schnee oder Gletschern bedeckt. Der Berggrund besteht aus paläozoischen Schiefern, auch Mergelschiefern, mit Grünsteingebieten. Die Bodenarten in den Tälern sind pleistozäne schalenführende Tone oder Sand. In kleinen Gebieten ist der Schotter aus ausgefälltem Kalk zusammengesintert. Warme Quellen springen einer Verwerfungslinie entlang, in der Nähe des nördlichen Ufers, hervor. Die Vegetation besteht hauptsächlich aus xerophytischen Kräutern. Ausserdem kommt örtlich Salices, *Rosa* und *Myricaria* vor. An dem südlichen Ufer liegen einige kleine Dörfer (Spangmik, Man und Mirak), von unbeträchtlichen Gerstenfeldern umrandet. Weiter oben in dem Tsaka-Lungpa-Tal im Süden liegt das Dorf Chushul, von kleinen bebauten Feldern umgeben. Das Zufliessen muss wegen der Grösse des Zuflussgebiets ziemlich bedeutend sein, sofern nicht das Verdampfen sehr gross ist. Wahrscheinlich ist jedoch dies der Fall, denn der See ist heute ohne Abfluss. Früher ist er gegen NW in den Shayok (Shejok auf der Karte Hedins) abgeflossen.

Die grösste bekannte Tiefe des Sees ist 51.8 m. und liegt an der östlichen Seite in der Nähe des Ufers. Nördlich von Spangmik ist 47.7 m. gelotet. Nach mir zur Verfügung stehenden Karten, besonders der Yale-Karte, zu beurteilen, ist die Tiefe der verschiedenen Teile des Sees ganz regelmässig; sie wird aber örtlich von kleinen jähen Abhängen (vgl. besonders in der nordwestlichen Bucht) abgebrochen. Die Farbe des Sees ist Forel-Ule II und die des Wassers < 5 mg. Pt/l. Die Sichttiefe ist 11 m. und der pH-Wert 9.3. Der ökologische Standard ist allerdings brackig, zeigt aber eine ausserordentlich hohe Cl-Menge: 3587 mg/l. Auch der SO_4-Gehalt, der 1553 mg/l beträgt, ist der nächst höchste dieser Seen. Die Summe der Alkalisalze ist 10039 mg/l. Als allgemeine Charakteristik des Wassers dürfte man sagen können, dass es einen Zwischentypus zwischen den brackigen Gewässern und den extremen Salzseen Son Sakesar Kahar und Tso Kar bildet.

Der Boden. Aus diesem grossen See gibt es nur 2 Proben: von resp. 31 m. in dem nordwestlichen Teil und 46 m. vor dem Dorf Man am südlichen Ufer. Das Sediment von Panggong Tso ist an der Oberfläche hellbraun und etwa 3 cm. darunter grau. In getrocknetem Zustand ist die Probe von 31 m. gelblich-hellgrau und die von 46 m. grauweiss. Die HCl-Probe zeigt eine recht starke Reaktion, 1-2 für die Probe von 31 m. und etwas stärker für diejenige von 46 m.: 2. Der Siebrest enthält Fragmente von *Gammarus*, der frei schwimmend "in the middle water" (Hutchinson, brieflich) lebt.

Strukturanalyse der beiden Proben

	31 m.	46 m.
Grobdetritus	....	....
Feindetritus	30%	81%
Mineralkorner	63%	17%
Diatomeen	7%	....
Chitin	....	2%
Pyrit	< 1%	< 1%

Der Feindetritus ist in der Probe von 31 m. hyalingraulich und in derjenigen von 46 m. grau. Die Verschiedenheit der Feindetritusmenge pro Volumen ist ja eine natürliche Folge der litoralen Zunahme des minerogenen Materials. Dasselbe Gesetz reguliert übrigens die Verteilung der Diatoméen. Unter Immersion scheint die Feindetritusprobe von 31 m. hyalin, teils sehr feinkörnig und teils recht grobkörnig und daneben ganz reich an bazillenähnlichen Körpern (1 × 5 μ). Die Feindetritusprobe von 46 m. scheint hyalin, feinkörnig und enthält reichlich von rundlichen, etwa 1 μ grosse Körner und vereinzelte bazillenähnliche Körper (½ × 2 μ). Die Tuschprobe von 31 m. zeigt nur wenig Algenschleim und diejenige von 46 m. gar keinen. Die Mineralkörner sind in der Probe von 31 m. gewöhnlich 25-50 μ; dock kommen auch zahlreiche solche von 100-200 μ vor. Dunkle Mineralien sind sehr zahlreich. Übrigens sind die Mineralkörner sehr scharfkantig und splitterig. In der Probe von 46 m. sind sie dagegen nicht so auffällig scharfkantig: die Grösse ist etwa 10-20 μ. Die Chitinreste in der Probe von 46 m. dürften aus *Gammarus* sein. Das Sediment von 31 m. besteht aus gyttjiger Feinsand, reich an Diatoméen, und das von 46 m. eine schluffige Feindetritusgyttja.

Die Mikrofossilienanalyse der Probe von 31 m. hat einen relativ grossen Artreichtum der Diatoméen gezeigt, die übrigens zum grossen Teil lebendig waren. Schon die Strukturanalyse gab ja 7% Diatoméen in der Probe von 31 m. Der grösste Teil dieser Prozente wird aus dem relativ grossen *Surirella ovalis* gebildet, der doch nur 9% des Diatoméenbestands macht, oder etwa 200 St. pro mm.[3] Am zahlreichsten sind *Cyclotella comta:* 47% oder etwa 1030 St. pro mm.[3] Unter Brack- oder Salzwasserformen bemerkt man *Amphiprora paludosa, Anomoconeis polygramma* (weniger als in Pangur Tso), *Epithemia turgida* var. *Westermanni, Navicula peregrina, N. salinarum* und *Rhoicosphenia curvata.* Die meisten sind jedoch in anderen Gegenden auch in süssem Wasser angetroffen worden. In der Probe von 46 m. gab es keine Diatoméen.

In mikrobiologischer Beziehung gibt es eine sehr grosse Verschiedenheit der beiden Proben: in der Probe von 31 m. leben 22 Diatoméenarten, in derjenigen von 46 m. ist kein einziges Fragment davon vorhanden. Es ist jedoch nicht möglich zu sagen, ob die Proben gleichzeitig und also vollkommen vergleichbar sind. Von den 22 Arten sind nur 4 typische Süsswasserformen, 4 sind Brackwasserformen und 2 leben auch im Salzwasser. 58% der ganzen Flora leben nur im süssen Wasser, die übrigen ertragen oder verlangen eine stärkere oder geringere Salzmenge. In Milieubeziehung ist der grösste Teil der Flora—47%—Plankton; 23% sind Aufwuchs—und 16% Bodenformen.[5]

Zusammenfassung. Panggong Tso ist ein sehr grosser Brackwassersee, der den Salzwasserseen nahe steht; das Wasser ist sehr reich an Cl, SO_4 und Karbonaten; die gefundenen Sedimente gehören zu zwei Typen: gyttjiger Feinsand und schluffige Feindetritusgyttja, beide sehr kalkreich, letztere völlig steril. Nur etwa die Hälfte der Diatoméen in dem Feinsand—die zum grossen Teil lebendig waren—gehört zu reinen Süsswasserformen; die anderen leben auch oder nur in brackigem oder salzigem Wasser. Die meisten sind Planktonformen.

15. *Ororotse Tso*

(5297 m. ü. M.)

Das Zuflussgebiet ist sehr klein und umfasst nur die umgebenden Hochgebirgsteile. Das Becken ist ein Kar. Der Berggrund besteht aus Granit und die Bodenarten sind Moränen in grossen Mhengen. Die Vegetation ist sehr ärmlich; dominierend sind Gräser und Kruciferen. Das Zufliessen geschieht durch kurze, reissende Alpenbäche. Der Abfluss dürfte gegen Norden verlaufen.

Die grösste bekannte Tiefe ist 13.4 m. Die Farbe des Sees ist Forel-Ule XII und die des Wassers 5 mg. Pt/l. Die Sichttiefe ist 5 m. ("hole in ice") und der pH-Wert 7.1. Der ökologische Standard ist süss. Hinsichtlich dieses Sees dürfte hervorgehoben werden, dass die Menge fester Stoffe überaus gering ist oder nur 78 mg/l, was bei dem Studium der Analysenwerte zu berücksichtigen ist. Die Summe der Alkalisalze ist 14 mg/l und der Karbonatgehalt beträgt 32 mg/l; daneben bemerkt man einen Überschuss an Na_2 CO_3 von 5 mg/l. Zuletzt ist eine Cl-Menge von 4 und eine SO_4-Menge von 3 mg/l zu erwähnen. Diese Werte sind unerwartet hoch, weshalb ich an die oben angeführte Reservation erinnern muss. Der allgemeine Typus des Wassers ist dem von Lokut Dal Lake und Yaye Tso am ähnlichsten.

Der Boden ist mit Algenkolonien besetzt. Im Mikroskop sieht man vereinzelte *Cladophora*-Zweige. Mit diesem Vorkommen stimmt übrigens die beobachtete Diatoméenflora gut überein. Eine Sedimentprobe ist bei 13.4 m. genommen. In getrocknetem Zustand ist sie grau. Die HCl-Probe zeigt nur eine unbeträchtliche Reaktion (0-1).

Strukturanalyse: Feindetritus (gräulich) 85%, Mineralkörner 11%, Diatoméen 3% und Chitin 1%. Der Feindetritus erscheint unter Immersion hyalin-gelblich (in dickeren Klumpen); er ist grobkörnig und hat ein zerrissenes und splitteriges Aussehen. Er enthält bazillenähnliche, $1 \times 5\text{-}6\,\mu$ grosse Körper. Die Tuschprobe zeigt keinen oder höchstens nur wenig Algenschleim. Die Mineralkörner sind 10-20 μ, vereinzelte doch 100 μ. Die meisten Körner sind splitterig und scharfkantig. Das Sediment ist eine diatoméenreiche Feindetritusgyttja.

Die Mikrofossilienanalysen zeigen, dass die Diatoméen die einzigen Fossilien sind und

[5] There is little doubt that by far the greater part of these diatoms are derived from an interglacial lake deposit, *c. f.* p. 235.—G. E. H.

dass es hier nur wenige Arten gibt. Diese sind aber sehr zahlreich vorhanden. Man bemerkt hier besonders *Cocconeis placentula* var. *lineata* (42%), *Cyclotella antiqua* (20%), *Rhoicosphenia curvata* (17%) und *Amphora ovalis* var. *pediculus* (15%). Daneben gibt es auch z. B. *Melosira arenaria* in 1% oder etwa 300 Zellen pro mm.[3]

Die Mikrobiologie des Sees—der nur etwa 14 Tage im Jahr eisfrei ist (Hutchinson 1933)—ist unerwartet reich entwickelt. 15 Diatoméenarten sind angetroffen worden, von denen die Hälfte typische Süsswasserformen sind. Von der ganzen Flora bilden diese nur 22%. 77% sind Aufwuchsformen und 20% fakultative Boden- und Planktonformen (*Cyclotella antiqua*).

Zusammenfassung. Ororotse Tso ist der allerhöchste der untersuchsten Seen; er ist von hochalpinem Typus; das Wasser ist süss und ohne besonderen Charakter; das Sediment ist eine schwach kalkige diatoméenreiche Feindetritusgyttja, deren Diatoméenformen zum grössten Teil in süssem und brackigem Wasser leben; die meisten sind Aufwuchsformen; eine ungewöhnlich grosse Menge sind aber fakultative Boden- oder Planktonformen.

Zusammenfassende Bemerkungen

Die vorstehende Untersuchung der Bodensedimente veranlasst aus verschiedenen Gesichtspunkten einige zusammenfassende Bemerkungen. Die untersuchten Seen gehören zu 3 ganz verschiedenen Gebieten: Salt Range, einem salzreichen Becken innerhalb der Bergkette auf der Grenze des nordwestindischen Flachlands, dem Kashmirtal, einem sehr vegetationsreichen von hohen Bergen umschlossenen Tal, und Ladak, einem stark zerrissenen Alpengebiet. Letzteres gehört zu den Fortsetzungen des Transhimalaya und des Himalaya, während Kashmir zum Himalaya gehört. Die verschiedenartigen Lagen dieser drei Gebiete bestimmen die grossen Züge der Typen und der Entwicklung der Seen. Einige Einzelheiten darin konnten nicht festgestellt werden können, da die Proben gar zu sporadisch genommen wurden. Gewisse Schlussfolgerungen können aber dennoch hervorgehoben werden.

Das Salzproblem. Seit alters her wusste man, dass Salz- oder Brackwasserseen in diesen Gegenden vorkommen. Schlagintweit (1874, S. 105) sagt im Bezug darauf, dass die Seen immer salziger werden. Sie müssen sich also zu konzentrierten Salzbecken entwickeln. Bei anderen Forschungsreisenden ist die Auffassung hierüber nicht so ausgeprägt. Hedin (1917) gibt eine Darstellung, die deutlich zeigt, wie die Auffassung über die betreffenden Seen zu verschiedenen Zeiten wechselte. Er gibt (1917) nach älteren Angaben eine Zusammenfassung der Abflussänderungen von Manasarovar und Rakastal, wodurch eine Tendenz zu Periodizität in Erscheinung kommt. Er scheint jedoch der Ansicht zu sein, dass die Seen im allgemeinen austrocknen (1907, S. 603); der Salzgehalt kann zwar auch in demselben See jährlich variieren (S. 601). Dasselbe ist übrigens von Decksbach (1924, S. 275) für das Turgaigebiet bewiesen worden.—Nach seiner nächsten Reise hebt Hedin hervor (1917, S. 173), dass wir nicht wissen, ob das Austrocknen der Seen fortsetzt; er scheint jedoch der Ansicht zu sein (S. 179): "When it has once reached its minimum it will probably again return towards a new maximum." Dieses gilt für den Wasserstand und also indirekt auch für den Salzgehalt.—De Terra und Hutchinson (1934) haben ebenfalls eine Zusammenstellung der Wasserstandsangaben, und zwar besonders für Panggong Tso gegeben. Und dank besonders glücklicher Umstände ist es ihnen gelungen, diese mit einer Kurve darzulegen. Die aus diesem Grunde ausserordentlich wichtige Arbeit, zeigt deutlich, dass

Panggong Tso seit der Mitte des vorigen Jahrhunderts starke und regelmässige Wasserstandsvariationen aufweist. In den Jahren 1860-70 war der Wasserstand 5.9 m. niedriger als jetzt, ein Umstand der die Salzkonzentration beträchtlich beeinflusst haben muss. Dieses Verhältnis ist auch durch Vergleichung mit Analysen, die von Henderson und Hume 1871 ausgeführt wurden, nachgewiesen worden. Das Resultat wird von de Terra und Hutchinson (1934, S. 316) folgendermassen angegeben: "A comparison of the chloride contents of the lake as given by him with that found in 1932, indicates that the lake has been diluted by fresh water by 16 per cent. of its former volume since that date. This increase in volume is comparable to the increase of 18 per cent. in area of the cross-section at Man indicated above. The whole clearly indicates that within 112 years, Tso Pangong has experienced one low and two high levels." Am Ufer von Tso Moriri steht eine Manen-Kiste, die nun vom Eis verschoben worden ist (vgl. Plate 3-4 bei de Terra und Hutchinson). Da die Tibetaner unter keiner Bedingung eine solche Kiste links passieren (z. B. Sörlin 1927), kann man nach der Photographie mit Bestimmtheit aussagen, dass die Lage derselben eine Wasserstandssteigerung von wenigstens ein paar m zeigt. Auch in Khyagar Tso, Mitpal Tso und Pangur Tso ist eine solche Steigerung von den erwähnten Verfassern konstatiert worden. Sie haben nach meiner Meinung einleuchtend gezeigt, dass mehrere der Seen von Ladak nach der Mitte des vorigen Jahrhunderts sowohl Senkungen als Erhöhungen des Wasserstands aufweisen, was—nach ihrer Meinung—von Variationen der Niederschlagsmenge abhängig ist. Obgleich das fragliche Verhältnis ganz wahrscheinlich ist, möchte ich doch zuletzt auch Hedin (1917, S. 192) anführen: "But the data we possess regarding the behavior of the lake are too meagre to allow us to draw absolutely reliable conclusions, and at our present state of knowledge, it would probably be impossible to say whether the monsoon rains or the cold weather storms in N. W. India are the most important factor affecting the rise and fall of the lakes, and the volume of waters in the rivers."

Die hier erwähnten Verhältnisse, also periodische Wasserstandsvariationen und damit folgende Salzgehaltänderungen, müssen selbstverständlich den Hintergrund, ausmachen, gegen den diese indischen Seen betrachtet werden sollen. Dadurch können Verschiedenheiten zwischen Seetypus und Mikroflora dieser nicht sehr genau gesammelten, früher untersuchten Sedimentproben, erklärt werden.

Das Hauptprinzip des geographischen Vorkommens der Seen betreffs ihres ökologischen Standards ist folgender. Die in einem Wassersystem höchst gelegenen Seen sind Süsswasserseen, tiefer unter liegen die Brackwasserseen und zu unterst die Salzseen, vorausgesetzt dass das ganze Seesystem in ein abflussloses Becken endet. Beispiele dafür sind Sta-rtsakpuk Tso und Tso Kar, das grossartigste aber die Seekette, die mit Panggong Tso endet.

Im Kashmirgebiet kommen Salz- oder Brackwasserseen nicht vor. Anderseits aber ist zu bemerken, dass die Sedimente hier regelmässig Brackwasserdiatoméen enthalten. Diesen Umstand möchte ich damit erklären, dass der jetzige Abfluss zu stark ist, um eine Salzkonzentration zu ermöglichen. Dass Voraussetzungen für eine solche Konzentration früher vorhanden waren, dürfte bewiesen sein. Betreffs der kleineren Seen (Manasbal Lake und der Srinagar-Seen) ist eine derartige Entwickelung nicht so merkwürdig; dass aber auch Wular Lake beinahe abflusslosgewesen sein soll ist unerwartet. Die Lösung dieser Frage ist von klimageschichtlichen Gesichtspunkt aus von grösstem Interesse. Dazu ist aber ein sehr genaues Probenehmen vonnöten.

Ein Problem von grossem Interesse in diesem Zusammenhang ist, woher diese grosse

Salzmenge kommt. Es gibt zwei denkbare Quellen: den umliegenden Berggrund und das Meer. Innerhalb des Wassergebietes von Son Sakesar Kahar gibt es Salzlager; Wynne (1878) schreibt aber, dass sie unter dem Wasserspiegel des Sees liegen und also kein salzreichen Zufluss liefern können. Vielleicht münden jedoch Salzquellen in den Boden des Sees (Fleming 1853 (1854), S. 237). Wynne ist aber (S. 47) der Ansicht, dass das Salz aus dem Niederschlag kommen könnte.

Das Salz wird bei Verdunstung aus dem Meer transportiert und wird von Nebel u. dergl. aufgenommen. Die Tröpfchen, die den Nebel verursachen, sind oft so minimal, dass sie einen Nebel in gewöhnlichem Sinne nicht bilden. Nebelbildung aber setzt die Gegenwart von "hygroskopischen Substanzen" voraus, die als Kondensationszentra dienen können. Wahrscheinlich ist es auch eine solche Tröpfchenbildung, die nur als eine halbdurchsichtige Trübung über dem Meer hervortritt (Köhler 1925, S. 71). Es sei hier auch an die Angabe von Schlagintweit (1871, S. 467) in Zusammenhang mit dem Klima des Kashmirgebiets erinnert: "Die durch die Besonnung erzeugte Wärme ist, bis Schneefall eintritt, auch durch eine sehr starke Trübung der Luft infolge von Suspension fester Körperchen bemerkbar." Nebelanalysen auf Chlor, Magnesium und Kalzium zeigen so hohe Werte dieser Stoffe, dass sie die Annahme bestätigen, dass die Meersalze wirklich Kondensationszentra der Nebelbildung sind (Köhler 1925, S. 70). Es ist aber die Frage, ob die Salzmengen, die jährlich aus dem Meer transportiert werden, so gross sein können. Köhler hat aus den Verdunstungswerten von Wüst berechnet, dass die Meersalze "nur für 80.2% der Erdoberfläche Kondensationskerne sein können oder dass mit anderen Worten die Mg Na—Zone über 80.2% der Erde verbreitet ist. Da die Meeroberfläche 70.8% der ganzen Oberfläche beträgt, können sie als Kondensationskerne für 32.2% des Niederschlags der festen Erdoberfläche dienen. Bei diesen Rechnungen habe ich von der Möglichkeit abgesehen, dass Schnee auf verschiedene Weise entsthen kann" (Köhler 1925, S. 73). Das Resultat von Köhlers Berechnungen ist, dass jährlich 1,969,850,000 Tonnen Salze aus den Meeren transportiert werden. Die Zahl erscheint ungeheuer hoch. Kürzlich hat aber Meinardus (1934) die von Wüst gegebenen Zahlen korrigiert und gezeigt, dass die Verdunstung des Meeres etwa dreimal grösser ist als die des Landes. Darum muss Köhlers Wert nur als ein Minimum angesehen werden. Obgleich man nichtgar zu grossen Wert auf diese Zahlen legen darf, scheint sie doch die ungefähre Grössenordnung der Salzmenge zeigen zu können. Als einen ferneren Beweis für den Salztransport aus dem Meer möchte ich auf die Verteilung des Jodgehalts in den schwedischen Flüssen hinweisen. Die höheren Jodwerte, die diese im südwestlichen Schweden enthalten (Eriksson 1929, Fig. 23), zeigen—wenn auch das Analysenmaterial nicht ganz erstklassig ist—eine Tendenz, die mann kaum anders erklären kann, als durch einen Materialtransport mit den Meereswinden bedingt. Kürzlich hat Cauer gezeigt, dass die Luftmassen von kontinentaler Herkunft sehr jodarm, von mariner Herkunft dagegen sehr jodreich sind (nach Goldschmidt 1934, S. 418, angegeben).

Die Windrichtungen innerhalb der vorliegenden Seegebiete sind also von grosser Bedeutung. Auf älteren Karten, z. B. in den allgemeinen Handatlassen, wird angegeben, dass die Winde während der Regenzeit regelmässig von SW über Indien hinauf wehen. Neuere Untersuchungen haben aber gezeigt (Harwood 1926 (1921) die Karten), erstens dass die Monsunbahnen anders laufen als früher angenommen wurde, und zweitens, dass eine wesentliche Verschiedenheit zwischen der Windrichtung an der Erdoberfläche und der in der höheren Luftschichten herrscht. In den letzteren kommen ähnliche Verhältnisse das ganze Jahr vor: der Wind weht etwa WSW in dem Gebiete, das uns hier interessiert. Auf niedrigeren Niveaus weht der Wind während der kalten Jahreszeit ungefähr von W, in Ladak von N (Fig. 3). Während der Monsunzeit aber kommt der Wind hauptsächlich vom Bengalischen Meerbusen her, biegt gegen den Himalaya und folgt dem Südabhang desselben gegen WNW. Die meisten Reisebücher über diese Gegenden heben mehr oder weniger hervor, wie genau der Monsun der Topographie folgt und über die Pässe des Himalaya aufwärtsdringt. Ja, der grösste Kenner dieser Gegenden, Hedin, leitet (1907, S. 605) das S-N-liche

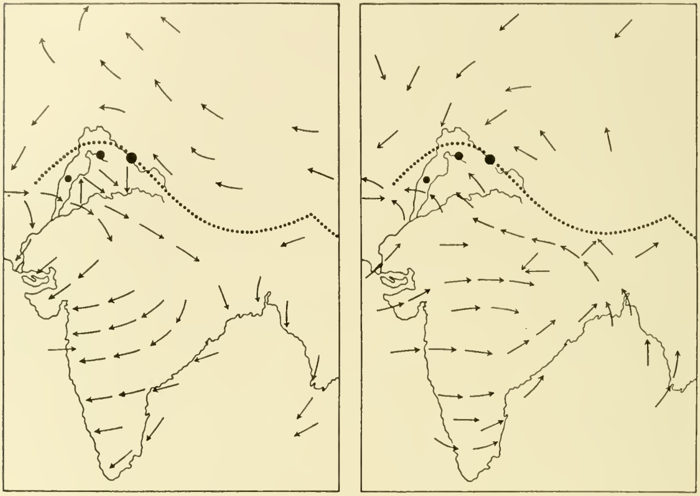


Figure 3. Die Windbahnen in Indien und im westlichen Tibet; links während der Kalten Jahreszeit, rechts während der Monsunzeit. Nach Harwood (1926, [1921]) und Bartholomew's Atlas von C. J. Östman zusammengestellt.

Frequenzabnehmen der Seen im westlichen Tibet von den Monsunen ab: "This circumstance is probably in some way connected with the passage of the monsoons across the Tibetan highlands and the varying amounts of their precipitation which fall to the lot of the different mountain-ranges." Es gibt also hier grosse Möglichkeiten eines Salztransports. Die grössten Luftmassen kommen nach Harwood vom Bengalischen Meerbusen her, woher also auch die grösste Salzmenge kommen dürfte. Nach Schotts Karte (1933) betragen aber die Niederschläge hier etwa 2,000 mm., was den Verdunstungswert beträchtlich senken kann. Die geringste Niederschlagsmenge, 100-250 mm., kommt im Arabischen Meer vor, und dort dürfte auch die grösste Verdunstung zu suchen sein. Nach Möller (1933, Taf. 29) ist der

Salzgehalt in diesen Teilen des Indischen Ozeans geringer als weiter gegen O. Die Ursache dieses Verhältnisses dürfte möglicherweise in einem grösseren Salztransport aus dem Meer durch Verdunstung zu suchen sein. Voransgesetzt dass obige Schlussfolgerungen richtig sind, so wären die West-Winde die wichtigsten für den Salztransport zu unseren Gebieten. Da auch die Winde in höheren Luftschichten diese Richtung haben, mag hervorgehoben werden, dass ihre viel niedrigere Temperatur lange Tröpfchenbildung weit unter 0 nicht verhindern. Also liegt kein Hindernis vor, dass auch Reif, der ein Sublimationsprodukt ist, Meeressalze enthalten kann. Dies ist von Bedeutung für kalte Gegenden wie z. B. Ladak. Obiges zusammenfassend scheint es mir glaubhaft, dass das Salz innerhalb unserer Seegebiete hauptsächlich aus dem Indischen Ozean, besonders dem Arabischen Meer, herrührt. Schliesslich dürfte es wohl selbstverständlich sein, dass dann auch die verschiedenen Salzseen Ursprungsorte eines weiteren Salztransports sein können.

Indessen ist das Salz, einmal in diesen Gegenden angelangt, noch nicht zur Ruhe gekommen. Es ist angeführt worden, dass die Seen säkuläre Wasserstandsvariationen erleiden (de Terra and Hutchinson 1934). Wenn der Wasserspiegel sinkt, vermehrt sich die Salzkonzentration; grösstenteils bleibt aber das Salz auf dem trockengelegten Ufer zurück (vgl. z. B. Lydekker 1883, S. 337). Bei der späteren Hebung des Wasserspiegels ist es aber nicht wahrscheinlich, dass dieses Salz demselben See aufs neue zu gute kommt. Die meisten Reisebücher aus diesen Gegenden beschreiben malerisch die "Staubmengen," die von den Stürmen umhergetrieben werden. Es scheint mir darum wahrscheinlich, dass wenigstens ein Teil der Salzmenge während der Niederwasserperioden in den vorherrschenden Sturmrichtungen weiterwandert und in die Zirkulation anderer Wassersysteme gelangt.

Die Wassertypen. Aus obigem geht hervor, dass die Zusammensetzung des Wassers dieser Seen ziemlich schnellen Veränderungen unterworfen ist. Die vorliegenden chemischen Analysen zeigen (Tabelle 1), die jetzigen Verhältnisse. Nur einige allgemeine Bemerkungen dürften hier ausgeführt werden; von chemischem Gesichtspunkte aus dürfte die Klarlegung dieser Probleme einem Chemiker, der eingehend sowohl die chemischen Eigenschaften des Berggrunds der resp. Wassergebiete sowie auch die chemischen Charaktere anderer Seen kennt überlassen werden.

Einem "gewöhnlichen Seewassertypus" am ähnlichsten sind Lokut Dal Lake, Manasbal Lake, Wular Lake, Yaye Tso und Ororotse Tso. Sie weisen alle eine niedrige Alkalisalzsumme auf, daneben aber ein unbeträchtliches, aber regelmässiges Vorkommen von Cl und SO_4. Die Karbonatgehalte sind einander sehr ähnlich ausser im Manasbal Lake, was wahrscheinlich davon abhängt, dass das Zufliessen zum grossen Teil aus dem Kalksteingebiet des Supra Kuling-Systems kommt. Die mikrobiologischen Verschiedenheiten dieser Seen dürfen nicht auf die Ungleichheit der Zusammensetzung des Wassers zurückgeführt werden. Brackwasserseen sind Tso Moriri, Khyagar Tso, Mitpal Tso, Pangur Tso und Panggong Tso. Ein gemeinsames Kennzeichen derselben ist die relativ hohe Summe von Alkalisalzen. Unter den Brackwasserseen haben Tso Moriri und Mitpal Tso einen viel niedrigeren Cl-Gehalt als die übrigen, während Pangong Tso so Cl-reich ist, dass er einen Übergangstypus zu den Salzwasserseen bildet. Eine Ähnlichkeit mit diesen ist auch der hohe SO_4-Gehalt. Von den übrigen sind auch Khyagar Tso und Pangur Tso CO_4-reich; sie dürften als Sulfatseen bezeichnet werden. Auch das Vorkommen eines relativ grossen Na_2 CO_3-Überschusses verursacht, dass sie einander in chemischer Beziehung ganz nahe stehen. In mikrobiologischer Hinsicht sind die ebenfalls deutlich mit einander verwandt; ich möchte beide als Algengyttjaseen bezeichnen, trotzdem Khyagar Tso völlig steril ist. Stütze dieser Ansicht dürfte das Resultat der Tuschprobe sein. Es is möglich, dass in chemischer Hinsicht, solche Algengyttjaseen sodareiche Sulfatseen sind.

Salzseen sind Son Sakesar Kahar und Tso Kar, zu denen—wie schon hervorgehoben wurde—Panggong Tso einen Übergangstypus bildet. Dieser unterscheidet sich von den anderen beiden teils durch niedrigere Cl- und SO_4-Gehalte, teils—vor allem—durch den sehr kleinen Mg Cl_2-Überschuss. Jene sind einander sehr ähnlich, zeigen aber eine gewisse Verschiedenheit darin, dass Son Sakesar Kahar etwas Cl-reicher und Tso Kar etwas SO_4-reicher ist. Beide haben einen sehr hohen Karbonatgehalt. Die Salzkonzentration ist zum Teil eine hydrographische Frage. Inwiefern die wesentliche Verschiedenheit von Unähnlichkeiten des Berggrundes abhängig ist, entzieht sich meiner Beurteilung.

TABELLE I

Wassertypen nach Chemischen Analysen von H. Newlands, Z. T. Umgerechnet von Dr. A. Assarsson

Seen		Ökologischer	Alkali-			Cl/SO_4	Karbonat-	Überschuss an		
Nr.	Namen	Standard	Salze Σ	Cl Mg/l	SO_4 Mg/l	in Mol.	Gehalt*	$MgCl_2$	$MgSO_4$	Na_2CO_3
1	Son Sakesar Kahar	Salz	73050	34400	17176	5.42	1276	7980	...	....
2	Lokut Dal Lake ...	Süss	9	1.6	5	1.0	65	....	...	14
5	Manasbal Lake	Süss	23	1.8	10	0.60	113	....	...	....
6	Wular Lake	Süss	18	1.7	11	0.40	62	2.3	...	....
7	Tso Moriri	Brackig	788	22	517	0.12	435	30	199	....
8	Khyagar Tso	Brackig	3784	257	2069	0.34	525	....	...	824
10	Tso Kar	Salz	61140	11662	35075	0.90	1633	9960	...	....
11	Yaye Tso	Süss	15	1	7	0.4	63	....	...	25
12	Mitpal Tso	Brackig	1011	82	625	0.35	364	110	...	....
13	Pangur Tso	Brackig	3180	629	1316	1.29	842	....	...	1936
14	Panggong Tso	Brackig	10039	3587	2750	3.56	1553	12	...	....
15	Ororotse Tso	Süss	14	4	3	3.6	32	....	...	5

* $Mg(Ca)CO_3$ nach Abrechnung von Ca und Mg an Cl und SO_4 gebunden.

Mikrobiologischer Rückblick. Gleichzeitig mit den oben besprochenen Variationen im Wasserstand und Salzgehalt verlaufen die biologischen Veränderungen. Ein zusammenfassender Bericht darüber für jeden See kann mit dem vorliegenden Material nicht gegeben werden; einige Analogieschlüsse dürften aber hervorgehoben werden.

Die Ungleichheit der untersuchten Seen der drei Gebiete ist ganz bedeutend. Son Sakesar Kahar enthält ein sehr reiches halofiles Leben. Es ist streng spezialisiert, indem nur zwei Arten vorkommen, darum aber—wie Thienemann (näch Decksbach 1924, S. 274, angeführt) sagt—hochproduktiv. Die Sedimente sind aber in dieser Beziehung vollständig nichtssagend.

Die Seen des Kashmirgebiets sind seichte Süsswasserseen mit gutem Abfluss und Wasserfarben Forel-Ule X-XVI. Die Sichttiefen sind unerwartet niedrig, 1.2-4 m. Mög-

Sediment-Analysen von Lundqvist. Die Zahlen bezeichnen Volumenprozente

Seen		Tiefe in m.	Strukturanalysen (%)								Grösse der Mineralkörner	Spegielle Proben			Bemerkungen	Sedimentnamen
Nr.	Namen		Grobdetritus	Feindetritus	Mineralkörner	Ca-Körner (und-Schlamm)	"Pyrit"	Chitin	Diatoméen	Übrige Fossilien		Trockenprobe	HCl-Probe (5-Gradige Skala)	Tuschprobe In % von Feindetritus		
1	Son Sakesar Kahar (1 cm u. B.)	1.5	< 1	71	12	12	2	3	..	..	< 15μ	dunkelgrau	3	10-20%	Karotingefärbte, flockige Stückchen, Mineralkörner z. T. Splitterig	Kalkreiche Feidetritusgyttja
1	Son Sakesar Kahar (2 cm u. B.)	1.5	2	20	6	64	..	8	..	..	15-25μ	weis	5		....	Chitinreiche Kalkgyttja
1	Son Sakesar Kahar (5 cm u. B.)	1.5	..	67	18	13	< 1	1	..	..	< 15μ	graugelblich	2	C:a 20%	Mineralkörner z. T. Splitterig	Kalkreiche Feidetritusgyttja
2	Lokut Dal Lake	1.2	54	33	2	< 1	< 1	10	< 1	< 1	5 + 10μ (+ c:a 25μ)	dunkelgrau	0	< 10%	....	Chitinreiche Grobdetritusgyttja
3	Bod Dal Lake	4	..	68	29	..	..	..	3	< 1	< 10μ (+ c:a 25μ)	grau	0	< 5%	....	Diatoméenreiche Schluffgyttja
4	Sundar Khun	5	23	56	10	..	2	4	5	< 1	2-10 μ	grau	0	10-20%	....	Diatoméenreiche Grobdetritusgyttja
5	Manasbal Lake	12	..	75	18	..	..	..	7	< 1	< 10μ (+ <50μ)	grau	0	C:a 10%	Mineralkörner oft Splitterig	Diatoméenreiche Feindetritusgyttja
6	Wular Lake (0-1 cm)	5	..	70	28	..	..	..	2	..	< 10μ	grau	0	etwas	Mineralkörner z. T. Splitterig	Diatoméenreiche Schluffgyttja
6	" " (6-12 cm)	5	..	69	29	..	..	..	2	..	< 10μ	grau	0	etwas	Mineralkörner z. T. Splitterig	Diatoméenreiche Schluffgyttja
7	Tso Moriri	48	..	43	57	< 1	..	..	..	..	10-40μ	hellgrau	4	0	Mineralkörner Sehr Splitterig	Gyttjige Feinsand
8	Khyagar Tso	21	..	93	6	..	..	1	..	..	20 μ (+ < 100μ)	hellrot gelblich	0	> 90%	Mineralkörner Selten Scharfkantig	Feindetritusgyttja (Algengyttja)
9	Sta-rtak-puk Tso ...	< 1.5	7	36	55	..	..	..	1	1	5-20μ + 50-60μ	grau	0	0	"Übr. Foss" = Merismopedia Min. Körner sehr scharfkantig	Gyttjige Schluff
10	Tso Kar	2	3	70	19	< 1	..	10	..	..	10-60μ	grauweiss	3	etwas	Mineralkörner Selten Scharfkantig	Chitinreiche Feindetritusgyttja
11	Yaye Tso	18.1	1	88	5	..	< 1	< 1	6	..	10-20μ	grau	0	0	Mineralkörner oft Splitterig	Diatoméenreiche Feindetritusgyttja
12	Mitpal Tso	24	3	90	7	..	..	..	..	..	C:a 15μ	hellgrau	1	0	....	Feindetritusgyttja
13	Pangur Tso (0-1 cm)	9.5	< 1	95	2	< 1	..	< 1	1	2	C:a 15μ + < 100μ	rotweiss gräulich	..	..	"Chitin" Z. T. = Ostracoden-Teile	Algengyttja
13	" " (untere)	9.5	< 1	87	6	< 1	..	5	1	1	C:a 15μ + < 100μ	rotweiss gräulich	3	> 90%	"Übr. Foss" = Oscillatoria	Algengyttja
14	Panggong Tso	31	..	30	63	< 1	< 1	..	7	..	25-50μ + 100-200μ	hellgrau gräublich	1-2	etwas	Mineralkörner sehr Scharf und Splitterig	Gyttjige Feinsand, reich an Diatoméen
14	" "	46	..	81	17	< 1	< 1	2	..	..	10-20μ	grauweiss	2	0	Mineralkörner nicht so Scharf wie bei 31 m	Schluffige Feindetritusgyttja
15	Ororotse Tso	14	..	85	11	..	..	1	3	..	10-20μ + < 100μ	grau	0-1	etwas	Mineralkörner Scharfsplitterig	Diatoméenreiche Feindetritusgyttja

TABELLE III

	Halobientypus	Milieutypus	1. Son Sakesar Kahar 1 cm.	1. Son Sakesar Kahar 5 cms.	2. Lokut Dal	3. Bod Dal	4. Sundar Khun	5. Manasbal Lake	6. Wular Lake 0·1 cm.	6. Wular Lake 6·12 cms.	7. Tso Moriri	8. Khyagar Tso	9. Startsak puk Tso	10. Tso Kar	11. Yaye Tso	12. Mitpal Tso	13. Pangur Tso	14. Panggong Tso 31 m.	14. Panggong Tso 46 m.	15. Ororotse Tso
Achnanthes calcar	F	A	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
" conspicua	F	A	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" exigua	F	A	..	..	+	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
" exilis	F	A	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
" hungarica	FB	A	..	..	.	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" lanceolata v. rostrata	F	A	..	..	..	+	1	..	..	..	..	..	..	..	..	..	..	..	..	..
" linearis	F	A	..	.	.	..	+	..	..	..	..	..	..	..	1	..	..	..	..	..
" minutissima	F?	A	..	..	..	9	1	5	2	1	..	..	..	..	..	..	..	..	..	..
" minutissima v. cryptocephala	F?	A																		
" rostrata n. sp.	F?	A	..	..	..	+	..	+	..	..	..	..	..	..	+	..	..	..	..	1
Amphiprora paludosa	B	Bo?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Amphora commutata	B	Bo	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
" ovalis	FB	ABo	..	..	3	5	4	..	+	7	1	..	..	..	2	11	..	..	..	1
" ovalis v. libyca	FB	A	..	..	..	+	..	..	..	..	..	..	+	..	..	..	..	..	..	..
" ovalis v. pediculus	FB	A	..	..	..	+	..	1	4	5	1	..	9	..	2	..	..	3	..	15
" perpusilla	F	A	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Anomoeoneis polygramma	F	Bo	..	..	.	..	..	..	..	..	..	..	..	..	..	..	79	3	..	..
Asterionella formosa	F	P	..	.	..	1	..	..	1	1	..	.	..	.	..	..	..	..	..	..
Caloneis amphisbæna	FB	ABo	..	..	.	.	..	..	..	..	+	..	..	..	..	..	..	..	..	..
" silicula	FB	Bo	..	..	..	..	..	..	..	..	..	.	6	..	1	..	..	..	..	..
" silicula v. ventricosa	FB	Bo	..	.	..	+	.	+	..	..	..	..	..	..	..	..	..	..	..	..
" sp.	?	?	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Campylodiscus noricus	F	Bo	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	+
Ceratoneis arcus	F	A	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
Cocconeis diminuta	FB	A	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
" pediculus	FB	A	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	+	..	..
" placentula	FB	A	..	..	2	4	5	13	3	6	3	..	1	..	..	..	..	+	..	+
" placentula v. lineata	FB	A	..	..	1	..	1	2	..	..	..	..	..	.	..	52	..	..	..	42
Cyclotella antiqua	F	BoP	..	..	..	..	..	..	..	..	89	.	3	..	..	..	..	..	..	20
" bodanica	F	BoP	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" comta	F	P	..	..	..	1	3	14	4	4	..	..	..	..	73	1	..	47	..	..
" comta v. oligactis	F	P	..	.	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" stelligera	F	P	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Cymatopleura elliptica	FB	Bo	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
" solea	F	Bo	..	..	..	..	+	..	..	..	..	..	3	..	..	..	..	..	..	..

TABELLE III—*Continued*

	Halinitatstypus	Milieutypus	1. Son Sakesar Kahar: 1 cm.	1. Son Sakesar Kahar: 5 cms.	2. Lokut Dal	3. Bod Dal	4. Sundar Khun	5. Manasbal Lake	6. Wular Lake: 0-1 cm.	6. Wular Lake: 6-12 cms.	7. Tso Moriri	8. Khyagar Tso	9. Sta-rtsak-puk Tso	10. Tso Kar	11. Yaye Tso	12. Mitpal Tso	13. Pang-ur Tso	14. Panggong Tso: 31 m.	14. Panggong Tso: 46 m.	15. Ororotse Tso
Cymbella affinis	F	A	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
" amphicephala	F	A	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" aspera	F	Bo	+	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" cistula	FB	A	..	..	1	+	2	1	..	2	..	..	1	..	+	..	..	..	..	..
" cymbiformis	F	A	..	..	..	2	..	1	2	..	..	..	..	..	..	..	..	..	..	..
" ehrenbergii	F	Bo	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
" helvetica	F	A	..	..	5	+	4	2	3	5	..	..	..	..	+	..	..	..	..	..
" lacustris	FB	A	..	..	..	+	..	+	..	..	..	..	..	..	..	..	..	..	..	..
" lanceolata	F	ABo	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" leptoceras	F	A	..	..	4	4	8	2	3	5	..	..	..	..	..	..	..	..	..	..
" microcephala	F	A	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" parva	F	A	..	..	15	12	9	13	14	6	..	..	..	..	1	..	..	..	..	..
" sinuata	FB	A	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
" sinuata v. antiqua	FB	A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
" tumida	F	A	..	..	..	1	+	..	1	+	..	..	..	..	..	..	..	..	..	..
" ventricosa	F	A	..	..	3	11	..	9	3	2	..	..	..	..	..	..	..	..	..	1
Denticula tenuis	F	A	..	..	..	+	..	1	..	1	..	..	..	..	..	..	..	..	..	..
Diatoma elongatum	FB	A	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Diploneis elliptica	FB	Bo	..	..	..	..	..	1	..	..	6	..	..	..	..	22	..	..	..	1
Epithemia sorex	FB	A	..	..	..	1	5	6	4	11	..	..	..	..	1	..	..	..	..	..
" turgida	FB	A	..	..	1	..	7	1	..	1	..	..	2	..	..	2	..	..	..	..
" turgida v. westermanni	FBS	A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
" zebra	FB	A	..	..	..	+	..	3	..	5	..	..	34	..	+	..	..	+	..	..
" zebra v. porcellus	FB	A	..	..	14	..	4	..	..	..	..	..	..	..	..	..	18	..	..	..
Eunotia arcus	F	A	..	..	6	..	·2	+	1	..	..	..	..	..	..	..	..	..	..	..
Fragilaria alpestris Krasske.	F	A	..	..	..	..	..	..	..	..	(1)	..	..	..	..	..	..	..	..	..
" bidens	F	A	..	..	..	..	..	(1)	..	..	..	..	..	..	..	..	..	..	..	..
" brevistriata	FB	Bo	..	..	(3)	..	(7)	..	..	..	..	..	(9)	..	+	..	..	..	..	..
" capucina	F	P	..	..	..	..	..	(2)	(2)	..	..	..	..	..	..	..	..	..	..	..
" construens	F	Bo	..	..	(9)	..	(20)	(3)	..	(3)	..	..	..	..	..	..	..	..	..	..
" construens v. exigua	F	Bo	..	..	(1)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" construens v. venter	F	Bo	..	..	(2)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" crotonensis	F(B)	P	..	..	..	(7)	+	(2)	(6)	..	..	..	..	..	..	..	..	..	..	..
" leptostauron	F	Bo	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	+	..	..
" pinnata	FB	Bo	..	..	(2)	..	(8)	..	..	+	(3)	..	(6)	..	(3)	..	..	..	..	..
" pinnata v. lancettula	F	Bo	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..

TABELLE III—*Continued*

	Halinitätstypus	Milieutypus	1. Son Sakesar Kabar: 1 cm.	1. Son Sakesar Kabar: 5 cms.	2. Lokut Dal	3. Bod Dal	4. Sundar Khun	5. Manasbal Lake	6. Wular Lake: 0-1 cm.	6. Wular Lake: 6-12 cms.	7. Tso Moriri	8. Khyagar Tso	9. Sta-rtsak puk T...	10. Tso Kar	11. Yaye Tso	12. Mitpal Tso	13. Pangur Tso	14. Panggong Tso: 31 m.	14. Panggong Tso: 46 m.	15. Ororotse Tso
Gomphonema acuminatum	F	A	..	..	..	1	2	..	..	2	..	..	..	..	..	..	..	..	..	..
" acuminatum f. turris	F	A	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" angustatum v. producta	F	A	..	..	..	..	..	..	..	..	..	..	6	..	..	..	..	..	..	+
" constrictum	F	A	..	..	..	1	..	1	3	1	..	..	..	..	..	..	..	..	..	..
" constrictum v. capitata / " constrictum v. capitata f. curta	F	A	..	..	..	3	3	3	1	+	..	..	..	..	..	..	..	..	..	..
" intricatum	F	A	..	..	31	+	18	1	1	2	..	..	2	..	..	1	..	..	..	..
" intricatum v. dichotoma	F	A	..	..	..	7	..	7	16	..	..	..	..	..	..	..	..	..	..	..
" lanceolatum	F	A	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..
" sphaerophorum	F	A	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
" subclavatum	F	A	..	..	..	..	1	+	1	+	..	..	..	..	..	..	..	..	..	..
Gyrasigma attenuatum	F	Bo	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
" kützingi	F	Bo	..	..	..	2	..	1	+	+	..	..	..	..	2	..	..	..	..	+
" spenceri	B	Bo	..	..	..	..	..	+	3	..	..	..	..	..	..	..	..	..	..	..
Hantzschia amphioxys	FB	ABo	..	..	..	+	..	..	1	2	..	..	..	..	+	..	..	..	..	..
" amphioxys v. pusilla	FB	ABo	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Melosira arenaria	F	Bo	..	..	..	..	..	..	..	..	+	..	1	..	1	10	..	..	..	1
" distans v. alpigena	F	Bo	..	..	..	..	..	..	(32)	(36)	..	..	..	..	..	..	..	..	..	..
" granulata	F	P	..	..	..	(5)	..	..	(45)	(79)	..	..	..	..	..	..	..	..	..	..
" granulata v. augustissima	F	P	..	..	..	4	..	..	(28)	(11)	..	..	..	..	..	..	..	..	..	..
Meridion circulare	F	A	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
Navicula bacilliformis	F	ABo	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
" cryptocephala	FB	A	..	..	..	3	..	1	3	1	..	..	..	..	1	..	..	..	..	1
" cuspidata	F	Bo	..	..	..	..	+	..	1	..	..	..	..	..	..	..	..	..	..	..
" cfr. dicephala	F	A	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
" gastrum	F	A	..	..	..	..	..	..	1	..	..	..	..	..	+	..	..	..	..	..
" hungarica v. capitata	F	A	..	..	..	2	..	..	..	..	..	..	9	..	..	..	..	..	..	..
" lacustris	F	A	..	..	..	+	..	..	..	..	..	..	..	..	1	..	..	..	..	..
" menisculus	FB	A	..	..	..	1	..	..	2	2	..	..	..	..	..	..	..	..	..	..
" protracta v. capitata	B	A	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
" pupula	F	A	..	..	1	6	..	..	1	..	..	..	..	..	..	..	..	..	..	..
" pygmoea	B	A	..	..	..	+	..	1	..	1	..	..	..	..	..	..	..	6	..	..
" radiosa	F	ABo	..	..	1	1	3	2	1	1	..	..	..	..	..	..	..	..	..	..
" radiosa v. tenellum	F	A	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" rheinhardtii	F	A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	+	..	..
" rhynchocephala	FB	ABo	..	..	..	3	+	2	3	1	..	..	..	..	..	..	..	..	..	..
" rhynchocephala v. rostellata	FB	A	..	..	..	12	..	..	..	..	..	..	14	..	..	..	..	..	..	..

	Halinitätstypus	Milieutypus	1. Son Sakesar Kabar 1 cm.	1. Son Sakesar Kabar 5 cms.	2. Lokut Dal	3. Bod Dal	4. Sundar Khun	5. Manasbal Lake	6. Wular Lake 0-1 cm.	6. Wular Lake 6-12 cms.	7. Tso Moriri	8. Khyagar Tso	9. Sta-rtsak-puk Tso	10. Tso Kar	11. Yaye Tso	12. Mitpal Tso	13. Pangur Tso	14. Panggong Tso 31 m.	14. Panggong Tso 46 m.	15. Ororotse Tso
Navicula salinarum	FS	A	..	..	..	+	..	..	1	1	..	..	..	..	..	..	..	5	..	..
" viridula	FB	A	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" ostrupi	B	A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
" sp.	B	A	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
" sp. (cfr. fortis?)	?	?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	..	..
Neidium affine v. amphirhynchus	F	Bo	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nitzschia amphibia	F	A	..	..	..	1	12	2	5	..	..	..	1	..	1	..	..	..	..	..
" angustata	FB	Bo	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" cfr. capitellata	FB	A ?	..	..	..	..	..	+	..	..	..	..	4	..	..	..	..	8	..	..
" cfr. communis	F	A	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	7	..	..
" gracilis	F	A	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
" hungarica	FB	Bo	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
" palea	FB	ABo	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..
" sigmoidea	F	Bo	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
" tryblionella	FB	Bo	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Opephora martyi	F	Bo	..	..	..	..	..	..	..	..	..	..	..	..	4	..	..	..	..	..
Pinnularia appendiculata	F	A	..	..	..	1	..	..	..	1	..	..	..	..	+	..	..	..	..	..
" borealis	F	A	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
" brebissoni	F	Bo	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	+
" interrupta v. stauroneiformis	F	A	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
" major	F	Bo	..	..	..	..	+	..	..	..	..	..	..	..	+	..	..	..	..	..
" nobilis	F	Bo	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" stauroptera	F	Bo	..	..	..	+	+	..	..	..	..	..	..	..	..	1	..	..	..	..
Rhoicosphenia curvata	FB	A	..	..	..	+	..	..	..	..	1	..	+	..	+	..	..	1	..	17
Rhopalochia gibba	FB	A	..	..	1	..	+	..	..	1	..	..	..	..	..	..	..	..	..	..
" ventricosa	FB	A	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Stauroneis anceps	F	Bo	..	..	..	1	..	..	..	..	..	..	..	..	..	..	2	..	..	..
" legumen	FB	Bo	..	..	..	+	..	..	..	+	..	..	..	..	..	..	..	..	..	..
Surirella elegans	FB	Bo	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" linearis	F	Bo	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
" ovalis var.	FB	Bo	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..	9	..	..
Synedra acus	F	A	..	..	..	1	+	..	2	3	..	..	..	..	..	..	..	..	..	..
" acus v. angustissima	F	P	..	..	..	1	..	(300)	..	..	..	..	..	..	..	..	..	..	..	..
" amphicephala	F	A	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..
" capitata	F	A	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
" cyclopum	F	A	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..

TABELLE III—*Concluded*

	Halinitätstypus	Milieutypus	1. Son Sakesar Kahar 1 cm.	1. Son Sakesar Kahar 5 cms.	2. Lokut Dal	3. Bod Dal	4. Sundar Khun	5. Manasbal Lake	6. Wular Lake 0·1 cm.	6. Wular Lake 6·12 cms.	7. Tso Moriri	8. Khyagar Tso	9. Sta-rtsak-puk	10. Tso Kar	11. Yaye Tso	12. Mitpal Tso	13. Pan ur Tso	14. Panggong Tso 31 m.	14. Panggong Tso 46 m.	15. Ororotse Tso
Synedra parasitica	F	A	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
" rumpens	F	A	..	..	..	+	..	..	..	1	..	..	..	..	..	..	..	..	..	..
" " v. familiaris	F	A	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
" ulna	F	A	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" " v. amphirhynchus	F	A	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
" " v. contracta	F	A	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..
" " v. danica	F	A(P)	..	..	..	..	..	..	2	2	..	..	..	..	..	..	..	..	..	..
" " v. oxyrhynchus	F	A	..	..	..	..	..	..	2	2	..	..	..	..	..	..	..	..	..	..
Arten, Varietäten usw. Anzahl.			1	..	28	64	44	46	46	47	10	..	21	..	34	8	4	22	..	15 ST.
Sie gehören:																				
Halinitätstypen:																				
Süsswasserformen	F	..	1	..	19	38	31	26	33	29	3	..	8	..	21	4	2	4	..	7 ST.
" + Brackwasserformen	FB	..	..	..	9	22	12	15	10	15	6	..	12	..	12	4	1	9	..	7 ST.
Brackwasserformen	B	..	..	..	..	1	..	3	2	1	..	..	..	..	..	..	1	4	..	.. ST.
" + Salzwasserformen	FS	..	..	..	..	1	..	1	..	1	..	..	..	..	..	..	..	2	..	.. ST.
Milieutypen:																				
Aufwuchsformen	..	A	..	..	17	47	27	32	29	32	4	..	12	..	20	3	1	11	..	8 ST.
" + Bodenformen	..	ABo	..	..	3	4	3	2	5	5	2	..	..	..	3	1	1	..	..	1 ST.
Bodenformen	..	Bo	1	..	8	7	11	7	6	5	3	..	7	..	10	3	2	5	..	5 ST.
" + Planktonformen	..	BoP	..	..	1	..	..	..	..	..	1	..	1	..	..	..	..	..	..	1 ST.
Planktonformen	..	P	..	..	..	6	4	4	6	4	..	..	..	..	1	1	..	1	..	.. ST.
" + Aufwuchsformen	..	PA	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	.. ST.
Arten, Varietaten usw., die zu den folgenden Typen gehoren, in Prozenten der Flora:																				
Halinitätstypen:																				
Süsswasserformen	F	..	+	..	77(+11)	62(+9)	71(+20)	61(+308)	73(+107)	48(+129)	89(+1)	..	26	..	90	13	3	58	..	22 %
" + Brackwasserformen	FB	..	..	..	23(+5)	29(+7)	28(+15)	32(+2)	20(+6)	43	12(+3)	..	71(+15)	..	9(+3)	87	18	23	..	77 %
Brackwasserformen	B	..	..	..	..	..	..	2	3	1	..	..	..	..	..	..	79	11	..	.. %
" + Salzwasserformen	BS	..	..	..	.	..	..	..	1	1	..	..	..	..	..	..	..	5	..	.. %
Milieutypen:																				
Aufwuchsformen	..	A	..	..	90	85	88	80	82	75	5(+1)	..	79	..	11(+1)	55	19	23	..	77 %
" + Bodenformen	..	ABo	..	..	6	9	7	4	6	12	1	..	..	..	3	11	..	..	..	1 %
Bodenformen	..	Bo	+	..	3(+17)	3	2(+35)	2(+5)	4(+32)	(39)	6(+3)	..	11(+9)	..	13(+3)	33	81	16	..	2 %
" + Planktonformen	..	BoP	..	..	1	..	..	..	..	..	89	..	3(+6)	..	..	..	..	..	..	20 %
Planktonformen	..	P	..	..	..	3(+16)	3	14(+304)	5(+81)	5(+90)	..	..	..	..	73	1	..	47	..	.. %
" + Aufwuchsformen	..	PA	..	..	..	..	..	..	2	2	..	..	..	..	..	..	..	..	..	.. %

lich ist die Ursache in Plankton etc. zu suchen. Der pH-Wert ist an den Oberflächen 8.2-9.0, weshalb die Seen also als eutroph angesehen sind. Leider kenne ich die Phytoplanktonproduktionen nicht. Die höhere Vegetation, wo man besonders *Lotus* und *Trapa* bemerkt, ist oftmals sehr üppig. Auch mikrobiologisch sind diese Seen relativ reichhaltig. An Diatoméenarten kommen insgesamt 118 vor und sie wechseln in den verschiedenen Seen zwischen 28 und 64. Unter diesen sind 79 St. nicht in den Ladakproben angetroffen worden (vgl. Tab. 3). Merkwürdigerweise, gibt es in jedem See 2-3 typische Brackwasserformen: *Gyrosigma Spenceri, Navicula protracta* v. *capitata, N. pygmaea, N. salinarum* und *N.* sp. Prozentuell wechselt ihre Frequenz zwischen < 1% und 3% der Diatoméenflora. Von sämtlichen Arten sind die meisten (17-47 St.) Aufwuchsformen, 5-11 sind Bodenformen und 4-6 Planktonformen. Von der ganzen Diatoméenflora sind 80-90% Aufwuchsformen. Boden- und Planktonformen sind also ganz untergeordnet. Neben Diatoméen kommen auch andere Mikrofossilien vor. Desmidiéen finden sich in Lokut Dal Lake, Sundar Khun and Manasbal Lake. Alle beobachteten Formen sind klein und unansehnlich. In Lokut Dal Lake gibt es ein paar *Pediastrum*-Arten, 2-4 St. pro mm.^{3} Die Tierreste sind sehr selten. So gibt es von *Bosmina*-Schalen kommen in Lokut Dal Lake und Sundar Khun 4 St. in Manasbal Lake 2 St. pro mm.^{3} vor. Von Spongiennadeln sind in Lokut Dal Lake 26 St. und in Sundar Khun 16 St. pro mm.^{3} angetroffen worden.

Die Ladakseen sind in der Regel relativ tief; am tiefsten ist Tso Moriri, am seichtesten Tso Kar. Die Wasserfarbe ist im allgemeinen Forel Ule V-VIII, aber auch Werte von III bis XII sind beobachtet worden. Die Sichttiefen sind unerwartet verschieden (1.5—9 m.); ob die Ursache in Suspensionen oder Plankton zu suchen ist (vgl. doch unten), ist mir unbekannt. Der pH-Wert ist 7.1-9.6, im allgemeinen doch etwa 9 oder mehr. Betreffs der Phytoplanktonproduktionen weiss ich nur, dass Ororotse Tso "considerable amounts of plankton" besitzt (Hutchinson 1933, S. 136), und dass in Yaye Tso "the water clouded with centric diatom prob. *Cyclotella*" ist (Hutchinson, briefliche Mitteilung). Diese beiden Seen sind also eutroph in Naumanns Sinn von 1932. Die höhere Vegetation ist sehr schwach entwickelt; gibt es eine solche höhere vie im Sta-rtsak-puk Tso und Pangur Tso, so besteht sie hauptsächlich aus *Potamogeton.* In mikrobiologischer Beziehung weichen die Ladakseen beträchtlich von den Seen des Kashmirgebietes ab. Die Anzahl Diatoméenformen beträgt 72, 30 davon sind nicht in den Kashmirproben gefunden worden. In verschiedenen Seen beträgt die Zahl 4-34, ist also durchschnittlich bedeutend niedriger als in Kashmir. Obgleich mehrere dieser Seen brackig (oder salzig) sind, sind typische Brack-oder Salzwasserdiatoméen nur in Pangur Tso und Panggong Tso angetroffen worden, nämlich: *Amphiprora paludosa, Anomoeoneis polygramma, Epithemia turgida* v. *Westermanni, Navicula pygmaea* und *N. salinarum.* Diese Brack—oder Salzwasserformen machen in Pangur Tso 79% und in Panggong Tso 16% der ganzen Diatoméenflora; daneben aber gibt es resp. 18% und 23% der fakultativen Süss- oder Brackwassertypen. In Milieubeziehung sind die Ladakfloren von einander sehr verschieden. In Sta-rtsak-puk Tso, Mitpal Tso und Ororotse Tso liegt der Schwerpunkt auf den Aufwuchsformen mit resp. 79, 55, und 77%. In Pangur Tso betragen die Bodenformen 81%, 79% sind *Anomoeoneis polygramma.* In Mitpal Tso betragen die Bodenformen 33%, selbst dies ist eine ausserordentlich grosse Zahl. In Tso Moriri bilden fakultative Boden- und Planktonformen (= die Süsswasserform *Cyclotella antiqua*) 89%. In Yaye Tso und Panggong Tso herrschen die Planktonformen—in beiden *Cyclotella comta*—mit resp. 73% und 47% vor.

○ ● ?

Nur Süsswasserformen. Auch Brack-oder Salzwasserformen. Keine Formen gefunden.

FIGURE 4. Die Verbreitung der Diatoméen nach Halinitätstypen in den Proben der untersuchten Seen. Fakultative Formen nicht mitgerechnet.

○ ⊕ ●

Süsswasserseen. Brackwasserseen. Salzwasserseen.

FIGURE 5. Der ökologische Standard der untersuchten Seen; dürfte mit Figure 4 verglichen werden.

Diese kurze Übersicht zeigt, dass oftmals eine sehr grosse Verschiedenheit zwischen dem ökologischen Standard der Seen und den Angaben der Bodenproben besteht. Auffallend ist das häufige Vorkommen von Brackwasserformen in den Süsswasserseen Kashmirs, und ebenso auffallend das Fehlen solcher Formen in den Proben mehrerer Salz- oder Brackwasserseen Ladaks (Figs. 4 und 5). Ich kann diese Unregelmässigkeiten nicht anders erklären, als dass der ökologische Standard so oft wechselt und die Proben nicht rezent sind. Da Variationen sicherlich ebenso oft wie hier stattfinden (vgl. Panggong Tso) und daneben die Sedimentation ganz sicher unbeträchtlich ist, ist es notwendigger als gewöhnlich, die proben mit allergrösster Genauigkeit einzusammeln. Nun sind wahrscheinlich die Proben aus Lokut Dal Lake und Wular Lake mit Rohrlot genommen, weshalb die Gefahr für Umrührung derselben nicht so gross war. In diesem Zusammenhang möchte ich hervorheben, dass für den Alyk-nor dasselbe Verhältnis zu bestehen scheint (siehe Mereschkowsky 1906). Der betreffende See ist abflusslos und die Diatoméenflora süss. Leider gibt es aber keine Angaben über den ökologischen Standard des Sees.

Betreffs der Diatoméenfloren der Ladakseen und ihrer ökologischen Variationen soll eine andere Möglichkeit in Betracht gezogen werden. Die Seen liegen ganz isoliert und sind während grosser Zeit des Jahres eisbedeckt. Die Zeit für die Einwanderung neuer Formen, ist darum sehr kurz. Durch die Steigerung des Salzgehalts sterben eine grosse Menge Süss- und Brackwasserarten und neue halofile Formen wandern relativ selten ein. Die Entwickelung dieser Seen geht also einem "Wüstenstadium" entgegen.—Wenn der Salzgehalt zufolge der steigenden Niederschläge und durch Wasserstandshebung vermindert wird, kommen die Süsswasserformen, die in Bächen, Sümpfen u. dgl. in der Nähe der Seen leben, zurück, um die Seen in Besitz zu nehmen.

In mikrobiologischer Beziehung sind die untersuchten Seen nach den Bodenproben zu beurteilen sehr dürftig. Es kann aber nicht genug hervorgehoben werden, dass die Diatoméen, wie andere Algen, zoniert leben, was sowohl für Boden—als Aufwuchsformen gilt (Thomasson 1926). Da man nur sporadische Proben bezitzt, ist es selbstverständlich nicht anzuraten, die Floren dieser Seen mit denen anderer Seen zu vergleichen. Ganz besonders gilt dies bei den sehr durchsichtigen Seen, wo die Zonen weniger zusammengedrängt vorkommen. Als Beispiel, wie verschieden die Angaben für einen einzigen See sein können, will ich die Resultate betr. Panggong Tso nach dem Material dreier Expeditionen mitteilen. Die Expeditionen sind Yale, Trinkler und Hedin und die Bearbeiter Thomasson (hier publiziert), Meister und Hustedt.

Diatoméenarten	Thomasson (hier)	Meister (1932)	Hustedt (1920)
Achnanthes lanceolata	....	....	1
" linearis	....	....	1
" microcephala	....	....	1
" minutissima	....	....	1
Amphiprora paludosa	1	....	....
Amphora commutata	1	....	....
" ovalis	....	....	1
" " v. pediculus	1	....	1
" Schroederi	....	....	1

Diatoméenarten	Thomasson (hier)	Meister (1932)	Hustedt (1920)
Anomoeoneis exilis	....	1	....
" polygramma	1	....	....
Caloneis bacillum	....	1	....
" fasciata	....	....	1
" silicula	....	1	....
" " v. truncatula	....	1	....
" sp.	1	....	....
Cocconeis pediculus	1	....	....
" placentula	1	....	1
Cyclotella comta	1	....	....
Cymbella aequalis	....	1	....
" affinis	....	1	1*
" " v. excisa	....	1	....
" aspera	....	....	1
" cistula	....	1	....
" " v. maculata	....	1	....
" lanceolata	....	1	....
" norvegica	....	1	....
" parva	....	1	....
" sinuata v. antiqua	1	....	....
" tumida	....	1	....
" ventricosa	....	....	1
Denticula tenuis v. frigida	....	1	....
Epithemia argus	....	1	....
" " v. alpestris	....	1	....
" " v. longicornis	....	1	....
" turgida v. Westermanni	1	....	....
" zebra	1	....	....
" " v. proboscidea	....	....	1
Fragilaria construens v. subsalina	....	1	....
" leptostauron	1	....	....
" pinnata	....	1	....
Meridion circulare	....	....	1
Navicula amphibola	....	1	....
" cryptocephala	....	1	....
" cuspidata	....	1	....
" sp. (c fr. fortis?)	1	....	....
" oblonga	....	1	....
" peregrina	....	1	....
" pygmaea	1	....	....
" Rheinhardti	1	....	....

* Massenhaft.

Diatoméenarten	Thomasson (hier)	Meister (1932)	Hustedt (1920)
Navicula salinarum	1	....	....
" tuscula	....	1	....
" Ostrupi	1	....	....
Neidium rectum	....	1	....
Nitzschia capitellata	1	....	....
" communis	1	....	....
" frustulum	....	....	1
" hungarica	1	....	....
" Kittlii	....	1	....
" thermalis	....	1	....
Pinnularia appendiculata	....	1	....
" Brebissonii	....	....	1
" gracillima	....	1	....
" leptosoma	....	1	....
" major v. linearis	....	1	....
" " v. paludosa	....	1	....
" Tibetana	....	1	....
Rhoicosphenia curvata	1	....	....
Rhopalodia gibba	....	1	1
" " v. ventricosa	....	1	....
" gibberula v. margaritifera	....	1	....
Stauroneis phoenicuteron	....	1	....
Surirella ovalis v. ovata	....	....	1
" " var.	1	....	....
Synedra pulchella	....	1	....
" Vaucheriae	....	1	....
" " v. capitellata	....	1	....

Die drei Listen sind einander sehr unähnlich. Zum Teil dürfte die Ursache in den Vegetationslokalitäten zu suchen sein. So sind die von Hustedt gefundenen Diatoméen an Herbariumpflanzen eingesammelt worden. Möglich ist aber auch, dass solch grosse Verschiedenheiten von ökologischen Veränderungen abhängig sind. Jedenfalls zeigt diese Zusammenstellung von Panggong Tso, wie unzuverlässig nähere Vergleiche zwischen diesen asiatischen Seen und anderen Seen sein müssen.

Nach meiner Meinung ist es notwendig, die Floren nicht nur qualitativ, sondern auch—und hauptsächlich—quantitativ mit einander zu vergleichen. Leider liegen von früher keine solchen Angaben vor. Als eine allgemeine Charakteristik kann aber hervorgehoben werden, dass vorliegende Floren durch die Abwesenheit von oder unbeträchtliche Mengen *Eunotia-*, *Fragilaria-* und *Pinnularia-*Arten gekennzeichnet sind. Dies ist nicht sehr erstaunlich, da diese Gattungen zum grossen Teil für die humusreicheren Gewasser bezeichnend sind.

Die Sedimenttypen. Da die Sedimente das Endresultat des Lebens eines Sees sind, durften sie wenigstens in besonderen Teilen dies Leben wiederspiegeln. Ein Rückblick auf die Sedimente der erwähnten Gebiete in Bezug auf die Strukturanalysen wird darum hier gegeben. Zuerst aber möchte ich nochmals betonen, dass das Material in jeder Probe ganz heterogen ist, und dass die Analysenresultate darum nur als relativ zu betrachten sind. Der Grundstoff der Sedimente besteht aus Detritus und Mineralkörnern. Es sind darum zu allererst die Variationen in den Mengenverhältnissen derselben zu beachten. Der Detritus ist von grobem oder feinem Typus. Zum Grobdetritus rechne ich Phanerogamenreste, die nicht so destruiert sind, dass die Zellkomplexe ganz aufgelöst sind. Sowie die gleichartigen Gewebe der höheren Kryptogamen. Der Feindetritus ist das vollständig destruierte organische Material. Die Mineralkörner sind limnoallochton und bestehen gewöhnlich aus Quarz oder Feldspat oder, was besonders angegeben wird, auch aus dunkeben Mineralien. Es ist oft schwierig, die limnoautochtonen "Ca-Körner" in der Strukturanalyse von den kleinen Mineralkörnern zu unterscheiden, weshalb jene z. T. in der Summe verborgen sein können.

Die Sedimente von Son Sakesar Kahar weichen, was zu erwarten, war ganz von denen der anderen Seen ab, in struktureller Beziehung zwar nicht so auffallend. Die Lagenfolge ist aus schwarzen Fe S-reichen und weissen Kalziumkarbonatreichen Schichten aufgebaut worden. Die Verschiedenheiten ihrer Zusammensetzung werden durch die Strukturanalysen (Tabel 2) deutlich gezeigt. Der grosse Gehalt an Fe S (und H_2 S) ist von der Zerlegung der beträchtlichen Mengen *Microcystis* und *Diaptomus* abhängig. Speziell aus dem letzteren stammen die karotingefärbten Reste, die jedoch nur in der Oberflächenlage vorkommen und darum möglicherweise aufgelöst worden sind. Als Ursache dieses Unterschiedes im Sedimenttypus dürfte nicht die Jahreszeiten angenommen werden. Dagegen spricht die relativ grosse Mächtigkeit der Schichten. Eher dürften diese das Pulsieren in den säkulären Wasserstandsvariationen und die davon bedingten biologischen Veränderungen wiederspiegeln, also dasselbe Phänomen beleuchten, das von de Terra und Hutchinson betr. Panggong Tso beschrieben wurde. Für eine nähere Besprechung der Sedimente und Naturverhältnisse wenn die letzteren abgelagert wurden, scheinen mir chemische Analysen sehr wertvoll zu sein. Solche stehen mir aber leider nicht zu Gebote.

Die Kashmirsedimente sind in trockenem Zustand klar grau und frei von Kalziumkarbonat. In diesen seichten Seen könnte man einen durchgehend hohen Grobdetritusgehalt erwarten. Das Vorkommen eines solchen ist aber ganz unregelmässig. Nur betr. Lokut Dal Lake und Sundar Khun macht sich dieser Gehalt in den Analysen geltend. Damit sei jedoch nicht gesagt, dass es den übrigen Proben an diesem Gehalt mangelt. In den ganz und gar von Litoraltypus bestehenden Kashmirsedimenten, sind dagegen die Mineralkörner sehr zahlreich (20-30%). Was die Grösse betrifft sind sie gewöhnlich $< 10\,\mu$, also hauptsächlich Schluff; einzelne grossere Körner können aber selbstverständlich vorkommen. In diesem Zusammenhang sei bemerkt, dass nach den Feldnotizen die oberflächlichen Sedimente von Lokut Dal Lake reichhaltige Muschelschalen enthalten, während tiefer in den Lagenfolge ihrer viel weniger sind. Im Mikroskop kann man zwar in den untersuchten Proben einige Fragmente davon bemerken; die HCl-Probe gab aber gar keine Reaktion. Obgleich sich der Muschelgehalt gegen die Gegenwart hier vermehrt haben kann, ist es wahrscheinlicher, anzunehmen dass die Schalen infolge des unbeträchtlichen Karbonatgehalts des Wassers und des relativ starken Humuszuschusses (Versumpfung der Umgebungen) sehr schnell aufgelöst werden. So verhält es sich oft in den dystrophen Seen. Der Feindetritus bildet im allgemeinen den Hauptbestandteil dieser Sedimente. Er enthält immer etwas Algenschleim, der jedoch zum Teil von den Schleimstielen der Aufwuchsdiatoméen herrühren kann. Bezeichnend für die Kashmirsedimente sind schliesslich die Diatoméenmengen, die sich auch in struktureller Beziehung in so hohem Grade geltend machen, dass sie für das Benennen der Sedimente bestimmend geworden sind. Zusammenfassend, kann man über die Kashmirsedimente sagen, dass sie, von den Variationen im Grobdetritusgehalt in Lokut Dal Lake und Sundar Khun abgesehen, einander sehr ähnlich sind. Sie gehören zum Typus der seichten Seen, die sich dem Zuwachsstadium nähern. Von den im folgenden besprochenen Sedimenten sind diese in vieler Beziehung stark verschieden.

Die Sedimente des Ladakgebietes sind viel mannigfaltiger als die von Kashmir; sie sind hauptsächlich von den sehr verschiedenen Seen typen abhängig. Auffallend bei der Mikroskopierung ist also hier das minerogene Material, die Mineralkörner. Bezüglich der Frequenz wechseln sie allerdings sehr, 2-63%, durchgehend aber sind die Körner viel grösser als die des Kashmirgebiets. Gewöhnlich sind sie grösser als 15 μ, oftmals 20-40 μ; Körner von 100-200 μ sind aber nicht so selten in den Proben bemerkt worden. Weiter sind die Körner hier oft splitterig und scharfkantig. Dies dürfte damit in Zusammenhang stehen, dass die Zuflüsse der Seen so kurz sind: die Mineralkörner haben darum nicht Zeit genug, abgerundet zu werden. Ich vermute, dass auch Frostsprengung und Wind beitragende Ursachen zu dem betreffenden Verhältnis sein können: kleine Splitter werden weggesprengt und von Winde beinahe unmittelbar in die Seen getragen, wo sie schnell sedimentieren. Auch Kalziumkarbonat gibt es nach der HCl-Probe in mehreren dieser Seen; es kommt aber hauptsächlich als limnoallochtones Korn aus den Kolkformationen des Panjalsystems vor und wird zu den "Mineralkörnern" gerechnet. Der Grobdetritus ist am reichhaltigsten (jedoch nur 7%) in dem seichten Sta-rtsak-puk Tso, von dem besonders berichtet wird, dass er mit *Potamogeton* bewachsen ist. Die Chitinreste sind sehr ungleichartig; sie können nicht immer bestimmt werden. Die zahlreichen Reste in Tso Kar dürften zu *Artemia* gehören, in Pangur Tso aber sind sie Ostracodenschalen. Diese bestehen grösstenteils aus Kalziumkarbonat und dürften darum in hohem Grade zu der starken Reaktion der HCl-Probe beigetragen haben. Bemerkenswert genug sind keine *Bosmina*-Reste in den Ladakproben angetroffen worden. Diatoméenreich sind Yaye Tso, Panggong Tso (in 31 m.) und Ororotse Tso. Beachtenswert scheint mir, dass auch dieser letztere, in einem wirklich arktischen Milieu gelegene See ein so reiches Leben beherbergt. Prinzipiell erinnert dies beinahe an den Planktonreichtum der antarktischen Meere. Der Feindetritus ist quantitativ wechselnd, bildet aber in den meisten Fällen den Hauptteil der Sedimente; Ausnahmen sind Tso Moriri, Sta-rtsak-puk Tso und Panggong Tso, 31 m. Algenschleim fehlt oder seine Quantität ist sehr untergeordnet, ausser in zwei Seen, Khyagar Tso und Pangur Tso, wo er $> 90\%$ des Feindetritus ausmacht. Diese Gyttjen kann man also Algengyttjen nennen. Der Sedimenttypus in Pangur Tso ist durch seinen Gehalt an Algenschleim und durch den hohen Gehalt von *Anomoeoneis polygramma* gewissen Seen der Stockholmer Gegend zu der Zeit, da sie von der Ostsee isoliert wurden, sehr ähnlich. Man war früher der Meinung, dass das Algengyttjenstadium der Seen sich nur unter wärmeren Klimaverhältnissen ausbildete. Da dieses Stadium unter besonderen Bedingungen im Hochland Tibets angetroffen worden ist, dürfte wohl darin diese erwähnte Meinung keineswegs eine Stütze erhalten haben. Daraus wäre auch der Schluss zu ziehen, dass das Leben der Seen zum grossen Teil von den Variationen der Klimatypen nicht unmittelbar unabhängig ist; sehr eigentümlich scheint mir, dass die Temperatur von gänzlich untergeordneter Bedeutung ist. Von grundlegender Bedeutung dagegen sind die chemischen Verhältnisse des Berggrundes des Wassergebietes. Besondere Umstände treffen aber selbstverständlich ein, wenn ein Zuschuss von Meeressalzen hinzukommt. Dies findet statt Gebieten, die durch Niveauveränderungen oder ähnliche Verhältnisse von dem Meer isoliert werden, sowie auch bei Wüstengebieten. Die Voraussetzung aber, dass sich die auf verschiedene Weise in den See eingeführten Elektrolyten geltend machen können, ist ein gewisser Zusammenhang zwischen Zu- und Abfliessen. Schlagintweit (1872, S. 139) äussert sich über eine ähnliche Frage: . . . "sowie Grösse des Quellengebietes der Zuflüsse im Verhältnisse zum Wasservolumen und zur Oberfläche, dies sind dabei die wichtigsten Momente."

Ein Rückblick auf die Mikrofossilien- und Sedimenttypen der besprochenen Seen gibt folgende Auffassung von den allgemeinen Prinzipien des Entwicklungsverlaufs. In den tiefen Seen herrschen die Planktonformen vor, hauptsächlich Diatoméen und Tierchen (Copepoden, die jedoch nicht resistent sind). Die Sedimentation ist im allgemeinen sehr schwach, kann aber örtlich durch kräftige Zufuhr von minerogenem Material in den litoralen Teilen verstärkt werden. Wenn das Verhältnis zwischen Zu- und Abfliessen unverändert bleibt, vermehren sich die Bodenformen wenigstens örtlich, bald. Sie sind in den tieferen Seen des Gebietes die relativ wichtigsten, bis die Verschlammung und andere Milieuverhältnisse so entwickelt werden, dass eine höhere Vegetation (z. B. *Potamogeton*) einwandern kann. Dann vermehren sich auch die Aufwuchsformen und nehmen überhand. Wenn der See innerhalb eines kalkreichen Gebietes liegt und das Wasser deshalb, oder anderer Umstände halber, von einem kalk- und sulfatreicheren Typus ist, so wandern die Myxophycéenmassen ein. Der Sedimentzuwachs geschieht dann dank dieser starken Materialzufuhr viel schneller. Innerhalb Gebiete mit geringen Niederschlägen und starker Verdunstung machen sich auch schnell kleine Variationen in Niederschlägen und Verdunstung geltend und der Konzentrationsgrad in dem Wasser der Seen verändert sich relativ leicht. Wenn sich die Niederschläge vermindern, nimmt das Zufliessen ab. Kommen dann Meeressalze hinzu, kann sich der ökologische Standard des Sees verändern und brackig oder salzig werden. Gleichzeitig sterben dann zum Teil die Süsswasserformen aus und Brack- oder Salzwasserformen wandern ein. Innerhalb des wärmeren Kashmirgebietes findet dieser Austausch relativ leicht statt; aber in ariden Gebieten wie Ladak, wo die Seen den grössten Teil des Jahres eisbedeckt liegen, sind die Aussichten auf eine Neueinwanderung stark vermindert. Darum sind die Brack- und Salzwasserfloren in diesen Gebieten sehr arm. Innerhalb Gegenden, die nicht so lange Zeit eisbedeckt sind, z. B. weiter in Tibet hinein, ist der Reichtum der Formen viel grösser (vgl. Mereschkowsky 1906 und Oestrup 1909). Wenn das Wasser der Seen steigt und der Salzgehalt also abnimmt, können die Süsswasser- und besonders die fakultativen Süss- und Brackwasserformen sehr leicht einwandern, da sie noch in Pfützen u. dgl. in unmittelbarer Nähe der Seen leben.

Ausblick

Nach vorstehender Untersuchung dieser asiatischen Binnengewässersedimente möchte ich einige daraus gezogene Konsequenzen darlegen. Obgleich die Proben nur kleine Bruchstücke der Geschichte jedes Sees bilden und ausserdem nur von einem einzigen Platz des betreffenden Sees stammen, kann man hier, gestützt auf frühere Untersuchungen anderer Art Möglichkeiten für fortgesetzte Arbeiten wahrnehmen. Durch die Arbeit von de Terra und Hutchinson wird gezeigt, dass die Seen relativ schnell und regelmässig zwischen Süss und Brackwasserstadien pendeln. Vorstehende Untersuchung zeigt, dass die Sedimente deutlich diese Stadien wiederspiegeln. Weiterhin sind, hauptsächlich in Kashmirsedimenten, Pollen verschiedener Arten so reichlich angetroffen worden, dass es nicht unmöglich wäre, mit Beistand derselben die Variationen in der Zusammensetzung der Wälder zu studieren. Dadurch würde man auf einen festen Boden kommen betreffs der Klimageschichte Kashmirs. Schwieriger ist es, diese Erfahrungen für die Hochgebirgsketten und die waldlosen Gegenden Ladaks zu auszunützen. Als Ausgangspunkte scheinen mir die pollenreicheren Zonen von Kashmir geeignet. Mit grösseren Pollenmengen dürften die Möglichkeiten für Verbreitung der leichtfliegenden Nadelwaldpollenkörner zunehmen. Durch Niveaukombinationen mit weithergeflogenen Pollen (z. B. auch *Tamarix*-Pollen?) und den Wechsel zwischen Süss- und Brackwasserstadien der Seen also nach den Mikrofossilien dürfte man eine relative Chronologie auf die Sedimente aufbauen können.

Rein theoretisch ist die hier vorgeschlagene Untersuchung relativ einfach auszuführen. Die Schwierigkeit liegt darin, ein geeignetes Material aufzuspüren und einzusammeln, aber sicher würde sich die Mühe reichlich lohnen, da durch eine solche Untersuchung einer der Schlüssel zur Klimageschichte Zentralasiens gefunden werden Könate.

Sveriges Geologiska Undersökning, Stockholm, im Januar 1935.

Note by Biologist of the Expedition

After Dr. Lundqvist's paper was received for publication, I heard from Dr. de Terra that he had forwarded a sample of diatomaceous deposit from the interglacial lacustrine beds of Pang-gong Tso to Mr. K. E. Lohman for determination. Mr. Lohman most kindly forwarded the names of the species present; as he did not think the report worth publishing as a separate paper, his list and comments are transcribed below. I have added indications of the present distribution in Indian Tibet of the species encountered. It is probable that the greater part of the diatoms in the shallow water deposit in Pang-gong Tso are derived from this interglacial bed and not from the living flora of the lake.—G. E. H.

Diatoms from a fresh-water interglacial lake bed in the northern Himalayas, India. Sample No. K-108, U. S. G. S. Diatom Locality No. 2274.

Cyclotella comta (Ehrenberg) Kützing	(F)	A	Ka. Yy. M. P31.
Stephanodiscus astraea minutula (Kützing) Grunow	Cold	R	not rec.
Fragilaria leptostauron (Ehrenberg) Hustedt	(F)	R	Ka. P31.
Eunotia suecica A. Cleve	Cold	R	not rec.
Cocconeis placentula lineata (Ehrenberg) Cleve	(FB)	A	Ka. M. Or.
Rhoicosphenia curvata (Kützing) Grunow	(FB)	F	Ka. Tm. St. Yy. P31 Ov.
Mastogloia elliptica Agardh		R	not rec.
Caloneis silicula (Ehrenberg) Cleve	(FB)	F	St. Yy.
Stauroneis montana Krasske	Cold	R	not rec.
Anomoeoneis polygramma (Ehrenberg) Cleve	(FB)	C	P31, Pa.
Navicula reinhardtii Grunow	(F) Cold	R	Pa. P31.
Navicula oblonga Kützing		A	not rec.
Pinnularia microstauron (Ehrenberg) Cleve	Cold	R	not rec.
Amphora ovalis Kützing	(FB)	F	Ka. Tm. Yy. Or.
Cymbella ventricosa Kützing	(F)	C	Ka. Or.
Cymbella lanceolata (Ehrenberg) Van Heurck	(F)	C	Ka.
Cymbella cistula (Hemprich) Grunow	(FB)	F	Ka. St. Yy.
Gomphonema intricatum Kützing	(F)	R	Ka. St. M.
Gomphonema cf. parvulum (Kützing) Grunow		R	not rec.
Epithemia turgida (Ehrenberg) Kützing	(FB)	A	Ka. St. M.
Epithemia zebra porcellus (Kützing) Grunow	(FB)	F	Ka. Pa.
Epithemia sorex Kützing	(FB)	C	Ka. Yy.
Rhopalodia gibba (Ehrenberg) Müller	(FB)	F	Ka.
Nitzschia denticula Grunow		F	not rec.

Ka. = Kashmir Valley, Tm. = Tso-moriri, St. = Sta-rtsak-puk Tso, Yy. = Yaye Tso, M. = Mitpal Tso, Pa. = Pangur Tso, P31 = Panggong mud 31 m., Or. = Ororotse Tso, not rec. = not recorded by Lundqvist from recent deposits, F. = fresh, FB. = Fresh and Brackish.
A = abundant, C = common, F = few, R = rare.

"All of the above species are living today in freshwater to somewhat saline lakes. One species, *Anomoeoneis polygramma*, is living at present in the Great Salt Lake in Utah and in the Gulf of Mexico. Its common occurrence in the Indian material suggests that the water was at least somewhat saline, and this is further indicated by the fact that half of the species live in both fresh and brackish water environments.

Stephanodiscus astraea minutula, *Eunotia suecica*, *Stauroneis montana*, *Navicula reinhardtii*, and *Pinnularia microstauron* are now living in cool water lakes and suggest that the Indian material was deposited from a cool water lake. These species all occur rarely, however, so they offer no very conclusive evidence."

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Explanation of Plate XI.

Fig. 1. Aspect of Vegetation around Dal Lake. Note: the natives are collecting water-plants (*Trapa*?). G. Jarring, July, 1935 (Copyright).

Fig. 2. Island with luxuriant vegetation, Dal Lake. Figures 1 and 2 give a good idea of the richness of the Kashmir Lakes in contrast to the Ladak Lakes. G. Jarring, July, 1935 (Copyright).

Fig. 3. The flat, flooded shore of Wular Lake in the midst of the great Kashmir-Basin. G. Jarring, July, 1935 (Copyright).

Fig. 4. Mitpal Tso. G. E. Hutchinson, August, 1932.

Figure 1.

Figure 2.

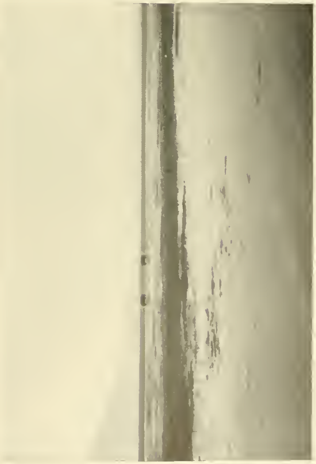


Figure 3.

Figure 4.

ARTICLE XIII

REPORT ON MYRIAPODS

By F. Silvestri (Portici)

(Received February 12, 1935)

The collection of Myriapods made by Mr. G. E. Hutchinson as biologist of the Yale North India Expedition contains specimens of 3 species of *Chilognatha*, 2 of *Symphyla* and 8 species and varieties of *Chilopoda*, of which last 6 are described as new.

Having before us the results of both this expedition and those of the "Niederlandischen Expedition in den Karakorum" we might deduce that the *Chilognatha* are almost absent from high altitudes, only a single species of *Polydesmidae* (*Kashmiriosoma contortipes* Schub.) having been collected at an altitude of about 3200 m.; but it is necessary to search more, in very special ground, before definitely drawing such a conclusion.

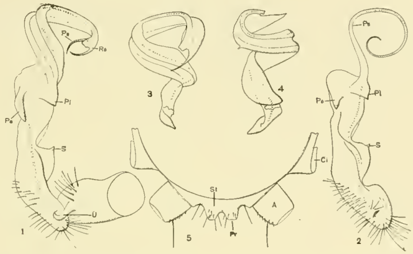


Figure 1. *Kashmiriosoma contortipes*, specimens of the Y. N. I. E.: 1, copulatory leg seen from the internal side; 2, the second joint of the same without the apical large and contorted branch, which is represented isolated in two positions in 3. and 4.; 5, anterior view of inferior part of 4th segment of the male: *A*, first joint of the fourth pair of legs; *Ci*, lower lateral carinae; *Pe*, external median process of the external branch of the copulatory legs; *Pi*, internal median process of the copulatory legs; *Pr*, sternal processes between the 4th pair of legs; *Ps*, internal branch (pseudoflagellum), *St*, sternum.

Both the above-named expeditions collected a number of Chilopods of the family *Lithobiidae*, which family appears to attain higher altitudes than any of the other Myriopods. This can be understood when we bear in mind the predacious habits of the *Lithobiidae*, which prey on other Arthropods, while the Chilognatha need decomposing vegetable matter, and a quite high humidity. Specimens of *Lithobiidae* were collected up to altitudes of about 5100 m.[1]

[1] The highest locality from which Myriopods were obtained was L 33, on the eastern slope of the Shakya-la, at about 5250 m. Immature and so indeterminable specimens of *Lithobius* here occurred among tufts of sparse grass and withered herbaceous vegetation.

With regard to the species of *Lithobius* here recorded, it must be noted that the specimens being few and not all in adult condition, it was not possible to appreciate the value of the range of variability of some characters, as for instance that of spines on first joint of the legs of the posterior part of the body; therefore I have, for the present, preferred to retain specimens showing such variation as varieties. It will be necessary, later, when more numerous specimens are available, to establish the range of variability of the characters under consideration.

As to the generic reference of the greater part of these *Lithobiidae*, notwithstanding the characters of the antennal joints and of the teeth of maxillipedes, I have referred them to the genus *Lithobius* s. l. and not to *Porobius* proposed for forms possessing such characters by Attems, attending a more scientific revision of the old genus.

CHILOGNATHA

Family POLYXENIDAE

Polyxenus sp.

One young specimen of but 8 segments was collected at K 2. Takht-i-Sulaiman, Srinagar, 20 March 1932, at c. 1585 m.

Family POLYDESMIDAE

Subfamily Strongylosominae

Kashmiriosoma contortipes Schubart

Through the kindness of Dr. J. B. Corporaal I have been able to compare the type material (3 specimens) of *Kashmiriosoma contortipes* Schubart, collected by the Dutch Expedition in Kashmir (Sind Valley and Matayan near Dras) with the few specimens (1 male, 2 females) of the Yale North India Expedition collected also at K 73, Matayan (under stones) at about 3170 m., 20 May 1932. The only appreciable difference I have found is in the copulatory legs, which in the typical specimens have not the external spine (Text-figure 1, 1-2, S) on the second joint well developed, and have a shorter process at the base of the pseudoflagellum. As the typical and paratypical material is too scanty and does not permit us to ascertain the range of the variation of the characters in question, I refer the specimens of the Yale Expedition to the same species.

Subfamily Polydesminae

Opisthoporodesmus sp.

One young female specimen with only 18 segments, which is too immature to refer to any of the described species or to describe as new.

Locality: Nilgiri Hills: Pykara at c. 2133 m.

SYMPHYLA

Family SCOLOPENDRELLIDAE

Hanseniella sp.

In the collection of the Expedition there are 2 specimens: 1 young and 1 in moult, which very probably belong to *H. subunguiculata* (Imms), but the state of the specimens does not permit a certain determination.

Locality: Nilgiri Hills: Ootacamund at 2316 m., 8 Nov. 1932.

Symphylella sp.

One adult specimen from Takht-i-Sulaiman, Srinagar, at about 1585 m., 20 March 1932, has characters related to those of *S. simplex* (Hansen) Bagnall, described from the Island Koh Chang, Gulf of Siam, but being poorly preserved, is not fitted for a complete study.

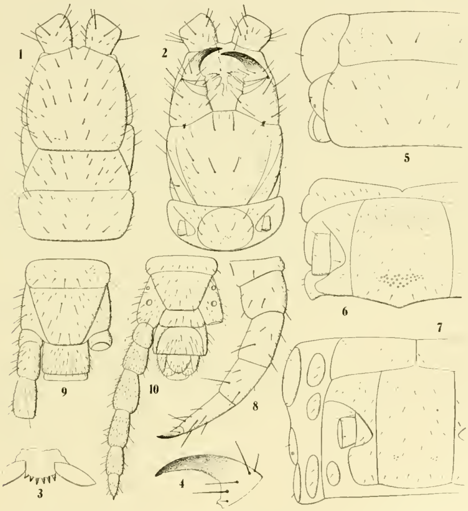


Figure 2. *Geophilus intermissus* var. **crenulata**: 1, corporis pars antica prona; 2, eadem supina; 3, labrum; 4, pedum maxillarium unguis; 5, segmentum decimum pronum; 6, idem supinum; 7, segmentum quinquagesimum supinum; 8, pes paris decimi; 9, corporis pars postica prona; 10, eadem supina.

CHILOPODA

Family GEOPHILIDAE

Mecistocephalus cephalotes Mein

One specimen from (N 17) Nilgiri Hills: Ootacamund, dam above Dhobi's quarter c. 2316 m., 15 Nov. 1932, and a very young specimen from (K 55) Kangan (Rest House) c. 1766 m., 16 May 1932.

Geophilus intermissus Silv.

var. **crenulata** nov.

Text-figure 2

♂ Corpus stramineum capite flavo-ferrugineo.

Lamina cephalica paullum latior quam longior setis brevibus modice numerosis instructa, antennae articulis elongatis, decimo exempli gratia c. duplo longiore quam apice latiore, pedes maxillares flexi capite retracto laminam cephalicam tractu brevissimo haud superantes, subcoxis et articulis ceteris inermibus, articulo ultimo tantum tuberculo interno basali perparvo aucto, ungue bene arcuato margine interno maxima pro parte tenuissime crenulato.

Tergita setis brevissimis parce numerosis instructa.

Sternitum primum area subpostica mediana poris 8 instructa, sternita 2^{um} ad 18^{um} fovea antica transversali et area mediana subpostica porosa ut Text-figure 2, 6 demonstrat, nec non setis nonnullis brevissimis instructa; sternita cetera areis duabus parvis sublateralibus subposticis porosis, in segmento 19' poris 10 + 5, in segmento penultimo 5 + 5.

Pedes breves parum setosi, ungue seta basili antica breviore et postica brevissima.

Segmentum ultimum pediferum scuto subtrapezoideum, subcoxis poris 4, quorum duo interni magni partim obtecti et duo sublaterales externi parum minores, sternito trapezoideum c. 1/3 ad basim latiore quam longiore, pedibus crassiusculis, articulis 1–5 subtus setis brevioribus numerosis instructi, ungue terminali parvo.

Pedum paria 57; long. corporis mm. 22; long. antennarum 3; long. pedum paris decimi 0.52, ultimi 0.70.

Habitat. Exemplum typicum ad "L 20 Ravine above Himis Gonpa at 3525 m. 12 June 1930," lectum est.

Observatio. Varietas haec a forma typica ("Matayan near Dras" *Niederl. Exp. Karakorum*) labri parte mediana denticulis sat distinctis, pedum maxillarium ungue margine interno minutissime crenulato saltem pro tempore distinguenda est.

Family LITHOBIIDAE

Lithobius (*Archilithobius*) *electus* Silv.

var. **imminuta** nov.

Text-figure 3

♂ Corpus sublatericium.

Lamina cephalica parum latior quam longior setis sparsis brevioribus (in exemplo typico maxima pro parte abruptis) instructa; antennae 20-articulatae (laeva in exemplo typico 19-articulata) articulis elongatis, decimo duplo longiore quam latiore omnibus setis numerosis brevibus instructis; oculi ocellis 11 compositi subtriseriatis, ocello postico a ceteris aliquantum remoto; pedes maxillares antice aliquantum angustatis margine externo ad setae anticae latus externum paullum latiore, margine antico medio profunde inciso, utrimque dentibus $2+2$ et seta externa breviore, superficie pone dentes setis paucis brevibus et brevioribus instructa.

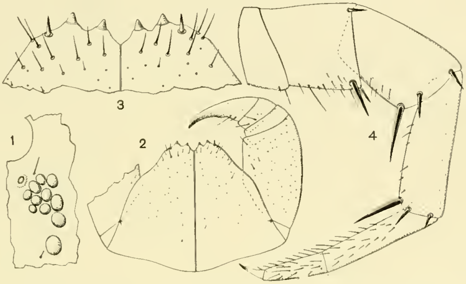


Figure 3. *Lithobius* (*Archilithobius*) *electus* var. **imminuata**: 1, capitis regio ocularis; 2, pedes maxillares; 3, pedum maxillarium subcoxarum pars antica magis ampliata; 4, pes paris decimi.

Tergita omnia angulis posticis rotundatis, margine postico tergiti segmenti penultimi pediferi vix sinuato; tergitum segmenti ultimi pediferi minus quam 1/6 longius quam latius postice vix sinuatum; sternita setis sparsis brevioribus a segmento 12° postice aliquantum magis numerosis instructa.

Pedes spinis primi paris $\frac{0, 0, 2, 2, 0}{0, 0, 2, 3, 1}$, paris decimi $\frac{0, 0, 2, 2, 2}{0, 0, 2, 3, 2}$, paris penultimi $\frac{1, 0, 3, 1, 1}{0, 1, 3, 2, 1}$, paris ultimi $\frac{1, 0, 3, 1, 0}{0, 1, 3, 2, 1}$, subcoxis segmenti 13^1 etiam spina supera antica armatis, pedes 14^1 et 15^1 quam praecedentes aliquantum longiores et cressiores, facie interna ab articulo 4° ad tarsum inclusum poris glandularibus numerosis instructa, praetarsi unguicula interna breviore. Poris subcoxales 4, 4, 4, 4 (in parte laeva anormaliter 3, 5, 4, 4), circulares, uniseriati.

Appendices genitales minimae, tuberculiformes, convexae, setis tribus instructae.

Long. corporis mm. 13; lat. laminae cephalicae 1.56; long. antennarum 5; long. pedum paris decimi 2.80, paris ultimi 5.

Habitat. Exemplum descriptum ad "(K 73) Matayan m. 3170 under stones near K 72) 10 May 1932" lectum est.

Observatio. Varietas haec a *Lith.* (*A.*) *electus* forma typica (Sanju, Karakash Valley, *Niederl. Exp. Karakorum*), statura minore ocellis minus numerosis, poris glandularibus subcoxalibus minus numerosis distincta est.

Lithobius (*Archilithobius*) *electus* Silv.

var. **secessa** nov.

Text-figure 4

Corpus avellaneum.

Lamina cephalica paullum latior quam longior; setis paucioribus brevissimis sparsis instructa; oculi ocellis 13-16 longitudinaliter 4-seriatis in exemplo uno oculus laevus anormaliter ocellis tantum 9 (3-seriatis); antennae breves, 20-articulatae, articulis longioribus quam latioribus (decimo c. 2/5 longiore quam latiore), omnibus setis brevissimis numerosis instructis; pedes maxillares subcoxis antice angustatis angulo externo rotundato, margine externo obliquo, margine antico medio sat profunde sinuato, cetero dentibus perparvis $2+2$ et seta brevi laterali aucto, superficie infera postdentali setis tantum brevioribus instructa.

Tergita marginata angulis posticis plus minusve rotundatis (haud acute productis); tergitum segmenti ultimi pediferi parum longius quam latius, margine postico paullum sinuato; sternita setis brevissimis sat numerosis instructa.

Pedes spinis primi paris $\frac{0, 0, 3, 2, 2}{0, 0, 2, 3, 2}$, paris decimi $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$, spinis minoribus apice denticulato, spina apicali ventrali mediana articuli decimi mm. 0.31 longa, tarso articulo primo quam secundus fere duplo longiore et ambobus setis brevioribus numerosis instructis, paris penultimi $\frac{1, 0, 3, 2, 2}{0, 1, 3, 3, 2}$, paris ultimi $\frac{1, 0, 3, 1, 0}{0, 1, 3, 2, 1}$ (in exemplo uno pes laevus articulo secundo supra etiam spina breviore aucto), ungue terminali seta basali sat longa aucto, articulorum 4-7 facie interna poris glandularibus obsessa, articulo sexto quam quintus paullum breviore; pedum paris 12^1 et 13^1 etiam subcoxa spina supera antica brevi robusta apice denticulato aucta.

Pori glandulares subcoxales 6-7, 8, 8, 8 subuniseriati, rotundi.

Feminae appendices genitales calcaribus $2+2$ robustis, ungue terminali simplici.

Long. corporis ad mm. 18, lat. laminae cephalicae 2.10; long. antennarum 6.5; long. pedum paris decimi 4.5, paris ultimi 8.5.

Mas juvenilis quam femina minor (corporis long. mm. 13) oculis ocellis 10 compositis, poris subcoxalibus 5, 6, 6, 6.

Mas adultus. Feminae statura subsimilis, oculis ocellis 12-13 compositis, poris subcoxalibus ut in femina, corporis parte postica sternarum et pedum setis ut mas typicum (cfr. fig. Niederl. Exp. Karakorum, Zoologie, p. 196, fig. 11).

Habitat. Exempla nonnulla vidi ad L 32a Zung-Lung, Ladak (Typi) c. 4400 m. under stones in stream bed, wet place, 24 June 1932.

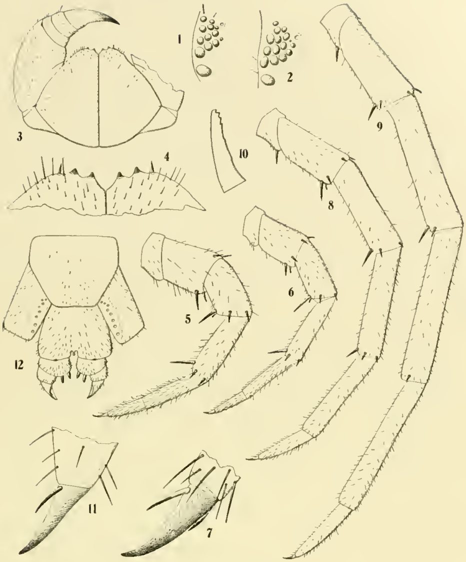


FIGURE 4. *Lithobius* (*Archilithobius*) *electus* var. **secessa**: 1, capitis regio ocularis; 2, capitis regio ocularis exempli alii; 3, pedes maxillares; 4, pedum maxillarium subcoxarum pars antica; 5, pes paris primi ab articulo secundo; 6, pedum paris decimi, minus quam primus ampliatus; 7, ejusdem tarsi apex et praetarsus magis ampliatus; 8, pes paris penultimi a facie externa inspectus; 9, pes paris ultimi a facie externa inspectus; 10, spina dorsualis articuli tertii pedis ultimi magis ampliata; 11, pedis ultimi tarsi apex et praetarsus externe inspecti; 12, feminae pars postica supina.

Paratypi ad Ladak L 62 Nying-ri, alt. 5114 m., 26 July 1932; exempla tria juvenilia ad L 68 An-zurma (camp below Anem La) 4890 m. 1 August 1932; marem juvenilem ad L 53 Sachuk-kongma 5160 m., 15 July 1932; exempla masculina 3 plus minusve juvenilia ad Tso Nyak region (western end) c. 4245 m., 12 August 1932; 1 ♀ e 1 ♂ juvenes ad L 20, Ravine above Himis gonpa, 3525 m., 12 June 1932; 1 pullus L 68a between An-zurma and Dambu-guru, under stone, c. 4725 m., 1 August 1932.

Observatio. Varietas haec a forma typica *Lith. electus* Silv. femina adulta ocellis magis numerosis pedibus posticis magis elongatis, subcoxis segmenti pediferi 12[1] etiam spina dorsuali armatis, ungue pedum paris ultimi seta basali sat longa instructa distinguenda est.

Lithobius (Archilithobius) bispinosus sp. n.

Text-figure 5

Corpus pallide testaceum.

Lamina cephalica vix latior quam longior, setis tantum paucissimis brevissimis instructa; oculi ocellis 16, quarum 15 inter sese adiacentes, subtriseriatis et ocello singulo postico majore a ceteris parum remoto; antennae 20-21 articulatae, articulis elongatis, decimo c. ¼ longiore quam latiore, ultimo c. duplo longiore quam latiore, omnibus setis brevissimis numerosis instructis; pedes maxillares subcoxis antice angustatis angulo externo et margine externo convexiusculis, margine antico medio profunde sinuato, cetero dentibus 2 + 2 parvis armato et seto brevi externa, superficie infera (postdentali) setis nonnullis brevibus et brevioribus instructa.

Tergita angulis posticis subrectis vel late rotundatis, margine postico etiam tergiti segmenti penultimi pediferi vix sinuato; tergitum segmenti ultimi pediferi c. ¼ longius quam latius, longius quam in speciebus praecedentibus et segmentum anale fere omnino obtegens; sternita setis paucis sparsis brevissimis instructa.

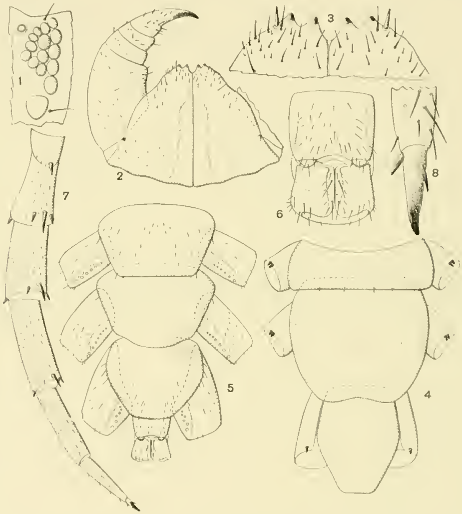


FIGURE 5. **Lithobius (Archilithobius) bispinosus**: 1, capitis regio ocularis; 2, pedes maxillares; 3, pedum maxillarium subcoxarum pars antica magis ampliata; 4, corporis pars postica prona; 5, idem supina; 6, segmenta genitale et anale supina; 7, pes paris ultimi a facie interna inspectus; 8, ejusdem tarsi apex et praetarsus subtus inspecti.

Pedes spinis primi paris $\frac{0, 0, 2, 1, 1}{0, 0, 2, 3, 2}$, paris decimi $\frac{0, 0, 2, 2, 2}{0, 0, 3, 3, 2}$, paris penultimi $\frac{2, 0, 2, 1, 1}{0, 1, 3, 3, 2}$, ultimi $\frac{1, 3, 3, 1, 0}{0, 1, 3, 2, 1}$; pedes parium 12^i, 13^i, ut 14^i, supra antice spinis brevioribus robustis duabus armati; pedes omnes tarso in articulinis duobus bene diviso, articulino primo quam secundus parum longiore, secundo, praesertim infra, setis numerosis brevibus instructo, praetarsi ungue mediano robusto, unguicola postica quam antica paullum breviore et robustiore; pedes paris 14^i quam praecedentes aliquantum crassiores et longiores, articuli 4^i usque ad tarsum inclusum facie postica (vel interna) poris glandularibus mimimis pernumerosis instructa; pedes paris ultimi quam praecedentes, praesertim articulis quarto et quinto, crassiores, poris glandularibus praecedenti similes, praetarso ungue seta externa brevi et unguicola interna breviore composito.

Pori glandulares subcoxales 6, 7, 7, 6.

Appendices genitales obsoletae, minimae, forma tubercoli convexi manifestae.

Long. corporis mm. 17; lat. laminae cephalicae 2.30; long. antennarum 6.50; long. pedum paris decimi 4 paris ultimi 5.20.

Habitat. Exemplum typicum tantum vidi ad "L 27-28, Digar Polu valley" lectum at 4050 m., 21 June 1932.

Observatio. Species haec a *Lithobius* (*P.*) *electus* Silv. pedum parium 12^i, 13^i, et 14^i subcoxis, spinis duabus superis armato et tergito segmenti ultimi pediferi majore, nec non pedibus ultimis crassioribus facile distinguenda est.

Lithobius (*Archilithobius*) *erraticulus* Silv. var. **plurispinata** nov.

Text-figure 6

Corpus testaceum.

Lamina cephalica subaeque longa atque lata setis sparsis brevibus et brevioribus nonnullis instructa; oculi ocelli 6-7, longitudinaliter subtriseriatis, ocello postico a ceteris aliquantum remoto; antennae 20-articulatae, articulis elongatis, decimo c. 1/3 longiore quam ad apicem latiore, omnibus setis numerosis brevibus instructis; pedes maxillares subcoxis antrorsum lateribus convergentibus, margine externo obliquo haud vel vix convexo, margine antico medio profunde sinuato, utrimque dentibus 2 armatis et seta externa quam dentes paullum longiore, superficie infera pone dentes setis paucis brevibus et brevioribus instructa.

Tergita omnia angulis posticis subrectis vel rotundatis, setis paucis brevibus et brevioribus instructa; tergitum penultimum margine postico paullum sinuato, tergitum ultimum c. 1/5 longius quam latius, margine postico parum sinuato; sternita setis paucis brevibus et setis brevioribus vel brevissimis parum magis numerosis instructa.

Pedes spinis paris primi $\frac{0, 0, 1, 2, 2}{0, 0, 2, 3, 2}$, paris decimi $\frac{0, 0, 3, 2, 2}{0, 0, 3, 3, 2}$, paris penultimi $\frac{1, 0, 3, 1, 1}{0, 1, 3, 3, 1}$, paris ultimi $\frac{1, 0, 3, 1, 0}{0, 1, 3, 2, 1}$; pedum 11-15 articulo primo (subcoxa) supra spina brevi ad apicem armato, pedes penultimi et ultimi aliquantum longiores et crassiores et facie interna ab articulo quarto ad tarsum inclusum poris glandularibus obsessa, pori ultimi praetarso unguicula interna breviore, seta proximali externa brevi. Pori glandulares subcoxales 3,4, 4, 3 vel 3, 4, 4, 4.

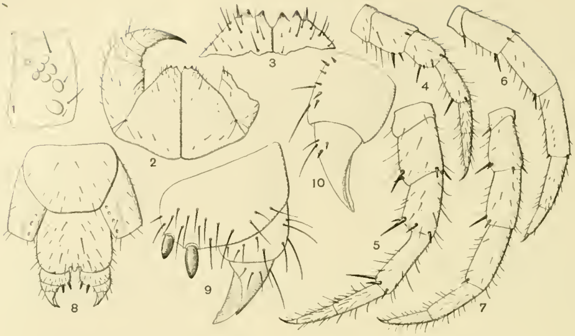


FIGURE 6. *Lithobius* (*Archilithobius*) *erraticulus* var. **plurispinata**: 1, capitis regio ocularis; 2, pedes maxillares; 3, pedum maxillarium subcoxarum pars antica; 4, pes primi paris (semper ab articulo secundo); 5, pes paris decimi; 6, pes paris penultimi a facie externa inspecti; 7, pes paris ultimi etiam a facie externa inspecti; 8, feminae corporis pars postica supina; 9, feminae appendix genitalis magis ampliata supina; 10, feminae appendicis genitalis articuli secundus et tertius proni.

Feminae appendices genitales calcarium paribus duobus, ungue terminali apice integro, sed incisione marginali externa infera, aliquantum longe ab apice, affecta, articulo penultimo supra externe setis brevioribus subspiniformibus 6-7 et articulo ultimo supra etiam setis similibus duobus.

Maris appendices genitales perparvae tuberculiformes.

Long. corporis ad mm. 10; lat. laminae cephalicae 1.20; long. antennarum 3.25; long. pedum paris decimi 2.10 paris ultimi 3.40.

Habitat. L 32, Zung-Lung, Ladak (2 ♀♀ and 1 ♂) 4224 m.

Observatio. Varietas haec a forma typica (N. Bengal, Kashmir) spina apicali supera etiam a pedum pare decimo primo incipiente, saltem diversa est.

Lithobius (Archilithobius) materiatus sp. n.

Text-figure 7

♀ Corpus pallide castaneum.

Lamina cephalica subaeque longa atque lata setis paucis brevioribus instructa; oculi ocellis 10 longitudinaliter triseriatis; antennae 19-articulatae, articulis longioribus quam latioribus, articulo decimo, exempli gratia, fere 1/3 longiore quam latiore, articulis omnibus setis numerosis brevioribus instructis, articulo ultimo quam penultimus parum longiore; pedes maxillares margine laterali aliquantum pone marginem anticum sinuatum, sinu subrecto, margine antico ipso parum pone libellam marginis antici interni pedum maxillarium articuli secundi pertinente, medio profunde sinuato et utrimque dentibus duobus et seta externa brevi aucto.

FIGURE 7. **Lithobius (Archilithobius) materiatus:** 1, capitis regio ocularis; 2, pedes maxillares; 3, pedum maxillarium subcoxarum pars antica; 4, pes primi paris (ab articulo secundo); 5, pes paris decimi; 6, pes paris penultimi a facie externa; 7, pes paris ultimi a facie externa; 8, paris ultimi tarsi apex et praetarsus a facie externa inspecti; 9, feminae corporis pars postica supina; 10, feminae appendix genitalis, supina, magis ampliata.

Tergita angulis posticis plus minusve rotundatis setis nonnullis brevissimis instructa; tergitum segmenti ultimi pediferi paullum longius quam latius, margine postico vix sinuato; sternita setis nonnullis brevioribus instructa.

Pedes primi paris spinis $\frac{0, 0, 2, 2, 1}{0, 0, 2, 3, 2}$, paris decimi $\frac{0, 0, 2, 2, 2}{0, 0, 2, 3, 2}$, tarso divisione obsoleta articulum praecedentem longitudine aequante, paris penultimi $\frac{1, 0, 3, 1, 1}{0, 1, 3, 3, 2}$, paris ultimi $\frac{1, 0, 3, 1, 0}{0, 1, 3, 2, 1}$, ungue terminali subintegro (seta ventrali vix distincta), pedum parium 14^1 et 15^1 facie interna poris numerosis obsessa.

Pori subcoxales 4, 4, 4, 4 parvi, rotundi.

Appendices genitales calcaribus robustis $2+2$, ungue terminali paullum trilobato.

Long. corporis mm. 13; lat. laminae cephalicae 1.38; long. antennarum 4.30; long. pedum paris decimi 1.80, paris ultimi 3.90.

Habitat. Exemplum typicum tantum vidi ad "Pass to Gya at base, Ladak lectum, at about 4203 m., September 1932."

Observatio. Species haec pedum maxillarium subcoxarum forma, pedum brevitate, tarso brevi divisione obsoleta et spinarum numero bene distincta est.

Lamyctes albipes (Pock.)

2 females collected at "Kandan (Kashmir), 1800 m., 16 May 1932, under rotten wood."

These specimens have antennæ of 28 and of 29 joints; and in the remainder of their characters are identical with a specimen from Srinagar previously figured by me (Niederl. Exp. Karakorum, Zoologie p. 202, fig. VII).

ARTICLE XIV

REPORT ON DIPLURA AND THYSANURA

By F. Silvestri

(Received February 16, 1935)

The Diplura of the Yale North India Expedition were not collected at very high altitudes, the highest locality being at 2159 m. in the Nilgiri Hills, where **Indjapyx Harrisoni** was obtained. Regarding the vertical distribution of this order, Mr. Hutchinson kindly wrote to me that "No *Campodeidae* could be found in Ladak, in spite of considerable search being made." Some of the Thysanura on the other hand, such as *Ctenolepisma* sp. and **Machilanus Hutchinsoni,** found at 5315 m., were collected at very high altitudes in Indian Tibet.

DIPLURA

Family CAMPODEIDAE

Lepidocampa Weberi Oud.

A few specimens of this species, which is very widely distributed throughout central and south Asia, and in the Oriental Islands, such as Japan and the Philippines, were collected at (K 55) Kangan, Kashmir, 1810 m., under rotten wood and earth, 16 May 1932, and a single specimen at (K 2) Takht-i-Sulaiman, Srinagar, 1645 m., 20 March 1932.

Family JAPYGIDAE

Indjapyx Harrisoni sp. n.

Text-figures 1 and 2

Corpus stramineum abdomine a segmento septimo ocraceo, segmento decimo ferrugineo, forcipis marginibus nigrescentibus.

Caput supra setis sat longis (mm. 0.28 longis) c. 15 + 15 et setis nonnullis brevioribus et brevissimis instructum; antennae 34-articulatae (anormaliter in exemplo uno antenna laeva 33-articulata et in exemplo alio antenna laeva 33-, dextera 32-articulata), articulis primo et secundo setis brevibus et brevioribus paucis, articulis tertio et quarto etiam setis paucis sat longis (tertii externa mm. 0.26 longa), articulis ceteris, decimo sexto exempli gratia, dimidia parte distali setis brevioribus sat numerosis et setis nonnullis proximalibus brevibus et nonnullis apicalibus parum brevioribus, articulorum 4-6 trichobothris consuetis, articuli quarti trichobothrio supero, fore basali, longo. Maxillae primi paris lobus internus laminis pectinatis 5.

Thorax. Pronotum setis sat longis (ad mm. 0.28) 4 + 4, brevibus 3 + 3 et 6 + 7 brevissimis; mesonotum praescuto setis submedianis 1 + 1, scuto setis sat longis (lateralibus ad mm. 0.33) 5 + 5 et setis nonnullis brevioribus et brevissimis instructum, metanotum mesanoto simile. Prosternum antice setis 3 + 3 sat longis, setis submedianis et sublateralibus, 4 + 4 sat longis et setis nonnullis brevioribus et brevissimis.

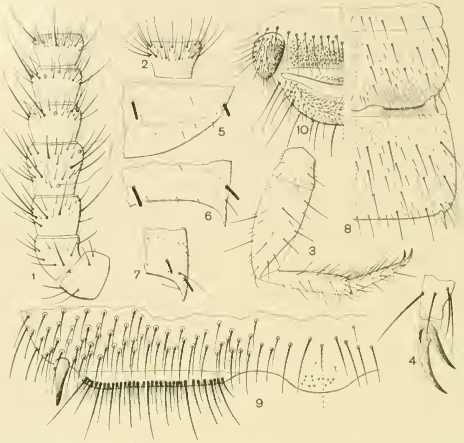


FIGURE 1. **Indjapyx Harrisoni**: 1, antennae dexterae pars proximalis prona; 2, ejusdem antennae articulus decimus sextus; 3, pes paris tertii a trochantero; 4, ejusdem pedis praetarsi apex et tarsus; 5, urotergiti sexti dimidia pars postica; 6, urotergiti septimi dimidia pars postica; 7, urotergiti octavi pars postica lateralis; 8, urosternitorum primi et secundi dimidia pars; 9, urosterni primi dimidia pars postica magis ampliata; 10, maris regionis genitalis dimidia pars.

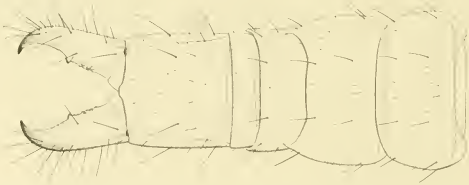


FIGURE 2. **Indjapyx Harrisoni**: abdominis pars postica a segmento sexto prona.

Pedes setis nonnullis brevibus et minus numerosis brevioribus et brevissimis instructi, tertii paris tibiae seta apicali mm. 0.13 longa, tarsi setis inferis etiam mm. 0.10-0.14, praetarso quam tarsus parum magis quam dimidium breviore, ungue postico quam anticus aliquantum longiore, unguicula mediana attenuata.

Abdomen. Tergitum primum praescuto eidem metanoti simili, scuto setis duabus submedianis subanticis brevioribus, duabus submedianis subposticis brevibus et setis nonnullis brevissimis, tergitum secundum etiam seta submediana sublaterali brevi et seta postica sublaterali brevi instructum; tergita 3-7 setis brevibus 5 + 5, setis brevioribus paucioribus et nonnullis brevissimis; tergitum sextum angulis posticis rotundatis; tergitum septimum angulis posticis retrorsum mm. 0.28 productis et parte apicali angustiore acuta; tergitum octavum lateribus postice acute aliquantum productis.

Urosternum primum organis subcoxalibus inter sese parum magis quam unius latitudo sitis, serie transverse setarum glandularium c. 32, longitudine inaequalium (mm. 0.06-0.08 longis) et serie postica setarum minimarum instructis, organo glandulari mediano parvo disculis 13 instructo, superficie pone organa subcoxalia setis brevibus (mm. 0.06-0.08), numerosis, transverse 3-5 inordinatim seriatis, pone organum glandulare medianum uniseriatis et setis minimis submedianis 1 + 1 subposticis, superficie cetera setis paucis brevibus transverse 4-subseriatis et setis brevioribus et brevissimis sat numerosis instructa; urosterna cetera setis paucis brevibus 4-subseriatis et setis brevioribus et brevissimis instructa, vesiculis minimis, stilis conicis consuetis.

Segmentum decimum supra mensum subaeque longum atque latum, acropygio parvo transverse rugoso, carinis lateralibus parum abbreviatis, superficie supera setis 3 + 3 sat longis, 4 + 4 brevibus et nonnullis brevissimis instructum. Forceps brachiis subsimilibus, dente submediano sat magno, margine praedentali tuberculis superis duobus et tuberculis inferis 4-6 (in exemplo uno tribus sed majoribus quam tubercula exemplorum ceterorum), margine postdentali denticulato vel crenulato.

Femina mari similis sed urosterni primi organis subcoxalibus setis glandularibus parum minus numerosis (ad c. 20) instructis.

Long. corporis ad mm. 10.5; lat. urotergiti septimi 1.24; long. antennarum 2.5; long. pedum paris tertii 1.80.

Habitat. Exempla typica tria vidi ad "Ponds beyond Cemetery, Pykara Rd., near Ootacamund, under leaves and moss, alt. c. 2195 m., 6 November 1932," lecta et tria ad "N 17 Ootacamund, by dam above Dhobi's quarter, alt. c. 2316 m., 15 November 1932."

Indjapyx Petrunkevitchi sp. n.

Text-figures 3 and 4

Corpus stramineum abdomine a segmento septimo ochroleuco forcipis marginibus fuscis.

Caput supra setis sat longis (ad mm. 0.13) c. 15 + 15 et setis minus numerosis brevioribus et brevissimis instructum. Antennae 30-articulatae, articulis primo et secundo setis nonnullis brevibus et brevioribus, articulis a tertio (praesertim tertio et quarto) setis nonnullis sat longis (tertii supera externa mm. 0.12 longa), articulis ceteris decimo quinto exempli gratia dimidia parte distali setis proximalibus brevibus et ceteris 1-2 transverse seriatis aliquantum brevioribus instructis, articulis 4-6 trichobothriis consuetis, quarti supero dorsuali subbasali longiore; maxillae primi paris laminis pectinatis 5.

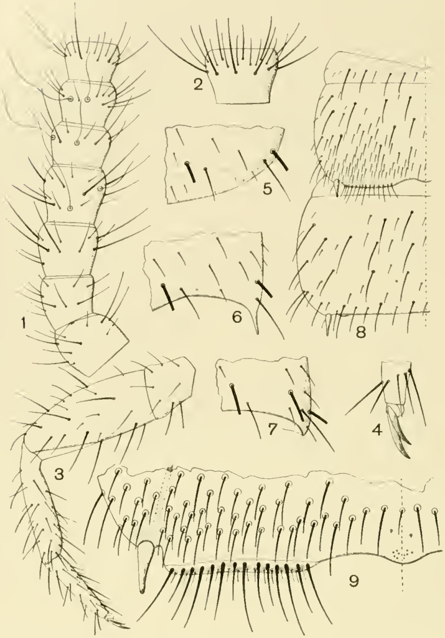


FIGURE 3. **Indjapyx Petrunkevitchi**; 1, antennae dexterae pars proximalis prona; 2, antennarum articulus decimus quintus magis ampliatus; 3, pes paris tertii a trochantero; 4, ejusdem pedis tarsi apex et praetarsus; 5, urotergiti sexti dimidia pars postica; 6, urotergiti septimi dimidia pars postica; 7, urotergiti octavi pars postica lateralis; 8, urosternitorum primi et secundi dimidia pars; 9, urosterniti primi partis posticae dimidia pars.

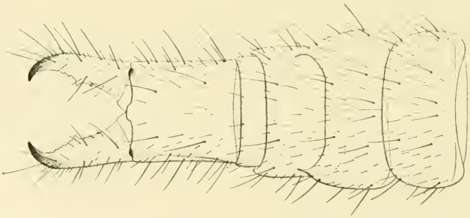


FIGURE 4. **Indjapyx Petrunkevitchi**: abdominis pars postica a segmento sexto prona.

Thorax. Pronotum setis sat longis (ad mm. 0.18) 5 + 5, setis brevioribus 4 + 4, et nonnulla brevissima; mesonotum praescuto setis submedianis sat longis 1 + 1, scuto setis longis (lateralibus mm. 0.23) 5 + 5 et setis c. 15 + 15 brevibus et brevioribus, metanotum mesonoto simile. Prosternum antice setis 3 + 3 sat longis, setis 4 + 4 brevibus vel sat longis (lateralibus subposticis) et setis nonnullis brevissimi instructum; sterna cetera similia.

Pedes setis sat longis, brevibus et brevioribus nonnullis instructi, tibiae seta apicali infera mm. 0.09 longa, tarsi setis inferis apicalibus 0.07 longis, praetarso quam tarsus aliquantum magis quam dimidium breviore, ungue postico quam anticus aliquantum breviore, unguicula mediana breviore.

Abdomen. Tergitum primum praescuto eidem metanoti simili, scuto setis submedianis subanticis brevibus, duabus submedianis subposticis sat longis et setis nonnullis brevissimis; tergitum secundum etiam seta submediana-sublaterali subantica et seta postica laterali sat longis instructum; tergita 3-7 setis brevibus vel sat longis 7 + 7, quarum subantica et submediana laterali, basi marginali infera, et setis brevissimis c. 20 + 20 instructis; tergitum sextum angulis posticis rotundatis, septimum angulis posticis retrorsum mm. 0.32 productis et parte distali angustiore acuta; tergitum nonum lateribus postice haud productis.

Urosternum primum organis subcoxalibus inter sese parum magis quam unius latitudo sitis, setis glandularibus 14 inter sese inaequalibus (mm. 0.20-0.28 longis) uniseriatis et setis posticis minimis etiam uniseriatis, organo glandulari mediano parvo, disculis c. 10 instructo, superficie ante organa subcoxalia setis numerosis brevibus transverse inordinatim 3-4 seriatis, ante organum glandulare medianum setis brevibus uniseriatis et setis minimis duabus submedianis subposticis, superficie cetera setis nonnullis brevibus 4-seriatis et setis nonnullis brevioribus vel brevissimis; urosterna cetera setis nonnullis brevibus transverse 4-seriatis et setis paucioribus brevissimis, vesiculis perparvis, stilis consuetis.

Segmentum decimum supra mensum subaeque longum atque latum, acropygio breviore, late rotundato, carinis parum abbreviatis superficie supera setis 10-10 sat longis et setis nonnullis brevioribus et brevissimis instructa. Forceps brachiis subsimilibus, dente submediano sat magno, margine praedentali tubercula supero et tuberculis 2-3 inferis parvis aucto, margine postdentali denticulato.

Long. corporis mm. 5; lat. urotergiti septimi 0.67; long. antennarum 1.60; long. pedum paris tertii 0.90.

Habitat. Exemplum descriptum ad "Takht-i-Sulaiman, Srinagar, 20 March 1932, alt. c. 1585 m.," lectum est.

Observatio. Species haec. clar. Prof. A. Petrunkevitch dicata, a specie praecedente abdomine parum magis setoso, antennarum articulorum numero et forcipis forma distinctissima est.

THYSANURA

Family LEPISMIDAE

Ctenolepisma longicaudata Esch.

Few specimens from (K 86) Cliff above Wakka Chu River, 2 miles West of Kargil at 2740 m. This species has a wide distribution, at least in Africa and Asia.

Ctenolepisma sp.

Specimens from (L 68), Camp below Anem La at 5315 m., 1 August 1932, are in poor condition and it can only be said that they are very similar to *Ct. mauritanica* (Lucos).

Ctenolepisma sp.

A few specimens, also in such a poor condition that a description cannot be given, were collected at (L 22) between Leh and Spitok (Spithug) at about 3350 m. The distribution of combs of setae of urotergites is as in the group *Ct. lineata*.

Lepidospora ceylonica Silv.

One female collected at (N 17) Ootacamund (Nilgiri Hills) 15 November 1932, has the same characters as are shown by the typical specimens, which I described from Ceylon. This species was also collected later at Rotuna and Kumaon so that it appears to have a wide distribution, from North India to Ceylon.

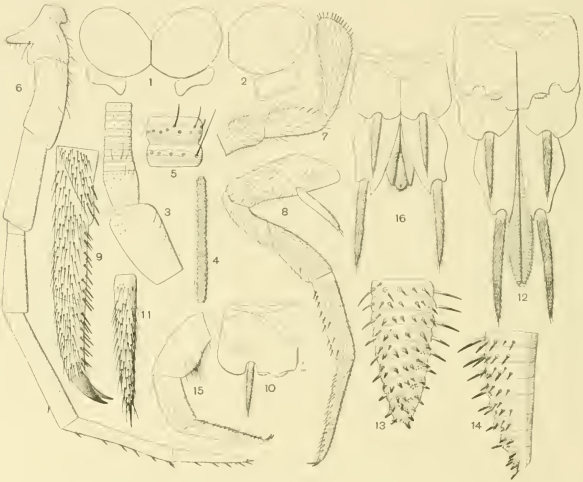


FIGURE 5. **Machilanus Hutchinsoni**: 1, oculi et ocelli laterales supra inspecti; 2, oculus et ocellus laevi supra parum oblique inspecti; 3, antennae pars proximalis; 4, ejusdem antennae partis distalis articuli duo; 5, ejusdem partis distalis articulini duo magis ampliati; 6, feminae palpus maxillaris; 7, feminae palpus labiallis; 8, feminae pes primi paris; 9, ejusdem pedis tarsus et praetarsus magis ampliati; 10, urosterni quinti dimidia pars; 11, ejusdem urosterni stilus magis ampliatus; 12, feminae urosterna 6 ^{um} ad 9 ^{um} cum ovipositore; 13, ovipositoris valvulae inferae laevae pars distalis; 14, ovipositoris valvulae superae laevae pars distalis; 15, maris pes paris primi a femore; 16, maris urosterna octavum et nonum cum pene et parameris.

Family MACHILIDAE

Machilanus Hutchinsoni sp. n.

Text-figure 5

Color ? (exempla typica squamis denudata sunt).

Oculi magni inter sese tractu quam oculi dimidia longitudine paullum longiore tangentes, oculus singulus c. 1/5 latior quam longior; ocelli laterales transverse subrectangulares oculi dimidiam latitudinem fere aequantes.

Antennae in exemplis typicis haud integrae, parte sistente mm. 8 longa, articulo primo fere duplo longiore quam latiore, flagello gradatim attenuato articulis distalibus partis sistentis (mm. 7.4 longa) articulinis 12-14 compositis, serie transversali setarum brevium et seta alia nonnulla breviore instructis; palpi maxillares gradatim attenuati, forma et armatura consuetis; palpi labiales articulo ultimo apicem versus gradatim parum latiore ut Text-figure 5, 7 demonstrat.

Thorax. Arcus thoracicus parvus late convexus; pedes primi paris femore et tibia quam ceteri parum crassioribus, secundi et tertii paris processu coxali longo, omnibus squamis paucis setis pernumerosis brevibus et tibia tarsoque infra setis brevibus robustis subspiniformibus biseriatis instructis.

Abdomen. Urosternum 2-6 pars mediana proximali lata, urosterni quinti exempli gratia c. duplo ad basim latior quam longior, subcoxarum angulo externo late subrotundato, angulo interno haud producto rotundato; vesiculae urosternorum 2+5 utrimque duae; stili urosterni quinti quam urosternum aliquantum breviores squamis paucis et setis brevibus numerosis, a basi ad apicem gradatim robustioribus, instructi.

Subcoxae urosterni septimi angulo interno retrorsum mm. 0.26 producto et margine rotundato, subcoxae segmenti noni angulo externo obtuso, angulo interno retrorsum acute aliquantum producto; stili segmenti noni quam subcoxae paullum breviores.

Ovipositor robustus plurianulatus, subcoxarum IX marginem posticum c. mm. 1.30 superans, anulis brevioribus, valvulis inferis anulorum superficie media setis nonnullis brevissimis, laterali setis brevibus et anulorum 6 posticorum setis brevissimis obtusis robustioribus ut Text-figure 5, 13-14 demonstrant instructis, valvulis superis magis attenuatis setis subsimilibus. Cercus medianus quam corpus aliquantum et quam cerci laterales fere triplo longior, setis ? (in exemplis tipicis abruptis).

Long. corporis ad mm. 13; lat. thoracis 3; long. antennarum ?; long. pedum paris tertii 5.5 stilorum IX-1.90, cerci mediani 14.

Mas. Palpi maxillares quam feminae paullum crassiores, setis? (in exemplo typico abruptis); pedes paris primi femore parte infera preapicale paullum inflata et setis brevibus numerosis sat robustis aucta.

Subcoxae segmenti octavi angulo interno oblique truncato, subcoxae segmenti noni angulo interno acute retrorsum aliquantum producti, stili subcoxarum longitudine aequantes.

Paramera apice attenuato ad stilorum basis libellam pertinentia, setis brevissimis numerosis instructa, penis quam paramera paullum longior.

Habitat. Exempla typica ad "Camp below Anem-la, L 68 at 5315 m., 1 August 1932," lecta vidi et exemplus paratypicum ad "Slope opposite Mulbe Gonpa, coll. G. E. Lewis, 27 May 1932."

ARTICLE XV

REPORT ON COLLEMBOLA

By J. R. Denis (Dijon)

(Received August 2, 1935)

Les difficultés de récolte, principalement aux hautes altitudes, ont fait que bon nombre d'échantillons ne sont pas en état satisfaisant et que certains d'entre eux ne sont pas étudiables. J'ai cependant fait en sorte—tout en sauvegardant leurs restes précieux—que les échantillons à peu près étudiables soient décrits aussi complétement que possible. Et si certaines de mes descriptions sont encore incomplètes, j'ai cru devoir les publier quand même, laissant à mes successeurs le soin de les parfaire.

Hypogastrura armata (Nic.)

Station: Edge of swamp, Phashakuri, near Pampur, 7–V–1932; 4 exempl.

Notes. Rapport Dens: mucron: 2.1 à 2.5. Rapport épine anale/g3: 1.2 à 1.6. Rapport épine anale/mucron: 1.7 à 2.1. Rapport g3/mucron: 1.20 à 1.45. Rapport mucron/post-antennal: 1.40 à 1.60. Caractères habituels, griffes avec une dent interne; ergots nets ou indistincts.

L'espèce peut être considérée comme à peu près cosmopolite.

Hypogastrura communis (Folsom)

Station: Gagirbal, swampy pond, 1580 m. alt., 1–IV–1932; 2 exemplaires.

Notes. Ces deux exemplaires concordent exactement avec ceux que j'ai pu voir jusqu' à présent, du Japon, de Chine et de Formose.

Friesea excelsa n. sp.

Text-figures 1-4

Station: Ororotse La, top, 5500 m. alt., 11–VII–1932; 4 exemplaires, qui me sont parvenus à sec et que j'ai dû traîter par la potasse.

Diagnose. Taille 1 mm. environ, couleur noire. Pas d'épines anales. Revêtement très incomplet, mais, à en juger d'après les insertions, il n'est pas impossible qu'il y ait eu des soies capitées sur le dos. 8 yeux par côté, avec deux soies sur chaque champ oculaire. Organites antennaires non étudiables, mais les poils olfactifs d'ant. IV sont nombreux, longs, courbes et très différenciés. Pièces buccales (Text-figures 1 et 2) indubitablement du genre *Friesea*. Griffes sans dent interne ni appendice empodial. Sur l'apex des tibias, il y a au moins deux cercles de soies effilées, courbées à l'apex et légèrement capitées. Tenaculum à deux dents bien nettes. Furca ayant un développement comparable à celui que montrent les espèces typiques d'Europe. Dens plus courte que la crête interne de g3, avec trois soies postérieures, sans mucron net—celui ci tout au plus représenté par un petit tubercule (Text-figures 3-4).

FIGURES 1–4. **Friesea excelsa** n. sp. (Obj. imm. 90 × oc.10), 1, mandibule. 2, maxille. 3–4, mucro-dens (assez déformé), tenaculum et g3.

Justification. Autant que je sache, la seule *Friesea* à 8 yeux par côté, connue jusqu'à présent est *F. grisea* (Schäffer), forme antarctique. Ses épines anales la séparent radicalement de la présente espèce.

Proisotoma ladaki n. sp.

Text-figures 5-8

Station: Mitpal Tso, N. edge., 16–VIII–1932; 6 exemplaires de 1 à 1.4 mm.

Diagnose. Taille maximum observée: 1.45 mm.; couleur gris uniforme clair, pouvant se foncer sur le dos. Yeux noirs, 8 omma. subégales, par côté avec 6-7 soies sur la plaque oculaire. Entre les antennes, une petite bande longitudinale pigmentée en noir occupe la place d'un ocelle. Postantennal de l'ordre de longueur de deux diamètres d' omma. Rapport post-

FIGURES 5–8. **Proisotoma ladaki** n. sp. 5, profil. 6, postantennal avec la longueur de l'appendice empodial (ae) et du mucron (m) à même échelle, pour le même exemplaire, 7: g3. 8, mucrodens, profil, face externe. 8A, un mucron à plus fort grossissement.

antennal/mucron: de 0.95 à 1.35, mais le plus souvent au voisinage de 1.0. Rapport g3/post-antennal: de 1.00 à 1.50, mais, semble-t-il, le plus souvent au voisinage de 1.40. Organites antennaires habituels, soies olfactives d'ant. IV, grêles et tubules d'org. ant. III, cachés ou découverts, inclinés ou droits selon l'état de turgescence de l'antenne. Antennes plus courtes que la diagonale de la tête, segments II et III subégaux, IV environ 1.5 fois le précédent. Tibias à subsegment distal incomplet mais très net, avec un certain nombre de soies grêles, effilées et un peu courbes à l'apex, mais qui ne sauraient passer pour des ergots différenciés (Text-figure 7), griffes minces et sans dent interne, appendice empodial effilé. Tenaculum à 3 dents et une forte soie au corpus. Furca de taille moyenne. Rapport Manubrium/dens-mucron: 1.0-1.2. Manubrium n'ayant, sur la face antérieure, que deux soies apicales. Dens (Text-figure 8) à face antérieure à 3 rangs de soies et munie de rides obliques, à face postérieure plutôt tuberculeuse qu'annelée, à deux rangs de soies. Mucron (Text-figures 8, 8A) plutôt court par rapport à la dens, à côte très courbe, mince et à trois dents, apicale plus petite, subapicale plus forte et externe sensiblement aussi forte que la subapicale; ces deux dernières sont reliées par une lamelle, les autres lamelles sont sensibles; la base du mucron est renflée sur sa face postérieure: il s'agit d'un prolongement du bord dental.

Justification. Cette *Proisotoma* (s. str.) semble bien séparée des espèces voisines de par son mucron. Une forme de mucron à peu près semblable se trouve chez *P. bayouensis* Mills (1931, Amer. Mus. novit., n°464, p. 2-3, figs. 1-6), trouvée en Louisiane. Ces deux espèces me semblent très voisines l'une de l'autre. Les seules différences portent sur la conformation des ergots (un seul, fort bien différencié dans l'espèce américaine)—cette différence est faible; sur le revêtement dental qui n'a, dans l'espèce américaine, de soies postérieures que dans la seule moitié apicale; enfin sur le nombre (4 contre 3) des dents du tenaculum. (Je n'ai pas observé le nombre 3 un nombre de fois suffisant pour affirmer que ce caractère signifie quelque chose.)

Ainsi, l'espèce la plus proche parente de notre forme du Ladak serait une forme de l'Amérique du Nord. Il est bien évident qu'on doit s'interdire, pour le moment, toute considération d'ordre biogéographique.

Isotoma spinicauda Bonet

1930. Bonet F., *Eos*, 6, p. 249-51, fig. 1.

Stations: Nyag-tzu, lower camp, Ladak, dry bank, 1–VIII–1932; 1 exempl. Ororotse-la, S. side, 5300 m. alt., 11–VII–1932; 2 exempl.

Mes exemplaires concordent fort bien avec les données de M. Bonet et il n'est pas douteux qu'on ait bien à faire à l'espèce indiquée. Celle ci n'est connue, pour le moment, que du Waziristan, près de la frontière de l'Afganistan. Comme l'a noté M. Bonet, elle est très voisine de l'*I. viridis* et risque fort d'être confondue avec cette dernière si on ne prend pas garde aux épines manubriales. M. Bonet indique encore d'autres affinités. A mon sens, il est permis d'admettre qu'*I. spinicauda* est une forme paléarctique, mais il est encore plus raisonnable de ne rien dire.

? *Orchesellides boraoi* Bonet

Text-figures 9-12

1930. Bonet F., *Eos*, 6, p. 253-5, fig. 2.

Stations: E. of Shakya-la, 5200 m. alt., 25–VI–1932.
Ororotse-la, S. side, 5300 m. alt., 11–VII–1932.
Marsimik La, under stones, 5600 m. alt., 16–VII–1932.

Remarques. Mes exemplaires sont en mauvais état et je ne puis étudier correctement leur coloration. Bonet donne une figure de l'ornementation mais signale que les dessins plus sombres peuvent s'estomper. Ce serait le cas de mes exemplaires. Même certains sont très pâles et presque sans pigment.

La taille peut atteindre 2.6 mm.

Je relève, entre la description de Bonet et mes exemplaires 1°) les ressemblances suivantes: Rapports Ant. II/I, III/II, les divers rapports tirés des griffes, en particulier A/I, qui varie de 1.25 à 1.45 et qui, d'après la fig. 2C de l'A., est de 1.45 et le rapport ae/d (3.10 d'après l'A.), içi 2.95 à 3.75.

Figures 9–12. *Orchesellides Boraoi* Bonet. 9–10, deux exemplaires, l'un bien coloré, l'autre pâle. 11-12, griffes et mucron (n'appartenant pas au même exemplaire).

2°) les différences suivantes: a) les yeux: je ne trouve que 6 yeux par côté (mais l'état des exemplaires ne permet pas une étude approfondie) et ce qui est plus grave, les yeux C et D me semblent subégaux aux yeux A et B et non pas plus petits comme l'indique la figure 2B de l'A. b) la région dentale non annelée est plus courte chez mes exemplaires que sur ceux de Bonet. c) Ant. IV/III est, selon l'A. 1.7 environ, tandis que je ne trouve que 1.2 à 1.4.

Il est aussi vain d'affirmer que ces différences sont spécifiques que de supposer le contraire. Seule l'expérience prouvera ce qu'elles valent. Pour le moment je me contente de mettre un ? devant ma détermination; mais ce qui importe surtout, c'est la très proche parenté entre mes exemplaires et ceux de Bonet.

Les exemplaires de M. Bonet proviennent du Wasiristan, près de la frontière afgane, et d'altitudes supérieures à 1000 m.

Sur le genre *Orchesellides* Bonet.—J'adopte ce genre pour de simples raisons de commodité, mais je crois devoir faire, à son sujet, les réserves suivantes.

1) Il ne se distingue pas d'*Orchesella* par le nombre d'yeux, car on sait que les *Orchesella* peuvent avoir 8 yeux (G. et H. réduits) ou seulement 6. On sait aussi que, dans la pratique, le nombre des yeux est souvent indéterminable.

2) Il ne se distingue pas d'*Orchesella* par la présence d'une soie lisse en face de l'ergot de p. 3, car cette soie lisse existe chez *Orchesella*.

3) L'absence de subsegmentation d'ant. Il le distingue assurément des *Orchesella* européennes. En sera t-il toujours ainsi quand on connaîtra mieux des *Orchesella* exotiques telles que mon *O. sinensis* où la subsegmentation en question est fort peu nette? On sait ce que vaut ce caractère chez *Dicranocentrus* et *Heteromurus*: pas grand chose.

4) La massue trilobée de l'apex d'ant. IV constitue, jusqu' à nouvel ordre, le meilleur caractère distinctif qu'ait invoqué M. Bonet. Ce n'est pas qu'*Orchesella* soit dépourvu d'un lobe plus ou moins saillant à l'apex d'ant. IV, mais *Orchesellides* exagère la saillie et la trilobe. Il ne me semble pas que l'organite en question puisse être dit rétractile. En tout cas, il n'est aucunement comparable à la massue rétractile des *Entomobrya*.

On pourra penser que les caractères justificatifs du genre *Orchesellides* sont plutôt suspects et qu'on ne manquera pas de trouver des formes telles qu'on ne saura si elles appartiennent à *Orchesella* ou *Orchesellides*. *O. sinensis* m. en est une sans doute (mais je n'en ai pas vu assez d'exemplaires pour l'affirmer).

Mais, *provisoirement*, l'*Orchesellides* de M. Bonet est assez distinct des Orcheselles connues jusqu'à ce jour pour mériter d'en être séparé, afin d'alléger la classification, si peu claire, des *Orchesella*.

Sira brahamides n. sp.

Text-figures 13-16

Stations: Karpet, S. shore of Panggong Tso c. 4250 m., damp grassy place, 8–VII–1932; 2 exempl.
Tang-yar. Ladak. 4400 m. alt. env., under stones in stream, 24–VI 1932; plusieurs exemplaires mais si détériorés que leur étude est impossible. Rapportés avec doute à l'espèce ci-dessus.

Description. Taille: 1.6 mm. env., presque incolore; sur la tête, seules les plaques oculaires et l'ocelle sont noirs. Aucune bande ne relie les yeux à l'ocelle (Text-figure 13). Avec les caractères habituels du genre (Ecailles pointues, costulées; pas d'écailles dentales et mucron complet) on notera la très grande minceur des écailles et la largeur relativement grande de l'appendice empodial qui est du type aigu. Les antennes sont cassées mais devaient avoir la taille habituelle. Une étude statistique des éléments des griffes et de la furca est impossible et on devra se contenter des figures ci-jointes.

Justification. Le genre *Sira*, tel que le comprennent la plupart des auteurs, peut se décomposer en deux groupes A et B avec un groupe AB (intermédiaire?).

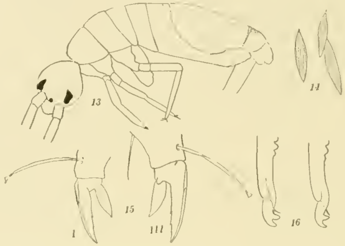
A. Appendice empodial tronqué: *S. formosana* m. et *S. hyalina* Handschin

AB. Appendice empodial paraissant tronqué ("schrag abgestutzt" dit l'A.), sans doute effectivement tronqué, mais sans que les figures ou les textes permettent de l'affirmer formellement: *Sira abrupta* Schött, *S. binoculata* C. B.

B. Appendice empodial aigu: les autres espèces.

Notre **S. brahamides** appartient à ce groupe B. A l'intérieur du groupe B, on est forcé de s'en tenir à des caractères d'ornementation et de répartition géographique: critériums détestables.

Laissant de côté le groupe *S. platani* Nic., révisé par HANDSCHIN et fait de formes d'Europe et d'Amérique du Nord, nous avons outre une série d'espèces colorées, toutes caractérisées par la tendance à former des bandes transverses: *S. intermedia* Schött (de Juan Fernandez), *S. Jacobsoni* C. B. (de l'Archipel Malais, de l'Inde et des iles Hawai), *S. japonica* Folsom (du Japon), *S. parajacobsoni* m. (de Madagascar) ; *S. purpurea* Schött



FIGURES 13–16. **Sira brahamides** n. sp. 13, profil. 14, écailles d' abd. II. 15, gl(I) et g3(III). 16, mucrons.

(de Californie—d'ailleurs douteuse en tant que *Sira*), *S. tricincta* Schött (du N. Queensland) et *S. variabilis* Schäffer (de la Terre de Feu). Je laisse de côté la forme hongroise: *S. pallidipes* Reuter, que M. STACH signale dans son travail sur les Collemboles de Hongrie, mais qu'il ne doit pas avoir revue.

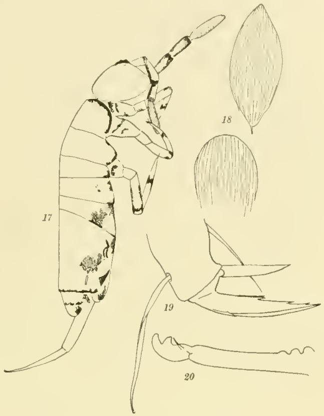
La seule *Sira* incolore ou à pigment uniformémént réparti, donc comparable à la notre, est *S. brahama* Imms (Proc. zool. soc. London, 1912, p. 99, Pl. 8, figs. 43-44). Mais les descriptions de IMMS sont tellement imprécises, qu'on ne peut tabler sur elles. Ainsi l 'A. indique une griffe à deux dents, mais je me garderai bien de tabler sur cette particularité. Cependant l 'A. figure un appendice empodial si allongé que je crois pouvoir justifier mon espèce en me fondant sur la différence de forme des appendices empodiaux. Il s'agit d'une justification très provisoire et je ne m'illusionne pas sur sa valeur. *S. brahama* vient d'Allahabad. IMMS la décore du nom d'espèce orientale. Je me garde de toute opinion sur les affinités des *Sira*.

Sira nilgiri n. sp.

Text-figures 17-20

Station: Hill south of Ootacamund, Rhododendron, env. 2378 m. alt., 13–XI–1932; 1 exempl.

Description. Taille 1.5–1.6 mm., aspect général et dessins cf. Text-figure 17. La plupart des écailles sont pointues, mais certaines sont arrondies au bout libre (Text-figure 18) ; toutefois leur striation est celle des *Sira* typiques. Antennes environ 1.5 fois la diagonale de la tête, avec anneaux apicaux relativement nets et ant. III plus court que II. Griffes assez étroites (Text-figure 19), appendice empodial étroit avec aile postéro-interne nettement crénelée. Cet appendice est du type aigu encore que, sous certaines incidences, les deux ailes externes puissant sembler confondues sur leur trajet apical (Nota: L'existence d'une telle



FIGURES 17–20. **Sira nilgiri** n. sp. 17, profil. 18, écailles. 19–20, g3 et mucron au même grossissement (Obj. 90 × oc.10).

disposition m'empêche de considérer les formes du groupe AB comme véritablement tronquées). Rapport manubrium/dens-mucron: 0.85 à 0.90. Région non annelée de la dens et mucron du type habituel. Rapport ae3/mucr.: 1.70.

Justification. L'appendice empodial est étroit et long comme chez *S. brahama* Imms, mais le type d'ornementation est différent, cette dernière ayant une pigmentation uniforme. Je m'abstiens de toute considération de parenté.

Parasira subornata n. sp.

Text-figures 21-26

Stations: Dambu-guru, Ladak, 4603 m. alt., dry bank, 1 VIII 1932; 1 exempl.
Takht-i-Sulaiman, Srinagar, 1585 m. alt., 20–III–1932; 3 exempl.

Description. Taille: 2.4–2.8 mm. Aspect général et dessins: cf. Text-figures 21, 22. Ecailles allongées, aigues du type *Sira*; face antérieure de la furca sans écailles. Yeux conformes à la figure 7C de BONET pour *P. ornata*. Antennes sans écailles Rapport: Ant./diag. céph.: 2.20 à 2.55. Rapport: tronc/ant.: 1.4 à 1.6 Ant. II aussi long ou un peu plus long que III. Ant. IV/III: 1.05 à 1.15. Massue apicale présente à ant. IV. Pas d'écailles sur les pattes. Tibias II nettement plus longs que tibias I. Griffe conforme à celle de *P. ornata* Bonet et n'en différent que par la position plus distale des dents latérales (et de la dent externe—que Bonet ne figure pas). L'appendice empodial, du type aigu, montre sur l'aile habituelle de très fines crénelures (Text-figure 25). Rapport mucro-dens/manubrium: 1.15 à 1.30. Région dentale non annelée finissant graduellement. Mucron (Text-figure) en crochet à épine basale.

Figures 21–26. **Parasira subornata** n. sp. 21–22, deux types d'ornementation. 23, cornéules en vue oblique. 24, écailles d'abd. IV (obj. 60 × oc.10). 25, g1(I) et g3(III) et 26, mucron au même grossissement (Obj. 90 × oc.10).

Justification. Cette espèce est extrêmement voisine de celle de Bonet. Le type d'ornementation est sensiblement de même. Dans l'un de mes échantillons, on voit même une bande transverse sombre sur le dos d'abd. III. Cependant mes échantillons ne montrent pas la fine bande médiane figurée par Bonet (Text-figure 7A). Cette legère différence ne m'empêcherait certes pas de faire rentrer mes exemplaires dans le cadre de *P. ornata* et, si j'établis **P. subornata,** c'est principalement à cause de la position, nettement plus distale, chez celle ci, des dents latérales de la griffe. Je ne serai d'ailleurs pas surpris qu'on vienne à montrer que ce caractère est variable et qu'on réunisse **P. subornata** à *P. ornata*.

Notes sur le genre Parasira Bonet.

M. F. Bonet (1930, *Eos*, 6, p. 263 & seq.) a établi le genre *Parasira* pour séparer des *Sira* les formes à mucron falciforme et pourvu d'une épine basale.

Jusqu'à présent je n'ai pas montré beaucoup d'ardeur à adopter les diverses classifications du groupe—*Sira-Lepidocyrtus* et je reste encore très sceptique sur les genres *Pseudo-*

sira, Mesira et *Lepidocyrtinus*—tout en reconnaissant que M. Bonet ait beaucoup clarifié les choses. En particulier je connais des formes (telles que *Lepidocyrtus vexans* m.) qu'on ne saurait actuellement classer. De plus j'estime qu'on doit laisser tomber le mot *Mesira*, car personne ne saura jamais ce que fut la *Mesira squamoornata* de Scherbokow—qui, par son ornementation se rapprochait sans doute du *Lepidocyrtinus Dollfusi* Carl: forme rare que peu d'auteurs ont vue. Cependant je souscris pleinement au genre Parasira de M. Bonet et j'y inscris les espèces suivantes:

Seira frigida Imms 1912, *P. ornata* Bonet 1930, *Seira pallida* Brown 1926, **P. subornata** m. et *Sira villosa* Börner 1903.

Toutes ces formes me semblent bien présenter les particularités requises pour faire partie du genre *Parasira*. On remarquera que l'aire de dispersion géographique du genre (tel qu'il est actuellement composé), comprend la Mésopotamie, le Wasiristan, l'Himalaya (Garhwal), le Kashmir, le Thibet occidental et le Japon. En dehors de cette aire, le groupe est encore inconnu.

Lepidocyrtinus unifasciatus n. sp.

Text-figures 27-30

Station: Edge of Phashakuri, near Pampur, env. 1585 m. alt., 7-V-1932; 3 exempl.

Description. Taille: 1.4 mm. env. Blanc avec une fascie noire sur le dos d'abd. III. Yeux noirs et individualisés ou à peu près (Text-figure 28), pas de bande les reliant à l'ocelle. Antennes de 0.6 fois la longueur du tronc, à segments II et III subégaux, à segment IV env. 1/3 plus long que III et non annelé—ce qui devrait faire placer l'espèce dans

Figures 27-30. **Lepidocyrtinus unifasciatus** n. sp. 27, profil. 28, tache oculaire. 29, écaille. 30, mucron.

le genre (ou sous-genre) *Pseudosira* et je l'y placerais si j'étais convaincu que les jeunes *Pseudosira* ne deviennent jamais des *Lepidocyrtinus* en vieillissant et si j'étais certain que mes exemplaires soient bien des adultes. Il y a naturellement une massue apicale à ant. IV et les antennes sont très pâles. Les écailles ovales ont l'ornementation habituelle et il y a naturellement des écailles sur la face antérieure des dentes. Griffes du type habituel, appendice empodial aigu (non tronqué) avec une ciliation longue et fine sur l'aile postéro-interne. A titre d'indication, voici quelques rapports tirés d'un seul exemplaire: A/B de 1.90 à 2.05; A/D: 1.30 à 1.35; A/D': 1.10 à 1.15; A/e: 1.95 à 2.10; A/1: 1.95 à 2.35; A/ae: 1.50

à 1.60; Δ/E: 1.05 (p. I), 1.00 à 1.05 (p. II), 0.95 (p. III); ae3/m: 2.30; rna/m: 1.5 à 1.8. Mucro-dens nettement plus long que le manubrium, région dentale annelée finissant brusquemment, mucron en crochet simple, sans épine basale.

Justification. En systématique de *Lepidocyrtinus*, nous en sommes réduits à comparer principalement des ornementations. Les deux formes qui me semblent les plus proches de la présente sont: *Lepidocyrtinus Schäfferi* (Schött), forme de Nouvelle Guinée, de l'île Seleo et des Philippines, décrite par SCHÖTT (1901, Ter. Fuz., p. 323, figs. 31-9) et revue par HANDSCHIN (1930, Philipp. Journ. sci., 42, p. 417, figs. 24-7). Cette espèce est plus colorée que la présente, ant. IV y est annelé (encore que les exemplaires d'H. n'aient qu'environ 2 mm.). Au sujet de l'appendice empodial SCHÖTT écrit: "Untere Klaue lancettenähnlich, nicht schräg abgestutzt, unbewaffnet." et HANDSCHIN: "Empodialanhang schmal, nach aussen, schräg zugespitzt." C'est dire que les auteurs ne sont pas précisément d'accord et qu'il est bien probable que l' on doive considérer deux espèces là où HANDSCHIN n'en fait qu'une seule. Je puis affirmer que notre **unifasciatus** n'est pas celle de M. HANDSCHIN. Je serais moins affirmatif touchant celle de SCHÖTT, encore que l'ornementation puisse sembler m'autoriser à l'être.

La seconde espèce à prendre en considération est celle que RITTER (1910, Ann. k. k. naturh. Hofmus., 24, p. 391-4, figs. 44-6) a décrite sous le nom de *Calistocyrtus indicus*. et dont BONET (1930, *Eos*, 6, p. 260-1, fig. 5) fait, à juste titre, une *Pseudosira*. Cette espèce est plus colorée que la nôtre; en particulier, la bande sombre transverse occupe le dos d'abd. III et II et il y a une bande transverse au bord postérieur d'abdomen IV. Je crois pouvoir considérer **L. unifasciatus** comme très voisin de *L. indicus* (Ritt.).

L'affinité de *L. unifasciatus* avec deux formes appartenant à la faune dite orientale ne doit tromper personne car personne n'oserait dire la parenté des *Lepidocyrtinus*.

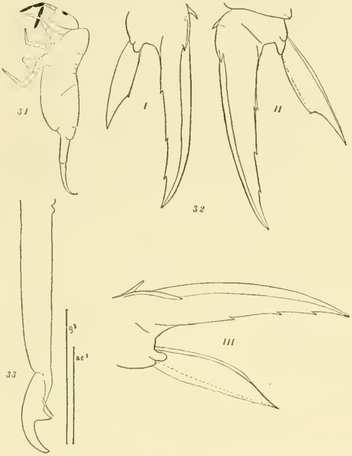
Lepidocyrtus orientalis E. Handschin

Text-figures 31-33

Station: Ootacamund, under leaves and moss, 2195 m. alt., environ, Nilgiri Hills, 6–XI–1932; 1 exempl.

Description. Taille: 2.4 mm. Coloration pâle, pratiquement sans pigment, alors que la fig. 17 de HANDSCHIN (1929, Rev. suisse Zool., 36 p. 242) en indique sur les coxae; ant. III et IV violet foncé, moitié apicale d'ant. II un peu colorée (concordance avec les données de l'A); écailles du type *Lepidocyrtus*. Taches oculaires noires à 8 yeux dont deux plus petits; ant. II, III, IV subégaux et IV pourvu d'une massue apicale rétractile (non notée par l'A). Rapport tronc/ant.: 2.15; rapp. ant./diagonale céphalique: 1.65 Mésonotum un peu débordant. Tibia III/I: 1.85. Ergots non étudiables. Griffes à 4 dents internes, dents latérales bien écartées et dent externe en pointe très détachée. Appendice empodial nettement du type tronqué à p. I et II, mais, à p. III, la troncature est peu nette et il semble bien que les deux lamelles externes se poursuivent jusqu'à l'apex, très rapprochées mais non soudées. Aile postéro-interne à denticulations presque indistinctes. Rapports: A/B: 3-3.4 (p. I), 2.85-3.15 (p. II), 2.5-2.6 (p. III); A/D: 1.75-1.90 (p. I), 1.70-1.75 (p. II), 1.55-1.60 (p. III); A/D': 1.25-1.30 (p. I), 1.25 (p .II, III); A/1: 1.0-1.1 (p. I), 1.1 (p. II), 1.2 (p. III); A/e: 0.9 (p. I, II), 0.95 (p. III); A/ae: 1.7-1.8 (p. I), 1.4-1.5 (p. II), 1.5 (p. III). Manubrium subégal au mucro-dens; pas de lobe particulier à la racine des dentes; région dentale non annelée 2.05 fois le mucron. Mucron complet à dent apicale longue et épine basale. Rapport: ea3/mucron: 1.25.

Justification. La diagnose de *L. orientalis* est forte courte. L'A. ne signale pas la massue apicale d'ant. IV et ne figure pas complétement la griffe. Ma détermination doit donc comporter certaines réserves.



FIGURES 31–33. *Lepidocyrtus orientalis* E. Handschin. 31, profil. 32, g1(I), g2(II) et g3(III) (Obj. 90 × oc.10). 33, mucron avec longueur de g3 et d'ae3 à la même échelle (Obj. 60 × oc. 10).

L. orientalis me semble très voisin de *L. caeruleicornis* Bonet (1930, *Eos*, 6, p. 262, fig. 6), des environs de Bombay. Mais l'A. dit formellement (p. 263) "appendice empodial lancéolé, non tronqué." Pour cette raison je ne puis songer à une synonymie. Il y aurait, entre *L. orientalis* et *L. caeruleicornis* les mêmes différences qu'entre nos *L. ruber* et *lanuginosus*. Il y a aussi, dans RITTER (l. c., p. 390) un *L. scaber*, de Peradenya, qui pourrait bien entrer en ligne de compte, s'il était mieux connu.

Nota. M. BONET inscrit parmi les *Lepidocyrtus* son *L. caeruleicornis,* pourvu d'une massue apicale à ant. IV. Jusqu'à nouvel ordre, je suis l'exemple de M. BONET.

Répartion géographique. HANDSCHIN indique, pour *L. orientalis,* plusieurs stations des Nilgiris, de 1600 m. à 2400 m. d'altitude. Autant qu'on puisse juger, *L. orientalis* présente de proches parents dans la faune orientale, mais il n'est pas impossible qu'on lui en trouve d'aussi proches ailleurs (*L. ruber* par exemple).

Paronella (*Aphysa*) *longicornis* (Oudemans)
Text-figures 34-35

Station: Pykara, env. 2133 m. alt., on wet, earthy cliff, 16–XI–1932; 4 exempl.

Remarques. En rapportant, avec quelque doute, mes exemplaires à l'espèce d'Oudemans, je dois dire que j'adopte l'idée que M. Handschin (1925, Treubia, p. 261) se fait de ladite espèce. En particulier j'admets que "Typisch ist die Anlage eines kleinen Aussenzahnes, sodass das Gebielde (Mucro) 7-zähnig wird." On sait que Schött ne signale pas cette petite dent.

Figures 34–35. *Aphysa longicornis* (Oud.). 34, deux types de coloration. 35, deux profils de mucrons en vue externe.

Je range mes exemplaires dans le genre (ou sous-genre) Aphysa encore qu'ils présentent, entre l'apex de la dens et la base du mucron, une petite saillie—sans doute articulaire—pouvant rappeler l'appendice dental des *Microphysa*.

Paronella longicornis, selon Handschin (1930, Philippine j. of Sci., 42, p. 424) est largement répandue sur toute la région orientale (l'A. la note aux Philippines) et (l. c., p. 421) fort peu variable, quant à la coloration, dans toute son aire.

Il n'est peut-être pas inadmissible que nos exemplaires des Nilgiri-hills appartiennent à cette espèce si répandue. Cependant, afin d'éclairer ceux qui reprendront la question, je donnerai la description desdits exemplaires.

Trois exemplaires ont de 3.2 à 3.8 mm., le quatrième a env. 5 mm. Les Text-figures 34-35 donnent une idée de leur coloration et j'ajoute que les tibias sont toujours violacés. Ant. I/II varie de 1.00 à 1.15; tibia I/II varie de 1.10 à 1.15; tibia III/I: de 1.05 à 1.25; mucro-dens/manubrium varie de 1.35 à 1.50. Voici, pour les trois premiers exemplaires les rapports conçernant les griffes: A/B: 3.8-4.1 (p. I), 3.3-3.7 (p. II), 2.6-3.0 (p. III); A/D: 1.5-1.6 (p. I), 1.4-1.5 (p. II), 1.4-1.5 (p. III); D' manque toujours, de même: impossible de voir la dent externe (e); A/I: 1.2-1.4 (p. I), 1.4-1.5 (p. II), 1.3-1.7 (p. III);

A/ae: 1.6-1.8 (p. I), 1.4-1.5 (p. II), 1.2-1.3 (p. III); appendice empodial tronqué avec denticule et aile postéro-interne crénelée; rapport ae/d (d étant la longueur de la troncature): 1.8-2.1 (p. I), 1.9-2.0 (p. II), 1.9-2.1 (p. III); E/A: 1.1-1.2 (p. I), 1.2-1.3 (p. II), 1.1-1.4 (p. III). Les figures ci-jointes donnent une idée de la structure du mucron—très comparable à celle qu'admet HANDSCHIN—et montrent le lobe articulaire dento-mucronal. Il n'est pas impossible que cette formation soit homologue à la vésicule des *Microphysa*. Rapport mucron/ae3: de 1.3-1.6.

Le grand exemplaire de 5 mm. doit sans doute être traîté à part—les coordonnées logarithmiques seraient peut être indiquées ici, si j'avais un plus grand nombre de données ma disposition.—A/B: 3.0-3.2 (p. I), 3.3 (p. II), 2.5-2.8 (p. III); A/D: 1.4 (p. I, II, III); D'et e manquent; A/1: 1.8(p. I), 1.6(p. II), 1.6-1.7(p. III); A/ae: 1.4-1.5(p. I et II), 1.2(p. III); ae/d: 1.8(p. I, II), 1.9-2.0(p. III); E/A: 1.0-1.1(p. I, II, III); mucro/ae3: 1.1-1.2.

S'il ne s'agit pas—ce qu'on saura plus tard—exactement de l'espèce d'OUDEMANS-HANDSCHIN, il s'agit à coup sûr d'une forme très voisine. En tout cas, on devait s'attendre à trouver, dans le matériel de la Yale North India expedition, des *Aphysa* et des *Microphysa*. Il s'agit de types caractéristiques de la faune orientale.

Salina celebensis (Schäffer)

Text-figures 36a, b, c

Stations. Ootacamund (Hill. south of.), 2378 m. alt. environ, Rhododendron, 13–XI–1932; 6 exempl. Ootacamund, dam above Dhobi's quarter, 2316 m. alt. env., 15–XI–1932; 2 exempl.

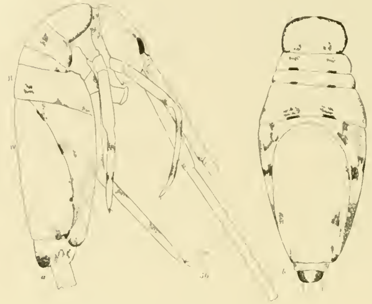
Description. Tailles: 2.3-3.3 mm. En ce qui conçerne la coloration, les Text-figures 36a, b, c montreront les types notés. Il m'est absolument impossible de les séparer de ceux que j'ai pu étudier d'Indo-Chine et dont j'ai donné la description (1935, Bull. soc. entom. Fr., p. 138-42).

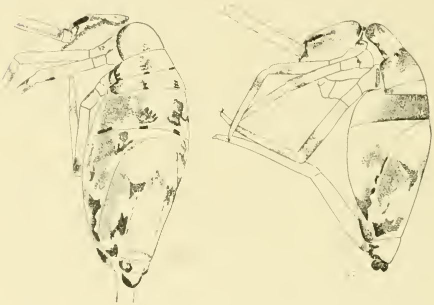
En ce qui conçerne les caractères morphologiques, je ne vois aucune possibilité de distinguer spécifiquement ces exemplaires de ceux d'Indo-Chine. On comparera les chiffres suivants à ceux que je donne dans le travail ci-dessus indiqué.

(Nota) les chiffres suivis d'un ° se rapportent à la forme dubiosa nov. (*ut species*) dont je parlerai plus loin.

Rapport A/Ba-p: 2°(3.0), 3(3.25), 1(3.50), 7(3.75), 9(4.00), 2(4.25), 5(4.50) pour p. I; 3(3.00), 1(3.25), 5(3.50), 5(3.75), 3(4.00) pour p. II; 1(2.75), 5(3.00) et 2°(id.), 9(3.25), 7(3.50), 2(3.75) pour p. III. Tableau très semblable au correspondant des formes indochinoises. Rapport A/D: 1(1.3), 2(1.35), 5(1.40), 3(1.45), 2(1.50) à p. I; 3(1.35), 4(1.40), 2(1.45) . . . 1(1.55) à p. II; 1(1.30), 2(1.35), 7(1.40) et 1°(id.), 2(1.45) à p. III; même conclusion que ci-dessus. Rapport A/D': 2(1.15), 7(1.20), 3(1.25) à p. I; 4(1.15), 4(1.20), 2(1.25) à p. II; 1°(1.10), 2(1.15), 8(1.20); même conclusion. Rapport A/e: 7(0.9) à p. I; 6(0.9) à p. II; 7(0.9) et 1°(id.), 2(1.0) à p. III; mêmes conclusions. Rapport A/1: 1(0.9), 3(1.0), 6(1.1), 3(1.2) à p. I; 4(1.0), 7(1.1) à p. II; 1(0.9), 9(1.0) et 1°(idem), 5(1.1), 1(1.2) à p. III; mêmes conclusions. Rapport A/ae: 1(1.4), 1(1.5), 3(1.6), 5(1.7) à p. I; 5(1.4), 3(1.5), 1(1.6) à p. II; 5(1.4) et 1°(idem), 4(1.5) à p. III; mêmes conclusions, Rapport ae/d: 1(1.6), 2(1.7), 3(1.8), 4(1.9), 1(2.0)

... 1(2.3) à p. I; 3(1.8) ... 5(2.0) ... 2(2.6) à p. II; 1(2.0) ... 2(2.2), 3(2.3), 2(2.4) ... 1(2.6), 1(2.7) et 1° (idem) ... 1(2.9) mêmes conclusions. Rapport E/A: 1(1.4), 1(1.6), 3(1.7), 4(1.8), 3(1.9) à p. I; 7(1.8) 2(1.9) à p. II; 1(1.6) et 1°(idem), 1(1.7), 7(1.8),





FIGURES 36a, b, c. Trois types de coloration de *Salina celebensis* (Schäffer).
FIGURE 37. **Salina dubiosa** n. sp., profil.

1(1.9), 1(2.0) à p. III; mêmes conclusions. Rapport mucron/g3: 4(0.95), 6(1.0), et 1° (id.), 1(1.05), 2(1.10); encore que les maximum soient déportés vers la gauche du tableau, on ne saurait fonder une distinction spécifique sur ce caractère. Rapport mucron/appendice dental: 1(1.3), 2(1.4), 6(1.5), 3(1.6); ce qui rentre dans les cadres donnés pour les formes d'Indochine. Rapport Dens/manubrium: 3(1.2), 3(1.3), 1(1.4) et 1 (id.); même conclusion.

En résumé: ni l'étude du dessin ni celle des principaux caractères morphologiques habituellement utilisés en détermination ne permet de distinguer ces exemplaires de ceux d'Indo-Chine. C'est pourquoi je leur attribue le même nom.

Il n'est pas impossible que le *Cremastocephalus indicus* de IMMS (1912, p. 104-5, figs. 58-9) doive rentrer dans le groupe dont le chef de file serait l'espèce de SCHÄFFER. Le *Cremastocephalus montanus* Imms présente un rapport mucron/appendice dental voisin de 1.0. J'ai trouvé ce rapport chez *S. celebensis* d'Indo-chine.

Salina dubiosa nov. sp.

Text-figure 37

Station: même localité que les précédents et récolté en même temps que les exemplaires du 15–XI–1932; 1 exemplaire.

Description. Caractères morphologiques compris au tableau précédent; mêmes aspects des griffes et du mucron. Coloration comme l'indique la Text-figure 37.

Justification. Le type de coloration diffère de tous ceux dont j'ai pu me procurer la figure et notamment de tous ceux que figure HANDSCHIN (1928, Treubia, 10) dans sa révision du genre. C'est donc uniquement faute d'intermédiaries entre les formes pâles, les formes à bandes ou séries de taches longitudinales et ce type à bande transverse, que je ne puis faire autement que de donner un nom au présent exemplaire.

Sminthurides aquaticus (Bourlet)

Text-figures 38-41

Station: Kyam. Small spring surface àt 35.5°, 4763 m. alt. env., 21–VII–1932; qq. exempl.

Justification. Je ne donne cette détermination que sous la réserve suivante: il s'agit d'une forme qui peut rentrer dans la compréhension actuelle de *Sminthurides aquaticus* (Bourl.). Il est possible que, quand cette dernière sera mieux connue, l'on doive renommer cette forme du Thibet. Afin de justifier ma détermination—en tant que première approximation—je crois devoir donner les Text-figures 38-41 qui serviront de points de comparaison.

La meilleure description que nous possédions de *S. aquaticus* est celle de BÖRNER (1901. Abh. naturwiss. Ver. Bremen, 17, p. 96 & seq.). En comparant mes figures à celles de BÖRNER, on trouvera sans doute de minimes différences, notamment sur l'antenne ♂. Cependant on ne saurait se défendre d'y trouver de grandes similitudes. De telles structures n'ont pas été étudiées systématiquement chez *S. aquaticus*. Il convient donc d'attendre qu'on sache leur valeur taxonomique. Pour le moment, afin de ne pas encombrer la nomenclature, je nomme mes exemplaires de Kyam du nom de *S. aquaticus*.

Répartition géographique. Que l'avenir démontre l'identité de mes exemplaires avec l'espèce d'Europe ou bien qu'il me contraigne à établir un noveau nom, il restera toujours ceci: on aura à faire à des formes excessivement voisines et on ne pourra se défendre de leur attribuer une origine commune.

S. aquaticus (Bourl.) existe certainement en Europe et on ne saurait douter que FOLSOM (1928, Mem. 101, Cornell. Univ. agr. exp. sta., p. 16) n'ait parfaitement raison quand il admet son identité avec la forme américaine *S. amicus* Fols. D'autre part, HANDSCHIN (1928, Arch. Naturg., 92, p. 8) le note d'Algérie. WOMERSLEY (1932, Conc. sci. ind. research, pamphl. n°34, p. 17) le signale d'Australie. Cependant je n'ose tenir pour assurée cette détermination (en particulier la fig. 4d de 1 'A., représentant un mucron, ne semble

FIGURES 38–41. *Sminthurides aquaticus* (Bourlet). 38, ant. II et III du ♂. 39, g2(II) et g3(III). 40, chétotaxie dentale en vue antérieure, côté médial à droite. 41, mucron, profil en vue externe.

pas s'accorder avec ce qu'on sait de *S. aquaticus*). Je crois donc, jusqu'à plus ample informé, laisser dans le doute la présence de *S. aquaticus* en Australie.

Dans l'état actuel de nos connaissances, on peut considérer *S. aquaticus* comme une forme paléarctique et néarctique. Sa présence dans le méditerranéen doit être affirmée par des stations plus nombreuses que celles qu'on possède actuellement. La présence de *S. aquaticus* au Thibet (ou d'une forme très voisine) indique, sans doute, une affinité paléarctique de la faune thibetaine.

Sminthurides (*Stenacidia*) *violaceus* (Reuter)

Text-figures 42-48

Station: Bao, East of Shakya la. surface of pool, 4616 m. alt. environ, 25–VII–1932; 1 exemplaire.

Justification. Je fais, pour cette détermination, les mêmes réserves que pour la précédente et, pour la justifier, dans le mesure du possible, je donne les figures ci-jointes ainsi que la description suivante: ♀ : taille: 0.6 mm., violet pâle. Revêtement assez dense, fait de soies assez longues et grêles; pas de soies en épine sur la tête; yeux habituels sur taches noires. Antennes: cf. Text-figure 42; ant. IV avec très faible ébauche d'annulation. Griffes à dent interne très nette à p. I et II et nulle à p. III. Je ne trouve rien de comparable à une "tunica"—STACH (1919-21, Bull. acad. polon. sci. & lett., p. 197) en indique une, con-

FIGURES 42–48. *Sminthurides* (*Stenacidia*) *violaceus* (Reuter). 42, profil de l'antenne (on ne saurait considérer ant. IV comme subsegmenté). 43, g1 et 44, g3 avec, en dessus, l'organe tibio-tarsal à plus fort grossissement et le tenaculum. 45, dens et mucrons en vue postérieure. 46, chétotaxie dentale en vue antérieure, côté médial à gauche. 47, mucron. 48, profil du petit segment abdominal ♀.

trairement à la plupart des auteurs. Dents latérales très nettes; appendice empodial à soie subapicale et plus large à p. III qu'aux autres paires. Organe tibio-tarsal fait de deux capuchons à pointe courbe et d'une soie élargie, assez courte (Text-figures 43-44). Cet organe est tout à fait conforme aux figures données par LINNANIEMI. Tenaculum avec trois soies au pars anterior. (LINNANIEMI en indique 4.) Mucron et chaetotaxie dentale: cf. Text-figures 45, 46, 47. Mucron conforme à la description de STACH (1. c.).

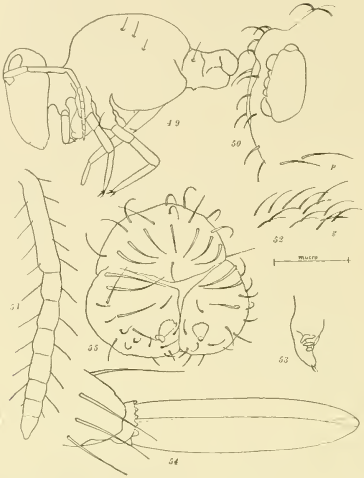
Répartition géographique. Il s'agit d'une forme européenne—d'ailleurs rare. Je ne pense pas trop aventurer en écrivant que le *S.* (*St.*) *violacea* de WOMERSLEY (1. c., p. 14-6, figs. 2b-g) n'est pas l'espèce de REUTER et n'ai pas scrupule de ne pas étendre à l'Australie la répartition géographique de cette dernière. La présence de *S. violaceus* au Thibet indique une affinité paléarctique.

Bourletiella arvalis (Fitch)

Text-figures 49-59

Station: Edge of Phashakuri near Pampur, env. 1585 m. alt., 7–V–1932; 3 exempl.

Description. Le plus grand exemplaire a 1.2 mm. (♀), le plus petit est encore un jeune dont on ne peut déterminer le sexe. Ses antennes ont leur IV article indistinctement segmenté. Les figures ci jointes tiendront lieu de description et justifieront la détermination que j'admets ici.



FIGURES 49–55. *Bourletiella arvalis* (Fitch). 49, ♀. 50, soies antérieures de la tête. 51, profil d'ant. IV. 52, p. et g: soies du petit et du grand abdomen comparées à la longueur du mucron, même échelle que fig. 50. 53, tenaculum. 54, mucron en vue externe. 55, abd. VI en vue postérieure (♀).

Il faut dire que j'admets la systématique proposée par FOLSOM (1934, Iowa st. coll. sci., 8, p. 466, figs. 52-58) selon laquelle *B. arvalis* (Fitch, 1863) est synonyme de *B. lutea* (Lubbock, 1868) et de la plupart des auteurs européens. Je renvoie donc à la synonymie donnée par M. FOLSOM. Cependant, je n'admets pas la synonymie avec la forme nommée *arvalis* par WOMERSLEY, 1932 (Pap. r. soc. Tasmania, 193, p. 9, Pl. I, fig. 5 et text-fig. IV, 1-5), principalement à cause de la forme des appendices anales ♀. Par suite, je dois rejeter la détermination du même auteur (1932, Conc. sci. ind. res., n° 43, p. 26-7, fig. 8a). Ces formes d'Australie ne sont certainement pas les mêmes que celles du paléarctique et du néarctique.

Répartition géographique. Dans l'état actuel de nos connaissances—il n'est pas dit que l'étude approfondie de *B. arvalis* (au sens actuel) n'apportera pas des surprises analogues

Figures 56-58. *B. arvalis* (Fitch). 56, abd. V et VI en profil (♀). 57, à gauche: appendix analis ♀ en vue oblique et, à droite: le même à peu près de face, striation exagérée à gauche, non figurée à droite. 58, chétotaxie dentale en vue antérieure.

Figure 59. *B. arvalis* (Fitch); p. I et p. III.

à celles dont j'ai pu faire soupçonner l'existence à propos de *Bourletiella hortensis* (Fitch) (Denis, 1931, Bol. soc. entom. Espan., p. 85-9, fig. 10-3)—il n'est pas illicite de penser que la présence de *B. arvalis* au Kashmir dénote une affinité faunistique vers l'Europe et l'Amérique du Nord.

Addendum

Il existe encore, dans le matériel qui m'a été confié;

1) un exemplaire d'un genre indéterminable—la furca manquant—de la station L 20, Ravine above Himis, 3360 m. alt.

2) au moins deux espèces d'*Entomobrya*.

L'une provient du Mt. Pamzal, Ladak., par 5240 m. d'altitude et ressemble beaucoup à notre *Entomobrya lanuginosa* (Nic.).

L'autre, de la station L 20, présente une ornementation rappelant celle de notre *E. disjuncta* (Nic.), mais sans série médiane de taches.

Je ne puis prendre la responsabilité de ces déterminations, n'ayant à ma disposition qu'un seul exemplaire des deux *Entomobrya* en question, mais je crois devoir signaler leur présence à ceux qui reprendront mon travail quand la systématique des *Entomobrya* européens sera plus assurée qu'elle ne l'est actuellement.

Vue d'ensemble sur le matériel récolté par la YNIE.
17 espèces ont pu être étudiées. On en dressera le tableau suivant

Noms	Altitudes	Affinités Paléarctiques	Affinités Orientales	Affinités Douteuses
Hypogastrura armata (Nic.)	1585			x
H. communis (Fols.)	1580	x		
Friesea excelsa n. sp.	5500			x
Proisotoma ladaki n. sp.	4753			x
Isotoma spinicauda Bonet	5300	?		
Orchesellides Boraoi Bon.	5200	?		
Sira brahamides n. sp.	4400			x
S. nilgiri n. sp.	2378 (Nilgiri Hills)			x
Parasira subornata n. sp.	1585–4664	x		
Lepidocyrtinus unifasciatus n. sp.	1585		?	
Lepidocyrtus orientalis H.	2195 (Nilgiri Hills)		x	
Aphysa longicornis (Oud.)	2133 (Nilgiri Hills)		x	
Salina celebensis (Schaff.)	2316–78 (Nilgiri Hills)		x	
S. dubiosa n. sp.	2316 (Nilgiri Hills)		x	
Sminthurides aquaticus (Bourl.)	4763	x		
S. (St.) violaceus (Reuter)	4616	x		
Bourletiella arvalis (Fitch)	1585	x		

Je ne crois pas devoir épiloguer sur la question des altitudes, le nombre des stations étant notoirement insuffisant. Il ne faut pas oublier qu' *Hypogastrura armata* est pratiquement cosmopolite et que les *Sminthurides* sont difficiles à capturer. Il n'est peut-être pas interdit de remarquer que les formes véritablement orientales (*Aphysa* et *Salina*) proviennent d'altitudes relativement faibles et déjà IMMS (1912) avait fait une constatation analogue. Mais, à mon sens, cette simple remarque ne saurait suffire pour établir quelque conclusion ferme.

Deux auteurs ont étudié des régions analogues à celles qui ont occupé la YNIE. Les résultats de l'un d'eux: M. Bonet (1930, 1. c.) sont fort intéressants en ce qui conçerne les constituants paléarctiques de la faunule du Waziristan. Voici la liste de M. Bonet:

Isotoma spinicauda Bonet
Orchesellides Boraoi Bonet
Drepanura falcifera Bonet
Paranura ornata Bonet

On ne manquera pas de souligner la grande similitude de la liste de Bonet et de la précédente.

L'autre auteur: Imms (1912 1. c.) admet, dans sa liste, 5 formes paléarctiques et écrit qu'elles proviennent d'au dessus de la limite des forets de l'Hymalaya. Ce sont:

Isotoma siva Imms (Garhwal, 10,300 ft.)
Tomocerus vulgaris Tullb. (id.)
Entomobrya crassa Imms (id. 12,500 ft.)
Sinella montana Imms (id. 10,300 ft.)
Seira frigida Imms (id.)

Mais les biogéographes feront bien de ne pas accepter sans contrôle le contenu de cette liste, car la systématique de 1 'A. appelle les remarques suivantes.

1°, *Seira frigida* Imms est une *Parasira.*

2°, L'A. donne avec un certain doute sa détermination de *Tomocerus vulgaris* Tulb. Il est vrai que les *Tomocerus* sont pratiquement inconnus dans la région orientale et qu'on est en droit de les considérer comme paléarctiques. Je ferai noter qu'il y a un *Tomocerus* en Indo-Chine (encore inédit). Cependant il reste fort probable que le *Tomocerus* de Imms dénote des affinités paléarctiques de la faune des Garhwal.

3°, *Isotoma siva* Imms n'a certainement rien à voir avec le genre *Isotoma* ni même avec la superfamille des Isotomiens. Elle n'en a aucun caractère et l'A. écrit lui même que le quatrième segment de l'abdomen est "triplo longius quam tertium." Les descriptions et figures de l'A. ne permettent pas de savoir ce qu'est *I. siva.* Peut être un très ordinaire *Entomobrya*? Peut être quelque chose de beaucoup plus intéressant pour le systématicien?

4°, *Entomobrya crassa* Imms présente un "segmentum abdominis tertium quartum longitudine fere aequans" et, selon l'A. ressemble assez à une *Orchesella.* Il ne s'agit certainement pas d'un *Entomobrya*, mais ni la description ni les figures (fig. 30-1) ne peuvent permettre une supposition soutenable. On peut soupçonner que Imms est passé à côté de quelque *Orchesellides.*

En résumé, on fera prudemment de s'en tenir à la liste suivante:

Un *Tomocerus* peut-être voisin de *vulgaris* Tullb.
Parasira frigida (Imms)
Sinella montana Imms

Encore n'est-il pas prouvé que la *Sinella* dénote des affinités paléarctiques.

Il me reste à attirer l'attention sur les *Parasira* dont l'aire de répartition va de la Mesopotamie au Japon et sur l' *Hypogastrura communis* (Fols.) qu'on trouve au Japon, en Chine et en Indo-Chine. J'ose espérer qu'on ne tirera pas, de ces répartitions, de conclusion exagérément générale.

Addendum n 2
(September 21, 1935)

Proisotoma ladaki m.—Station: Togarma Tso, 10–VII 1932; 7 exemplaires conformes à ceux décrits plus haut.

Orchesellides Boraoi Bonet.—Station: Ororotse-Tso, 5513 m. alt., Indian W. Tibet, 11–VII–1932; 2 exemplaires à bandes transverses bien nettes et presque uniformes.

Salina celebensis (Schäff.).—Station: Ootacamund, S. of town by beating Rhododendron, 11–XI–1932; 4 exempl.

Entomobrya Hutchinsoni n. sp.

Text-figures 60, I-III

Station: Shakya La, Indian Tibet, E. side, talus slope, 5440 m. alt., 25–VI–1932; 1 ex.

Description. Taille 1 mm. ¼ env., Jaunâtre, sans pigment sur le corps; yeux noirs, une ombre tient lieu de bande frontale; ant. II un peu teinté de gris à l'apex, ant. III bien teinté, ant. IV idem, mais plus clair; pattes et furca pâles. Rapport tronc/antennes: 1.40; ant. II, III et IV subégaux; les tubules de l'org. antennaire III sont particulièrement volumineux; apex d'ant. IV à massue rétractile comme chez la plupart des espèces du genre. Revêtement

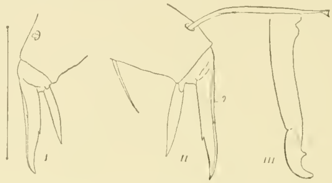


FIGURE 60. **Entomobrya Hutchinsoni** n. sp. I, p. I, à côté: la longueur de l'ergot. II, p. III. III, mucron. Tout du même exemplaire au même grossissement.

général très abîmé mais certainement sans écailles. Griffes très particulières: dent externe probablement présente, dents latérales très distales (Text-figure 60, I-II), une paire de dents internes dans la moitié distale de la griffe dont l'apex est un peu courbe; impossible de découvrir les dents impaires. Appendice empodial du type acutus allongé; impossible d'y découvrir des crénelures. Ergot beaucoup plus long que la crête interne de la griffe. Rapport Manubrium/mucro-dens: 0.95; mucron (Text-figure 60, III) à dent antéapicale très nettement plus faible que l'apicale; pas trace d'épine basale.

Justification. Les *Entomobrya*—j'entends ceux qui sont suffisamment connus—à mucron sans épine basale sont rares, de plus, je ne connais pas d'*Entomobrya* dont la griffe présente les caractères que je viens de dire. Il est donc infiniment probable que la nouvelle espèce que je propose—d'après un seul exemplaire—sera facile à reconnaître. Je ne saurais lui trouver de proche parente parmi toutes celles qui sont suffisamment connues, encore que la récente tentative de révision du genre par M. BONET (1934, Eos, 9, p. 152 & seq.) facilite grandement la recherche. Les quelques espèces dont M. BONET dit ne pouvoir tenir compte, ne sauraient non plus être comparées à **E. Hutchinsoni**.

ARTICLE XVI

REPORT ON CLADOCERA

By Dr. V. Brehm

With 8 Text-Figures

(Received August 16, 1935)

Die Yale North India Expedition untersuchte in erster Linie die Hochgebirge von Kaschmir und Ladak, doch wurden auch in Punjab und in den Nilgiri Hills Aufsammlungen gewonnen.

Bei dem kosmopolitischen Charakter der Cladoceren konzentriert sich aber das Interesse auf die im Hochgebirge vorgenommenen Untersuchungen, die ökologisch bemerkenswerte Resultate erwarten liessen. Doch erwies sich auch die Untersuchung der nicht im Hochgebirge gewonnenen Proben als dankenswert, da sie zur Auffindung einer neuen *Moina* führte, von der später die Rede sein wird.

Zunächst sei an der Hand einer Tabelle das Augenmerk auf einen Vergleich mit der Cladocerenfauna benachbarter Gebiete gelenkt. Als solche kommen Pamir und das angrenzende Tibet in Betracht, worüber folgende Berichte vorliegen:

Daday E. v.: Entomostraca et Hydrachnidae e Tibet. Erschienen in Report on a collection of aquatic animals made in Tibet by Captain F. H. Stewart, I. M. S., during the year 1907.

Werestschagin, G.: Notiz über die Süsswasserfauna des Pamirs. Deutsches Resume einer russischen Arbeit, deren Erscheinungsort aus dem Separatum nicht zu entnehmen ist.

Rylov, M.: Cladocera et Copepoda in Abhandlungen der Pamir—Expedition 1928. II. Zoologie. 1930.

Sars, G. O.: On the Crustacean Fauna of Central Asia. Part II. Cladocera. Annuaire du Musee Zoologique de l'Academie Imperiale des Sciences de St. Petersbourg. T. VIII. 1903.

Sars, G. O.: Local Faunae of Central Asia. Ibidem.

In der nebenstehenden Tabelle sind in der ersten Spalte mit R die von Rylov gefundenen Arten bezeichnt, die von Werestschagin gefundenen mit W, in der zweiten mit S die von Sars angegebenen, in der dritten die von Daday gefundenen mit D, während die letzte Kolumne die von der Yale—Expedition mitgebrachten Arten enthält, wobei die Signatur des Fundortes angegeben ist.

Vergleichen wir die hier gegenübergestellten Artenlisten, so sehen wir im allgemeinen eine weitgehende Übereinstimmung. Wir begegnen unter den Yale-Cladoceren nur sechs, die von den Untersuchern der Nachbargebiete nicht namhaft gemacht werden: *Sida* spec., *Drepanomacrothrix* sp., *Alonella exigua Leptodora hyalina, Camptocercus rectirostris* und *Polyphemus pediculus.*

Moina esau scheidet als Vergleichsobjekt aus, da sie dem Nilgiri-Gebirge angehört. *Drepanomacrothrix* aber ist von besonderem Interesse, da diese bisher als kaukasischer Endemismus gegolten hat. Es scheint sich da um eine ausgesprochene Hochgebirgsform zu handeln, da ihre Fundstelle im Kaukasus bei rund 3000 m. liegt und die von der Yale Expedition mitgebrachten Exemplare gar aus 5217 m. Seehöhe stammen. Dass *Alonella exigua* in den Nachbargebieten nicht gefunden wurde, mag bei dieser kleinen, weit verbreiteten Art wohl nur einem Zufall zuzuschreiben sein und sie wird künftig wohl noch dort gefunden werden. Dass *Leptodora* von der Yale Expedition gefunden wurde, verdient Beachtung, da diese Form wohl mehr tiefer gelegene, wärmere Gewässer bewohnt, wenn man nach den Verbreitungsverhältnissen in den europäischen Alpen schliessen darf. Sie fehlt daher wohl in allen oben zitierten Arbeiten. Aber ihr Vorkommen in 1548 m. Seehöhe, wie es von der Yale Expedition gefunden wurde, steht nicht ohne Beispiel da, weil Sars die Art—allerdings ohne Höhenangabe—aus dem Altai zitiert und Rylov aus dem Kaukasus, wo sie sogar noch in 2080 m. Höhe angetroffen wurde. Merkwürdig ist schliesslich, dass in keiner der Vergleichsarbeiten Bosminen erwähnt werden, die ja auch im Kaukasus völlig zu fehlen scheinen, während sie durch die Art *B. longirostris* in Kaschmir von vier Fundstellen vertreten sind.

Haben wir damit einige Formen namhaft gemacht, die in den benachbarten Hochgebirgsseen fehlen oder zum mindesten bisher nicht gefunden wurden, so sei andererseits auch bemerkt, dass im Yale-Material die aus dem Pamirgebiet beschriebene Gattung *Cornuella* nicht gefunden werden konnte.

In den Travaux de la Station Biologique du Caucase du Nord (Vol. III.—1930) veröffentlichte K. Decksbach eine Arbeit: „Zur Cladocerenfauna von Kaukasus und Nord-Persien." In dieser Arbeit werden als Kaukasus-Endemismen erwähnt: *Drepanomacrothrix Stschelkanowzewi, Ceriodaphnia reticulata* var. *dubia* und *Alona aculeata*. In negativer Hinsicht wird abgesehen von dem bereits erwähnten Mangel der Bosminen noch auf das Fehlen der Gattungen *Holopedium* und *Bythotrephes* aufmerksam gemacht, die in den Gebirgen Nord und Mitteleuropas verbreitet sind, während die Gattung *Polyphemus* dem Kaukasus ebenso zukommt, wie den genannten europäischen Gebirgen. Den innerasiatischen Gebirgen scheinen nun diese Gattungen mit Ausnahme des *Polyphemus pediculus* zu fehlen, da sie auch von der Yale Expedition nicht erbeutet wurden.

Nächst der geographischen Verbreitung interessiert an dem vorliegenden Material besonders die vertikale Verbreitung der einzelnen Arten, die nun in einzelnen Fällen den analogen Angaben früherer Beobachter gegenübergestellt werden mögen. Es sei aber vorher darauf aufmerksam gemacht, dass die Angabe der Seehöhe des Fundortes noch kein genügender Anhaltspunkt zur Beurteilung der ökologischen Verhältnisse ist. Ich verweise diesgezüglich auf die Mitteilungen die F. H. Stewart der oben zitierten Arbeit von Daday über die Verhältnisse des in 14,700 Fuss Höhe gelegenen Gyan Tse vorausschickt. Es heisst da: „From April to October this lake is entirely free from ice. During the summer no climate could be more delightful. In the daytime the temperature rises to about that of an English summer's day and even at night remains moderate, so ringed in is the plain by bare hills which store up the sun's heat."

Immerhin geht aus den Übereinstimmungen der von verschiedenen Autoren mitgeteilten Tabellen zur Genüge hervor, dass gewisse Arten in ausserordentlich unwirtliche

Regionen emporzusteigen vermögen und dass andere geradezu als Charakterformen sehr hoch gelegener Gewässer zu gelten haben.

Merkwürdig sind die Befunde hinsichtlich der Fortpflanzungsverhältnisse, wenn wir sie den im Pamirgebiet gemachten Beobachtungen gegenüberstellen: Werestschagin schliesst seine Arbeit mit den Worten: „In den Hochgebirgsseen des Pamirs sind die Cladoceren wahrscheinlich monocyclisch und die Zeit der parthenogenetischen Fortpflanzung ist sehr reduziert, so dass es für einige Arten wahrscheinlich ist, dass die sexuelle Fortpflanzung in der ersten Generation nach dem Erscheinen aus den Ephippien eintritt." Dieser Auffassung pflichtet auch Rylov bei, der in seiner oben zitierten Arbeit sagt: „Unsere Befunde bestätigen durchaus die Angaben Werestschagins. Das Zurücktreten der parthenogenetischen Vermehrung der Pamircladoceren und die vorwiegende Bedeutung der Vermehrung auf sexuellem Wege wird durch folgende Tabelle illustriert" und hier schaltet Rylov eine Tabelle ein, aus der hervorgeht, dass von 14 Arten 7 im männlichen Geschlecht vertreten waren und von 6 Arten Ephippialweibchen vorlagen.

Demgegenüber muss für das Yale-Material festgestellt werden, dass überwiegend parthenogenetische Exemplare angetroffen wurden. Es erinnert dieser Fall an einen ähnlichen, der die Cladocerenfauna Spitzbergens betrifft. Auch für diese, wie überhaupt für die arktische Cladocerenfauna, wurde lange Zeit das Fehlen bzw. Zurücktreten der Parthenogenese behauptet, bis es Olofsson durch längere, persönlich an Ort und Stelle vorgenommene Untersuchungen nachzuweisen gelang, dass auch auf Spitzbergen Parthenogenese zu den regelmässig auftretenden Erscheinungen gehört. Wenn nicht über einen längeren Zeitraum sich erstreckende Fänge vorliegen, kann es leicht passieren, dass die bisexuelle Periode der Beobachtung entgeht. Bei der Untersuchung der in 4000 m. Seehöhe am Mount Elgon lebenden Cladoceren (Cladocera und Phyllopoda in „Mission scientifique de l'Omo.—Tom. II. Fasc. 8.—Paris, 1935) konnte ich bei keiner Art das Männchen und nur bei zweien Ephippialweibchen beobachten. Wären die Proben 14 Tage später entnommen worden, hätte das Bild jedesfalls ganz anders aussehen können. Jedesfalls—um auf das Yale-Material zurückzukommen—sprechen alle hier gemachten Beobachtungen gegen die Annahme, dass aus den überwinternden Ephippien sofort wieder eine bisexuelle Generation ausschlüpfen würde.

Auch Daday erwähnt für den Rham Tso das Vorkommen eines einzigen Männchens einer einzigen Cladocere, nämlich von *Moina rectirostris*.

DIE UNTERSUCHTEN LOKALITÄTEN, DEREN HÖHENLAGE UND FAUNA

I.

Punjab and adjacent part of the North-West Frontier Province

P 2 Sohawa (528 m.): P 2 (4) *Simocephalus vetula* mit rundem Augenfleck. P 2 (7) *Pleuroxus aduncus*, *Simocephalus vetuloides* und *Alona* cf. *bukobensis*.

P 3 (2) Sohawa: *Simocephalus vetuloides*.

P 6 Sohawa: *Simocephalus vetula* mit rundem Augen fleck.

P 13 Haripur: *Macrothrix hirsuticornis*.

II.

Stations in Kashmir

K 21 Lokut Dal Lake (1582 m.): *Camptocercus rectirostris, Bosmina longirostris.* K 21a: *Polyphemus pediculus, Simocephalus vetula, Scapholeberis Kingi, Bosmina longirostris, Diaphanosoma brachyurum, Acroperus harpae, Graptoleberis testudinaria, Alonella exigua, Chydorus sphaericus.*

K 8 Gagirbal: Srinagar. Open swamp. 1580 m.: Bruchstücke einer Sidide. *Bosmina longirostris, Acroperus harpae, Graptoleberis testudinaria, Alonella exigua.*

K 19 Gagirbal: Srinagar. Closed swamp. 1580 m.: *Daphnia pulex,* mit Ephippien, *Scapholeberis Kingi, Ceriodaphnia quadrangula, Alonella excisa* und *nana.*

K 26 Sundar Khun (1582 m.): Einige junge nicht näher bestimmbare Exemplare von *Diaphanosoma* und *Ceriodaphnia.*

K 31 Pampur (1585 m.): *Moina rectirostris.*

K 24 Nishat Bagh, pond (1585 m.): *Alonella excisa.*

K 33 Phashakuri (1585 m.): *Daphnia magna.*

K 34 Ebenda: *Ceriodaphnia sp. Acroperus harpae, Graptoleberis testudinaria, Dunhevedia crassa* var. **interrupta.**

K 34 Ebenda: *Simocephalus vetula,* mit rundem Augenfleck, *Ceriodaphnia quadrangula,* in Menge, vereinzelt die Formen der vorigen Probe.

K 46 Bakh Hajan, Jhil (1575 m.): *Simocephalus vetula* mit rundem Augenfleck, *Ceriodaphnia quadrangula.*

K 48 Manasbal Lake (1584 m.): *Leptodora hyalina.*

K 51 Bod Dal Lake: *Bosmina longirostris, Sida cristallina, Diaphanosoma* juv. *Scapholeberis Kingi, Acroperus harpae, Ceriodaphnia pulchella, Graptoleberis testudinaria, Alonella excisa. Ceriodaphnia* und *Acroperus* dominierend.

K 54 Anchar Lake (1580 m.): *Polyphemus pediculus.*

K 68 Pond, Sonamarg (2620 m.): *Moina rectirostris.*

K 69 Ebenda: *Moina rectirostris.*

III.

Stations in Indian Tibet (Ladak and Rupshu)

L 1 Shargola (3050 m.): *Chydorus sphaericus.*

L 13 Leh. Pool (3506 m.): *Chydorus sphaericus.*

L 14 Spitok (3270 m.): *Simocephalus vetula, Chydorus* cf. *sphaericus.*

L 16 Spitok. Small muddy hole: *Simocephalus* juv., *Alona rectangula, Chydorus sphaericus.*

L 18 Gulam Bagh, Chushod, pools in swamp (3230 m.): *Simocephalus vetuloides, Chydorus sphaericus.*

L 47 Lung-yun (4977 m.): *Chydorus sphaericus.*

L 50 Togarma Tso (5217 m.): Drei Proben mit Daphniden, in Probe L 50 (2) ausserdem *Drepanomacrothrix* und *Alona guttata.*

L 60 Kyam, largest pool (um 5000 m.): *Chydorus sphaericus.*

L 61 Ebenda: *Chydorus sphaericus.*

	Frühere Beobachter			Yale North India Expedition			
	Pamir R Rylov. W Werest-schagin	Innera-siens Sars	Tibet Daday	Pendschab	Kashmir	Ladak	Nilgiri
Diaphanosoma brachyurum	......	......	......	......	K 21a, 26, 51	......	......
Sida crystallina	......	......	......	......	K 51	......	......
*Daphnia pulex**	R, W	S	......	......	K 19	......	......
" *magna*	R, W	......	......	......	K 33	......	......
" *pamirensis*	R, W	......	......	......	......	......	......
" *longispina*	R, W	S	D	......	......	......	......
*Daphniopsis tibetana**	......	S	......	......	......	L 80	......
Scapholeberis aurita	R	......	......	......	......	......	......
" *mucronata*	......	......	D	......	......	......	......
" *Kingi*	......	......	......	......	K 19, 21a, 51	......	N 15
Ceriodaphnia quadrangula	......	S	......	......	K 19, 34, 46	L 73	N 15
" *reticulata*	W	......	......	......	......	......	......
" *pulchella*	W	......	D	......	K 51	......	......
Simocephalus vetula	R, W	......	D	P2, 3	K 21a	L 14, 16, 71, 73	......
" " mit rundem Augenfleck	......	......	......	P 2(4), 6	K 34, 46	......	......
" *vetuloides*	......	......	......	P 3(2)	......	L 18, 73	(Mysore)
Moina rectirostris	W	......	D	......	K 31, 68 69	......	......
" *dubia*	......	......	......	......	......	......	N 5, 6
" **esau**	......	......	......	......	......	......	N 14
Bosmina longirostris	......	......	......	......	K 8, 21, 21a, 51	......	N 19
Macrothrix rectirostris	......	......	......	......	K 31, 68 69	......	......
" *hirsuticornis*	R, W	......	D	P 13	......	......	......
" *laticornis*	......	......	......	......	......	L 71a	N 5
Drepanomacrothrix sp.	......	......	......	......	......	L 50(2)	......
Camptocercus rectirostris	......	......	......	......	K 21	......	......
Acroperus harpae	W	......	......	......	K8, 21a, 34, 51	......	......
Eurycercus lamellatus	W	......	......	......	......	......	......
Euryalona annandalei	......	......	D	......	......	......	......
Alona affinis	W	......	......	......	......	......	......
" *quadrangularis*	R	......	......	......	......	......	......
" **ladacensis**	......	......	......	......	......	L 82	......
" *costata*	......	S	......	......	......	......	......
" cf. *bukobensis*	......	......	......	P 2(7)	......	......	......
" *guttata*	R	......	D	......	......	L 50, 71a, 73, 82	N 15
" *rectangula*	W	......	......	......	......	L 16, 82, 82a	......
Rhynchotalona falcata	R	......	......	......	......	......	......
Graptoleberis testudinaria	R, W	......	......	......	K 8, 21a, 34, 51	......	......
Cornuella pamirensis	W	......	......	......	......	......	......
Pleuroxus cf. *aduncus*	R	......	......	P 2(7)	......	......	......
" cf. *trigonellus*	......	......	......	......	......	......	N 5, 15
Alonella excisa	R	......	......	......	K 19, 24, 51	......	......
" *nana*	......	......	......	......	K 19	......	......
" *exigua*	......	......	......	......	K 8, 21a	......	......
" *karua*	......	......	......	P 2(7)	......	......	......
Dunhevedia crassa	......	......	D	......	......	......	......
" " var. **interrupta**	......	......	......	......	K 34	......	......
Chydorus sphaericus	R, W	......	D	......	K 8, 21	L 1, 13, 14, 16, 18, 47, 60, 61, 71, 72	N 5, 6, 13, 15
Polyphemus pediculus	......	......	......	......	K 21a, 54	......	......
Leptodora hyalina	......	......	......	......	K 48	......	......

* The species of the genus *Daphnia* are being studied by Professor R. Woltereck and consequently are not treated in the present contribution.—G. E. Hutchinson.

L 71a Tso Nyak (4241 m.): *Simocephalus vetula, Ceriodaphnia* juv., *Macrothrix laticornis, Alona guttata* mit starker Längsstreifung und viel *Chydorus sphaericus.*
L 72 Chushol, Large pond: Daphnien.
L 72a Small pool by Pond: Chushol (4491 m.): *Chydorus sphaericus.*
L 73 Chushol Pond: Viel *Ceriodaphnia quadrangula,* einige *Simocephalus vetuloides* und stark gestreifte *Alona guttata.*
L 76 Mitpal Tso (4875 m.): *Daphnia.*
L 80 Khyagar Tso (4672 m.): *Daphniopsis tibetana.*
L 82 Estuary, Tso Moriri (4529 m.): *Alona guttata, A. rectangula* und **Alona ladacensis.**

IV.

Nilgiri Hills

N 5 Ootacamund Lake (2201 m.): *Moina dubia* dominierend *Chydorus* cf. *sphaericus* sehr häufig. Vereinzelt: *Macrothrix laticornis, Pleuroxus* cf. *trigonellus* und cf. *aduncus.* Ein einzelnes Stück einer schlecht erhaltenen und daher nicht determinierbaren Helmdaphnie.
N 6 Pool near milestone 4. *Moina dubia, Chydorus* spec.
N 9 Ootacamund, small grassy pool: *Chydorus*-fragmente.
N 13 Umbrella Tree (2316 m.): *Chydorus sphaericus.*
N 14 Ponds. Pykara Road near Ootacamund **Moina esau.**
N 15 Ebenda: *Ceriodaphnia quadrangula, Scapholeberis Kingi* ?, *Pleuroxus* spec. (vgl. Seite 296). *Chydorus sphaericus.*
N 19 Pykara: *Bosmina longirostris* f. *cornuta.*
Yanni Hole Mysore: *Simocephalus vetuloides.*

Diese Tabelle mag noch durch einige Angaben über Cladocerenfunde in den Hochgebirgen des südlichen China ergänzt werden. Diese stammen von O Pesta—Wien und finden sich veröffentlicht in meiner Arbeit „über südasiatische Diaptomiden" (Archiv f. Hydrobiologie Bd. XXII. 1930.) Das Material stammte von den Forschungsreisen Handel-Mazettis. Seite 158 ff.

Setschwan. Sumpfgewässer am Tscheschajoch. 4100 m.	*Alona costata-tuberculata*
	Chydorus sphaericus
Yünnan. Pongatong. See 4075 m.	*Chydorus sphaericus*
Yünnan. Tsukne. See 3825 m.	*Chydorus sphaericus*
Yünnan. See bei Likiang. 2820 m.	*Chydorus sphaericus*
	Graptoleberis testudinaria
	Alonella excisa
Yünnan. See bei Mahaidse. 3675 m.	*Bosmina longirostris*
Yünnan. Wahaschimi. See 4325 m.	*Ceriodaphnia* spec.
	Chydorus sphaericus
	Alona guttata
	Alona costata

Man sieht, dass die faunistische Zusammensetzung ganz der entspricht, die aus unserer Tabelle für die weiter westlich gelegenen Hochgebirge zusammengestellt wurde, nur dass hier gar keine spezifischen Faunenbestandteil zu verzeichnen sind.

BEMERKUNGEN ZU EINZELNEN ARTEN

1. **Moina esau** n. sp.

Text-figure 1, a-f

In der Bearbeitung der Cladoceren der Deutschen Limnologischen Sundaexpedition habe ich bei einem provisorischen Versuch, die mir bekannten *Moina*—arten übersichtlich zu gruppieren jene Arten als besondere Gruppe herausgegriffen, die durch einen Haarbesatz

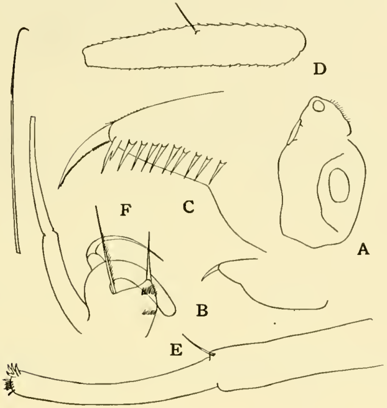


FIGURE 1. **Moina esau** n. sp. A, Ephippialweibchen; B, Kontur des ♀ Postabdomens; C, Distaler Teil des Postabdomens, Bewimperung der Wimperzähne nicht eingezeichnet; D, Antennula des ♀; E, Antennula des ♂; F, I Fuss des ♂. Endteil wegen Raummangel separat gezeichnet.

am Kopfe sich von den anderen unterscheiden und die man nach der am längsten bekannten zugehörigen Form als *Banffyi*-Gruppe bezeichen könnte. Diese Gruppe umfasste bisher die Arten *Banffyi* aus Europa, *Belli* Gurney aus Südafrika und *tonsurata* Brehm aus Westafrika. Zu diesen Arten kommt nun als vierte die hier zu beschreibende neue Art **esau** aus dem Nilgirigebirge. Bevor ich deren Beschreibung gebe, will ich nochmals wie in der Arbeit über die Sundacladoceren und wie bei der Beschreibung der *tonsurata* betonen, dass es mir sehr zweifelhaft scheint, ob diesen Arten eine wirkliche Verwandtschaft zuzuschreiben ist. Ihre

Zusammenfassung erfolgte ja nur mit Rücksicht auf die für einen Bestimmungsschlüssel sehr bequeme Abtrennung von den übrigen Arten.

Im Körperumriss unterscheidet sich unsere Art von den Vergleichsarten durch eine hinter dem Auge gelegene leichte Impression. Die Kopfhaltung entspricht der zwischen „semierect" und „semidepressed" gelegenen Stellung der *dubia*—Form nach dem Schema, das Penelope Jenkin auf Seite 148 ihrer Arbeit Cladocera from the Rift Valley Lakes in Kenya (Ann. & Mag. Nat. ist., 1934. Ser. X. Vol. XIII.) mitgeteilt hat. Die antennula des Weibchens zeigt nicht das schuppige Bild wie bei *Banffyi*, doch ist die Kontur fein wellig und den kleinen Wellenbergen sitzen kleine Stacheln auf. Die seitliche Sinnesborste ist etwa in der Mitte inseriert. Die Endkralle des Nebenkammes besitzt im Gegensatz zu *Banffyi* und *Belli*, aber in Übereinstimmung mit *tonsurata* einen Nebenkamm. Die Zahl der Wimperzähne beträgt 10 oder 11.

Ephippialweibchen lag leider nur ein schlecht erhaltenes vor, das keine verlässlichen Angaben über die Struktur des Ephippiums erlaubte. Doch enthielt das Ephippium jedesfalls nur ein Dauerei. Auch Männchen fand sich nur eines in dem Material, dessen erstes Beinpaar in Figur 1 abgebildet ist. Die antennula trägt am Ende 4 Haken,[1] wie *tonsurata*, während *Belli* 6 Haken haben soll und für *Banffyi* mir keine Angaben hierüber bekannt sind. Die Knickung, an der die seitliche Sinnesborste inseriert ist, befindet sich bei **esau** etwa in der Mitte der antennula, während bei *tonsurata* diese Stelle etwa im proximalen Drittel liegt und bei *Belli* eher noch vor diesem.

Fassen wir also die mit behaartem Kopf versehenen Moinaarten der Bequemlichkeit halber als eine Gruppe auf, so ergäbe sich folgende Trennung der betreffenden Arten:

I. Endkralle mit Nebenkamm:	
1. Männliche antennula in der *Mitte* geknickt:	*esau* Brehm
Männliche antennula im ersten Drittel geknickt:	*tonsurata* Brehm
II. Endkralle ohne Nebenkamm:	
1. Schale hinten in eine Spitze ausgezogen	*Belli* Gurney
Schale hinten abgerundet	*Banffyi* Daday

Nach dieser Tabelle scheint die Trennung von *Belli* und *Banffyi* recht gekünstelt. Leider liegen mir die beiden Orginalbeschreibungen nicht vor, die vielleicht eine sicherere Trennung möglich machen würden.

2. *Dunhevedia crassa* var. interrupta n.

Text-figure 2, c

Von der Fundstelle K 34 in Kaschmir lag in mehreren parthenogenetischen Weibchen die genannte Art in einer Form vor, die neu zu sein scheint. Während nämlich nach den Abbildungen, die Stingelin von dieser Art sowohl nach Schweizer (Text-figure 2a), wie auch nach indischen Exemplaren (Text-figure 2b), gibt, die Lippe mehr oder weniger zugespitzt ist und der Vorderrand derselben eine gleichmässig fortlaufende Kontur zeigt, war bei den

[1] Nachträglich fand ich ein Männchen, das an der einen antennula 5, an der anderen 6 Haken träg, sich also in diesem Punkte der Art *Belli* näherte.

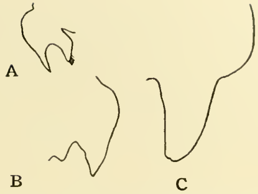


FIGURE 2. Lippe von *Dunhevedia crassa* King. A, Form von Basel, nach Stingelin; B, Form von Indien, nach Stingelin; C, Form **interrupta** aus Kaschmir.

Tieren aus Kaschmir die Lippe stumpf und der Vorderrand zeigte eine Knickung der Kontur (Text-figure 2c), die vielleicht als Anlauf zu einer Zahnbildung gedeutet werden kann, wie eine solche bei anderen Arten dieser Gattung vorliegt.

3. *Drepanomacrothrix* sp.

Text-figure 3, a-c

Die Probe L 50 (2) von Togarma-Tso enthielt ein vollständiges und zwei defekte Weibchen einer Macrotrichide, die schon ohne nähere Untersuchung als zu der von Wereschagin aufgestellten Gattung *Drepanomacrothrix* gehörig erkenntlich war. Da ich an der

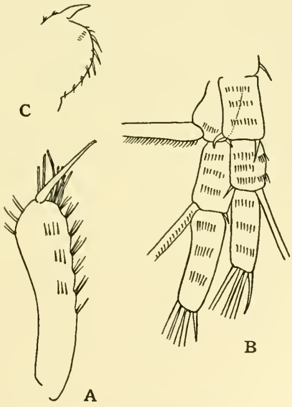


FIGURE 3. *Drepanomacrothrix* sp. von Togarma Tso. A, Antennula; B, Antenna; C, Distaler Teil des Postabdomens.

Existenzberechtigung dieser Gattung Zweifel hege, wäre es natürlich erwünscht gewesen, wenn ich durch Untersuchung der vorliegenden Form die Berechtigung meiner Zweifel hätte erweisen können. Ich wollte aber das einzige unversehrte Exemplar nicht opfern und die beiden defekten Exemplare gestatteten keine so eingehenden Ergebnisse, wie sie zur Begründung meiner Meinung notwendig gewesen wären. Ich habe daher vorläufig die Bezeichnung *Drepanomacrothrix* beibehalten und lasse auch die Speciesfrage offen, obwohl selbst die unvollständige Beschreibung erkennen lässt, dass in mancher Hinsicht unsere Form von den zwei oder drei bisher bekannten und als *Drepanomacrothrix* zusammengefassten Arten verschieden sein dürfte; freilich bliebe auch die Möglichkeit offen, dass alle diese Arten Formen einer einzigen, variablen Art seien.

Bevor wir auf die Erörterung dieser Angelegenheiten eingehen, wird es gut sein, sich über die Aufstellung der Gattung *Drepanomacrothrix* und über die zu dieser Gattung gerechneten Arten zu orientieren, zumal da die Aufstellung dieser Gattung in einer nicht leicht erreichbaren Zeitschrift erfolgte.

Über die Gattung *Drepanomacrothrix*

Die Aufstellung der fraglichen Gattung erfolgte durch G. Werestschagin in seiner Arbeit „Notiz über die Cladocerenfauna des Karsischen Plateau und des Batumischen Strandes" (Arb. d. Hydrobiol. Station am See Glubokoje. Bd. V. Lief. 1. 1913). Da mir diese Arbeit nicht zugänglich war, hatte Herr Dr. Smirnov—Leningrad die Liebenswürdigkeit, mir nicht nur eine Abschrift des Deutschen Resumes dieser Arbeit—soweit unsere Gattung in Frage kommt—sondern auch Kopien der dort mitgeteilten Figuren zu übermitteln, wofür ich dem Genannten an dieser Stelle nochmals herzlichst danken möchte. Uberdies aber teilte mir Herr Dr. Smirnov etliche weitere, nur aus dem russischen Text ersichtliche Daten mit, die ich hier einzuschalten für gut finde, da auch den meisten anderen Cladocerenuntersuchern diese Mitteilungen schwer erreichbar sein dürften.

Gefunden wurde diese neue Form von Werestschagin am 2. VII. 1907 im See Chantschauly (Kreis Achalkalaki, Gouv. Tiflis) in 4 weiblichen Exemplaren. Dieser See liegt 6385 Fuss ü.d.M. ist 6.5 km. lang, 2.5 km. breit und 1 bis 1½ m. tief. Die Ufer sind stark bewachsen. Decksbach ist der zweite Autor, der diese Form gefunden hat und zwar im kleinen Kabarda im Nordkaukasus. (Zur Cladocerenfauna von Kaukasus und Nord—Persien. Trav. de la Stat. Biol. du Caucase du Nord. v. III. fasc. 1-3. 1930.)

Beschreibung der Gattung *Drepanomacrothrix* und ihrer Art *Stschelkanowzewi* nach Werestschagin *Drepanomacrothryx* (sic!)

„Bei der Seitenansicht befindet sich am Rückenrand des Körpers ein zahnartiger Fortsatz; er ist von einem kragenartigen Fortsatz des Hinterrandes der Kopfschildes gebildet. Der Kopf ist konusartig zugespitzt; das Auge ist grösser als der Pigmentfleck; die ersten Antennen bestehen aus einem Glied; der Aussenast der 2. Antenne ist 3 gliedrig mit 5 Schwimmborsten; der Innenast viergliedrig mit 4 Schwimmborsten; Kiemenfüsse, die denen der *Drepanothrix dentata* sehr ähnlich sind. Die Cauda ist breit und kurz; ihr Rückenrand besteht aus zwei konvexen Teilen. Der Anus befindet sich an dem, der den caudalen Krallen am nächsten liegt. Der Darmkanal ist ohne Schlinge und Blindsäcke. Die Abdominalborsten sind zweigliedrig, die Abdominalfortsätze fehlen.

Zum neuen Genus gehört nicht nur die neubeschriebene Form, sondern auch die im Jahre 1903 von Daday beschriebene *Macrothrix cornuta*, der die neubeschriebene Form am nächsten steht. Beide stehen zwischen dem Genus *Drepanothrix* und *Macrothrix* und müssen in eine besondere Gattung gestellt werden, da sie durch das Fehlen der Darmschlinge den Arten von *Macrothrix* sich nähern und durch die Form der Kiemenfüsse und den Rückenfortsatz der Gattung *Drepanothrix*.

Drepanomacrothrix Stschelkanowzewi n. g., n. sp.

Die Gesammtform des Körpers ist oval. Am Rückenrand befindet sich am Ende des Kopfschildes ein zahnartiger Fortsatz; am Hinterende des Rückenrandes befindet sich ein gut ausgesprochener Kiel, der am Aussenrand sehr kurze und seltene Dornen trägt. Der Hinterrand ist mit unregelmässigen Tuberkeln, die am Ventralrande allmählich zu sägeartigen Dornen werden, versehen. Der Vorderrand der Schalenklappen entbehrt aller Haare und Borsten. Das Auge ist zweimal grösser als der Pigmentfleck, die Entfernung vom Auge bis zum Pigmentfleck ist beinahe ebenso gross, wie die vom Pigmentfleck zur Basis der antennula. Die Fornices sind nicht stark entwickelt. Die antennulae sind eingliedrig, schwach kolbenförmig und konkav. Ihr Vorderrand ist wellenförmig, in 9 bis lo Teile geteilt, an deren Ende lange und starke sehr durchsichtige Haare sich befinden. Am Ende befindet sich eine Tastborste und ein Bündel kurzer, dünner Härchen.

Bei der zweiten Antenne trägt das erste Glied des Aussenastes am Ende eine 2 gliedrige, an einer Seite bewimperte Schwimmborste, das 2. Glied trägt die längste Schwimmborste der Antenne, die dreimal länger als das Aussenglied der Antenne ist. Diese Borste ist zweigliedrig und trägt am Ende des ersten Gliedes einen starken Dorn. Das dritte Glied trägt drei gleich lange, zweigliedrige, einseitig bewimperte Schwimmborsten und ausserdem am Ende einen starken Dorn. Das erste Glied des Innenastes trägt keine Borsten, das 2. ist an der Innenseite am Ende mit einem stumpfen Fortsatz versehen, an der Hinterseite befindet sich ein starker, langer, krummer Dorn. Das dritte Glied trägt an der Innenseite einen ebensolchen Fortsatz wie das zweite, und am Ende der Aussenseite eine Schwimmborste; diese ist die kürzeste Schwimmborste. Das 4. Glied trägt am Ende drei Schwimmborsten wie beim Aussenast. Das Labrum ist zugespitzt. Die Maxillen bestehen aus drei schwach gekrümmten, befiederten Zähnen. Der Darmkanal ist ohne Schlinge. Der Rücken der Cauda besteht aus 2 konkaven Teilen, von denen der, der den Abdominalborsten zunächst steht, zweimal länger als der andere ist. An den Seiten der Analfurche finden sich 6 bis 7 schwach nach hinten gekrümmte Dornen. Der proximale Teil der cauda ist am Rande mit zahlreichen dünnen kurzen Dornen versehen. Die Caudalkrallen sind glatt und ohne Basalstachel. Abdominalfortsätze fehlen. In der Brutkammer befanden sich 1 bis 2 Embryonen. Die Dimensionen sind folgende: Länge = 0.42 bis 0.43; grösste Breite = 0.28 bis 0.29. Die Länge der antennula = 0.12 mm. Die Länge der Cauda von der Basis der Abdominalborsten bis zur Basis der Caudalkrallen 0.14 mm."

Werestschagin charakterisiert also die *Drepanomacrothrix* als Zwischenform zwischen *Macrothrix* und *Drepanothrix* und begründet seine Ansicht damit, dass das Fehlen einer Darmschlinge seine Gattung in Beziehung zur Gattung *Macrothrix* setze, während der zahnartige Rückenfortsatz sowie der Bau der Beine Beziehungen zur Gattung *Drepanothrix* bedinge. Es scheint mir nun, dass die Gattung *Drepanomacrothrix* zur Gattung *Macrothrix* gehöre, mit der sie u. a. in folgenden Punkten übereinstimmt: Die von Werestschagin als Tastborste und Sinneshaare bezeichneten Sinnesschläuche entsprechen ganz den Verhältnissen bei *Macrothrix*, nicht aber denen von *Drepanothrix*; die zweite Antenne ist eine typische *Macrothrix* antenne, da sie einen mit 4 Borsten versehenen Aussenast hat, während bei *Drepanothrix* das vorletzte Glied dieess Astes keine Schwimmborste trägt, also der ganze Ast nur dreiborstig ist. Der von Werestschagin erwähnte an der Gliederungsstelle der längsten Schwimmborste befindliche starke Dorn ist bei vielen *Macrothrix* arten in der gleichen Form entwickelt. Der Hinterkörper der zu *Drepanomacrothrix* gestellten Formen erinnert sehr stark an den mancher *Macrothrix* arten, z.B. den von *Macrothrix spinosa* und zeigt die Teilung in zwei konvexe—Werestschagin spricht von konkaven—Abschnitte, ein Verhalten, das für *Drepanothrix* nicht zutrifft.

Stimmt somit *Drepanomacrothrix* weitgehend mit *Macrothrix* überein, so zeigt sich andererseists, dassdie Übereinstimmungen mit *Drepanothrix* nur scheinbare sind. Denn der Rückenzahn der Gattung *Drepanothrix* scheint mir etwas ganz anderes zu sein als der zahnartige Vorsprung des Hinterrandes des Kopfschildes bei *Drepanomacrothrix*. Und was die Übereinstimmung der Gliedmassen anbelangt, sei zuerst erwähnt, dass Werestschagin gar keine spezielle Beschreibung derselben gibt und dass Daday zwar Bilder und Beschreiung seiner heiher gehörigen Art mitteilt, dass aber diese kaum beweisend genug sind, da ja nach Lilljeborg überhaupt kein fundamentaler Unterschied zwischen den Extremitäten dieser beiden Gattungen besteht, was nicht verwunderlich ist, da ja innerhalb der Gattung *Macrothrix* weitgehende Verschiedenheiten im Extremitätenbau vorliegen. Lilljeborg sagt diesbezüglich von *Drepanothrix* in seiner Monographie der schwedischen Cladoceren (pag. 368): "Es sind fünf z. Th. denjenigen der vorigen Gattung und der Gattung *Macrothrix* ähnliche Fusspaare vorhanden." So dürfte die Abtrennung der Gattung *Drepanomacrothrix* von *Macrothrix* kaum haltbar sein.

Eine andere Frage ist nun die, wie sich die von der Yale-Expedition gefundene Art zu den bereits bekannten hieher gehörigen Arten verhält. Vergleichen wir unsere Art mit der kaukasischen *Stschelkanowzewi*, so finden wir folgende Differenzen: Bei der kaukasischen Art ist die Entfernung des Auges vom Pigmentfleck etwa eben so gross wie die Entfernung von diesem zur Insertionsstelle der antennulae, bei unserer Form ist die erste Distanz etwa doppelt so gross als die zweite. Die Stacheln am ventralen Schalenrand sind bei unserer Art viel länger. Für die antennulae der Art *Stschelkanowzewi* gibt der Entdecker eine Teilung des Vorderrandes in 9 bis 10 Abschnitte an, während sich bei den Tieren der Yale expedition deren nur 6 bzw. 7 finden liessen.

Bei einem Vergleich mit der turkestanischen Art *cornuta* ergeben sich folgende Differenzen: Die Art *cornuta* trägt an der antennula zwei lange Sinnesschläuche, unsere Art hat nur einen; unsere Form zeigt an den Gliedern der zweiten Antenne drei flächenständige Haarsäume, während für *cornuta* von Daday eine unregelmässige Behaarung abgebildet wird. Die Art *cornuta* zeigt am distalen Teil des Postabdomens „5 Querreihen feiner Borsten," während unsere und die kaukasische Art hier „nach hinten gekrümmte Dornen aufweisen. Es gäbe vielleicht noch manche andere Differenzen, aber wenn man auf einen Vergleich mit Bildermaterial angewiesen ist, können hier leicht Irrtümer unterlaufen, weshalb ich nicht weiter auf einen solchen Vergleich eingehe.

Resumieren wir das gesagte, so ergibt sich, dass die als *Stschelkanowzewi. cornuta* beschriebenen Arten sowie unsere Form wohl eine zusammen gehörige innerasiatische Gruppe von *Macrothrix* formen bilden, über deren Selbständigkeit sich ohne Nachprüfung von Originaltypen zur Zeit nichts sagen lässt. Ob, wie Daday meint, auch *odontocephala* dazugehört, bleibt noch unentschieden. Fraglich ist es, ob man in diesen Formen einen Übergang zur Gattung *Drepanothrix* sehen darf. Nach meinen oben gemachten Mitteilungen zweifel ich daran. Es scheint mir eher, dass *Drepanothrix* zu den altersstarren Monotypen gehört, die zusammenhanglos neben den anderen Gattungen ihrer Verwandtschaft stehen.

4. Über eine vermutlich neue *Alona* aus dem Tso Moriri: A. ladacensis

Text-figure 4, a-c

Unter den ziemlich vielen Exemplaren von *Alona guttata*, die allerdings durch längsgestreifte Schalenklappen vom Typus abwichen, fand sich neben einem vereinzelten Stück der *Alona rectangula* ein Weibchen einer *Alona*, das auf den ersten Blick ein *guttata*—Exemplar zusein schien, sich bei näherem Zusehen, aber als ziemlich abweichend gebaut erwies.

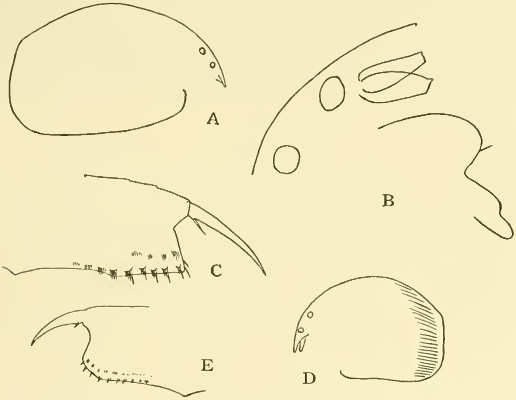


FIGURE 4. A, **Alona ladacensis** n. sp. B, Vorderende unter starkem Deckglasdruck; C, Postabdomen; D, *Alona* sp. aus dem Tso-Nyak; E, Postabdomen.

Die undeutlich polygonal gefelderten aber stark punktierten Schalenklappen dieses 500 μ grossen Tieres zeigten den durch unsere Figur gezeigten Umriss. Auch die Form der antennulae und der breiten gerundeten Lippe ist aus der Abbildung ersichtlich. Was nun dieser Form ein besonders auffallendes Aussehen gibt ist die Bewehrung des Abdomens, das im Umriss dem von *guttata* ziemlich nahe kommt. Die distale Hälfte trägt am Rand 6 Gruppen von meist zu dreien beisammenstehenden groben Stacheln und oberhalb dieser an der Flanke mehrere Haargruppen. Es ist mir keine *Alona* bekannt die diese Eigentümlichkeit zeigte ausser einer Form, die möglicherweise einen ähnlichen Bau hat und die von Schiklejew in seiner Arbeit „Die Cladocerenfauna der kaukasischen Hegegewässer," etc. (Archiv. für Hydrobiologie, Bd. XXI. 1930) auf Seite 343 beschrieben und auf Seite 344 abgebildet wurde. Da ihm auch nur ein einziges Exemplar vorlag, unterliess Schiklejew eine Benennung. Leider sind die Figuren des genannten Autors so mangelhaft, dass man über manchen Punkt Zweifel hegen muss und keinen einwandfreien Vergleich durchführen kann. Zudem lag dem genannten Biologen ein männliches Tier vor, so dass die Unterschiede im Umriss sowohl des Schalenbildes als auch des Postabdomens auf Geschlechtsdifferenzen zurückgehen könnten. Frappant ist jedes falls das Vorhandensein von „sechs Bündel Dörnchen" am distalen Rand des Postabdomens. Im weiteren Verlauf spricht Schiklejew von 5 bis 6 Wimpern, aus denen sich jedes solches Bündel zusammensetzt und auch seine Abbildung spricht dafür, dass es sich um feine Borsten handle, während in unserem Fall grobe Dornen oder Zähne vorliegen. Jedesfalls ist das Vorhandensein von sechs Gruppen solcher Anhänge eine sehr auffallende Ubereinstimmung. Merkwürdig ist es, dass sowohl bei der aus dem kaukasischen See Inkrit beschriebenen Form wie bei unserer, nur je ein Exemplar gefunden wurde, was den Verdacht aufkommen lässt, es handle sich um eine vereinzelte Mutation einer bereits bekannten Art. Andererseits möchte ich aber doch zu bedenken geben, dass diese Form gerade aus zwei Gebieten vorliegt, die tiergeographisch enge Beziehungen aufweisen, wenn wir an *Drepanomacrothrix* denken und daher eine Benennung dieser Form in Vorschlag bringen: **Alona ladacensis.**

5. *Alona* sp.?

Text-figure 4, d-e

In der Probe aus dem Tso Nyak, L 71a, der in einer Seehöhe von 4241 m. gelegen ist, fand sich ein einzelnes Exemplar einer *Alona*, von der ich aber nur das Schalenbild und den Bau des Postabdomens ermitteln konnte. Lippe und antennula waren nicht gut erhalten. Ich bin im Zweifel, ob ich diese Art mit einer bereits bekannten identifizieren kann und mit welcher und gebe daher blos die beiden Figuren, aus denen ersichtlich ist, dass die am unteren hinteren Schalenwinkel abgerundete, nicht gezähnte Schalenklappe mit weit über 20 recht markanten Längslinien versehen ist und dass das kurze, breite Postabdomen etwa 8 kurze Randstacheln zeigt, hinter denen noch einige Börstchengruppen folgen, sowie ferner, dass die Flanken des Postabdomens mit kleinen Börstchengruppen versehen sind. Die Endkralle trägt einen Basaldorn.

6. Die *Pleuroxus*—Arten

Pleuroxus aduncus Jurine. Sowohl die wenigen Exemplare von P 2, Sohawa als auch das einzelne Exemplar von Ootacamund Lake stimmten mit dem Typus so weit überein, dass man sie ohne Bedenken als *aduncus* bezeichnen kann. Anders liegt der Fall bei den *Pleuroxus* exemplaren, die sich in einigen Proben aus dem Nilgiri Gebirge befanden. Hier liegt die Schwierigkeit darin, dass innerhalb derselben Population sich nicht nur sehr beträchtliche Verschiedenheiten bei verschiedenen Alterstufen zeigen, sondern, dass auch etwa gleichalterige Stücke eine starke individuelle Variation aufweisen. Die von Birge vorgenommene Scheidung in langgestreckte und hochgewölbte Formen lässt hier insoferne im Stich, als junge Tiere mehr dem ersten Typus zuneigen, ältere mit Embryonen versehene aber dem zweiten. Nach solchen älteren Typen möchte ich alle diese Tiere dem *trigonellus*-Kreis zurechnen, doch zeigen viele Individuen eine leichte, beim typischen *trigonellus* nicht vorhandene Konkavität des Hinterrandes des Postabdomens, die als Kennzeichen der amerikanischen Art *denticulatus* angesehen wird. In diesem Punkte kämen auch die Arten *assimilis* Brady aus Ostafrika sowie die leider nicht gut abgebildete Art *australis* Henry von Australien als Vergleichsarten in Betracht. Bei dem gegenwärtigen Stand der Systematik dieser Gattung ist es wohl am besten die Tiere als *denticulatus*-bzw *assimilis*ähnliche Formen aus dem *trigonellus* Kreis zu bezeichnen. Die *Pleuroxus* arten scheinen sehr variabel zu sein und ich vermute, dass die grosse Menge der bisher beschriebenen Arten sich bei genauerer Analyse dieser Formenkreise auf sehr wenige Arten reduzieren wird, in welchem Falle wohl die Nilgiri-Tiere zur Species *trigonellus* fallen werden.

7. *Chydorus* n. sp.?

Text-figure 5, a-b

Die Probe N 15 aus den Nilgiri Hills enthielt einen *Chydorus* aus der *sphaericus*—Gruppe im weiteren Sinn, der wohl neu sein dürfte, den ich aber—da nur parthenogenetische Weibchen vorlagen—nicht als neu beschreiben will, da gerade bei einer so vielgestaltigen und nur durch minutiöse Merkmale die Artentrennung ermöglichenden Gruppe zur Charakterisierung einer Art die Männchen und womöglich auch die Ephippialweibchen bekannt sein sollten.

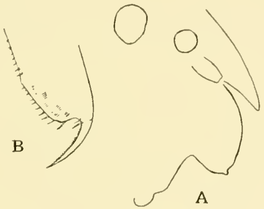


FIGURE 5. *Chydorus* n. sp. ? der *C. sphaericus* Gruppe. A, Vorderende; B, Postabdomen.

Unsere Form steht wohl den als *eurynotus* und *denticulatus* beschriebenen Formen durch die breite nicht zugespitzte Lippe am nächsten, doch zeichnet sich diese Lippe durch einen kleinen knopfförmigen Vorsprung aus. Ob diese Kleinigkeit konstant ist und als Merkmal einer kleinen Art verwendet werden kann, ist bei der Variabilität, die die Lippenformen gerade in der *sphaericus*—Gruppe zeigen, noch unsicher. Das Postabdomen und die Endklaue zeigen in Form und Bewehrung grosse Ahnlichkeit mit der von Robert Gurney für *Chydorus denticulatus* gegebenen Abbildung, wie unsere Figur zeigt (Vgl. dessen Arbeit „Some Australian Freshwater Entomostraca reared from dried mud." Proc. Zool. Soc. London. 1927. Fig. 11 auf Seite 77.)

ARTICLE XVII

REPORT ON FISHES. PART I: COBITIDAE[1]

By Sunder Lal Hora, D.Sc., F.R.S.E., F.A.S.B.

Zoological Survey of India, Calcutta

(Received August 16, 1935)

CONTENTS

INTRODUCTION

Mr. G. E. Hutchinson, biologist to the Yale North India Expedition, entrusted to me an extensive and interesting collection of fishes for study and report in October 1933, but it was not possible to take up the work till the later part of 1934. The collection was made in the Kashmir Valley and Ladakh, and comprises representatives of *Sisoridae* (*Glyptothorax* and *Glyptosternum*), Cyprininae (*Labeo* and *Crossocheilus*), *Schizothoracinae* (*Schizothorax, Ptychobarbus, Schizopygopsis, Diptychus* and *Oreinus*) and *Cobitidae* (*Botia* and *Nemachilus*). As was to be expected, *Glyptothorax, Labeo, Crossocheilus* and *Botia* were found only in the Kashmir Valley, while *Nemachilus* and the *Schizothoracinae* were equally abundant at high altitudes and in the Valley. In this article, I propose to deal with the *Cobitidae*, especially the genus *Nemachilus*, which in the lakes and torrential streams of Central Asia has proliferated into many species showing diverse structural, adaptive modifications. The present collection contains one species of *Botia* and eight species of *Nemachilus*.

I take this opportunity to offer my sincere thanks to Mr. Hutchinson for affording me an opportunity to investigate this interesting material and for his invaluable field notes. I am indebted to the authorities of the Yale North India Expedition for a grant towards the cost of drawings which were executed by Babu R. Bagchi under my supervision.

[1] Published with permission of the Director, Zoological Survey of India.

ECOLOGY AND STRUCTURAL MODIFICATIONS

Ecologically, the eight species of the genus *Nemachilus* represented in the collection of the Yale North India Expedition may be divided into three "associations": (i) Bottom-dwelling species of the lakes, such as *N. vittatus*, which live in 4 to 6 feet of water but probably rise from the bottom occasionally and swim about; (ii) bottom-dwelling species in torrential streams, such as *N. stoliczkae*, *N. gracilis*, *N. microps* and *N. tenuicauda*, which habitually live adhering to rocks and stones in swift currents though at times, especially during the breeding season, may enter into springs, pools and lakes; (iii) free-swimming lake species, such as **N. deTerrai**, **N. hutchinsoni** and **N. panguri**, which swim about freely in still waters but for feeding purposes have to cling to rocks and other objects, usually at the bottom. Correlated with the above differences in habits and habitats, the species have undergone remarkable modifications in the structure of certain organs.

Air-bladder. In 1930, I[2] referred to the modifications of the air-bladder in species of *Nemachilus* from several localities and indicated the close relation between its structure and the type of habitat in which the species lived. On account of the occurrence of gradations between the *Nemachilus*-type of bladder and the *Diplophysa*-type of bladder, it was indicated that the differences in the structure of the bladder could not be used for taxonomic purposes. Rendahl[3] has, however, used this character in proposing several sub-genera for the species of *Nemachilus* obtained by Dr. Sven Hedin in Central Asia, and has given a detailed morphological account of the modifications observed by him. The accompanying figure shows some of his illustrations and an attempt is made below to explain the possible significance of these modifications, as I interpret them.

The structure of the air-bladder of *N. barbatula* (Text-figure 1F) is characteristic of the species that live in swift currents and, though they may dart from place to place, are rarely seen to swim. In these circumstances, the air-bladder has lost its buoyant function and its anterior portion is represented by two small lateral chambers (*a*) enclosed in bony capsules and the posterior chamber by a small, thick-walled bag (*c*). This type of structure is found in *N. stoliczkae*, *N. gracilis*, *N. microps* and *N. tenuicauda*. In *N. yarkandensis* (Text-figure 1D) the form of the bladder remains the same but the lateral chambers are greatly enlarged so that they come in close contact with the skin. In the areas of contact, the bony capsules are incomplete so that the bladder can react to the surrounding changes in pressure. The structure of the bladder in *N. yarkandensis* is more or less similar to that of *N. vittatus* (Hora 1930, Text-figure 6*c*) and probably the habits and habitats of the former are similar to those of the latter. *N. vittatus* is a lake species and the Yale North India Expedition obtained several specimens, mostly from the weedy marginal areas of the Kashmir lakes. Probably the species lives at or near the bottom and does not swim about much. The Netherlands Karakorum Expedition obtained specimens of *N. yarkandensis* from pools in the neighbourhood of extensive marshes at Rabat-Utsang. The real lake forms that move about in all possible directions are characterised by a bladder of the type found in *N. stewarti* (Hora 1930, Text-figure 8), *N. hutjertjuensis* (Text-figure 1A) and three new species of *Nemachilus* described here from Western Tibet (Text-figures 5*b*, 7*b*, 9*b*). The posterior

[2] Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 379-385 (1930).

[3] Rendahl, *Arkiv för Zoologi* XXV, No. 11, pp. 1-51 (1933).

chamber of the bladder has assumed the form of the typical Cyprinid bladder and probably functions in exactly the same way.

The type of bladder found in *N. kungessanus* (Text-figure 1B) shows that the species

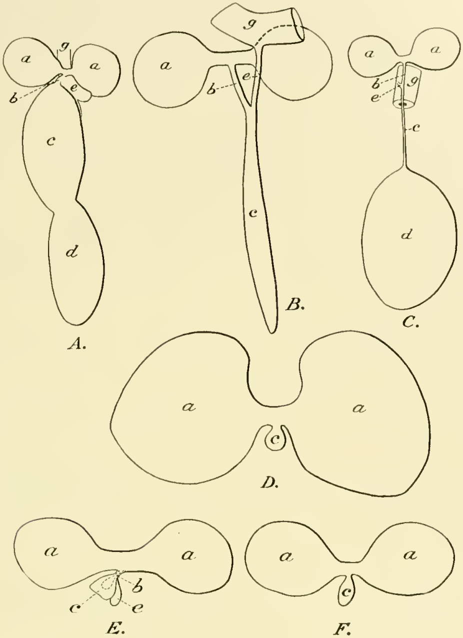


FIGURE 1. Various types of air-bladder found in *Nemachilus* (after Rendahl). Various magnified. A: *N. hutjertjuensis* Rend.; B: *N. kungessanus* (Kessl.); C: *N. papillo-labiatus* (Kessl.); D: *N. yarkandensis* Day; E: *N. hsutschouensis* Rend.; F: *N. barbatula* (Linn.). a = portion of bladder enclosed in bone; b = duct connecting the enclosed and the free portions of the air-bladder; c = anterior chamber of the free portion of the bladder; d = posterior chamber of the free portion of the bladder; e = pneumatic duct connecting the air-bladder with oesophagus; g = gut.

has reverted again to a ground habit of life in comparatively swift currents. Its long, narrow and thick-walled posterior portion shows that the bladder is losing its utility as a hydrostatic organ. In this connection reference may be made to the modification of the swim-bladder in species of the genus *Garra*[4] in which the torrential species possess a similar type of posterior chamber. This process of retrogression is much more pronounced in *N. hsutschouensis* (Text-figure 1F).

The type of bladder found in *N. papillo-labiatus* (Text-figure 1C), *N. strauchii* (Hora 1930, Text-figure 7) and *N. acuticephalus* (Hora 1930, Text-figure 9) is remarkable in so far as the free bladder is situated very far back in the abdominal cavity and is connected with the bilobed anterior portion and the oesophagus by means of a long tube. In the case of *N. acuticephalus* I surmised that the position of the bladder was probably due to its burrow-

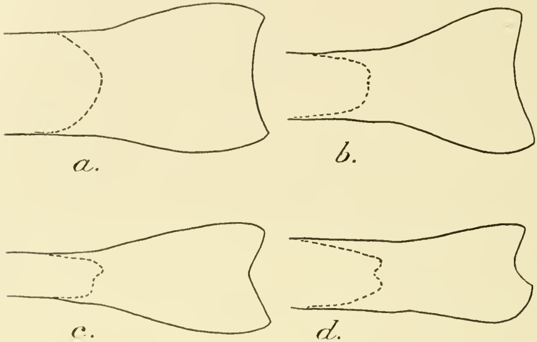


FIGURE 2. Form of caudal fin in the torrential species of *Nemachilus* from Western Tibet. *a*: *Nemachilus gracilis* Day × 2; *b*: *Nemachilus stoliczkae* (Steind.). × 2½; *c*: *Nemachilus tenuicauda* (Steind.). × 3½; *d*: *Nemachilus microps* (Steind.). × 2½.

ing habits. This hypothesis receives support from the fact that in *Pseudapocryptes lanceolatus*, an eel-like burrowing Gobioid fish, the bladder has shifted backwards to the anal region, though in the young stages, when the fish leads a pelagic life, the bladder occupies almost the whole of the abdominal cavity.[5]

In air-breathing fishes of the families *Anabantidae* and *Aphicephalidae*, the air-bladder extends into the caudal region as far as the base of the caudal fin. The utility of this remarkable modification has been explained by me in another place (Hora, *Cur. Sci.* III, pp. 336-338, 1935). It seems probable, however, that the backward position of the bladder in *N. papillo-labiatus*, *N. strauchii* and *N. acuticephalus* enables them to lie horizontally at the bottom and obviates any tendency of the anterior part to rise. This is merely a tentative suggestion as no observations have yet been made on the mode of life of these fishes.

[4] Hora, *Rec. Ind. Mus.* XXII, p. 646 (1921).

[5] Hora, *Current Science* III, p. 336 (1935).

From the above it is clear that the form and structure of the air-bladder is liable to considerable variation and that the modifications noted above are definitely correlated with the diverse types of habitats. In view of these considerations, and also on account of the fact that all possible gradations exist between different types of bladders, I am of the opinion that the character of the air-bladder should not be used for splitting up species into genera. All the same, it is a good index of the type of habitat of a particular species.

Caudal Fin: It is well known that in most of the hill-stream fishes the lower lobe of the caudal fin is distinctly longer and better developed than the upper. A powerful stroke from

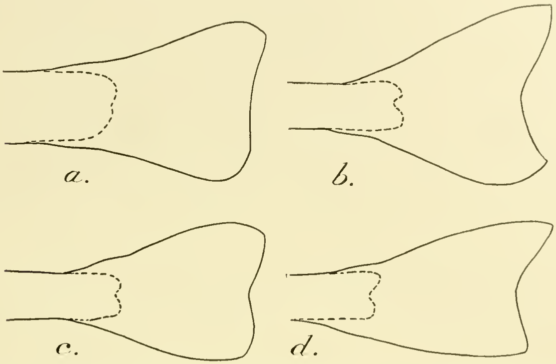


FIGURE 3. Form of caudal fin in the lake inhabiting species of *Nemachilus* from Western Tibet. *a*. *Nemachilus vittatus* (Heckel). ×3; *b*: **Nemachilus panguri**, sp. nov. ×3; *c*: **Nemachilus hutchinsoni**, sp. nov. ×; *d*: **Nemachilus deTerrai**, sp. nov. ×3.

such a fin would not only result in the forward movement of the fish but the differential displacement of water by the two lobes would tend to rotate the anterior end of the fish upwards. This is probably advantageous in the case of torrential fishes when darting from rock to rock in shallow rapid-running waters. By the operation of this device the fish actually moves with its head pointing towards the surface and thus obviates encountering any obstructions in its path. In the torrential species of *Nemachilus* (Text-figure 2), the caudal lobes are either equal or the lower is slightly longer than the upper. But in the case of the free-swimming "lake" species (Text-figure 3), the upper lobe is longer and better developed than the lower. This modification no doubt enables these buoyant fishes to go to the bottom more easily and to keep the head-end directed towards the bottom. The difference in the form of the caudal fin is so marked in the species of the two habitats that it is usually easy to separate, with its help, the specimens with a free air-bladder in the abdominal cavity.

Attention may be directed to the modifications of the air-bladder and the structure of the caudal fin in the species of *Nemachilus* obtained by the Netherland Karakorum Expedition.[6] The four torrential species, *N. stoliczkae*, *N. gracilis*, *N. tenuicauda* and *N. microps*, with greatly reduced bladder and with the lower lobe of the caudal fin better developed than the upper, were found either in small, rapidly flowing streams or in springs and pools to which they resort for breeding purposes. In the specimens of *N. ladacensis* from Alinazar-Kurghan, the bladder is like that of *N. papillo-labiatus* (Text-figure 1C) and it is likely that the fish leads a bottom life in still or slowly flowing waters. The two lobes of its caudal fin are almost symmetrical, suggesting that the fish does not perform any regular vertical movements.

The three species collected from the plains of Turkestan near Yarkand were obtained from marshes, lakes or canals and, in consequence, the bladder is considerably modified. The structure of the bladder of *N. yarkandensis* is referred to above (p. 300); and that of *Nemachilus* sp. prox. *tarimensis* is similar. The bladder of *Nemachilus* sp. from Rabat Utsang is like that of *N. papillo-labiatus*. It is thus seen that all the three species of *Nemachilus* from Turkestan are adapted to live at the bottom in the marshy areas and do not swim about much. In *N. yarkandensis* and *N. tarimensis* the upper lobe of the caudal fin is longer as is the case in *N. vittatus* (*vide supra*, p. 300), while that of *Nemachilus* sp. is almost symmetrical. It is thus seen that the study of the material obtained by the Netherland Karakorum Expedition supports the hypotheses advanced regarding the ecology and bionomics of the species collected by the Yale North India Expedition.

GEOGRAPHICAL DISTRIBUTION AND ORIGIN OF THE FISH FAUNA

I[7] have often remarked that the fish fauna of the high altitudes of Central Asia is derived from the fauna of the low-lying lands of the neighbouring countries, and this hypothesis is supported by the geographical distribution of the species and the modifications undergone by the air-bladder of the forms living in stationary waters at great heights. Almost all the species of *Nemachilus* found along the slopes of the Himalaya are characterised by the great reduction of their air-bladder, but when they enter lakes, etc., a functional bladder is developed once again. The three new species of the Panggong complex are no doubt descendants of forms once living in torrential streams. When acknowledging the preliminary determinations of the fish collected by the Expedition Mr. Hutchinson made the following observations regarding the distribution of the new species:

> "As you will see from the map, one species (**N. hutchinsoni**) which now seems to occur in small ponds and the very small lake Tsar Tso occupies a region formerly filled by the great freshwater lake which represented Panggong in the late glacial and which extended far to the west. The species from Man (**N. deTerrai**) occurred only in a small lagoon, cut off from the edge of the lake. I saw one specimen actually in the lake, almost certainly of this species, and think that it may have been washed out from the lagoon during a rather heavy storm the night before. . . . . . It is quite clear that all fish are extremely rare in lake Panggong itself at the present time. This is due no doubt partly to its high salt content and still more to its complete lack of higher vegetation which is abundant in the

[6] Hora & Mukerji, Visser's *Karakorum* I, pp. 426-445 (1935).

[7] Hora, *Rec. Ind. Mus.* XXIV, p. 58 (1922); *Phil. Trans. Roy. Soc. London* (B) CCXVIII, p. 268 (1930); *Rec. Ind. Mus.* XXXVI, p. 281 (1934).

lagoons. No doubt the latter are far richer in food stuffs than the lake itself. In the case of the third species (**N. panguri**), from Tso Nyak and Pangur Tso, there is no doubt that the species actually lives at present in the lakes which are fairly rich in vegetation, though it also enters the streams running into them. To my mind there can be no doubt that all three species developed in the late glacial lake but only the third one has remained common in lacustrine environments, the others hanging on as best they can chiefly in small pools in the basin."

It is clear from the above that at the present time the Panggong Lake acts as an effective barrier for the distribution of various species. Further it seems probable that this habitudinal segregation may have induced the development of different species. It is likely that in the late glacial lake there was only one species derived from a torrential stock and that when the environments became restricted, it developed along different lines in different localities and resulted in the production of several new species.[8] This supposition supports the hypothesis of Regan[9] "that as a rule the first step in the origin of a new species is the formation of a community with a new and restricted environment, or with new habits; in other words, that some form of isolation, either localization or habitudinal segregation, is the condition of the development of a new species."

From the modifications of the bladder described above, it does not follow that the lake species cannot enter into brooks or *vice versa.* All species of *Nemachilus* are flattened and adapted for clinging to foreign objects and if ponds, pools and lakes are in communication with brooks it is possible that the species of one habitat may enter the habitat of the other set of species. For instance, it often happens that torrential forms enter springs and pools for breeding purposes. The occurrence of a species (*N. panguri*) in both types of habitats, therefore, does not in any way help to fix its evolutionary status.

N. vittatus seems to have developed in the Kashmir lakes and is endemic in them. *Nemachilus stoliczkae, N. microps, N. tenuicauda* and *N. gracilis* are widely distributed species. The first three are, however, restricted to the high altitudes, whereas *N. gracilis* is found as far down in the Indus as Attock.[10] Almost all the species were obtained by the Netherland Karakorum Expedition not only from the Nubra Valley but also from the Karakash river, which now drains into the Tarim river system. Mukerji and I referred to this discontinuous distribution of the species, but the difficulty has now disappeared for "On the basis of his geomorphological studies, Dr. de Terra has reconstructed the Tertiary drainage pattern of the western part of the Tibetan plateau. A number of rivers ran from west to east, one of them occupying the present valley of the Upper Indus."[11] The close similarity between the torrential fish fauna of the Karakash river and of western Tibet suggests, at any rate, a common drainage for the waters of these two areas at no great distant date and lends great support to the hypothesis advanced by de Terra. Reference may also be made to the occurrence of *N. ladacensis* in Ladakh and the Karakash Valley, but it has to be remembered that only a few specimens of this species are known so far, and, in consequence, its specific limits have not yet been precisely defined.

[8] Dr. A. W. C. T. Herre had a similar problem in the evolution of the seventeen species of fishes of Lake Lanao in the Philippines (*Amer. Nat.* XLVII, pp. 154-162, 1933).

[9] Regan, *Nature,* CXIII, p. 569 (1924).

[10] Hora, *Rec. Ind. Mus.* XXXV, p. 189 (1933).

[11] Hutchinson, *Nature,* CXXXIV, p. 87 (1934).

SYSTEMATIC ACCOUNT

Nemachilus stoliczkae (Steindachner)

1866. *Cobitis stoliczkae*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, p. 793, pl. xiv, fig. 2.
1868. *Nemachilus stoliczkae*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 360.
1876. *Nemacheilus stoliczkae*, Day (in part), *Proc. Zool. Soc. London*, p. 795.
1878. *Nemacheilus stoliczkae*, Day (in part), *Sci. Res. 2nd Yarkand Miss. Ichthyol.*, p. 14, pl. v, fig. 2.
1878. *Nemacheilus stoliczkae*, Day (in part), *Fish. India*, p. 620, pl. clv, fig. 10.
1889. *Nemachilus stoliczkae*, Day (in part), *Faun. Brit. Ind. Fish. I*, p. 235, fig. 84.
1922. *Nemachilus stoliczkae*, Hora, *Rec. Ind. Mus.* XXIV, p. 78.
1935. *Nemachilus stoliczkae*, Hora & Mukerji, Visser's *Karakorum* I, p. 429, pl. iv, fig. 4.

The species was originally described from 12 specimens obtained from Tsho Mararai (Tso Moriri), a lake in the Rupshu Province of Western Tibet at an altitude of 15,500 ft. Day[12] assigned a very wide range of distribution to this species and recorded it from Leh, Snima, Lukong, Chagra, Yarkand, Sarikol and Aktash. Since then it has been reported from widely different places in Central Asia and several varieties of it have been described by Russian ichthyologists[13] from Eastern Turkestan (Tarim River System) and Turkestan (Oxus River System). In 1922, it was pointed out by me that of the large number of specimens referred to *N. stoliczkae* by Day and now preserved in the collection of the Indian Museum, only those that came from Rupshu, Lukong and Chagra could be definitely assigned to this species. A specimen from "Kashmir" was also referred to *N. stoliczkae*, but there seems to have been some mistake about the locality of this example, as the species appears to be restricted to high altitudes. Mukerji and I have recorded this species from Leh, Panamik, Nungstet, Suget-Karaul and Alenazar-Kurghan after studying the material obtained by the Netherland Karakorum Expedition. The first three localities are on the headwaters of the Indus, while the last two are in the Karakash Valley whence the waters flow into the Tarim River. All these places are situated at fairly high altitudes.

The Yale North India Expedition made collections in Western Tibet and obtained specimens from several places to the north-east of the type-locality. Though originally described from a lake,[14] it appears to be a torrential form as it is devoid of a functional air-bladder. It seems likely that the species enters lakes for breeding purposes. Several young specimens were obtained by the Expedition from Yaye Tso; while fully grown specimens were obtained from several streams.

In view of the great confusion that prevails regarding this species, I take this opportunity to give a detailed description with figures from freshly preserved material.

D.3/8; A.3/5; P.13; V.8; C.19

Nemachilus stoliczkae is a long and slender species in which the head and the anterior part of the body are depressed; while the tail region is compressed and whip-like. The

[12] Day, *Proc. Zool. Soc. London*, p. 595 (1876); *Sci. Res. 2nd Yarkand Mission, Ichthyol.*, p. 14, pl. v, fig. 2 (1878).

[13] Herzenstein, *Wiss. Res. Przewalski Central As. Reis. Zool.* III (2), p. 14 (1888); Berg, *Poiss des Eaux Douces de L'U. R. S. S.*, pt. ii, p. 559 (1933).

[14] Mr. Hutchinson informs me that he used a trawl on very favourable ground at the north end (estuary of Peldo-le stream) of Tso Moriri, and found no fish. He is of opinion that the types of *N. stoliczkae* must have come from a stream flowing into the lake. (This is stated to be the case in the original description. G. E. H.)

dorsal profile is gently, but slightly, arched and the ventral profile is straight and horizontal throughout. The head is long and narrow and broadly pointed; its length is contained from 5.6-5.9 times in the total length and from 4.2-4.8 times in the length without the caudal. The head is relatively longer in the female specimens. The greatest width of the head is contained from 1.4-1.6 times and its height at occiput from 1.7-2.1 times in its length. The eye is almost in the middle of the head in female specimens, while in the males the snout is sometimes considerably longer than the postorbital part of the head. The diameter of the eye is contained from 5.2-6.5 times in the length of the head, from 2.3-3.2 times in the length of the snout and from 1.3-1.6 times in the interorbital width. The supraorbital margin of the eye projects slightly beyond the profile and the eyes are not visible from the ventral surface. The mouth is on the ventral surface considerably behind the tip of the snout; it is lunate and horizontal. The lips are thick, continuous and greatly papillated or striated. The posterior lip is reflected backwards so that a portion of the jaw is left bare. The post-labial groove is interrupted in the middle by a slight ridge. The posterior jaw has a sharp, evenly rounded edge. The form of the lips is a very characteristic feature of the species. The barbels are short and stumpy; they are as long as or slightly longer than the diameter of the eye.

The greatest height of the body is above the pectoral fins; the depth of the body is contained from 8.2-10.4 times in the total length and from 6.8-8.6 times in the length without the caudal. The body is scaleless. The lateral line is complete; anteriorly it is continued over the head and divides into two branches behind the eyes. The caudal peduncle is long and narrow; its least height is contained from 3.1-3.6 times in its length.

The dorsal fin is inserted somewhat in advance of the ventral and its commencement is distinctly nearer to the base of caudal than to the tip of snout. The longest ray of the dorsal is considerably higher than the depth of the body below it; its anterior margin is rounded near the tip and the free border is concave. The paired fins are broad, rounded and horizontally placed. The pectoral is somewhat shorter than the head and extends almost half the way to the ventral. The ventral fin extends beyond the anal opening and in some cases almost reaches the anal fin. The anal fin is separated from the caudal by a distance equal to its own length. The caudal fin is almost as long as or slightly longer than the head in males, while in the females it is shorter than the head; its length is contained from 5-5.8 times in the total length. It is slightly emarginate and has two rounded lobes; the lower lobe is better developed and longer than the upper.

Nemachilus stoliczkae exhibits sexual dimorphism. The secondary sexual characters of the male are well developed and of the type described by me[15] for *N. tibetanus*. In the males the head is relatively shorter and the snout is longer than the postorbital part of the head.

In spirit specimens, the general colour is dark above and on the sides and much lighter below. The head and body are mottled with numerous black spots, and in some specimens short, saddle-shaped, black bands are distinguishable along the dorsal surface, especially in the tail region. The dorsal and the caudal fins are spotted. The anteriormost ray of the dorsal fin is provided with a series of conspicuous spots. The dorsal surface of the outer rays of the paired fins is sometimes spotted.

In young specimens, the whole of the body is grayish in colour, though somewhat

[15] Hora, *Rec. Ind. Mus.* XXIV, p. 81 (1922).

lighter on the ventral surface. There is a series of spots along the lateral line and also along the dorsal surface. The fins are without any colour markings.

Distribution. Reference has been made above to the general distribution of the species. Its precise range is, however, difficult to assign till the limits of the forms referred to *N. stoliczkae* from all over Central Asia are properly elucidated. The Yale North India Expedition obtained specimens from the following localities in June-August, 1932:

Between Tangtse and Mugleb, *ca* 13,700 ft. (L 37). 1 specimen (♂).
Migpal-kongma, *ca* 16,082 ft. (L 64). 5 specimens (♂).
Between Chume-sang and Nyagtsu, *ca* 15,500 ft. (L 65). 4 specimens (3 ♀ + 1 ♂).
Nyagtsu, *ca* 15,324 ft. (L 65). 1 specimen (♂).
Tso-skam, *ca* 15,800 ft. (L 77b). 1 specimen (♀).
Yaye Tso, *ca* 15,373 ft. (L 78). 18 specimens (young).

Remarks. *Nemachilus stoliczkae* can be readily distinguished by the following combination of characters:

(i) The ventrals extend considerably beyond the anal opening.

(ii) The commencement of the dorsal is nearer to the base of the caudal than to the tip of the snout.

(iii) The least height of the caudal peduncle is about 3-4 times in its length.

(iv) The lips are papillated and continuous; the posterior lip is broad and reflected backwards.

Bionomics. From its general build, position and form of the paired fins and the structure of the lips and jaws, *N. stoliczkae* appears to be a torrential species. The absence of a functional swim-bladder indicates that it is a stream form and lives at the bottom. An examination of the stomach contents has shown that it feeds on insect larvae and algal growths that encrust rocks and stones. Caddis-worms, dipterous larvae, eggs (probably of Trichoptera) and slimy matter have been found in the stomachs of specimens dissected from different localities. The length of the alimentary canal is slightly greater than the length of the fish. Some of the specimens opened have been found to harbour worms.

Measurements in millimetres

	♂	♂	♂	♀	♀	♀
Total length including caudal	121.0	106.0	100.0	102.5	96.9	84.5
Length of caudal	21.2	18.8	17.0	18.0	16.2	14.8
Length of head	21.0	18.0	17.8	18.5	19.0	16.4
Width of head	15.0	11.5	11.3	12.5	12.1	9.3
Height of head	11.8	9.2	9.8	10.4	9.0	7.8
Depth of body	14.0	10.3	10.7	9.8	10.2	10.2
Length of snout	10.0	8.8	7.8	7.6	8.2	7.0
Diameter of eye	4.0	2.9	2.8	3.0	3.0	2.8
Interorbital width	5.5	4.0	4.0	3.9	5.0	3.6
Length of caudal peduncle	23.6	20.0	20.0	21.0	20.0	18.0
Least height of caudal peduncle	7.0	6.4	5.5	6.2	5.8	5.0
Longest ray of dorsal	18.0	15.1	14.0	15.0	14.8	11.0
Longest ray of anal	15.5	13.6	12.0	14.0	14.0	10.5
Length of pectoral	18.5	16.0	14.5	15.8	15.0	12.0
Length of ventral	15.6	14.5	13.0	12.5	13.0	11.0
	L 66	L 64			L 65	

Nemachilus gracilis Day

1876. *Nemacheilus gracilis*, Day, *Proc. Zool. Soc. London*, p. 798.
1878. *Nemacheilus gracilis*, Day, *Sci. Res. 2nd Yarkand Miss. Ichthyology*, p. 16, pl. iv, fig. 5.
1878. *Nemacheilus gracilis*, Day, *Fish. India*, p. 621.
1889. *Nemachilus gracilis*, Day, *Faun. Brit. Ind. Fish.* I, p. 257.
1898. *Nemachilus stoliczkae*, Alcock (*nec* Steindachner), *Rep. Nat. Hist. Pamir Bound. Comm.*, p. 38.
1922. *Nemachilus gracilis*, Hora, *Rec. Ind. Mus.* XXIV, p. 74.
1933. *Nemachilus gracilis*, Hora, *Rec. Ind. Mus.* XXXV, p. 189.
1935. *Nemachilus gracilis*, Hora & Mukerji, in Visser's *Karakorum*, I, p. 430, pl. iv, fig. 2.

Nemachilus gracilis appears to be one of the commonest loach of the Indus River and its range extends from very high altitudes to as low down as Attock in the North-Western Frontier Province. Few specimens of the species were also obtained by the Netherland Karakorum Expedition from the Karakash Valley. In the collection of the Yale North India Expedition, *N. gracilis* is represented from the following localities. The specimens were collected during May to July, 1932.

Stream 1 mile of Dras, *ca* 10,100 ft. (K 76). 6 specimens (young).
Dras, *ca* 10,144 ft. (K 77). 22 specimens (9 ♂ — 13 ♀).
Spring below Kargil, *ca* 8,790 ft. (K 81). 1 specimen (♂).
Above Leh, *ca* 15,000 ft. (L 25). 3 specimens (young).
Between Tangtse and Mugleh, *ca* 13,700 ft. (L 37). 1 specimen (♂).
Kyam rivulet, *ca* 15,500 ft. (L 59). 1 specimen (young).
Kyam, a pool below camp, *ca* 15,500 ft. (L 60). 1 specimen (♂).
Yalapuk, *ca* 13,521 ft. (L 79). 2 specimens (young).
Sta-rtsak-puk Tso, *ca* 14,889 ft. 4 specimens (young).

The above distribution shows that the species frequents pools in the course of streams, springs and lakes for breeding purposes as young specimens were collected from such localities. It is essentially a torrential species of wide range.

N. gracilis is readily distinguished by the fact that, as a rule, the ventrals do not extend as far as the anal opening, the eye is almost in the middle of the head and the ventrals commence in advance of the dorsal. The structure of the lower lip is also characteristic of the species.

The air-bladder is of the usual reduced type, consisting of two lateral chambers enclosed in bone. The alimentary canal is simple and not much convoluted; its length is about three-fifths of the total length of the fish. The food consists of insect larvae, mostly free-living Diptera and Trichoptera, and of the slime encrusting rocks and stones in rapid current. The small, fan-shaped, horizontal paired fins, reduced air-bladder and its food strongly suggest that the fish lives in very fast currents. Young specimens were collected from underneath stones in a rivulet.

In the mature females, the ovaries occupy almost the whole of the abdominal cavity and even the alimentary canal is flattened out. The eggs are of a fairly large size (diameter about 1.25 mm.).

Nemachilus microps (Steindachner)

1866. *Cobitis microps*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 794, pl. xii, fig. 3.
1868. *Nemachilus microps*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 357.
1878. *Nemachilus microps*, Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology*, p. 17.
1922. *Nemachilus microps*, Hora, *Rec. Ind. Mus.* XXIV, p. 80.
1935. *Nemachilus microps*, Hora & Mukerji, in Visser's *Karakorum*, I, p. 430, pl. iv, fig. 3.

I refer to *Nemachilus microps* 4 specimens, from 30 to 86 mm. in total length, collected by the Yale North India Expedition on the 27th of August 1932 from underneath large stones in the bed of a stream flowing into the west end of the Tso-Moriri lake about 14,853 feet above sea level. The two larger specimens are females with fully developed ovaries. The eggs are minute and the ovaries do not extend forwards beyond the middle of the abdominal cavity. The air-bladder is reduced and enclosed in bony capsules, as is characteristic of the stream-dwelling forms. The alimentary canal is about as long as the length of the fish and the stomach contents show that the fish feeds on white, slimy stuff that is found encrusting rocks and stones.

In my key to the species of *Nemachilus* from Central Asia in the collection of the Indian Museum (1922, p. 73) *N. microps* was separated from the ♀ of *N. yasinensis* by the relative lengths of the anal fin and of the caudal peduncle. In the specimens now before me the portion of the caudal peduncle is much less than the length of the anal fin, but in all other respects they agree with the other specimens in the Indian Museum collection. In *N. yasinensis* the caudal peduncle is low, while in the four specimens from Western Tibet it is two-fifths as high as long. In the earlier specimens, the caudal peduncle is one-third as high as long. These differences do not seem to me sufficient to justify the erection of a new species in such a variable genus. For future reference, however, I give below measurements of two mature female specimens.

The species was originally described from 10 specimens, 4 from Leh and 6 from "Phirse-Bach in einer Hohe von circa 16000 Fuss bei Manechan in Rupshu (Juli 1865)." The specimens in the collection of the Yale North India Expedition were also collected in the Rupshu Province, Western Tibet.

Measurements in millimetres

	♀	♀
Total length including caudal	86.0	86.0
Length of caudal	15.6	15.5
Length of head	15.0	16.0
Width of head	9.5	11.2
Height of head	7.5	7.0
Depth of body	8.8	9.5
Length of snout	5.5	6.2
Diameter of eye	2.8	2.6
Interorbital width	3.8	3.8
Length of caudal peduncle	13.2	12.8
Least height of caudal peduncle	5.3	5.0
Longest ray of dorsal	11.6	12.5
Longest ray of anal	10.5	10.0
Length of pectoral	12.2	12.5
Length of ventral	11.5	11.0

Nemachilus tenuicauda (Steindachner)

1866. *Cobitis tenuicauda,* Steindachner, *Verh. Zool.-bot. Ges. Wien.* XVI, p. 792, pl. xvii, fig. 3.
1868. *Nemachilus tenuicauda,* Günther, *Cat. Fish. Brit. Mus.* VII, p. 357.
1922. *Nemachilus tenuicauda,* Hora, *Rec. Ind. Mus.* XXIV, p. 79.
1935. *Nemachilus tenuicauda,* Hora & Mukerji, in Visser's *Karakorum,* I, p. 430.

There is a single, mature, female specimen of *Nemachilus tenuicauda,* about 62 mm. in total length; it was collected by the Expedition from a pool in a swamp by Sta-rtsak-puk Tso at an altitude of 14,885 feet. It is a small species and was originally collected from a small brook in Western Tibet. It is also known from Leh and the Nubra Valley.

The ovaries occupy only the posterior half of the abdominal cavity. The air-bladder is reduced and enclosed in two bony capsules. The length of the alimentary canal is about seven-tenths of the total length of the fish. The food consists of Dipterous and Trichopterous larvae and of insect eggs. The long and narrow caudal peduncle indicates that the species lives in turbulent waters.[16]

Nemachilus vittatus (Heckel)

1838. *Cobitis vittata,* Heckel, *Fische Kaschm.,* p. 80, pl. xii, figs. 3 and 4.
1844. *Cobitis vittata,* Heckel, in Hugel's *Kashmir* IV, p. 382, fig.
1922. *Nemachilus vittatus,* Hora, *Rec. Ind. Mus.* XXIV, p. 74.
1930. *Nemachilus vittatus,* Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, p. 379 (air-bladder structure).

Nemachilus vittatus is represented by 40 specimens in the collection of the Yale North India Expedition; of these 33 are from the Wular Lake and 7 from a small lake at Shadipur. The Wular Lake specimens were dredged at Kiuhnus. Though a lake form, *N. vittatus* appears to be a bottom-living species and, in consequence, is devoid of a free air-bladder in the abdominal cavity. The two lateral chambers are large and lie next to the skin as the bony capsule is incomplete in that region. The alimentary canal is four-fifths of the total length of the fish. The food consists of algae, mud, insect larvae, leeches, etc.

The species exhibits well marked sexual dimorphism and the secondary sexual characters of the males are similar to those of the other species described in this paper. The gonads were ripe towards the end of April when the specimens were collected. The ovaries occupy almost the whole of the abdominal cavity and the eggs are of a relatively large size.

Of the 40 specimens obtained by the Expedition, 24 are females and 16 are males, giving a percentage of 60 females and 40 males. Usually the males predominate in collections as the females are of rather secretive habits, but in this case the dredge used seems to have made a considerable difference in the proportional representation of sexes in the collection.

Nemachilus deTerrai, sp. nov.

D./38; A.2/5; P.10; V.7; C.16

Nemachilus deTerrai is a long and slender species in which the head and the anterior part of the body are slightly depressed, while the posterior part, especially the tail region, is compressed and whip-like. The head is moderately long and broadly pointed; its length

[16] Hora, *Phil. Trans. Roy. Soc. London* (B) CCXVIII, pp. 250-254 (1930).

is contained from 5.7-6.2 times in the total length and from 4.6-5 times in the length without the caudal. The width of the head is contained from 1.4-1.8 times and the height of the head from 1.6-1.8 times in the length of the head. The eye is situated somewhat nearer

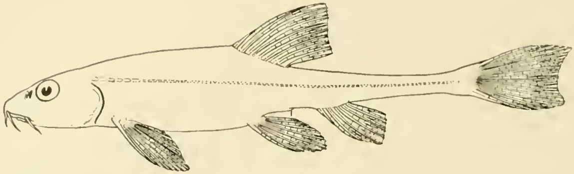


FIGURE 4. Lateral view of a female specimen of **Nemachilus deTerrai,** sp. nov. × 1½.

the tip of the snout than to the opercular margin; its superior border projects slightly beyond the dorsal profile of the head, but it is slightly visible from the ventral surface. The diam-

FIGURE 5. Alimentary canal and air-bladder of a male specimen of **Nemachilus deTerrai,** sp. nov. × 2½.
a: alimentary canal; *b*: air-bladder.

eter of the eye is contained from 4-4.7 times in the length of the head, from 1.4-1.8 times in the length of the snout and from 1-1.4 times in the interorbital width. The mouth is lunate and transverse; it is situated on the ventral surface somewhat behind the tip of the snout and is bordered by fleshy lips. The lips are striated; the posterior lip is interrupted in the middle and reflected towards the sides so that a small, triangular portion of the posterior jaw is left bare. The posterior jaw is sharp and shovel-like and the anterior jaw lies as a hood in front of it. The barbels are thin and long; the inner rostrals are as long as the diameter of the eye while the other two pairs are much longer.

Some of the specimens are heavily parasitised by worms, so that the depth of the body is liable to considerable variation. The depth of the body is contained from 8.5-9.9 times in the total length and from 7-7.6 times in the length without the caudal. Behind the gill-opening and above the base of the pectoral fin, the lateral line is represented by a thin-walled, broad tube beyond which it is faintly marked, though it is continued to the base of the caudal fin. The caudal peduncle is long and narrow; its least height is contained from 4.8-6.4 times in its length. In the male specimens the least height is either equal to or greater than the diameter of the eye while in the females it is considerably less.

The dorsal fin is inserted slightly in advance of the ventrals and its commencement is considerably nearer to the tip of the snout than to the base of the caudal; it is longer than the head; its posterior edge is truncate or slightly crenulate. The paired fins are horizontally placed; the pectoral fin is broad but pointed in the middle; it is somewhat shorter than the head and separated from the ventral by a distance equal to half of its length. The ventrals extend beyond the anal opening and in some cases even beyond the commencement of the anal fin which extends about half the way to the base of the caudal. The caudal fin is longer than the head; its posterior border is concave with the upper rays considerably longer than the lower.

Nemachilus deTerrai exhibits sexual dimorphism. The secondary sexual characters of the male are similar to those described above for *N. stoliczkae*. The difference in the height of caudal peduncle is also well marked in the two sexes.

Air-bladder: The air-bladder is divided into two parts, (i) the anterior part consisting of two round, lateral chambers enclosed in bony capsules and connected by a short, transverse tube, and (ii) a large posterior part lying free in the abdominal cavity and connected with the transverse tube by a short tube. By another short, but broader, tube it is connected with the oesophagus. The posterior part is slightly constricted in the middle so that it consists of two chambers. In a specimen about 110 mm. in total length, the measurements of the bladder are as follows:

Total length of bladder	25.00 mm.
Length of posterior part	20.00 mm.
Width of anterior part	7.50 mm.
Width of posterior part	7.50 mm.
Transverse diameter of each anterior chamber	3.25 mm.
Length of tube between two anterior chambers	1.00 mm.
Length of tube between anterior and posterior parts	1.70 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules of the air-bladder lie just beneath the skin and are distinctly visible from the external surface.

In spirit specimens the general colour of the body is pale-olivaceous. There is usually a black, fairly broad streak along the lateral line which is composed of a series of darker blotches. In some the dorsal surface is gray so that there is a lighter stripe between the dorsal band and the lateral line. The dorsal and the caudal fins are provided with 2 to 4 series of spots and the anterior ray of the dorsal fin is provided with 3 or 4 black spots along the front margin. The dorsal surface of the paired fins and the anal fin are sometimes provided with black patches.

Locality: Nine specimens of **N. deTerrai** were obtained by the Yale North India Expedition from the Man Lagoon on the 4th and 5th of July. It is an isolated lagoon in the drowned valley at an altitude of 14,008 ft.

Remarks: The most distinguishing feature of **N. deTerrai** is the great length of its dorsal fin. The other fins are also elongated. The form of the caudal fin is very characteristic of the species.

Bionomics: From the extensive air-bladder in the abdominal cavity, and from the nature of the fins, it is clear that the fish is adapted to live in stationary waters. The general facies, especially the whip-like caudal peduncle, suggests that the fish is a fast swimmer. For feeding purposes, the fish probably adheres to rocks with the help of the paired fins and scrapes off animal and vegetable matter. In the case of two specimens dissected the stomach was found to be full of a whitish, pulpy material without any sand or small bits of stones. The alimentary canal is not much convoluted; its length is about three-fifths of the total length. It would thus seem to be a flesh-eating species.

Measurements in millimetres

	♂	♂	♂	♀	♀
Total length including caudal	104.0	95.0	95.0	83.0	68.0
Length of caudal	21.0	18.5	19.0	14.8	11.5
Length of head	17.9	16.5	15.2	14.0	12.0
Width of head	11.5	9.2	8.8	9.8	7.0
Height of head	10.9	10.0	9.5	8.2	6.5
Depth of body	12.0	10.5	9.6	12.0[17]	8.0
Length of snout	6.5	6.5	6.5	5.0	4.5
Diameter of eye	4.2	3.5	3.8	3.5	2.8
Interorbital width	5.2	5.0	4.0	3.5	3.2
Length of caudal peduncle	23.0	21.6	20.0	20.5	16.0
Least height of caudal peduncle	4.8	4.3	4.0	3.2	2.5
Longest ray of dorsal	19.8	17.8	17.0	15.0	14.2
Longest ray of anal	15.0	14.0	13.2	12.5	9.0
Length of pectoral	17.2	15.0	15.0	13.2	11.5
Length of ventral	15.5	13.8	14.0	11.5	10.0

Nemachilus hutchinsoni, sp. nov.

D.3/8; A.2/5; P.9; V.7; C.16

In **Nemachilus hutchinsoni** the head and the anterior part of the body are depressed so that the ventral surface is somewhat flattened. In the tail region the body is compressed and whip-like. The head is short, high and broadly pointed; its length is contained from 5.4-5.6 times in the total length and from 4.4-4.6 times in the length without the caudal. The width of the head is contained from 1.4-1.6 times and the height of the head at the occiput 1.6 times in its length. The eyes are situated nearer to the tip of the snout than to the posterior

[17] The abdominal portion is greatly swollen due to heavy parasitisation by worms.

margin of the operculum; they are dorsolateral in position and invisible from the ventral surface. The diameter of the eye is contained from 4.1-4.9 times in the length of the head, from 1.5-1.7 times in the length of the snout and from 1-1.5 times in the interorbital width. The mouth is lunate and transverse; it is on the ventral surface not very far behind the tip of the snout and is bordered by fleshy lips which are continuous at the angles of the mouth. The ventral lip is divided in the middle almost imperceptibly. The lips are folded, fimbriated and covered with minute papillae. The lower jaw is sharp and horizontal, while the upper jaw is vertical and lies in front of the lower. The barbels are thin and long; the inner rostrals are almost as long as the diameter of the eye, while the other two pairs are much longer.

The only mature female specimen is heavily parasitised and, in consequence, the depth of its body is relatively greater. In the male specimens the depth of the body is contained from 7.7-8 times in the total length and from 6.2-6.6 times in the length without the caudal. The lateral line is well developed above the base of the pectoral fin beyond which it is incon-

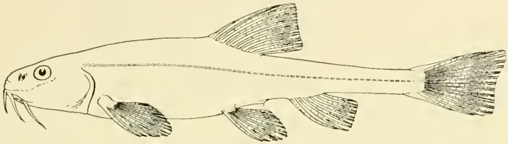


FIGURE 6. Lateral view of a female specimen of **Nemachilus hutchinsoni**, sp. nov. Nat. size.

spicuous. The caudal peduncle is long but fleshy; its least height is contained from 4.4-5.1 times in its length. The least height is either greater than or equal to the diameter of the eye; in the female specimen the least height is considerably greater than the diameter of the eye.

The dorsal fin is inserted in advance of the ventrals and its commencement is considerably nearer to the tip of the snout than to the base of the caudal fin; it is somewhat longer than the head but this character is more marked in the female specimen. The posterior margin of the fin is almost truncate. The paired fins are horizontally placed and are broadly pointed in the middle. The pectoral is shorter than the head and is separated from the ventral by a considerable distance. The ventral extends beyond the anal opening and almost reaches the anal fin which extends half way to the base of the caudal fin. The caudal fin is somewhat longer than the head; it is slightly emarginate with the two lobes broadly rounded. The upper lobe is better developed and longer than the lower.

Nemachilus hutchinsoni exhibits sexual dimorphism and the secondary sexual characters of the male are similar to those of the other species discussed here. The mature male and female specimens are from two different localities so one cannot be certain that they belong to the same species. A male specimen has been selected as the type of the species. Attention may be directed to the fact that in the female specimen the caudal peduncle is relatively deeper and the dorsal fin longer than is the case in the males.

Air-bladder. The air-bladder is of the usual Diplophysid type. The anterior part is dumbbell-shaped and is enclosed in two bony capsules while the posterior part, which is deeply

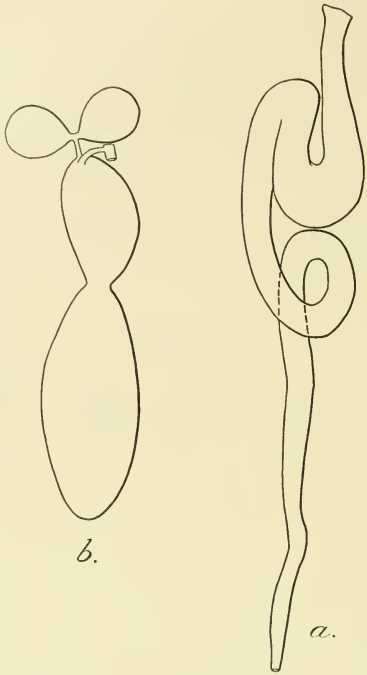


FIGURE 7. Alimentary canal and air-bladder of a male specimen of **Nemachilus hutchinsoni,** sp. nov. × 4.
a: alimentary canal; *b*: air-bladder.

constricted to form two chambers, lies free in the abdominal cavity. The two anterior chambers are connected by a short tube and the anterior and posterior parts of the bladder are connected by a short tube. In a male specimen about 90 mm. in total length the measurements of the bladder are as follows:

Total length of bladder	21.60 mm.
Length of posterior part	18.40 mm.
Width of anterior part	7.00 mm.
Width of posterior part	4.80 mm.
Transverse diameter of each anterior chamber	3.20 mm.
Length of tube between two anterior chambers	0.66 mm.
Length of tube between two parts of bladder	0.90 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules are incomplete in the part where they touch the skin so that their position can be readily made out from the external surface.

In spirit specimens the general colour of the body is pale-olivaceous. A series of fairly broad blotches is present along the lateral line and in some specimens they unite to form a longitudinal band. Along the dorsal surface, especially in the tail region, there are a number of saddle-shaped bands. The dorsal surface and the sides are further irrorated with small black dots. The dorsal and the caudal fins are provided with two to three broad bands. The anal and the ventral fins are provided with one or two bands each.

Localities: In all six specimens were collected by the Yale North India Expedition during June 1932 from the following localities:

About 3 miles west of Mugleb, *ca.* 13,525 ft. (L 35). 1 specimen (young).
Pond between Durbuk and Tangtse, *ca.* 13,000 ft. (L 36). 3 specimens (♂).
Tsar Tso, *ca.* 13,950 ft. (L 39). 1 specimen (young).
Pool isolated from the river at Lukung, *ca.* 14,164 ft. (L 40). 1 specimen (♀).

It is seen from the above that the species occurs in pools, and small lakes.

Bionomics: The species is adapted for life in stationary waters of lakes where its well developed air-bladder enables it to swim about freely at different depths. It feeds on insect larvae and pupae that encrust rocks and stones. Its horizontal, paired fins enable it to adhere to rocks and its lower jaw appears to be capable of acting as a shovel for rasping off encrusting organisms. The alimentary canal is a simple tube without many convolutions and its length is about three-fifths of the total length. The eggs are small and the ovaries extend right up to the anterior end of the abdominal cavity.

Measurements in millimetres

	♀	♂	♂	♂
Total length including caudal	110.0	94.0	90.0	89.0
Length of caudal	20.5	18.5	17.0	15.5
Length of head	19.5	17.0	16.5	16.0
Width of head	12.2	11.0	11.0	11.0
Height of head	11.9	10.5	10.5	10.0
Depth of body	17.0	12.2	11.5	11.0
Length of snout	6.9	6.5	6.0	6.0
Diameter of eye	4.0	4.0	3.6	3.6
Interorbital width	5.0	4.2	4.0	5.5
Length of caudal peduncle	22.0	20.5	19.5	18.0
Least height of caudal peduncle	5.0	4.0	4.0	3.6
Longest ray of dorsal	21.5	17.0	16.0	17.5
Longest ray of anal	16.5	12.0	12.5	12.6
Length of pectoral	17.5	15.5	15.0	15.0
Length of ventral	15.5	13.2	13.2	13.5
	L 40	L 36		

Nemachilus panguri, sp. nov.

D.3/8; A.2/5; P.9; V.7; C.16

The build of **Nemachilus panguri** is more or less of the same type as in the two preceding species. The head and the anterior part of the body are somewhat depressed while the tail region is slightly compressed and whip-like. The head is moderately long and broadly pointed anteriorly; its length is contained from 5-5.6 times in the total length and from 4-4.6 times in the length of the caudal. The width of the head is contained from 1.78-1.95 times and the height of the head from 1.73-1.76 times in its length. The position of the eye in the length of the head is variable; the upper margin of the orbit is slightly raised above the dorsal profile of the head and the eyes are not visible from the ventral surface. The diameter of the eye is contained from 4-5 times in the length of the head, from 1.5-2 times in the length of the snout and from 1-1.1 times in the interorbital width. The mouth is small, lunate, transverse and horizontal; it is situated on the ventral surface slightly

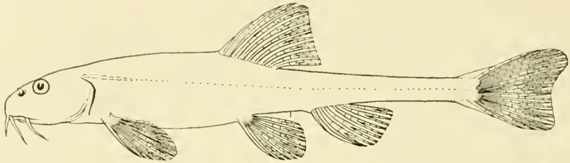


FIGURE 8. Lateral view of a female specimen of **Nemachilus panguri,** sp. nov. from Tso Nyak. × 1½.

behind the tip of the snout and is bordered by fleshy and papillated lips. The lower lip is interrupted in the middle. The posterior jaw is sharp, truncate and horizontal. The three pairs of barbels are fairly well developed; the inner rostrals are as long as or slightly longer than the diameter of the eye while the other two pairs are much longer.

The depth of the body is contained from 9-10.5 times in the total length and from 7.3-8.6 times in the length without the caudal. Behind the gill-opening and above the base of the pectoral fin, the lateral line is represented by a thin-walled, broad tube beyond which it is faintly marked to the base of the caudal fin. The caudal peduncle is long and narrow; its least height is contained from 5.3-6.5 times in its length. In both the sexes the least height of the caudal peduncle is usually less than the diameter of the eye, but in some female specimens it is greater than the diameter of the eye.

The dorsal fin is inserted slightly in advance of the ventrals and its commencement is either equidistant between the tip of the snout and the base of the caudal or nearer to the tip of the snout than to the base of the caudal; it is almost as long as the head; its posterior border is slightly arched. The paired fins are broad and horizontal; the pectorals are pointed in the middle, especially in the males. The pectoral fin is considerably shorter than the head and is separated from the ventral by a distance almost equal to half of its length. The ventrals extend beyond the anal opening and reach the base of the anal fin. The anal fin is similar in shape to the dorsal. The caudal fin is almost as long as the head; it is slightly emarginate with the upper lobe considerably longer and better developed than the lower.

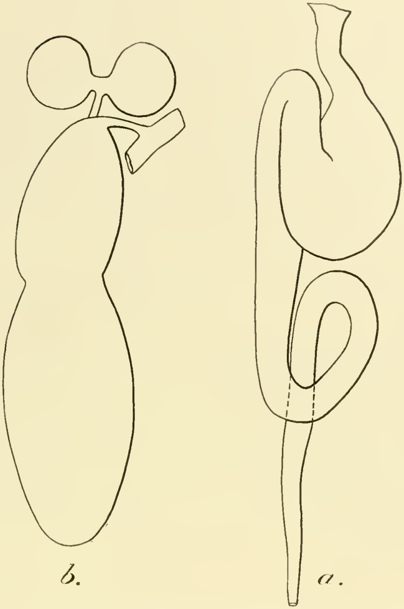


FIGURE 9. Alimentary canal and air-bladder of **Nemachilus panguri**, sp. nov. $\times 5$. *a*: alimentary canal of a male specimen; *b*: air-bladder of a female specimen.

Nemachilus panguri exhibits well-marked sexual dimorphism. The secondary sexual characters of the male are similar to those of other Nemachiloid fishes of Central Asia.

Air-bladder: The air-bladder of **N. panguri** is similar to that of **N. deTerrai**. In a female specimen about 95 mm. in total length, the measurements of its various parts were as follows:

Total length of bladder	26.6 mm.
Length of posterior part	19.0 mm.
Width of anterior part	6.7 mm.
Width of posterior part	5.8 mm.
Transverse diameter of each anterior chamber	3.0 mm.
Length of tube between two anterior chambers	0.9 mm.
Length of tube between anterior and posterior parts of bladder	1.4 mm.

The above measurements are of the bladder after its removal from the bony capsules.

The bony capsules of the air-bladder lie just beneath the skin and are distinctly visible from outside.

The ground color of the spirit specimens is pale-brown, the dorsal surface being somewhat darker than the ventral. There are patches of dark colour along the lateral line and saddle-shaped bands along the dorsal surface. These colour markings are more pronounced in the younger specimens. The head is grayish above and pale-yellow below. The dorsal fin is provided with 4-5 dark bands in the adult while in the smaller individuals there may be only one or two bands. The ventral and the anal fins are also similarly marked. The caudal fin is provided with 3 broad bands, but in young specimens only one broad, prominent band is present in the middle of the fin.

Localities: Several specimens in **N. panguri** were collected by the Yale North India Expedition in August 1932 from the following localities:

Pangur Tso, *ca.* 14,203 ft. (L 74).	Several young, half-grown and adult specimens.
Tso Nyak (L 71a).	Several young, half-grown and adult specimens.

Remarks: **Nemachilus panguri** seems to be a very close ally of **N. deTerrai** from which it differs in proportions, especially of the eye and the dorsal fin. Though the differences do not seem to be markedly specific, it is better to regard the two species as distinct in the present state of our knowledge of the fish fauna of Western Tibet.

Bionomics: Like the two preceding species, **N. panguri** is also adapted to live in stationary waters where it can dart from place to place with the help of the whip-like caudal peduncle or make vertical movements with the help of the large swim-bladder. The stomach contents of a male specimen consisted of Chironomid larvae with their sandy and calcareous cases. The alimentary canal is only slightly convolute; its length being seven-tenths of the total length of the fish.

Measurements in millimetres

	♂	♂	♂	♀
Total length including caudal	73.0	84.0	98.0	58.0
Length of caudal	12.6	15.5	18.6	11.0
Length of head	13.0	16.0	19.6	11.5
Width of head	7.1	8.2	11.0	6.2
Height of head	7.5	9.1	11.5	6.5
Depth of body	7.4	8.0	10.9	5.8
Length of snout	4.8	5.9	8.0	3.8
Diameter of eye	3.2	3.2	4.0	2.5
Interorbital width	3.5	3.5	4.2	2.5
Length of caudal peduncle	15.8	18.0	20.2	13.0
Least height of caudal peduncle	2.5	3.0	3.8	2.0
Longest ray of dorsal	14.0	16.1	19.2	11.0
Longest ray of anal	10.5	12.0	12.5	12.2
Length of pectoral	12.9	14.5	14.5	9.8
Length of ventral	11.2	12.9	14.1	7.8

Botia birdi Chaudhuri

1909. *Botia birdi*, Chaudhuri, *Rec. Ind. Mus.* III, p. 339.
1922. *Botia birdi*, Hora, *Rec. Ind. Mus.* XXIV, p. 319.

The Yale North India Expedition collected a dozen specimens of *Botia birdi* at Srinagar during March 1932. The specimens vary from 86 mm. to 138 mm. in total length. The colour pattern on the body is subject to considerable variation.

In 1922, I assigned Day's *B. geto* to the synonymy of *B. birdi*, but on an examination of the material from the Eastern Himalayas it became clear that Day's form represented a new species,[18] differing from *B. birdi* mainly in the nature and form of its head.

[18] Hora, *Rec. Ind. Mus.* XXXIV, p. 571 (1932).

Explanation of Plate XII.

Nemachilus from Western Tibet

Nemachilus hutchinsoni, sp. nov.

Fig. 1. Lateral view of a male specimen. × ½.
Fig. 2. Ventral surface of head and anterior part of body of same. × 1½.

Nemachilus panguri, sp. nov.

Fig. 3. Lateral view of a male specimen. × ½.
Fig. 4. Ventral surface of head and anterior part of body of same. × 1½.

Nemachilus deTerrai, sp. nov.

Fig. 5. Lateral view of a male specimen. × ½.
Fig. 6. Ventral surface of head and anterior part of body of same. × 1½.

Nemachilus stoliczkae (Steindachner)

Fig. 7. Lateral view of a male specimen. × 1¼.
Fig. 8. Ventral surface of head and anterior part of body of same. × 1¼.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ARTICLE XVIII

REPORT ON FISHES. PART II: SISORIDAE AND CYPRINIDAE

By Dev Dev Mukerji, M.Sc.

Zoological Survey of India, Calcutta

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CONTENTS

INTRODUCTION

Professor G. Evelyn Hutchinson, Biologist to the Yale North India Expedition, entrusted to Dr. S. L. Hora of the Zoological Survey of India a representative collection of fishes made by the Expedition in 1932 in various localities in the Kashmir valley and Indian Tibet (Ladak) for taxonomic study and report. The collection comprises representatives of the families *Sisoridae*, *Cyprinidae* and *Cobitidae*. A report on the *Cobitidae* is presented by Dr. Hora as Part I above, and the collection of the *Sisoridae* and the *Cyprinidae* was after a preliminary determination by him turned over to me for detailed study and report.

Though the material came in my hands towards the latter part of 1934, it was not possible for me to take up the work before the middle of 1935. Furthermore, in studying the *Schizothoracinae*, particularly the different species of *Schizothorax*, more time had to be devoted than I anticipated. Though all the species of the genus brought back by the Expedition are referable to the already known forms from the Kashmir basin[1]), the specific limits and the ranges of variation among these fishes are by no means easy to define. The difficulty is further accentuated by hybridisation in the *Schizothoracinae*, as a result of which even the limits of genera sometimes become obscure.

The collection under report consists of 119 specimens,[2] of which 6 belong to the family *Sisoridae* and the rest to the *Cyprinidae*. Among the Cyprinids, 12 belong to the subfamily *Cyprininae* and 101 to the *Schizothoracinae*. This clearly indicates the great preponderance of the *Schizothoracinae* over other fishes in the Kashmir valley and in the portions of Indian Tibet traversed by the Expedition.

So far as the present collection is concerned, the Expedition obtained specimens mainly from (i) the lakes, rivers and channels in the Kashmir valley and (ii) from several rapid running and torrential streams of the Upper Indus system in Indian Tibet at altitudes varying from 8,790 feet to 15,215 feet. I give below a complete list of the specimens with their localities:

KASHMIR VALLEY:

Sisoridae:

[3]***Glyptothorax kashmirensis* Hora	Jhelum River, Shadipur (Sta. K 40).

Cyprinidae:

Labeo diplostomus (Heckel)	Srinagar (Sta. K 7); Jhelum River, Pampur (Sta. K 10).
Crossochilus punjabensis Mukerji	Srinagar (Sta. K 7).
Schizothorax longipinnis Heckel	Channel, Manasbal Lake, Srinagar (Sta. K 48).
Schizothorax esocinus Heckel	Srinagar (Sta. K 7); Jhelum River, Srinagar Sta. K 14); Channel, Manasbal Lake, Srinagar (Sta. K 48).
**Schizothorax planifrons* Heckel	Canal to Dal Lake, Srinagar (Sta. K 6); Dal Lake, Srinagar (Sta. K 11); Channel to Manasbal Lake, Srinagar (Sta. K 48).
**Schizothorax micropogon* Heckel	Canal to Dal Lake (Sta. K 6); Dal Lake, Srinagar (Sta. K 11); Manasbal Lake, Srinagar (Sta. K 48); Kashmir.
**Schizothorax curvifrons* Heckel	Srinagar (Sta. 7); Channel to Manasbal Lake, Srinagar (Sta. K 48).
Orcinus sinuatus (Heckel)	Jhelum River, Srinagar (Sta. K 14); Jhelum River, Pampur (Sta. K 16); Rivers and canals in Srinagar.
Schizothorax labiatus × *Orcinus sinuatus*	Jhelum River, Srinagar (Sta. K 14); Rivers and canals in Srinagar.
Schizothorax planifrons × *Orcinus sinuatus*	Main canal, Srinagar (Sta. 12); Jhelum River Srinagar (Sta. K 14); Channel to Manasbal Lake, Srinagar (Sta. K 48).

[1] Heckel, J. J.: *Fische aus Caschmir* (Wien, 1838).

[2] For keeping down the cost of transport some of the specimens of easily determined species were not sent for report.

[3] An asterisk (*) against a species denotes that it is endemic in the Kashmir Valley.

INDIAN TIBET (Ladak):

Sisoridae:

Glyptosternum reticulatum McClelland	A small rapid stream at Kalatse (Sta. L 10); Leh (Sta. L 13).

Cyprinidae:

Schizothorax labiatus (McClelland)	Spitok, Upper Indus (Sta. L 17).
Schizothorax esocinus Heckel	Spitok, Upper Indus (Sta. L 17).
Oreinus sinuatus (Heckel)	Kargil (Sta. K 88); Spitok, Upper Indus (Sta. L 17).
Schizothorax labiatus × *Oreinus sinuatus*	Lake near Chushol (Sta. L 73).
Schizopygopsis stoliczkae Steind	Spitok, Upper Indus (Sta. L 17); Large rapid stream between Tangtse and Mugleb (Sta. L 37); Stream above Lukong (Sta. L 45a); Stream at Chagra (Sta. L 46); Stream into Pangur Tso (Sta. K 74); Yalapuk near Nyoma; Upper Indus (Sta. L 46); stream at Leh.
Dyptichus maculatus	A rapid stream at Nimu (Sta. L 12); Torrential stream at Lhabaps (Sta. L 31); Large rapid stream between Tangste and Mugleb (Sta. L 37); Stream at Chagra (Sta. L 46); Stream at Leh.
Ptychobarbus conirostris Steindachner	Kargil (Sta. K 88); Kalatse, Upper Indus (Sta. L 17); Yalapuk, Upper Indus (Sta. L 79).

As is evident from the above list, the family *Sisoridae* is represented in the collection by two genera and only two species, *viz.*, *Glyptothorax kashmirensis*, and *Glyptosternum reticulatum*. *G. kashmirensis* is an endemic species in the Kashmir Valley and is a river form mainly restricted to sluggish water. *G. reticulatum* is essentially a torrential species and is widely distributed in the head-waters of the principal river systems in High Central Asia and Eastern Turkestan, and, as is to be expected, specimens of the species were obtained by the Expedition only from the rapid streams in Indian Tibet. Of the two representatives of the sub-family *Cyprininae*, *viz.*, *Labeo diplostomus* and *Crossochilus punjabensis*, special attention may be directed to the latter species which had hitherto been known from the Punjab and Baluchistan. The present record of the fish from the Kashmir valley greatly extends its range in the Western Himalayan territory. The subfamily *Schizothoracinae* is represented in the collection by six species of *Schizothorax* and one species each of *Oreinus*, *Schizopygopsis*, *Diptychus* and *Ptychobarbus*. It may be noted that of the eight species of *Schizothorax* described by Heckel (*op. cit.*) from the Kashmir basin, only five were obtained by the Expedition; three of these (*S. planifrons*, *S. micropogon* and *S. curvifrons*) are endemic in the valley. *S. labiatus* is essentially an Afghanistan species and its occurrence in the head waters of the Indus is reported here for the first time. *Oreinus sinuatus*, *Schizopygopsis stoliczkae*, *Diptychus maculatus* and *Ptychobarbus conirostris* were found in their usual habitats and do not call for any special remarks. The two hybrid forms between *Schizothorax* and *Oreinus* are worthy of interest, but similar hybridisation among fishes in nature, particularly at high altitudes in Central Asia, is by no means a rare phenomenon

A detailed account of the ecology, bionomics and zoogeographical distribution of the fishes of the Expedition is being published by Mr. G. Evelyn Hutchinson, and in the present report no attempt has, therefore, been made to refer to these problems. In the systematic account, besides discussing various taxonomic problems, and giving necessary descriptive notes, I have, however, added, wherever possible, certain biological observations which, though made by me independently, are meant only to corroborate the observations of Mr. Hutchinson. Such information as I have been able to collect on the breeding habits of the different species of *Schizothoracinae* from a study of the material is also included here. Observations on the parasitism in several species of fish[4] under investigation have also been made.

Before concluding I must mention that but for the excellent preservation of the material and the invaluable field-notes by Mr. Hutchinson this report would have been of much less value, and I take this opportunity to record here my appreciation of the care with which Mr. Hutchinson dealt with the collection in the field. I am grateful to the authorities of the Yale North India Expedition for a grant towards the cost of illustrations which have been executed by Mr. B. Bagchi under my supervision. I am indebted to Dr. B. Prashad, Director, Zoological Survey of India, and Dr. S. L. Hora for affording me every facility and help in the course of preparation of the report. To Dr. Hora I am particularly thankful for the opportunity to investigate this interesting material and for his valuable suggestions.

SYSTEMATIC ACCOUNT

Family SISORIDAE

Genus *Glyptothorax* Blyth (1860)

Glyptothorax kashmirensis Hora

1923. *Glyptothorax kashmirensis*, Hora, *Rec. Ind. Mus.* XXV, pp. 22-24, figs. 2, *a*, *b* and *c*.

Glyptothorax kashmirensis belongs to the group of species of the genus in which the pectoral spine and the ventral rays are not plaited below. It is provided with a strong dorsal spine and a moderately developed adhesive apparatus on the chest with a circular depression in the middle.

The Yale North India Expedition obtained 2 specimens of the species in April, 1932, from the following locality:

Jhelum River, Shadipur:
(Sta. K 40) ; *ca.* 5,192 ft. ....2 (98.85 mm.)

The eyes are situated almost in the middle of the head. The pectorals are slightly shorter than the head and are separated from the ventrals by a considerable distance. The ventrals extend as far as the anal papilla. The caudal fin is much shorter than the head; its upper lobe is longer than the lower.

The colouration of the specimens in alcohol is light to dusky brown with a lighter under

[4] At the instance of Dr. S. L. Hora, my colleague, Mr. M. N. Datta, has undertaken a systematic study of the intestinal parasites of the fishes of the Yale North India Expedition and a separate report on this material will be published in another place.

surface. Black dots are irregularly scattered all over the body. All the fins are marked with faint black spots and bands.

Distribution: Glyptothorax kashmirensis is an endemic species of the Kashmir Valley and is fairly common in rivers and sluggish waters.

[Attention has already been directed to the two ecological groups into which the species of the genus *Glyptothorax* can be divided (*Rec. Ind. Mus.* XXV, pp. 4-8, 1923). The first group comprises less specialized forms which live in larger streams at the bases of hills and are liable to be carried into slow currents, while the members of the second group are more specialized and are invariably found in torrential streams. In the former case, the body is cylindrical and the adhesive apparatus is restricted to the chest and the belly as an elongated, compact structure. The paired fins are not horizontally placed and play only a small part in the adhesion of the fish. The species of the second group are depressed and possess a flattened ventral surface; the paired fins are horizontally placed and the function of adhesion is transferred from the chest region to the outer, flattened rays of the paired fins. The thoracic, adhesive apparatus is considerably reduced and is restricted to the region behind the isthmus in a semilunar patch. The probable evolution of *Glyptothorax* from forms like *Erethistes* and *Laguvia* and their ultimate development into forms like *Glyptosternum* have already been explained (*Phil. Trans. Roy. Soc. London*, B, CCXVIII, p. 236, 1930).

The form of the body and the structure of the adhesive apparatus of *Glyptothorax kashmirensis* are different from the species assigned to the above groups. The body, though cylindrical, is much deeper and the adhesive apparatus is restricted to the chest region only (*Rec. Ind. Mus.* XXV, p. 23, fig. 2 *a-c*, 1923); it is almost circular in outline and possesses a deep pit in the centre. Not knowing the precise habitat of the fish, it was not possible to explain on ecological grounds the differences in the structures referred to above. Mr. Hutchinson now informs me that "the species is moderately common in the Jhelum near Srinagar, and also inhabits some of the sluggish canals around the city." The species would thus appear to be restricted to deep and flowing waters, but a rapid current is not essential for its existence. The deep form of the body can be associated with life in sluggish waters where, it seems probable, that the fish feeds by scraping off algal matter from hard objects. During the feeding process the fish probably adheres to the substratum before bringing into action its sharp, lower jaw. This would explain the utility of the adhesive apparatus in this species even when living in sluggish waters.

Attention may here be directed to the mode of life of the fishes of the genus *Garra* (Mukerji, *Acharyya Sir P. C. Ray Comm. Vol.*, Calcutta, pp. 477-482, 1932) which possess a suctorial disc behind the lower lip. The disc may have originally developed for stemming rapid currents, but some of the species now live in lakes and deeper streams where the sucker is used for holding on to hard objects while the fish scrapes off algal matter from them. There is thus a parallelism between the mode of life of *Glyptothorax kashmirensis* and the lake-inhabiting species of *Garra*.

The adhesive apparatus of *Glyptothorax* is not a sucker device in the same sense as the mental disc of *Garra*, but is a mechanical device for increasing friction (*Phil. Trans. Roy. Soc.* London, B, CCXVIII, p. 262, 1930). The ridges are provided with sharp, curved spines (*Rec. Ind. Mus.* XXIV, pp. 55-58, 1922) which fix themselves into the unevennesses of the rocks. When the fish applies its adhesive apparatus to a rock, it is likely that the water flows out of the grooves by adpression and a series of partial vacua is created. The central depression in the adhesive apparatus of *G. kashmirensis* is probably a device for the production of a partial vacuum. The circular form of the apparatus and the fact that it is incomplete posteriorly shows that the species is probably derived from a member of the highly specialized group. This again shows how at high altitudes torrential forms revert to primitive mode of life on finding sluggish waters, but it is significant that structures acquired for stemming currents in torrential streams are retained in connection with their feeding habits. Thus the utility of a structure plays an important part from the beginning of its evolution to its ultimate fate.

The mechanism of adhesion of the highly specialized members of *Glyptothorax* is similar to that of the Glyptosternoid fishes. The ridges and grooves on the lips and the outer rays of the paired fins are used for adhesion which is greatly facilitated by the inner rays of the pectoral fins which, by their vigorous movements, shoot out any water that may enter below the fish when adhering (*Phil. Trans. Roy. Soc. London,* B, CCXVIII, p. 258, 1930). *Sunder Lal Hora.*]

Genus *Glyptosternum* McClelland (1842)

Glyptosternum reticulatum McClelland

1842. *Glyptosternum reticulatum,* McClelland, *Calcutta Journ. Nat. Hist.,* II, p. 584.
1860. *Glyptosternum reticulatum,* Blyth, *Journ. Asiat. Soc. Bengal,* XXIX, p. 153.
1876. *Exostoma Stoliczkae,* Day, *Proc. Zool. Soc. London,* p. 782.
1877. *Exostoma Stoliczkae,* Day, *Fish. India,* p. 502, pl. cxvii, fig. 3.
1878. *Exostoma stoliczkae,* Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology,* p. 1, pl. i, figs. 1.
1889. *Exostoma Oschanini,* Herzenstein, *Mel. Biol.,* XIII, p. 69.
1890. *Exostoma Oschanini,* Herzenstein, *Bull. Acad. St. Petersb.,* XXXIII, p. 120.
1905. *Exostoma stoliczkae,* Berg, *Ryby Turkestan,* p. 211, fig. 31.
1905. *Parexostoma stoliczkae,* Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 183.
1907. *Exostoma gracile,* Grazianov, *Trudy Otdela Ichthyologic,* IV, p. 58.
1907. *Exostoma labrax,* Grazianov, *ibid.,* p. 59.
1908. *Exostoma stoliczkae,* Berg, *Ezhegodnik Zoologischeskago Muzeya Akademii Nauk,* XIII, p. 450.
1916. *Parexostoma stoliczkae,* Berg, *Poiss. des Eaux Douces de Russie,* p. 371, figs. 289, 290.
1923. *Glyptosternum stoliczkae,* Hora, *Rec. Ind. Mus.,* XXV, p. 37.
1925. *Parexostoma stoliczkae,* Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
1932. *Glyptosternum reticulatum,* Hora, *Ann. Mag. Nat. Hist.* (10), X, p. 179, fig.
1932. *Glyptosternum reticulatum,* Hora, *Current Sci.,* I, p. 130.
1933. *Glyptosternum reticulatum,* Hora, *Journ. Bombay Nat. Hist. Soc.,* XXXVI, p. 697.
1933. *Glyptosternum reticulatum,* Berg, *Poiss. des Eaux Douces de* l'U. R. S. S. (3rd ed.), pt. 2, p. 597, figs. 549-551.
1934. *Glyptosternum reticulatum,* Hora, *Journ. Bombay Nat. Hist. Soc.,* XXXVII, p.
1934. *Glyptosternum reticulatum,* Hora, *Rec. Ind.* Mus., XXXV, pp. 287-292.

From the above list of synonymy it is clear that the true identity and the systematic position of *Glyptosternum reticulatum* have long been obscure, while the wide range of variation that it exhibits in regard to relative proportions of the principal parts of the body has led to its being described under several names from different areas of its extensive range. Recently, Hora (*op. cit.,* 1932, 1933, 1934) has succeeded in rediscovering this interesting species and made its position abundantly clear; he also published a detailed study of the species both from systematic and biological points of view.

The Yale North India Expedition collected 4 specimens of the species in May-June, 1932, from the following localities:

A small rapid stream near Kalatse: Ladak (Sta. L 10), *ca.,* 9,700 ft..3 (106-128 mm.; 1 ♂ and 2 ♀ ♀)
Leh: Ladak (Sta. L 13), 11,500 ft. .... 1 (130 mm.; ♀)

Of these 4 specimens, 2 from Kalatse and 1 from Leh are females, while the remaining 1 from Kalatse, 128 mm. long, is a male. Hora (*op. cit.*, 1934) observed that the species exhibits sexual dimorphism. In the males there is a sharp, conical and well-defined papilla projecting behind the anal opening. In the females there is no anal papilla but the vent is bordered by prominent, fleshy lips. The secondary sexual characters noted above are well marked in the specimens under report (Text-figure 1, *a-b*).

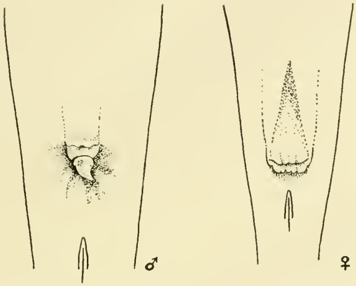

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FIGURE 1. *Glyptosternum reticulatum* McClelland. Anal region of a male specimen and a female specimen from rapid streams at Kalatse, Indian Tibet, showing sexual differences and form and position of anal opening and structures of anal papilla in male. × *ca.* 2.

Distribution: Glyptosternum reticulatum is "widely distributed in the head waters of the Indus (Basgo, Sneema, Leh, Ladak and the Kashmir valley), of the Kabul River (Sri-i-Chusma, Tulraiz, Paghman and the Chitral valley), of the Syr-Darya and the Amu-Darya in the Eastern Turkestan (Oxus system)."

Family CYPRINIDAE

Subfamily *CYPRININAE*

Genus *Labeo* Cuvier (1817)

Labeo diplostomus (Heckel)

1838. *Varicorhinus diplostomus*, Heckel, *Fische aus Caschmir*, pp. 67-75, pl. xi.
1839. *Gobio ricnorhynchus*, McClelland, *Asiat. Res.* (*Ind. Cyprin.*), XIX, pt. ii, pp. 279, 363-364, pl. lv, fig. 1.
1844. *Tylognathus valenciennesii*, Heckel, *Fische Kaschmir's* in *Hugel's Reise*, p. 378, fig. xiii.
1868. *Labeo diplostomus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 57.
1877. *Labeo diplostomus*, Day, *Fish. India*, p. 540, pl. cxxix, fig. 2.
1889. *Labeo diplostomus*, Day. *Faun. Brit. Ind., Fish.*, I, pp. 265, 266.
1913. *Labeo diplostomus*, Zugmayer, *Die Fische von Balutschistan* (*Munchen*), p. 26.

Labeo diplostomus belongs to the group of species characterised by a thick and fleshy head, short dorsal and anal fins, a thick, prominent and pendulous snout, a wide mouth, horny jaws, and thick and loose lips. The species is distributed along both the Eastern and the Western slopes of the Himalayas, and presents a certain amount of variation in body proportions, etc., which, as far as I can judge from the material before me, is more individual than geographical.

In the collections of the Indian Museum *L. diplostomus* is represented by 11 specimens. The localities of 10 are definitely known, 5 are from Simla, 1 from Hardwar, 2 from Assam, 1 from Chumba and 1 from Baluchistan. The first nine specimens are the originals of Day's description of the species, while the one from Baluchistan is a representative of the series collected by Dr. Erich Zugmayer from the Vindar River at Sonmiani during his travels in that country in 1911. The 11th specimen, labelled "*Labeo ricnorhynchus*" (Reg. No. Cat. 687), is from the old collections of the Asiatic Society of Bengal, but unfortunately its history is completely effaced from the original label which is still attached to the specimen. It appears probable, however, that the specimen comes from "Northern part of Bengal" and is the original of McClelland's description of *Gobio ricnorhynchus*, for, in reference to the only specimen of the species that he examined, he mentioned: "The specimen here described was found by Mr. Hodgson by whom it was presented to the Asiatic Society" (*op. cit.* p. 364). The only other Asiatic Society of Bengal specimen of the species preserved in the Indian Museum collections is Day's original from Hardwar.

The Yale North India Expedition obtained 2 specimens of the species in March, 1932, from the following localities in Kashmir:

Srinagar (Sta. K 7); *ca.* 5,200 ft. ....1 (165 mm.)
Jhelum River, Pampur (Sta. K 10); *ca.* 5,200 ft.................1 (140 mm.)

The specimens agree in all respects with the above mentioned series of specimens from the different localities as also with Heckel's description of the species, and do not call for any special remarks, except for the fact that there are only 41 scales along the lateral line and 13 rows of scales in a transverse series between the bases of the dorsal and the ventral fins. The scales on the chest region are considerably reduced in size and are partly imbedded in the skin, thereby producing a more or less smooth under surface. In most of the specimens that I have examined, the snout is studded with well defined horny tubercles which apparently develop quite early in life. In the specimens from Kashmir under report the snout is, however, perforated with a few fine mucous pores instead. It appears that the tuberculate condition of the snout is a secondary sexual character of the males, but from the material before me it is not possible to give a definite opinion.

The colouration of the specimens in alcohol is uniformly reddish-brown with a slightly darker upper surface. The outer edges of the dorsal and the caudal fins are dusky.

Distribution: Labeo diplostomus occurs in Kashmir (Type-locality), "along the Sind hills and Himalayas, also in Brahmaputra in Assam" (Day). In regard to the habitat and the size of the species in the Assamese waters McClelland (*op. cit.* p. 364) observed: "The *Nepura* of the Assamese I found as low as Bishenath, where the current is slow, and the bottom is sandy; here its colour is deep blue on the back. It is small, and very rarely met with in Lower Assam; but above the rapids Mr. Griffith says it is very common. and attains a large size, and that the fins and tail are dusky, the body below white, above olive-green."

Attention may here be directed to the fact that in 1930 and later in 1931 Tchang[5] recorded a species under the name *Labeo diplostomus* Heckel from Kiating in the Szechwan Province in China. In 1932 Rendahl[6] reported the same fish from Chungking in the said Province, but doubted its identity with Heckel's species, in view of the differences in the form of the mouth, body proportions, squamation, etc. In 1934 Kimura[7] recorded the form from Yangtze-kiang and definitely assigned it to a new species, "*Labeo* (*Varicorhynchus*) *Rendahli*."

As *Labeo diplostomus* presents variations in different body proportions, length of the fins, etc., I give below the measurements of the two specimens under report:

Measurements in millimetres

Total length without caudal	165.0	140.0
Length of head	37.0	32.0
Width of head	24.0	20.0
Height of head	28.0	23.0
Diameter of eye	6.0	6.0
Length of snout	13.0	12.0
Interorbital width	14.0	12.0
Depth of body	40.0	30.0
Longest ray of dorsal	33.0	31.0
Longest ray of anal	25.0	22.0
Length of pectoral	31.0	26.0
Length of ventral	27.0	23.0
Length of caudal	38.0	....
Least height of caudal peduncle	19.0	15.0

Genus *Crossochilus* Van Hasselt (1823)

Crossochilus punjabensis Mukerji

1934. *Crossochilus latius punjabensis*, Mukerji, *Journ. Bombay. Nat. Hist. Soc.*, XXXVII, p. 53, fig. 7.

From an examination of large series of specimens of "*Crossochilus latius*" from different parts of India and Burma, preserved in the collections of the Indian Museum, I came to the conclusion that the species is a composite one and that the dwarf form from the Punjab and Baluchistan, at any rate, should be regarded as distinct from the typical form from northern Bengal. At that time I had no specimens at my disposal from the Kashmir waters for comparison with the subspecies *punjabensis* and it was, therefore, not possible to judge the affinities of the former with the latter. On an examination of the ten specimens collected by the Yale North India Expedition in March-May, 1932, from parts of Kashmir, I find that in all essential characters they correspond to the form *punjabensis* which I now consider on re-examination to be sufficiently distinct from *C. latius* to merit specific rank.

[5] Tchang, L.: *Sinensia*, I, No. 7, pp. 87-94 (1930); *Bull. Fan. Mem. Inst. Biol.*, II, No. 11, p. 227 (1931).
[6] Rendahl, H.: *Arkiv. f. Zoologi*, XXIV (A), No. 16, pp. 74-79 (1932).
[7] Kimura, S.: *Journ. Shanghai Sci. Inst.*, Sec. 3, I, pp. 125-128, pl. iii, fig. 2 (1934).

The Yale North India Expedition obtained 10 specimens from the following localities:

Dal Lake, Lokut (Sta. K 3), *ca.* 5,190 ft. ....3 (55- 62 mm.)
Srinagar (Sta. K 7), *ca.* 5,200 ft. ....7 (62-108 mm.)

Of these 10 specimens, 3 taken at Lokut Dal Lake, are badly desiccated and shrivelled. The majority are females either with ripe eggs or fairly mature gonads. The species seldom exceeds 150 mm. in length, and apparently attains sexual maturity at 30 to 45 mm. stage (Mukerji, *op. cit.*). The fish is of a stout and thick build with a somewhat deep body and a broad and blunt snout. The position of the vent is from 3 to 4 scales in advance of the insertion of the anal fin. In small specimens the ventrals extend as far as the vent, but in larger full-grown individuals they just miss it.

The colouration of the specimens in alcohol varies from dark brown to dusky with a darker upper half. In medium sized specimens of 30 to 70 mm. in length, the scales are sometimes infuscated with fine black dots. All the fins are diaphanous.

Bionomics: The peritoneum is black. The length of the air-bladder is contained about 3.5 times in the length of the body excluding the caudal fin. The posterior chamber is long and narrow with a sharp end; it is of uniform thickness and its length is almost twice that of the anterior chamber which is somewhat of a knob-like structure (Text-figure 2).

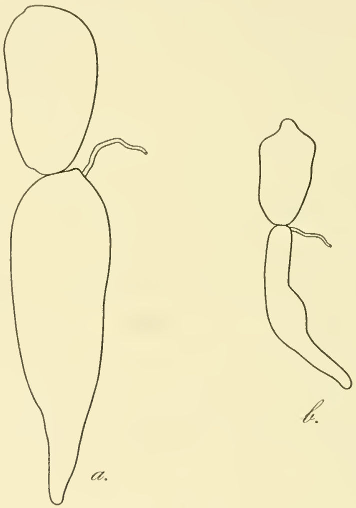

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FIGURE 2. *Crossochilus punjabensis* Mukerji. Air-bladder of (*a*) an adult specimen, 108 mm. long from Kashmir valley and (*b*) a young specimen, 65 mm. × 3⅓.

The intestine is of considerable length, narrow with many convolutions. In specimens over 100 mm. in length, the intestine is about 6 times as long as the body excluding the caudal fin, while in smaller specimens it is about 6.5 times the same length. The gut contents include lumps of slime and algae mixed with sand particles, bits of leaves and twigs.

Parasites: The specimens obtained by the Yale North India Expedition are heavily infected with Trematode parasites the cysts of which appear as small black nodules all over the body and the fins. In a gravid female, 108 mm. long, six specimens of a species of an Acanthocephalan worm have been found.

Distribution: As far as I can judge, *C. punjabensis* is distributed in the mountainous rivers, streams and lakes in the Western Himalayan territory through Kashmir and the Punjab along the North Western Frontier to Baluchistan in the Western territory. In the Eastern sub-Himalayan and Burmo-Malayan territories the species is replaced by *C. latius* (Ham. Buch.).

Subfamily *Schizothoracinae*

Genus *Schizothorax* Heckel (1838)[8]

Schizothorax labiatus (McClelland)

1842. *Racoma labiatus,* McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 578, pl. xv, fig. 1.
1842. *Schizothorax Ritchieana,* McClelland, *ibid.*, p. 580.
1868. *Racoma labiatus,* Günther, *Cat. Fish. Brit. Mus.*, VII, p. 162 (footnote).
1868. *Schizothorax ritchianus,* Günther, *Cat. Fish. Brit. Mus.*, VII, p. 162 (footnote).
1877. *Schizothorax Ritchianus,* Day, *Fish. India,* p. 531 (footnote).
1877. *Schizothorax labiatus,* Day, *ibid.*, p. 532 (footnote).
1934. *Schizothorax labiatus,* Hora, *Rec. Ind. Mus.*, XXXVI, pp. 292-297, figs. 2 and 3.

The narrow, subcylindrical body, the large and pointed head, the well developed and reflected posterior margin of the lower lip which is invariably trilobed and the sharp and shovel-shaped lower jaw are some of the principal features of *S. labiatus* originally described from the Kunar river near Jalallabad. Recently, Hora (*op. cit.*) published a detailed account of this hitherto little-known species from a series of specimens obtained from the Chitral Valley. He has shown that in the species the structures of the lower lip and the air-bladder are considerably variable. Further, according to him *S. ritchieana* McClelland, a species described also from Afghanistan, is synonymous with *S. labiatus.*

The Yale North India Expedition obtained a single specimen of the species in June, 1932, from the following locality:

Upper Indus, Spitok, Ladak (Sta. L 17), 10,730 ft. .... (260 mm.)

[8] Just before this report went to the press, Dr. Yuanting T. Chu's paper on "Comparative studies on the scales and on the pharyngeals and their teeth in Chinese Cyprinids, with particular reference to taxonomy and evolution" (*Biol. Bull. St. John's Univ., Shanghai, China*, pp. 1-225, pls. i-xxx, No. 2, 1935) was available for reference. In regard to the taxonomic positions of the genera (*Schizothorax* Heckel and *Oreinus* McClelland the author has pointed out that according to Bleeker's restriction (*Nat. Tijd. Dierk*, I, p. 196, 1863) the name *Schizopyge* Heckel should be used in place of "*Schizothorax*" of authors and *Schizothorax* Heckel should replace the name *Oreinus* of McClelland. Although I thoroughly agree with this statement I am in favor, in view of the general application, to conserve the names *Schizothorax* and *Oreinus* in their hithertofore accepted sense.

In the single specimen before me the snout is sparsely studded with fairly sharp, warty tubercles. The eyes are situated slightly nearer to the tip of the snout than to the posterior margin of the operculum. The lower lip is trilobed; the lateral lobes are broad and flat, while the central one is narrower and somewhat elongated. The dorsal spine is fairly strong and sharply denticulated posteriorly; its length is equal to the head behind the nostrils.

The ground colouration of the specimen in alcohol is reddish brown with a darker dorso-lateral surface.

Distribution: Schizothorax labiatus is essentially confined to Afghanistan and is common in the Kunar or the Chitral river and in its tributaries in the Chitral Valley. Its occurrence in the Upper Indus is reported here for the first time. Hybrids between this species and *Oreinus sinuatus* occur in the Kashmir Valley (*v. i.* p. 349) but do not necessarily indicate that both parent species are present in that region. The species is usually found in rapid-flowing waters.

Schizothorax longipinnis Heckel

1838. *Schizothorax longipinnis*, Heckel, *Fische aus Caschmir*, pp. 27-29, pl. iv.
1844. *Schizothorax longipinnis*, Heckel, *Fische Kaschmir's* in *Hugel's Reise*.
1868. *Schizothorax longipinnis*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 166.
1877. *Schizothorax longipinnis*, Day, *Fish. India*, p. 532 (footnote).
1889. *Schizothorax longipinnis*, Day, *Faun. Brit. Ind. Fish.*, I, p. 252 (footnote).
1916. *Schizothorax longipinnis*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, XLVII, p. 141.

The species can be readily distinguished from others by its narrow and high anal fin, which when laid back, extends to the root of the caudal fin (Text-figure 3) and also by its sharp lower jaw. The body is somewhat narrow and cylindrical with a moderately compressed caudal peduncle. The contour of the body as well as the development and structure of the fins highly suggest that the fish is an inhabitant of the rapid-running streams and rivers.

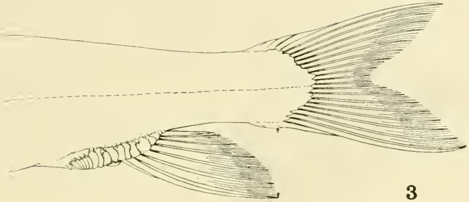
The Yale North India Expedition obtained a single gravid female in April, 1932, from the following locality:

Channel: Manasbal Lake (Sta. K 48); 5,196 ft. ....(300 mm.)

The mouth is inferior, horse-shoe-shaped and very slightly oblique; it is much broader than long and its gape is almost equal to the length of the head in front of the nostrils. The upper jaw is longer than the lower and is provided with a fairly developed and partly protrusible fleshy lip; the lower jaw has a free and sharp margin, practically denuded of a true lip. The lower lip seems to have undergone atrophy both in its structure and function, and is represented only laterally as two short and thin loose flaps (Text-figure 4).

The osseous ray of the dorsal fin is moderately strong and almost as long as the head behind the nostrils; its posterior serrations are fine and close-set. The length of the head is contained nearly 4.25 times in the length of the body without the caudal. The diameter of the eye is contained 5.5 times in the length of the head. The interorbital space is flat and wide and more than twice the orbital width. The snout is broadly rounded anteriorly and almost twice as long as the diameter of the eye.

The colouration of the specimen in alcohol is reddish brown with a somewhat darker dorsal surface. All the fins are tipped with black.



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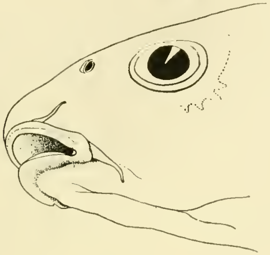

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FIGURE 3. Lateral view of posterior part of body of *Schizothorax longipinnis* Heckel from Manasbal Lake, showing form of anal and caudal fins and nature of tiled rows of anal scales. × ⅔. The arrow indicates the extent of the anal fin in relation to the root of the caudal.

FIGURE 4. Ventro-lateral view of head of *Schizothorax longipinnis* Heckel from Manasbal Lake, showing sharpness of free margin of lower jaw and specially modified lower lip. × 1⅓.

Distribution: *Schizothorax longipinnis* is found in the Kashmir Valley and the Indus at Skardu. It presumably inhabits rapid streams and rivers, occasionally entering lakes.

Schizothorax esocinus Heckel

1838. *Schizothorax esocinus*, Heckel, *Fische aus Caschmir*, p. 48, pl. ix.
1842. *Schizothorax esocinus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 579.
1844. *Schizothorax esocinus*, Heckel, *Fische Kashmir's* in *Hugel's Reise*, p. 372, 3 figs.
1868. *Schizothorax esocinus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 166.
1876. *Schizothorax esocinus*, Day, *Proc. Zool. Soc. London*, p. 785.
1876. *Schizothorax punctatus*, Day, *ibid.*, p. 785.
1877. *Schizothorax esocinus*, Day, *Fish. India*, p. 533, pl. cxxiii, fig. 4.
1877. *Schizothorax punctatus*, Day, *ibid.*, p. 532 (footnote), pl. cxxiii, fig. 3.
1878. *Schizothorax esocinus*, Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology*, p. 4, pl. i, fig. 4.
1878. *Schizothorax punctatus*, Day, *ibid.*, p. 4, pl. i, fig. 3.
1889. *Schizothorax esocinus*, Day, *Faun. Brit. Ind. Fish.*, I, p. 254.
1889. *Schizothorax punctatus*, Day, *ibid.*, p 252 (footnote).

1910. *Schizothorax esocinus*, Zugmayer, *Zool. Jahrb.* (*Abth. Syst.*), XXIX, p. 277.
1916. *Schizothorax esocinus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (3) VII, p. 142.
1934. *Schizothorax esocinus*, Hora, *Rec. Ind. Mus.*, XXXVI, pp. 297-300.

The Yale North India Expedition obtained 12 specimens of the species in April-June, 1932, from the following localities:

Srinagar (Sta. K 7); *ca.* 5.200 ft. ....5 (270, 250 mm., ♀ ♀; 102-105 mm.)
Main Canal, Srinagar (Sta. K 12); *ca.* 5,200 ft. ....1 (235 mm., ♀)
Jhelum River, Srinagar (Sta. K 14); *ca.* 5200 ft...........3 (270, 235 mm., ♂ ♂; 410 mm., ♀)
Channel: Manasbal Lake (Sta. K 48); 5,196 ft. ....1 (260 mm., ♀)
Upper Indus, Spitok, Ladak (Sta. L 17); 10,730 ft. ....3 (290 mm., ♂; 425 mm., ♀)

Schizothorax esocinus is, as far as one can judge from a study of series of specimens from different localities, a very variable species in regard to the different body proportions, structure of the jaws and the lips, the position of the eye and the relative positions and lengths of the fins and its colouration. Among an assemblage of specimens of the species there may be found forms which show a remarkable combination of variations from the typical *esocinus*-characters. Such aberrant forms, if judged by themselves, are very baffling and tend to assert claims to distinct specific ranks. Day's *Schizothorax punctatus* is one of such forms, as I find from a study of Day's originals of the figures of *S. esocinus* and *S. punctatus*, as also from a careful examination of a fair series of specimens from various localities in Kashmir. Zugmayer, Vinciguerra and recently Hora referred at some length to the discrepancies in Day's descriptions of the two species and to the inaccuracies in his drawings and considered the two species as identical. Opportunity is here taken to substantiate the views of these authors by a detailed analysis of more extensive material before me.

Condensing Day's loose descriptions of the two species and the differences exhibited by his original specimens I find that *S. esocinus* and *S. punctatus* differ in the following three principal characters only:

S. esocinus	*S. punctatus*
1. Upper jaw slightly longer than lower.	1. Lower jaw slightly longer than upper.
2. Serrated dorsal spine equal to length of head behind nostrils.	2. Serrated dorsal spine equal to length of head behind middle of eye.
3. Anal fin laid flat almost reaches root of caudal or just misses it.	3. Anal fin laid flat does not reach root of caudal or widely separated from it.

With a view to testing the validity and studying the nature and the range of variation, if any, of these three distinguishing features, I have made observations in details, which for convenience of reference, are given in a tabular form (Table I). It is clearly seen from the table that of a series of 20 specimens examined by me, including Day's 2 original specimens, in 17 cases, of which 6 are adult females and 4 adult males, the upper jaw is slightly longer than the lower, similar to the typical *esocinus*-condition (Text-figure 5, *a*), while only in 3 cases, one of which is a full-grown female and two half-grown, the lower jaw is slightly longer than the upper and corresponds to that of the typical *punctatus* (Text-figure 5, *b*). In regard to the length of the serrated dorsal spine, it was found that in 14 cases, the majority of which are full grown and of which at least 7 are females and 4 males, the spine is like that of typical *punctatus*, equal to the length of the head behind the middle of the eye, whereas only in 6 individuals, which are either half-grown or young, the length of the spine is nearly equal to that of the head behind the nostrils. In reference to the third character, *e. g.*, the length of the anal fin, the table shows that in 12 specimens, all of which are full grown and of which at least 6 are females and 4 males, the anal fin laid flat does

TABLE I

Variation of characters in *Schizothorax esocinus* Heckel

LOCALITY	Sex	No. of specimens examined	Length in mm. without caudal	Upper jaw slightly longer	Lower jaw slightly longer	Origin of dorsal nearer caudal than tip of snout	Origin of dorsal equidistant between caudal and tip of snout	Length of dorsal spine equals length of head behind middle of eye	Length of dorsal spine equals length of head behind nostrils	Anal laid flat widely separated from caudal	Anal laid flat just misses caudal	Anal laid flat reaches caudal
Y. N. I. E. (Sta. K 7) Srinagar	♀	1	270.0	x		x		x		x		
" " " "	♀	1	250.0	x		x		x		x		
" " " "	?	2	*105.0 105.0	x x		x x		 x	x 		x x	
" " " "	?	1	102.0		x	x			x		x	
" (Sta. K 12) Srinagar	♀	1	235.0	x		x		x			x	
" (Sta. K 14) Srinagar	♂	1	270.0	x		x		x		x		
" " " "	♂	1	235.0	x			x	x		x		
" " " "	♀	1	†410.0		x	x		x		x		
" (Sta. K 48) Srinagar	♀	1	260.0	x		x		x		x		
" (Sta. L 17) Spitok..	♀	1	425.0	x		x		x		x		
" " " " ..	♂	1	290.0	x		x		x		x		
(I. M.) Chitral R.	♂	1	230.0	x			x	x		x		
" Jhelum R.	?	1	*115.0	x		x			x			x
" " "	?	1	*108.0	x		x			x		x	
" " "	?	1	* 97.0	x		x			x		x	
" Wular L.	♀	1	200.0	x			x	x		x		
" Gandarbal	?	1	280.0	x			x	x		x		
" Leh (Day's *S. esocinus*)	?	1	*170.5	x		x			x		x	
" Kashmir L. (Day's *S. punctatus*)..	?	1	†192.0		x	x		x		x		
	7 ♀♀ 4 ♂♂	20		17	3	16	4	14	6	12	7	1

Y. N. I. E.—Denotes specimens collected by the Yale North India Expedition.
I. M.—Denotes specimens preserved in the collection of the Indian Museum.
* Denotes typical *esocinus* characters.
† Denotes typical *punctatus* characters.

not reach the caudal and is rather widely separated from its root, a condition that corresponds to the *punctatus*-type (Text-figure 6, *a*); in 7 cases, all of which are, with the exception of an adult female, young or half-grown, the anal fin laid flat just misses the root of the caudal, similar to the typical *esocinus*-condition (Text-figure 6, *b*), while only in a single specimen (115 mm.) from the Jhelum River does the anal fin actually reach the caudal (Text-figure 6, *c*).

From a study of the table it is moreover apparent that of the 18 specimens examined by me, excluding Day's 2 originals, all the three typical *esocinus*-characters are present in half-grown specimens only (marked with an asterisk in the table), while only a single

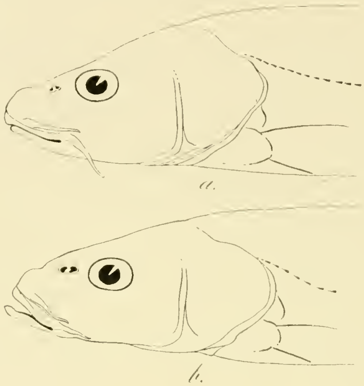

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FIGURE 5. Lateral view of anterior parts of body of two specimens of *Schizothorax esocinus* Heckel showing "*esocinus*" and "*punctatus*" types of head and jaws. (*a*) Day's original specimen of "*Schizothorax esocinus*" from Leh (upper jaw longer). $\times 1\frac{1}{3}$. (*b*) Day's original specimen of "*Schizothorax punctatus*" from "Kashmir Lake" *i.e.*, Wular Lake (lower jaw longer). Nat. size.

specimen, a large female (410 mm.) from the Jhelum River (marked with a dagger in the table) represents all the true *punctatus*-characters. The rest of the specimens exhibit mixed variations.

Summarizing the above analysis of characters the following facts may now be definitely established:

(i) In the majority of full-grown specimens the upper jaw is, irrespective of sex and age, longer than the lower, while in a few cases the lower jaw is longer than the upper.

(ii) In the majority of full-grown specimens, the length of the serrated dorsal spine is, irrespective of sex, almost equal to the length of the head behind the middle of the eye, while as a rule, in young or half-grown individuals, the spine is comparatively long, equalling the length of the head behind the nostrils.

(iii) In the majority of full-grown individuals, irrespective of sex, the anal fin laid flat is widely separated from the root of the caudal, while invariably in young and half-grown specimens it just misses or only exceptionally it reaches the root of the caudal.

(iv) Combination of all the three *esocinus*-characters is found almost invariably in young or half-grown specimens, and

(v) Combination of all the *punctatus*-characters is rarely met with.

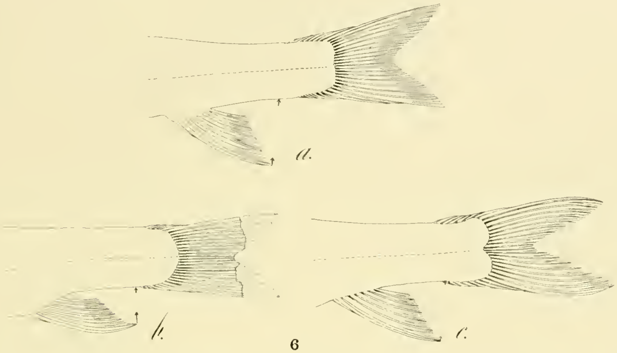


FIGURE 6. Lateral views of anterior parts of body of three specimens of *Schizothorax esocinus* Heckel showing different forms of anal and caudal fins. (*a*) Day's original specimen of "*Schizothorax punctatus*" from Wular Lake (anal widely separated from caudal). × ¾. (*b*) Day's original specimen of "*Schizothorax esocinus*" from Leh (anal almost reaching caudal). × ¾. (*c*) A young specimen, 115 mm. long (Kashmir Survey coll.), from Jhelum River, Kashmir valley (anal reaching caudal). × 1¼. The arrow indicates the extent of the anal fin in relation to the root of the caudal.

From the foregoing account it is, I believe, abundantly clear that specific differentiation between *S. esocinus* and *S. punctatus* is impossible and that Day's *S. punctatus* is only an aberrant variation of *S. esocinus* Heckel.

Bionomics: The peritoneum is black. The length of the intestine is approximately 1.5 times the length of the body excluding the caudal fin. In adult individuals the length of the anterior chamber of the air-bladder, in proportion to that of the posterior chamber, is comparatively longer than it is in young specimens. In a specimen, 270 mm. long, the length of the anterior chamber is 35 mm. and that of the posterior chamber 60 mm., while in a specimen about 105 mm. long, the corresponding measurements are 16 mm. and 22 mm. The gut contents of several specimens from the Jhelum River and other localities in Srinagar were examined. In some cases the intestine was practically empty, whereas in others fragments of semi-digested insect larvae and a kind of soft, pulpy organic substance mixed with sand and gravel and bits of twigs and weeds were found. From a large gravid female, 425 mm. from Spitok lumps of semi-digested fleshy substance and large quantity of fragments of fish bones were also found. Judging from the nature of the stomach contents it appears that *S. esocinus* is somewhat a dirty, nonselective and mixed feeder, but its short intestine indicates that it feeds chiefly on animal matter. It is believed to be a scavenger fish, feeding on dead fish and other organisms at the bottom of pools, etc.

Breeding: Nothing is definitely known about the breeding habits of the species, but it is significant that all the female specimens collected by the Yale North India Expedition during the months of April and June bear mature eggs.

Parasites: A species of Acanthocephalan worm has been found in moderate numbers in the intestine of certain specimens from Srinagar and Spitok.

Distribution: Schizothorax esocinus is distributed in Leh and Ladak, in the head waters of the Indus, in the Kashmir and in the Chitral valleys and in Afghanistan. In the Kashmir valley the species is popularly known as "*chiruh*" (Hutchinson).

Schizothorax planifrons Heckel

1838. *Schizothorax planifrons,* Heckel, *Fische aus Kaschmir,* p. 48, pl. viii, fig. 2.
1844. *Schizothorax planifrons,* Heckel, *Fische Kaschmir's* in *Hugel's Reise,* p. 370, 3 figs.
1868. *Schizothorax planifrons,* Günther, *Cat. Fish. Brit. Mus.,* VII, p. 163.
1877. *Schizothorax planifrons,* Day, *Fish. India,* p. 532 (footnote).
1889. *Schizothorax planifrons,* Day, *Faun. Brit. Ind. Fish.,* I, p. 252 (footnote).
1910. *Schizothorax planifrons,* Zugmayer, *Zool. Jahrb. Abth. Syst.,* XXIX, p. 278.

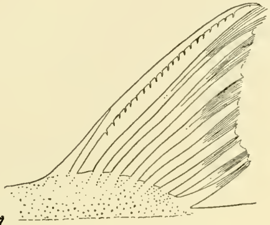
The Yale North India Expedition obtained 9 specimens of the species in March-May, 1932, from the following localities:

Canal to Dal Lake; Srinagar (Sta. K 6); *ca.* 5,200 ft. ....2 (212 mm., ♂; 200 mm., ♀)
Dal. Lake: Srinagar (Sta. K 6); *ca.* 5,200 ft. ....3 (218 mm., ♀; 178 mm., ♀; 165 mm.)
Channel, Manasbal Lake: Srinagar (Sta. K 48); 5,196 ft. ....4 (235 mm., ♂; 178 mm., ♀; 175 mm., ♂; 168 mm., ♂)

Schizothorax planifrons is a narrow and elongated form; the maximum depth of the body is contained from 4.5 to 5.3 times in the total length excluding the caudal and the least height of the caudal peduncle is about twice in its length. The mouth is somewhat anterior, oblique and wide, and the chin is sharply ascending forwards. The jaws are almost of equal length. The margin of the lower jaw is not sharp, but its inside is covered with a thin deciduous cartilaginous layer[9] (Text-figure 7), which in some cases may be absent. The lips are thick, the lower one being broadly interrupted in the middle. The barbels are nearly equal to or slightly longer than the diameter of the eye. The head is elongated, flat

[9] The presence of this character may induce an impression that the species is a hybrid between *Schizothorax* and *Oreinus,* but in such hybrids the manifestation of this character is always more pronounced and attended with several other *Oreinus* characters. I am inclined to think that the development of a thin cartilaginous layer on the inner margin of *S. planifrons* is an adaptive modification which can be correlated with the scraping and scooping mode of feeding of the species. Furthermore, it is suggested by Dr. Hora that the mouth parts of *S. planifrons* indicate the probable mode of evolution of the *Oreinus* type of structure which in this case may have developed in sluggish waters for scraping food from hard objects and later becomes accentuated in swift currents.

above and arched below; its length is contained from 4 to 4.5 times in the length of the body excluding the caudal. It is slightly higher than broad. The snout is thick and prominent with broadly rounded anterior edge; its length is contained about 3.5 times in the length of the head. The interorbital space is flat and wide, with a prominent nuchal region; it is nearly twice as broad as the orbital width. The eyes are moderate and their diameter is contained from 5.4 to 5.7 times in the length of the head and about 1.5 times in the length of the snout.



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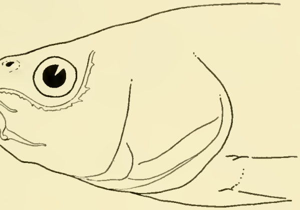

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FIGURE 7. Lateral view of anterior part of body of a specimen of *Schizothorax planifrons* Heckel from Manasbal Lake, showing contour of head, nature of mouth, jaws, lips and barbels. Nat. size. The dotted portion of the lower jaw indicates the position of the cartilaginous layer on its inner margin.

FIGURE 8. Dorsal fin of a specimen of *Schizothorax planifrons* Heckel from Manasbal Lake, showing structure of spine and nature of serration on its posterior border. × 1⅓.

The origin of the dorsal fin is opposite that of the ventrals and is much nearer the root of the caudal than the tip of the snout. The dorsal spine is long and strong and has from 18 to 21 coarse serrations posteriorly (Text-figure 8); it is slightly shorter than the head or equal to the length of the head behind the nostrils which are situated much nearer the anterior margin of the eye than the tip of the snout. The anal fin is somewhat narrow and its longest ray is almost as long as that of the dorsal; in the grown-up specimens it almost reaches the root of the caudal (Text-figure 9), while in young and half-grown individuals it is separated by a little distance. The pectorals are much shorter than the head, about as long as the head behind the anterior margin of the eyes; they are separated from the ventrals by a wide space. The ventrals are a little shorter than the pectorals and are separated from the insertion of the anal by a considerable distance. The caudal is deeply furcate with pointed lobes, the upper of which is appreciably longer than the lower. It is slightly shorter than the head; the length of its central rays is contained nearly 2.5 times in that of the outer ones. The lateral line is uniformly and moderately concave, and runs to the middle of the root of the caudal; in some specimens it is irregularly wavy in the anterior half of the body. The vent is in front of the origin of the anal; in female specimens it is provided with a raised fleshy area. The scales on the body are very small. The tiled row of anal scales are moderately developed, the largest ones being about half as broad as the orbit.

The colouration of the majority of specimens in alcohol is reddish brown with a much darker upper surface, while a few are somewhat paler.[10] The entire body, except for the ventral surface is powdered with black pigments. All the fins are dusky.

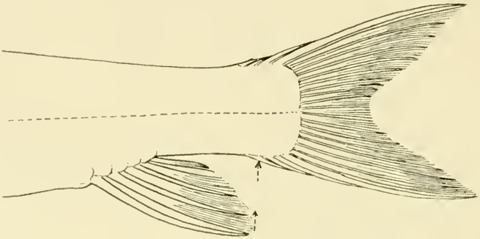

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FIGURE 9. Lateral view of posterior part of a specimen of *Schizothorax planifrons* Heckel from Manasbal Lake, showing form of anal and caudal fins. Nat. size. The arrow indicates the extent of the anal fin in relation to the root of the caudal.

Bionomics: The peritoneum is black. The structure of the air-bladder is more or less similar to the other members of the genus. Its posterior chamber is elongated and spindle-shaped, while its semi-rounded and wider anterior chamber is much shorter. In a specimen, 212 mm. long, the lengths of the anterior and the posterior chambers are 28 mm. and 45 mm. respectively. The alimentary canal is long, wide and moderately convoluted. Its length in grown-up individuals is nearly 3.5 times the length of the body excluding the caudal. The gut contents of 4 specimens from the Dal and the Manasbal lakes were examined. Lumps of a kind of soft pulpy substance mixed with sand and mud, vegetable débris and huge amount of filamentous algae were found. There was no trace of any insect larvae or of any other animal matter. In the case of a gravid female the intestine was partially empty. The gut contents and also the length of the intestine suggest that the species is a vegetable feeder.

[10] In one of his letters Mr. G. E. Hutchinson informed us that the Kashmiri fishermen observe difference between the paler specimens and the darker ones by using the name "*Chatta*" and "*Chush*" respectively. There is not the least doubt, however, that "*Chatta*" is a colour variation of "*Chush*." Dr. S. L. Hora kindly informs me that in the Punjab a similar word "*Chitta*" means white, while "*Chatta*" would denote a licking habit on the part of the fish. Evidently reference is made to the colour of the species in this case.

Breeding: There are no data available so far about the breeding of the species, but all the female specimens collected by the Yale North India Expedition during the months of March to June are full of mature eggs, the approximate diameter of which is 1.5 mm.

Parasites: Large numbers of a species of Acanthocephalan worm were found in the intestine of both male and female specimens.

Distribution and Remarks: Schizothorax planifrons, known amongst the Kashmiri fishermen and anglers as "*Chush*," is one of the commonest endemic species of the Kashmir valley, usually inhabiting the principal lakes and the adjoining channels. It co-occurs with two closely allied species, *e.g. S. micropogon* and *S. niger*. *S. micropogon* is a somewhat smaller species and is known amongst the Kashmiris as "*Ramghurdi*," while *S. niger*, as the name indicates, is a much darker species with somewhat larger eyes, a shorter anal and shorter barbels; it is locally known as "*Alghard*" or "*Alghad*." It is probable that *S. planifrons* and *S. niger* represent one and the same species, but in the absence of more extensive material it is difficult to judge the range of variation and to come to any definite conclusion. The specimens obtained by the Yale North India Expedition, however, correspond to the *planifrons*-type.

Measurements in millimetres

	♂	♀	♀
Total length without caudal	235.0	218.0	200.0
Length of head	57.0	52.0	51.0
Width of head	30.0	30.0	30.0
Height of head	35.0	34.0	34.0
Diameter of eye	10.0	9.0	9.0
Length of snout	16.0	15.0	15.0
Interorbital width	20.0	19.5	18.0
Depth of body	44.0	44.0	42.0
Longest ray of dorsal	42.0	42.0	36.0
Longest ray of anal	41.0	40.0	36.0
Length of pectoral	40.0	39.0	36.0
Length of ventral	35.0	35.0	31.0
Length of caudal	52.0	51.0	44.0
Distance between pectoral and base of ventral	26.0	26.0	25.0
Distance between ventral and base of anal	24.0	24.0	24.0
Length of caudal peduncle	40.0	40.0	34.0
Least height of caudal peduncle	19.0	19.0	17.0

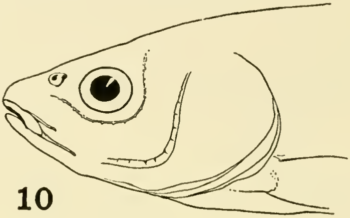
Schizothorax micropogon Heckel

1838. *Schizothorax micropogon*, Heckel, *Fische aus Caschmir*, p. 41.
1844. *Schizothorax micropogon*, Heckel, *Fische Kaschmir's* in *Hugel's Reise*, p. 369, 3 figs.
1868. *Schizothorax micropogon*, Günther, *Cat. Fish. Brit. Mus.*, VII, pp. 163, 164.
1877. *Schizothorax micropogon*, Day, *Fish. India*, p. 532 (footnote).
1889. *Schizothorax micropogon*, Day, *Faun. Brit. Ind., Fish.*, I, p. 252 (footnote).

In the collection of the Yale North India Expedition the species is represented by 10 female specimens obtained in March-May, 1932, from the following localities:

Canal to Dal Lake: Srinagar (Sta. K 6); *ca.* 5,200 ft. ....4 (105-165 mm.)
Dal Lake: Srinagar (Sta. K 11); *ca.* 5,200 ft. ....1 (112 mm.)
Manasbal Lake: Srinagar (Sta. K 48); 5,196 ft.............................2 (135, 132 mm.)
Kashmir ....3 (165, 160, 130 mm.)

Schizothorax micropogon is one of the smallest species of the Kashmir valley, rarely exceeding 7 inches in length excluding the caudal fin. It has a somewhat dwarfed appearance with a thick and broad head and a deep body. The depth of the body is contained from 4 to 4.5 times in the total length excluding the caudal and the least height of the caudal peduncle about 1.5 times in its length. The cleft of the mouth is small, crescentic and obliquely



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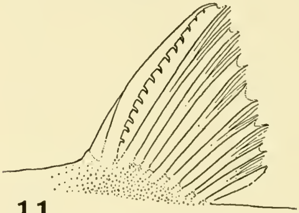

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FIGURE 10. Lateral view of anterior part of body of a specimen of *Schizothorax micropogon* Heckel from Dal Lake, showing contour of head, nature of mouth, jaws, lips and barbels. × 2.

FIGURE 11. Dorsal fin of a specimen of *Schizothorax micropogon* Heckel from Dal Lake, showing structure of spine and nature of serration on its posterior border. × 2.

ascending forwards. The jaws are sub-equal in length, the upper one being the longer. The margin of the lower jaw is rounded and devoid of horny covering. The lips are well developed (Text-figure 10); the lower one is interrupted in the middle. The barbels are always shorter than the diameter of the eyes. The head is sub-triangular in shape, with a flat and trenchant upper surface; it is slightly higher than broad and its length is contained about 3.7 times in the total length excluding the caudal. The snout is thick with obtuse anterior margin; its length is contained from 3.1 to 3.3 times in the length of the head. The interorbital space is flat and is about 1.5 times as broad as the orbit. The eyes are prominent and their diameter is contained from 4.2 to nearly 5 times in the length of the snout.

The commencement of the dorsal fin is opposite that of the ventrals and considerably nearer the root of the caudal than the tip of the snout; in certain specimens it is almost equidistant between these two points. The osseous dorsal spine is more or less narrow and slender towards the distal end, slightly curved and armed posteriorly with 17 to 20 prominent teeth (Text-figure 11). It is as long as the head behind the anterior margin of the eyes or the nostrils. The anal fin is short and its longest ray is shorter than that of the dorsal; it rarely reaches the root of the caudal. The pectorals are considerably shorter than the head, not more than the length of the head from behind the middle of the eyes; they are sepa-

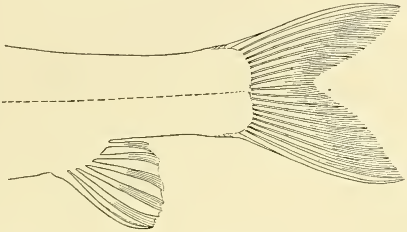

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FIGURE 12. Lateral view of posterior part of body of a specimen of *Schizothorax micropogon* Heckel from Dal Lake, showing form of anal and caudal fins. × 1½.

rated from the origin of the ventrals by a distance equalling more than half their own length. The ventrals are slightly shorter than the pectorals and are separated from the insertion of the anal by a distance equalling almost half their own length. The caudal fin is somewhat shorter than the head, deeply furcate and appreciably higher than long with more or less equal lobes; the length of the central rays is contained nearly 2.5 times in the length of the outer rays (Text-figure 12). The vent is situated in front of the anal and in female specimens is provided with a prominent fleshy papilla. The scales on the body are minute. The tiled row of anal scales are small, the largest one being less than half as broad as the orbit.

The colouration of the specimens in alcohol is reddish brown with a darker upper surface. As in *S. planifrons* some of the specimens are paler. The entire body excluding the ventral surface is dusted with fine black pigments. The dorsal and the caudal fins are dusky.

Bionomics: The peritoneum is black. The structure of the air-bladder is similar to that of *S. planifrons.* In specimen, 132 mm. long, the lengths of the anterior and the posterior chambers are 19 mm. and 31 mm. respectively. The alimentary canal is short and of moderate width with a few convolutions. Its length varies from 1.5 to about 2 times the length of the body excluding the caudal fin. The gut contents of 5 specimens from the Dal and the Manasbal lakes were examined, and the intestines were found to be partially empty, but small amount of a soft pulpy substance mixed with filamentous algae and fragments of insect larvae were found. The species is apparently a mixed feeder and the short length of the intestine suggests that the fish feeds chiefly on animal matter.

Breeding: So far as I can gather, nothing is known about the breeding habits of the species. It is, however, significant that all the female specimens obtained by the Expedition during the months of March to May bear mature eggs, the diameter of which is about 1 mm.

Parasites: No Acanthocephalan parasites were found in the intestine of the specimens examined, but in a specimen, 132 mm. long, from the Manasbal lake several specimens of a species of Nematode worm were found.

Distribution: Schizothorax micropogon is one of the smallest endemic species of the Kashmir valley, co-occurring with *S. planifrons* in the lakes and the adjoining channels. It is known by the Kashmiris as "*Ramghurdi.*"

Measurements in millimetres

	♀	♀	♀
Total length without caudal	165.0	132.0	112.0
Length of head	44.0	35.0	30.0
Width of head	27.0	21.0	17.0
Height of head	31.0	21.0	20.0
Diameter of eye	9.0	8.0	7.0
Length of snout	14.0	11.0	9.0
Interorbital width	14.0	11.0	9.0
Depth of body	40.0	32.0	25.0
Longest ray of dorsal	32.0	26.0	21.0
Longest ray of anal	28.0	21.0	16.0
Length of pectoral	28.0	21.0	21.0
Length of ventral	25.0	20.0	20.0
Length of caudal	34.0	28.0	25.0
Distance between pectoral and base of ventral	21.0	16.0	11.5
Distance between ventral and base of anal	15.0	11.0	6.0
Length of caudal peduncle	25.0	19.0	19.0
Least height of caudal peduncle	14.0	12.0	11.0

Schizothorax curvifrons Heckel

1838. *Schizothorax curvifrons*, Heckel, *Fische aus Caschmir*, p. 25, pl. iii.
1844. *Schizothorax curvifrons*, Heckel, *Fische Kaschmir's* in *Hugel's Reise*, p. 361, 3 figs.
1868. *Schizothorax curvifrons*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 164.
1877. *Schizothorax curvifrons*, Day, *Fish. India*, p. 532 (footnote).
1889. *Schizothorax curvifrons*, Day, *Faun. Brit. Ind., Fish.*, I, p. 252 (footnote).

The species is represented in the collection of the Yale North India Expedition by five young and half-grown specimens collected in March-May, 1932, from the following localities:

Srinagar (Sta. K 7), *ca.* 5,200 ft. ....4 (110-178 mm.)
Channel: Manasbal Lake: Srinagar (Sta. K 48), 5,197 ft. ......1 (122 mm.)

In the specimens before me the length of the head is contained about 4.5 times or a little over in the total length excluding the caudal fin. The eyes are large and their diameter is contained from 4.5 to nearly 5 times in the length of the head. The snout is short and stumpy and 1.5 times longer than the orbit. The interorbital space is nearly 1.5 times the orbital width. The barbels are very short and not more than half as long as the diameter of the eyes. The mouth is somewhat narrow and horse-shoe-shaped. The lips are moderately developed and more or less tough. In some specimens the lower jaw is provided with a sharp margin.

The dorsal fin is inserted slightly nearer the root of the caudal than the tip of the snout; its osseous spine is straight and fairly strong and has rather fine serrature on the posterior border. In the smaller specimens the anal fin laid flat does not reach the root of the caudal, whereas in the larger ones it almost reaches it.

The colouration of the specimens in alcohol is reddish brown with a slightly darker upper surface. The inner margin of the caudal fin is dusky.

Bionomics: The air-bladder is of the normal *Schizothorax*-type. It appears that in young specimens the posterior chamber is proportionately shorter than the anterior chamber. In a specimen, 120 mm. long, the length of the anterior chamber is 15 mm., while that of the posterior one is 20 mm. In a specimen, 178 mm. long, however, the corresponding measurements are 25 mm. and 50 mm. The length of the intestine is almost 3 times the length of the body excluding the caudal fin. The gut contents of 2 specimens (120, 178 mm.) were found to consist of fragments of some insect larvae mixed with a brownish pulpy substance.

Parasites: In the intestine of a specimen (178 mm.) a few specimens of a species of Acanthocephalan worm were found.

Distribution: Schizothorax curvifrons is one of the endemic species of the Kashmir valley. It grows to a fairly large size, weighing about 3 lbs. and is known by the Kashmiri fishermen as "*Sottir.*"

Genus *Oreinus* McClelland (1839)

Oreinus sinuatus (Heckel)

1838. *Schizothorax sinuatus*, Heckel, *Fische aus Caschmir*, p. 21, pl. ii.
1839. *Oreinus maculatus*, McClelland, *Asiat. Res.* XIX, pt. ii, pp. 274, 345, pl. lvii, fig. 6.
1844. *Schizothorax sinuatus*, Heckel, *Fische Kaschmir* in *Hugel's Reise*, p. 359, 3 figs.
1868. *Oreinus sinuatus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 161.
1876. *Oreinus sinuatus*, Day, *Proc. Zool. Soc. London*, p. 783.
1877. *Oreinus sinuatus*, Day, *Fish. India*, p. 529, pl. cxxiv, fig. 4.
1878. *Oreinus sinuatus*, Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology*, p. 3.
1889. *Oreinus sinuatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 248.

The Yale North India Expedition obtained 14 specimens of the species in March-June, 1932, from the following localities:

Jhelum River, Srinagar (Sta. K 14); *ca.* 5,200 ft. .... 1 (208 mm.)
Jhelum River, Pampur (Sta. K 16); *ca.* 5,200 ft. .... 3 (270, 220, 220 mm.)
Rivers and Canals, Srinagar .... 2 (280, ♀, 184 mm.)
Kargil, Ladak (Sta. K 88); 8,790 ft. .... 5 (495, 270, 260, 180, 145 mm.)
Upper Indus, Spitok, Ladak (Sta. L 17); 10,730 ft. .... 3 (280, 275, 180 mm.)

The specimens under report agree fairly well with the description of the species and exhibit well marked differences from the variety *griffithi* McClelland from Afghanistan, which has been recently redescribed by Hora.[11] *O. sinuatus* is very closely allied to *O. plagiostomus*, but differs from it chiefly in the structure of the serrated dorsal spine, which is long and strong with moderate serrations on its posterior border in *sinuatus* and considerably weak with feeble or obsolete serrations in *plagiostomus* (Text-figure 13, *a*, *b*).

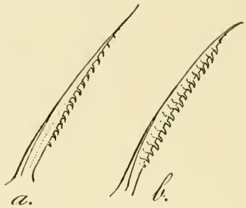

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FIGURE 13. Dorsal spines of nearly equal-sized specimens of (*a*) *Oreinus plagiostomus* (Heckel) and (*b*) *Oreinus sinuatus* (Heckel), showing difference in structure of spines and nature of serration on their posterior borders. × *ca.* 2.

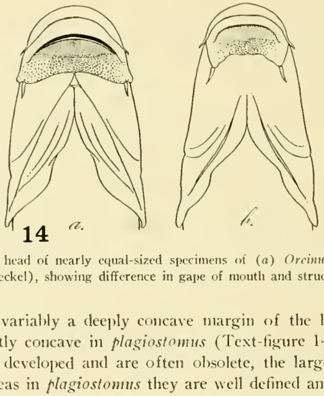

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FIGURE 14. Ventral views of head of nearly equal-sized specimens of (*a*) *Oreinus plagiostomus* (Heckel) and (*b*) *Oreinus sinuatus* (Heckel), showing difference in gape of mouth and structure of lower lip. × 1½.

Further, *sinuatus* has invariably a deeply concave margin of the lower lip which is more or less straight or slightly concave in *plagiostomus* (Text-figure 14, *a*, *b*). The anal scales in *sinuatus* are not well developed and are often obsolete, the largest being nearly half as broad as the orbit, whereas in *plagiostomus* they are well defined and almost as broad as the orbit. From the Expedition material as also from the Indian Museum specimens from different localities I find that in *O. sinuatus* the dorsal spine is somewhat variable in length.

[11] Hora, S. L.: *Rec. Ind. Mus.*, XXXVI, pp. 300-306, figs. 4 and 5 (1934).

It is normally as long as the head behind the nostrils, but it may be as long as or a little longer than the entire head.

Bionomics: The peritoneum is black. The air-bladder, although bipartite is peculiarly modified. The anterior chamber is roughly knob-like with a broader anterior portion, while the posterior chamber is narrow in the beginning, becoming broadest in the middle and narrower again towards the free portion and has thus a somewhat bulbular appearance. The posterior chamber is moderately thick-walled, specially near and behind the constriction between the two chambers (Text-figure 15). The posterior chamber is nearly twice as long as the anterior one. The alimentary canal is capacious, long and much convoluted;

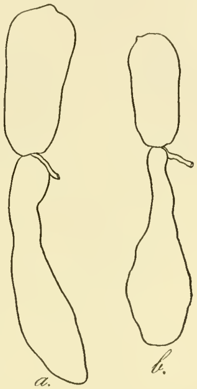

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FIGURE 15. *Oreinus sinuatus* (Heckel). Air-bladder of (*a*) a specimen, 275 mm. long, from Spitok, Indian Tibet and (*b*) a specimen, 255 mm. long, from Kargil, Indian Tibet, showing structural variation. Nat. size.

it is about 4 to 5 times as long as the body excluding the caudal fin. The intestines of specimens from Kargil and Spitok were examined and found to contain lumps of gravel and mud mixed with pulpy vegetable matter. A few chironomid larvae were also found.

Breeding: No definite information is available in regard to the breeding habits of the species. Day, however, observed: "In May (at Chumba) the ova of these fish inhabiting the main stream, were almost fully developed, being numerous and of large size, whilst there were a considerable number of fry in the side streams of the Ravi." Of the few Expedition specimens opened by me, I find in one case, a female 280 mm. long, that the eggs are fully developed and have a diameter of about 1.5 mm.

Distribution: Oreinus sinuatus occurs in the rivers of Kashmir and the Punjab, and prefers to live among rocks. In Afghanistan the species is replaced by the variety *griffithi*

McClelland. *O. maculatus* McClelland from the Kabul river[12] (*nec* Simla), as indicated by Hora (*op. cit.*), is a young form of the var. *griffithi*.

? *Schizothorax labiatus* × *Oreinus sinuatus*

Hybridisation among fishes in nature is not a rare occurrence and usually takes place between closely related genera of the same ancestral stock or between two congeners that co-occur in specialized and restricted areas, such as the high altitudes of Central Asia, etc., and live under more or less similar conditions of life. Intermediate forms between *Schizothorax* and *Oreinus* have often been observed by various authors and recently Hora[13] has recorded a very interesting series from the Chitral valley which he has designated as *Schizothorax labiatus* × *Oreinus sinuatus* var. *griffithi*. Among the fishes brought by the Yale

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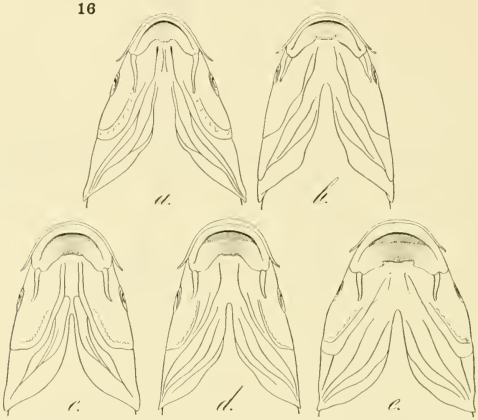

FIGURE 16. A series (*a-e*) of ventral surface of head of five specimens, intermediate between *Schizothorax* and *Oreinus*, roughly showing progressive modifications from *Schizothorax labiatus* towards *Oreinus sinuatus* type of mouth parts. (Figures variously magnified.)

North India Expedition there is a series of specimens detailed below which undoubtedly represent intermediate forms between *Schizothorax* and *Oreinus* and as far as can be judged from the nature of the head, the jaws and the lips, they seem to be hybrids between *S. labiatus* and *O. sinuatus*; they agree fairly well with the series described by Hora.

Srinagar (Sta. K 14); *ca.* 5,200 ft. ....1 (180 mm.)
Rivers and Canals, Srinagar ....3 (223, 160, 150 mm.)
Lake near Chushol (Sta. L 73); 14,735 ft. ....1 (215 mm.)

[12] McClelland, J.: *Calcutta Journ. Nat. Hist.*, II, p. 580 (1842).
[13] Hora, S. L.: *Rec. Ind. Mus.*, XXXVI, pp. 307-310, figs. 7 and 8 (1934).

These 5 specimens can roughly be arranged in a series showing progressive modifications towards the formation of an *Oreinus* type of mouth parts (Text-figure 16, *a-e*). The specimen from Srinagar (Sta. K 14) represents true *Schizothorax labiatus* type, while the one from the lake near Chushol (Sta. L 73) almost approaches typical *Oreinus sinuatus* type. The three specimens from the rivers and the canals show the successive intermediate stages.

It is a matter of congratulation to mention here that the striking peculiarities of these five specimens did not escape the notice of Mr. G. E. Hutchinson, who had rightly labelled them in the fields as "Intermediates."

? *Schizothorax planifrons* × *Oreinus sinuatus*

Besides the five specimens of an intermediate type which I have designated as *Schizothorax labiatus* × *Oreinus sinuatus*, there are, in the collection of the Yale North India Expedition, six specimens collected from the following localities which correspond to *S. planifrons* in all essential characters except for the sharp, horny tubercles on the snout and the sharp, horny covering of the lower jaw. In one of his letters Mr. G. E. Hutchinson informed us that this intermediate form "co-occurs with *Schizothorax esocinus* and the *Schizothorax* species called in Kashmir "*Chush*." The "*Chush*" of the Kashmiris is *S. planifrons* and I am inclined to believe that the six specimens under report are hybrids between *S. planifrons* ("*Chush*") and *O. sinuatus* with dominant "*Chush*" characters. This statement finds support in the fact that, according to Mr. Hutchinson, these intermediate forms are also called "*Chush*" by the Kashmiri fishermen.

The specimens have been collected from the following localities:

Main Canal: Srinagar (Sta. K 12); *ca.* 5,200 ft. ....2 (228, 215 mm.)
Jhelum River: Srinagar (Sta. K 14); *ca.* 5,200 ft. ....2 (290, 275 mm.)
Channel to Manasbal Lake: Srinagar (Sta. K 48); 5,196 ft. ....2 (370, 150 mm.)

Schizopygopsis stoliczkae Steindachner

1866. *Schizopygopsis stoliczkae*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 786, pl. xvi, fig. 2.
1868. *Schizopygopsis stoliczkae*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 170.
1876. *Schizopygopsis stoliczkae*, Day, *Proc. Zool. Soc. London*, p. 791.
1878. *Schizopygopsis stoliczkae*, Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology*, p. 9, pl. ii, fig. 2.
1878. *Schizopygopsis stoliczkae*, Day, *Fish. India*, p. 531, pl. cxxiv, fig. 2.
1889. *Schizopygopsis stoliczkae*, Day, *Faun. Brit. Ind., Fish.*, I, p. 251, fig. 89.
1891. *Schizopygopsis stoliczkae*, Herzenstein, *Wiss. Result. Przewalski Central-Asien unter Reisen, Fische*, p. 191, pl. xvi, fig. 3.
1898. *Schizopygopsis stoliczkae*, Alcock, *Report Nat. Hist. Res. Pamir Bound. Comm.*, p. 14.
1907. *Schizopygopsis stoliczkae*, Berg, *Ann. Mus. Zool. Petersb.*, X (1905), p. 323.
1910. *Schizopygopsis stoliczkae*, Zugmayer, *Zool. Jahrb. Abth. Syst.*, XXIX, p. 290.
1911. *Schizopygopsis stoliczkae*, Stewart (in part), *Rec. Ind. Mus.*, VI, p. 73, pl. iii, figs. 1-3.
1914. *Schizopygopsis stoliczkae*, Berg, *Faune de la Russie*, Poissons, III, p. 702.
1916. *Schizopygopsis stoliczkae*, Berg, *Poiss. des Eaux Douces de la Russie*, p. 290.

1916. *Schizopygopsis stoliczkae,* Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova,* XLVII, p. 143.
1932. *Schizopygopsis stoliczkae,* Berg (in part), *Poiss. des Eaux Douces de l'U. R. S. S.* (3rd ed.), pt. i, p. 473.
1935. *Schizopygopsis stoliczkae,* Hora and Mukerji, in *Visser's Karakorum,* I, p. 434, pl. iii, figs. 1-4.

Among the Schizothoracinae of Central Asia *Schizopygopsis stoliczkae* is one of the most variable forms, particularly in regard to size and the proportions of the height of the body, and of the length, breadth and the height of the head in relation to the length of the body. The diameter of the eyes in proportion to the length of the head is also considerably variable. The species is generally uniform in colouration, but spotted and blotched forms are not rare. In view of considerable variations of a number of characters which again are not infrequently inconstant even in series of specimens from any particular area—a very wide interpretation has been given to *S. stoliczkae* by certain authors, while others form restricted groups of extreme and intermediate variations which may almost be regarded as distinct taxonomic entities.

In 1911, Stewart (*op. cit.*), while reporting the species from various localities (from 11,500 ft. to 15,000 ft.) between the Chumbi valley and the town of Gyantse in the Tibetan province of Tsang,[14] took opportunity of examining the extensive collection of *S. stoliczkae* preserved in the Indian Museum. Besides specimens from various localities, the Indian Museum collection includes the topotypes of the species which were obtained by Dr. Stoliczka from the Pamirs and Ladak during Sir Douglas Forsyth's Mission to Yarkand in 1873-74, as also those of *S. severzowi* from the Pamris.

Herzenstein's species, *S. severzowi,* may be superficially separated from *S. stoliczkae* by its somewhat smaller size (dwarf), flattened lower surface of the head instead of being curved, and by the position of its mouth which is somewhat overhung by the snout and is more terminal than ventral. But Stewart has shown, after a very detailed analysis of the so-called characteristics of the two forms that all probable gradations exist between the typical form of *stoliczkae* and the *severzowi* type, so much so that specific distinction seems hardly justifiable.

In this connection mention may also be made of the Seistan form of *stoliczkae* reported by Annandale and Hora.[15] In all probability this is yet another dwarf race, distinct from both the typical *stoliczkae* and *severzowi.* Recently, while dealing with the material obtained by the Netherland Karakorum Expedition, Hora and Mukerji[16] have indicated, after thoroughly examining the entire collection of *S. stoliczkae* in the Indian Museum, that both *severzowi* and the Seistan form should be considered at least as separate subspecific forms. But unless further material from the Pamirs and Seistan become available, no definite conclusions are possible.

The Yale North India Expedition obtained 17 specimens from the following localities in June-August, 1932, which, in my opinion, are all referable to the typical form of *stoliczkae.* The specimens are of variable sizes, the largest one from Spitok being about 300 mm. long excluding the caudal fin.

[14] "The province of Tsang lies roughly north of Sikhim and Nepal and includes the district from Tang-la to Gyantse and Shigatse."

[15] Annandale, N., and Hora, S. L.: *Rec. Ind. Mus.,* XVIII, pp. 173, 174, figs. 7a, 7b, 7c (1920).

[16] Hora, S. L., and Mukerji, D. D.: in Visser's Karakorum, I, pp. 434, 435, pl. iii.

Spitok, Upper Indus: Ladak (Sta. L 17); *ca.* 10,730 ft. ....2 (300 mm.; 110 mm.)
A large rapid stream between Tangtse and Mugleb: Ladak (Sta. L 37); *ca.* 13,700 ft. 6
Stream above Lukong; Ladak (Sta. L 54a); *ca.* 14,164 ft. ....3 (50-72 mm.)
Stream into Pangur Tso; Ladak (Sta. L 74); *ca.* 14,203 ft. ....1 (77 mm.)
Yalapuk, Upper Indus near Nyoma; Ladak (Sta. L 79); *ca.* 13,521 ft. 2

It is apparent from the above detailed distribution that only the young and small adult specimens were obtained by the Expedition from the shallow streams and pools in the vicinity of Pang-gong and Pangur lakes, while the larger individuals were taken from the Indus river itself. This suggests that either the species breeds in the shallower waters of the streams and pools that are associated with the lakes and the river, or the young forms migrate to the former habitat for the opportunity of having better food supply and other more favourable conditions of life that naturally prevail there. The former view finds support in the fact that the Yale North India Expedition collected mature eggs of *S. stoliczkae* from the streams between Tangtse and Mugleb.[17] The eggs are comparatively large, their average diameter being 2 mm. Further, the Second Yarkand Mission also obtained "fry and small fish from Lukong and Chagra" (Day).

Breeding: Stewart (*op. cit.*) has observed that the "breeding season (of *S. stoliczkae*) in the neighbourhood of Gyantse appears to occur about June. In the less favoured waters near watershed it is probably later." The mature eggs of the species referred to above were collected by the Expedition on the 27th June, and indicate that the breeding of the species in Western Tibet probably occurs at almost the same time as in Eastern Tibet.

Bionomics: The peritoneum is black. The air-bladder of *S. stoliczkae*, as is characteristic of the cyprinoid fishes, is free in the abdominal cavity, extensive, and bipartite; the posterior chamber is longer and somewhat narrower than the anterior one which is short and rounded and marked off from the former by a deep constriction. A well developed pneumatic duct opens at the junction of the two chambers (Text-figure 17). It is interesting to note that unlike the cyprinoid fishes of the typical calm waters, such as lakes, ponds, etc., both the chambers of the air-bladder of *S. stoliczkae* are very thick-walled. This type of air-bladder is to be expected in this species in so far as "its characteristic habitat is in the streams and small rivers of the open, tree-less, 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." (Stewart, *op. cit.*). *S. stoliczkae*, owing to its being a denizen of rapid waters and in consequence of ground habitat, does not use the air-bladder as a hydrostatic organ, and its walls, therefore, become more and more thick.

The alimentary canal is much convoluted; in young and half-grown specimens its length is a little less than twice the length of the body including the caudal fin, while in adult individuals it is just a little more than twice. The stomach contents of some of the young specimens obtained by the Yale North India Expedition show that, in young and immature individuals at any rate, *S. stoliczkae*, like the young of most of its allies, feeds on nymphs and larvae of insects, such as Plecoptera, Diptera, etc. The examination of the gut con-

[17] The population in the Chagra stream is isolated, and it is clear that its largest members never reach the size of the largest specimens from the Indus. An operculum from the shore of Tso-Nyak suggests this species, and indicates a very large fish.—G. E. H.

tents of the adult specimens, however, shows that the species, when full grown, feeds exclusively on vegetable matter.

Parasites: Day already observed in connection with the specimens obtained by the Second Yarkand Mission that "these fishes appear to be much attacked by parasites, which occasion yellowish elevated tubercles, not only on the head and body but also on the dorsal fin." The specimens under report not only show similar parasitism but in the intestine of certain specimens taken at the streams between Tangtse and Mugleb a species of Acanthocephalan worm has also been found. From a single specimen as many as eleven worms were collected.

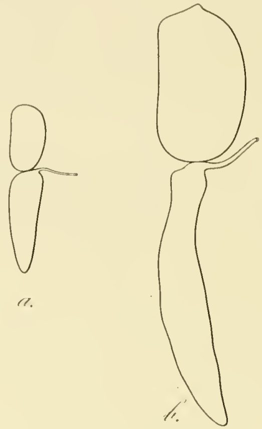

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FIGURE 17. *Schizopygopsis stoliczkae* Steindachner. Air-bladder of (*a*) a young specimen, 72 mm. long, from a stream above Lukong, Indian Tibet, and (*b*) an adult specimen, 300 mm. long from Spitok, Indian Tibet. Nat. size.

Distribution: The species is widely distributed "from Badakshan and the Pamirs to the Eastern Himalaya 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."

Genus *Diptychus* Steindachner (1866)

Diptychus maculatus Steindachner

1866. *Diptychus maculatus*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 788, fig. 6.
1868. *Diptychus maculatus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 171.
1876. *Diptychus maculatus*, Day, *Proc. Zool. Soc.* London, p. 272.

1878. *Diptychus maculatus*, Day, *Sci. Res. 2nd Yarkand Miss., Ichthyology*, p. 10, pl. ii, fig. 3.
1878. *Diptychus maculatus*, Day, *Fish. India*, p. 534, pl. cxxiv, fig. 3.
1889. *Diptychus maculatus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 255, fig. 92.
1910. *Diptychus maculatus*, Zugmayer, *Zool. Jahrb., Abth. Syst.*, XXIX, p. 292.
1914. *Diptychus maculatus*, Berg, *Faune de la Russie, Poissons*, III, p. 677, figs. 133-135.
1916. *Diptychus maculatus*, Berg, *Poissons des Eaux Douces de la Russie*, p. 286.
1916. *Diptychus maculatus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, XLVII, p. 145.
1931. *Diptychus maculatus*, Berg, *Zool. Anz.*, XCVI, p. 311.
1932. *Diptychus maculatus*, Berg, *Poiss. des Eaux Douces de l'U. R. S. S.* (3rd ed.), pt. i, p. 466.
1935. *Diptychus maculatus*, Hora and Mukerji, in Visser's *Karakorum*, I, p. 435.

Diptychus maculatus is a very widely distributed species in Central Asia, usually inhabiting rocky, mountainous streams. It exhibits considerable variations in different body proportions, nature of the barbels, the diameter of the eyes and the colouration. The Yale North India Expedition obtained 16 specimens of the species in May-July, 1932, from the following localities:

A rapid stream at Nimu: Ladak (Sta. L 12); *ca.* 10,250 ft. ....4 (123 mm.; 33-60 mm.)
A torrential stream at Lhabaps: Ladak (Sta. L 31); *ca.* 11,855 ft. ....4 (108 mm.; 27-32 mm.)
A large rapid stream between Tangtse and Mugleb: Ladak (Sta. L 37); *ca.* 13,700 ft. 2 (118 mm.; 107 mm.)
Stream at Chagra: Ladak (Sta. L 46); *ca.* 15,215 ft. ....2 (270 mm.; 225 mm.)
Stream at Leh ....5 (95-135 mm.)

From the above list of localities it will be seen that the majority of the specimens collected by the Expedition are either young or half-grown and they all come from rapid to torrential streams. The two specimens taken at Chagra are large; the larger one being 270 mm. in length excluding the caudal fin.

Breeding: The breeding season of *D. maculatus* is not definitely known so far,[18] but from an examination of the nature of the gonads of a number of specimens brought back by the Yale North India Expedition, it appears that the spawning of the species takes place, like *Schizopygopsis stoliczkae*, during the months of May to August. Both the specimens taken at Chagra are gravid females.

Bionomics: The peritoneum is black. The air-bladder is more or less similar in structure to that of *Schizopygopsis stoliczkae* (Text-figure 18). The alimentary canal is much convoluted. In young and half-grown specimens its length is about twice the length of the body including the caudal fin, while in larger individuals it is more than twice. The gut contents of a number of specimens under report indicate that the young immature stages feed on nymphs and larvae of Ephimeropterous, Plecopterous and Dipterous insects, while the adults live chiefly on slime, filamentous algae, and other vegetable matter.

Parasites: Like *Schizopygopsis stoliczkae* this species is also attacked with parasites which cause brownish tubercles on the head, cheeks, different parts of the body and the fins. No intestinal parasites were found in the specimens under report.

[18] V. A. Anikin's work, "Die Fische der Gattung *Diptychus* Steind., ihre Systematic und biologische Bedeutung" (*Tomsk*, 1906), seems to contain interesting biological accounts of *Diptychus*, but unfortunately it is not available in India.

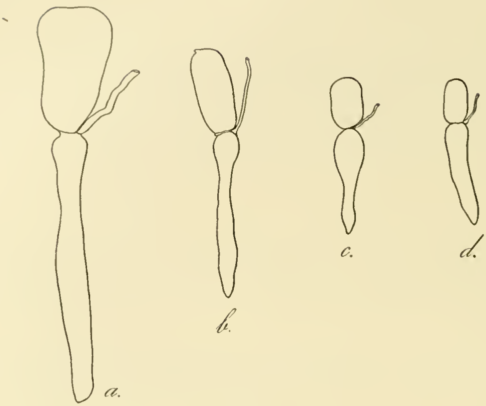

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FIGURE 18. *Diptychus maculatus* Steindachner. Air-bladder in different stages of growth. × 1½. (*a*) A specimen, 220 mm. long, from Chagra, Indian Tibet. (*b*) A specimen, 138 mm. long, from Leh, Indian Tibet. (*c*) A specimen, 72 mm. long, from Lukong, Indian Tibet. (*d*) A specimen, 60 mm. long, from Nimu, Indian Tibet.

Distribution: *D. maculatus* is one of the most common species found in the Indus, Tarim and the Yarkand river systems. It has also been found in other parts of Tibet and Nepal. It is an inhabitant of the rapids.

Remarks: Reference may here be made of a species, "*Diptychus annandalei*" described by Regan[19] from Katamundu in Nepal. I have shown elsewhere[20] that the form is congeneric with *Schizothorax* and that the description is based on juvenile specimens.

Genus *Ptychobarbus* Steindachner

Ptychobarbus conirostris Steindachner

1866. *Ptychobarbus conirostris*, Steindachner, *Verh. Zool.-bot. Ges. Wien*, XVI, p. 790, pl. xvii, fig. 4.
1868. *Ptychobarbus conirostris*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 169.
1876. *Ptychobarbus conirostris*, Day, *Proc. Zool. Soc. London*, p. 789.
1878. *Ptychobarbus conirostris*, Day, *Sci. Res. 2nd Yarkand Miss.*, *Ichthyology*, p. 7, pl. ii, fig. 3.
1878. *Ptychobarbus conirostris*, Day, *Fish. India*, p. 533, pl. cxxv, fig. 3.
1889. *Ptychobarbus conirostris*, Day, *Faun. Brit. Ind.*, *Fish.*, I, p. 253, fig. 91.

[19] Regan, C. T.: *Rec. Ind. Mus.*, I, p. 158 (1907).
[20] Mukerji, D. D.: *Rec. Ind. Mus.*, XXXIII, pp. 63-65, figs. 1-4 (1931).

1898. *Ptychobarbus conirostris*, Alcock, *Rep. Proc. Pamir Bound. Comm.*, p. 37, pl. i, figs. 2 and 3.
1910. *Ptychobarbus conirostris*, Zugmayer, *Zool. Jahrb., Abth. Syst.*, XXIX, pp. 291, 292.
1935. *Ptychobarbus conirostris*, Hora and Mukerji, in *Visser's Karakorum*, I, p. 436.

The species is represented in the collection of the Yale North India Expedition by five specimens collected in June-August, 1932, from the following localities:

Kargil: Ladak (Sta. K 88); *ca.* 8,790 ft. ....1 (262 mm.; ♀)
Kalatse, Upper Indus: Ladak (Sta. L 6-9); 9,700 ft. ....1 (174 mm.; ♀)
Spitok, Upper Indus: Ladak (Sta. L 17); *ca.* 10,730 ft. ....2 (270 mm. ♀; 250 mm. ♂)
Yalapuk, Upper Indus near Nyoma: Ladak (Sta. L 79); *ca.* 13,521 ft. ....1 (100 mm.)

In the report on the fishes obtained by the Netherland Karakorum Expedition Hora and Mukerji (*op. cit.*), on the authority of Mr. G. E. Hutchinson, stated that *Ptychobarbus* is usually found in large, deep and rapid-flowing rivers and seldom in small, clear streams or springs overgrown with vegetation. The above list of localities corroborates this view inasmuch as all the specimens of *P. conirostris* collected by the Expedition come from rivers. Alcock (*op. cit.*), during the Pamir Boundary Commission, collected specimens of the species, both males and females, from the Yasin river at an altitude of about 8,500 feet between Kashmir and the Pamirs. This adds further support to the statement that *P. conirostris* is essentially a mountainous river form.

The species is variable specially in regard to the size and proportions of the head and the eyes. In young and half-grown specimens the diameter of the eyes is contained nearly four times in the length of the head and 1.5 times in the length of the snout; in fairly grown up individuals, on the contrary, the proportions are 6.5 times and 2.5 times respectively. The interorbital space is equal to the diameter of the eyes in young specimens, but in adults it is much wider, being from 1.5 to 2 times the orbital width.

The head is slightly higher than or as high as broad. Its width is equal to the length of the head behind the middle of the eyes. The length of the head is contained nearly five times in the length of the body including the caudal fin. In young and half-grown individuals the caudal fin is almost as long as the head, but in adults it is much shorter, being equal to the length of the head behind the nostrils. In young stage the barbels are equal to the orbital width, while in full-grown specimens they are twice the same.

A well-developed thick fleshy appendage is present in the axillae of the ventral fins. In *Schizopygopsis stoliczkae* this structure is poorly developed, while in *Diptychus maculatus* it is hardly present. The scales on the chest are considerably reduced.

The colouration of the specimens in alcohol is pale brown with a silvery sheen. The upper half of the body, the head and the back are comparatively dark. The upper surface of the head is spotted with black. The back and the upper half of the body are somewhat irregularly marked with black patches which give the fish a characteristic maculated appearance. In young and half-grown specimens these markings show a tendency to form reticulations, while in adult individuals they represent series of small stars. All the fins are marked with black spots and small blotches.

Sexual Dimorphism: From an examination of the specimens of *P. conirostris* taken by him at the Yasin river, Alcock (*op. cit.*) observed that the females "are singular in having

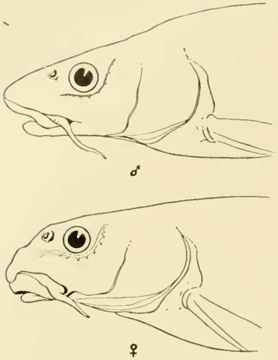

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FIGURE 19. *Ptychobarbus conirostris* Steindachner. Lateral views of anterior portion of body of a male specimen, 250 mm. long, from Spitok, Indian Tibet, and a female specimen, 262 mm. long, from Kargil, Indian Tibet, showing sexual differences in structure of upper lip and curvature of snout. × ¾.

FIGURE 20. Air-bladder of a female specimen of *Ptychobarbus conirostris* Steind., 262 mm. long, from Kargil, Indian Tibet. × ¾.

the upper lip greatly broadened and thickened and the profile of the snout is conspicuously concave." Similar secondary sexual characters are also to be found in the female specimens of the species brought back by the Yale North India Expedition (Text-figure 19, *a*, *b*).

Bionomics: The peritoneum is black. The air-bladder is more or less similar to that of *Diptychus maculatus*. Its posterior chamber is greatly elongated and extends as far back as the rectal end of the intestine. In a female specimen, 262 mm. long, excluding the caudal fin, the length of the anterior chamber of the air-bladder is 25 mm. and that of the posterior chamber 88 mm. (Text-figure 20). The alimentary canal is much convoluted; its length in grown-up specimens is 1.2 to 1.5 times the length of the body including the caudal fin. In the gut contents lumps of slime and algae mixed with mud and sand, as also large numbers of Chironomid larvae were found. It appears probable that *P. conirostris* is a mixed feeder.

Distribution: *P. conirostris* has so far been reported from the headwaters of the Indus and the western border of Tibet.

Remarks: Berg[21] regards *Ptychobarbus* as a subgenus of *Diptychus* and gives the following synopsis for the separation of the various subgenera:

[21] Berg, L. S.: *Faune de la Russie, Poissons*, III. p. 677 (1914).

A. Lower jaw provided with sharp, horny covering. Body densely covered with scales above the lateral line .... *Diptychus* (s. str.)
B. Lower jaw without sharp, horny covering.
   a. Body almost naked; scales present along lateral line and base of pectoral fin *Gymnodiptychus*
   b. Body covered with scales .... *Ptychobarbus*

In the character of the mouth, the lower jaw, the lips and the squamation, however, *Diptychus* differs so markedly from *Ptychobarbus* that I am unable to agree with Berg, and consider *Ptychobarbus* to be a distinct genus.

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