

Miss Jay R. Traver on *Himalayan Mayflies*

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*Himalayan Mayflies (Ephemeroptera) **.

By JAY R. TRAVER.

THE mayflies described in this article were collected in 1932 by the Yale North India Expedition, under the direction of Prof. G. E. Hutchinson. These specimens are largely from Kashmir and Indian Tibet (Ladak). One new genus and five new species are recognizable. Much of the material is in rather poor condition. Other new species may be present but are represented by immature stages (nymph or subimago) only, or are too fragmentary to permit of description. The two species of Heptagenine nymphs designated as "single-spine" and "double-spine" allies of the genus *Iron* probably represent new genera.

Relatively little is known of the Ephemeroptera of the Himalayan region. Eaton (1) mentions the occurrence of four genera: *Leptophlebia marginata* L., from the vicinity of Taschkent; *Epeorus psi* Etn., from Kooloo, Himalaya; *Pægniodes* and *Ecdyonurus*, from Tibet and Himalaya respectively. McLachlan (2) lists the genera

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Bælis, *Clæon*, *Heptagenia*, *Siphonurus*, *Leptophlebia marginata* L., and *Centroptilum*, from Turkestan; he designates no other species. Ulmer (3) has described a new species of *Cinygma* (*Cinygma asiaticum*), from Djarkent, and reports (4) *Clæon inscriptum* Bgtss., from the vicinity of Srinagar. Tshernova (5) has described two new species—*Heptagenia tadzhikorum* Tsh. and *Clæon zimini* Tsh.—from southern Buchara and the vicinity of Taschkent. To date, the work of Brodsky (6) has added most to our knowledge of the mayfly fauna of this interesting region. In his paper on the mayflies of middle Asia sixteen new species are described, and three others listed as occurring in that area. Several of these are from Samarkand or Taschkent, many others from the River Issyk. I am unable to recognize any of the species previously reported from the Himalayan region in the material collected by the Yale North India Expedition.

Family Heptageniidae.

Genus OROROTSIA, nov.

Imago (female). *Frontal portion of head greatly enlarged* (fig. 5). Only fragments of wings remain; in these stigmatic cross-veins are not anastomosed. Tarsi five-jointed. In all legs tibia as long as or slightly longer than femur; tarsus three-quarters of tibia in fore leg, half or slightly less than half of tibia in middle and hind legs. *Claws on all legs similar, sharp-pointed*; one claw of each pair slightly wider at base than the other (fig. 7). In fore leg basal tarsal joint about three-quarters of the second and subequal to third; fourth slightly shorter than basal joint; distal joint longest, about equal to third and fourth combined; second very slightly shorter than distal (fig. 1). In middle and hind legs basal joint of tarsus subequal to second; third and fourth progressively shorter; distal joint longest, approximately equal to basal and second joints combined. Subanal plate with a V-shaped median cleft on apical margin.

Nymph (mature). Outline of head of subimago, and the similar sharp-pointed claws on each tarsus, visible through the nymphal cuticle. Typical Heptagenine venation (determined by removing wing of subimago from nymphal wing-pad). Cross-veins at bulla 2, 2, 2 in

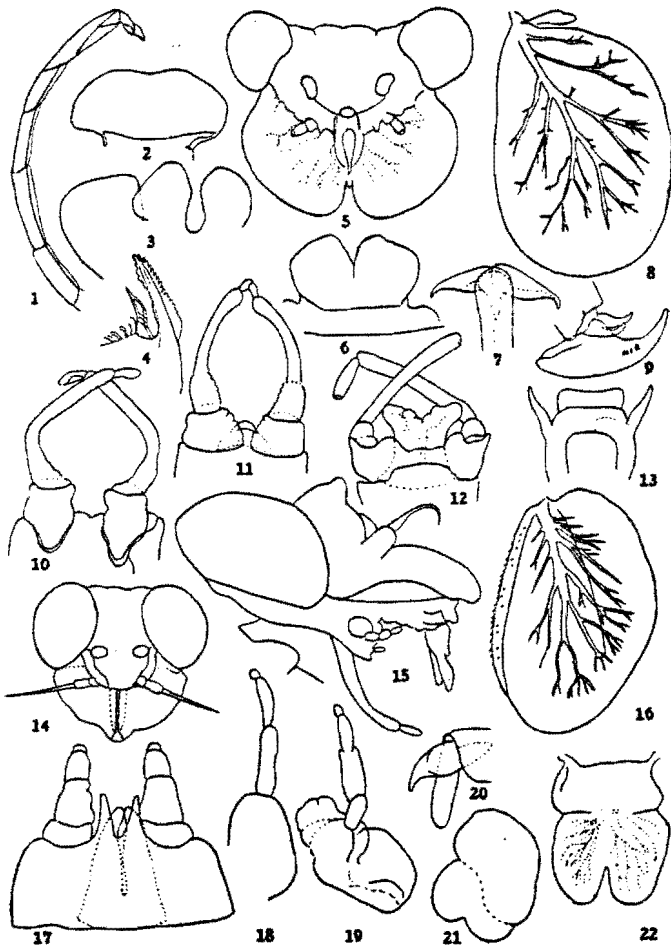
first three spaces; in fourth space 2 nearer apex than those in space above; in fifth space 1 well developed and 1 barely indicated; in sixth space, two cross-veins. Frontal border of head distinctly emarginate at median line. Mouth-parts reminiscent of *Cinygmula*. Gills likewise quite similar to those of *Cinygmula* in that the fibrillar portion is much reduced (fig. 8). Tibiæ equal to or exceeding femora in length; tarsi short, each only slightly more than one-third the length of the corresponding tibia. Claws with five pectinations. A few very short inconspicuous hairs and spines on posterior margins of femora. Tails three (broken, except at base).

A single female imago; wings fragmentary; six legs, unattached, in vial with specimen. Three mature nymphs which, by reason of the subimaginal head and claws visible through the cuticle, evidently belong with the above imago. Distinct from all other genera of this family by reason of the greatly produced frontal portion of the head and the similar sharp-pointed claws. Probably allied to *Cinygmula*.

Genotype: *Ororotsia hutchinsoni*, sp. n.

Ororotsia hutchinsoni, sp. n.

Female imago. Body 10 mm.; wing 11 mm.; tails 15 mm. Head dark olive-brown. Eyes set at outer angles of head (fig. 1). Antennæ broken. Thorax dark red-brown. Medio-lateral areas of pronotum shaded with darker brown. Antero-lateral, posterior, and postero-lateral margins (below scutellum) of mesonotum blackish. Posterior half of mesosternum dark red-brown, other portions lighter red-brown. Legs dark olive-brown; fore legs distinctly tinged with red-brown. A narrow black line along front margin of fore femur. On middle and hind legs tarsi faintly tinged with red-brown, slightly darker than other segments. Wings hyaline; venation reddish brown. Cross-veins somewhat heavier than longitudinal. In costal space before bulla 5 or 6 cross-veins, slightly aslant; in basal subcostal space 5 or 6 cross-veins. A reddish-brown stain in stigmatic area, filling costal and subcostal spaces. 9 to 12 stigmatic cross-veins; simple, slightly aslant. 7 or 8 subcostals in corresponding space. A distinct dark brown stain at extreme bases of both fore and hind wings. Humeral



Figs. 1-9.—*Ororotia hutchinsoni*. 1. Fore tarsus, female imago. 2. Labrum of nymph (all hairs omitted). 3. Glossa and paraglossa of nymph (hairs omitted). 4. Canines of mandibles, nymph. 5. Head of female imago. 6. Penes, male nymph. 7. Claws, hind tarsus of female imago. 8. Gill from middle abdominal segment, nymph. 9. Claw, fore leg of nymph (broken off to expose similar paired claws of subimago).

Fig. 10.—*Baeitiella ladakæ*. Male genitalia.

Fig. 11.—*Cloeon kashmiri*. Male genitalia.

Fig. 12.—*Epeorus* sp. Male genitalia.

Fig. 13.—*Caenis srinagari*. Genitalia, male subimago.

Figs. 14-22.—*Ameletus primitivus*. 14. Head of female imago. 15. Same, lateral aspect, to show mouth-parts. 16. Gill of fourth abdominal segment, nymph. 17. Genitalia, male nymph. 18. Labial palpus, female imago. 19. Maxillary palpus, female subimago. 20. Claws of female imago. 21. Mandible, female subimago. 22. Labrum, female imago.

cross-vein dark red-brown, blackish at crossing of subcosta.

Abdomen light red-brown. Tergite 1 shaded obscurely with greyish black. Tergites 9 and 10 olive-brown. Posterior margins of tergites 7-10 very narrowly dark brown. A narrow, pale, median stripe is faintly indicated. Traces of obscure, darker, submedian streaks on tergites 8-10. Intersegmental area and pleural fold greyish. Sternites very slightly paler than tergites. Egg-valve outlined in dark brown. Oviducts appear as faint, dark, submedian streaks parallel to and near the pleural fold. A wide, V-shaped, median cleft on apical margin of subanal plate. Tails red-brown; a pale, opaque ring at each joining.

Locality: L 52. Ororotse Tso; on ice at margin; July 11, 1932. Altitude 17,381 ft.

Nymph (mature). Body of female 12 mm.; tails broken. General colour dark red-brown. Mouth-parts much as in *Cinygmula* (figs. 2, 3, & 4). Frontal margin of head deeply emarginate at median line. Pronotum widest just behind anterior margin; its length is greater on each side than at median line. Proportions of leg-joints as indicated in generic description; claw shown in fig. 9. Legs reddish brown. Dorsal surface of femur finely set with many very short spinules. Femoral flange rather short, conical. The five-jointed, sharp-clawed legs of the subimago are plainly visible within the nymphal leg (fig. 9). A few short weak spines on posterior margin of each femur. Wings of subimago, removed from nymphal wing-cases, exhibit typical Heptagenine venation. In hind wing costal angulation moderately acute; median vein forked near base; radial sector normal. In both wings cross-veins are slightly infuscated, distinctly so in the costal margin. Very short postero-lateral spines on middle abdominal segments only. Each basal and middle tergite marked with a pair of pale submedian streaks, almost straight, extending from anterior margin about to the middle of the tergite; a round pale spot at end of each streak. On middle tergites pale streaks laterad of these markings, next to bases of gills, are faintly indicated. Median area of middle and apical tergites indistinctly paler. Tergite 9 rather paler than other tergites; two short, dark, sub-

median streaks. Venter without distinct markings; however, a narrow, dark, lateral line near pleural fold may be faintly indicated. Tails broken. Gills greyish. Tracheation brownish; appears almost palmate (fig. 8). Fibrillar portion reduced to one short filament (not seen on all gills). As gills were lying at bottom of vial, unattached to bodies of nymphs, it is not possible to determine to which segment each belonged.

Locality: L 26-27, below Polu Digar; June 21, 1932. Three mature female nymphs.

A younger male nymph from L 34 is probably of the same species. In this younger specimen the upper surfaces of the femora are distinctly yellow in median area: narrow dark lines enclose this pale area, converging apically to form a wide dark streak. Distal third of each tarsus darker than preceding portions. Genitalia of this immature male nymph are shown in fig. 6.

Locality: L 34, Bao stream; June 25, 1932.

Holotype.—Female imago. L 52, Ororotse Tso; July 11, 1932. Yale North India Expedition. In private collection of the author.

Paratypes.—Three mature female nymphs. L. 26-27, below Polu Digar; June 21, 1932; and one male nymph, L 34, stream at Bao; June 25, 1932. In private collection of author.

GENUS RHITHROGENA Eaton.

Rhithrogena sp.

Immature nymphs of this genus were collected at several stations. Apparently all are of the same species. One of the largest of these nymphs measures 12 mm. in length of body. No distinctive markings nor unusual coloration of body or gills are evident. Structurally the nymphs resemble European and Nearctic nymphs of this genus.

Localities:

K 57. Sind River, Kangan, Kashmir, 1810 m., under stones at edge; May 16, 1932, Alt. c. 5795 ft.

K 65. Sind River between Gund and Sonamarg. (a) Backwater, not more than 10 metres per minute under stones. (b) 20-50 metres per minute under stones; May 18, 1932. Alt. c. 8000 ft.

K 72. Matayan. Stream coming in at bridge from south. Under stones. 50 m. per minute. Temp. 2°-2 C. May 20, 1932. Alt. 10,430 ft.

L 6. Kalatse, stream: May 29, 1932. Alt. 9700 ft.

L 11. First stream east of Nurla; May 31, 1932. Alt. c. 9900 ft.

Attached by a few threads to the right side of the abdomen of the dorsum of one nymph from K 57 is the pupa of a species of *Simulium* *. The head of this pupa is directed toward the caudal end of the body of the mayfly nymph. Dr. Hutchinson states that his notes indicate an habitual relationship between the mayfly nymphs and the *Simulium* larvæ and pupæ. Thus, at Llabaps about one-third of the Heptagenine nymphs were found to carry larvæ or pupæ of the *Simulium*.

Genus *EPEORUS* Eaton.

Epeorus sp.

A single male imago in rather poor condition. Body 6 mm.; wings represented by a few small fragments only. General colour dark red-brown. Frontal margin of head paler. Eyes quite large, contiguous apically; lateral ocelli also large. Pro- and mesonota bright red-brown; posterior portion of mesonotum darker. Pleura paler and duller; thoracic sternum still paler, posterior half of mesosternum yellowish. Legs yellowish amber. Fore femur reddish brown; two indistinct darker bars, one near each end. Third femur tinged with reddish brown near apex. A very small black dot at apex of each trochanter. Fore tibia almost twice as long as femur; apex deep brown. Basal joint of fore tarsus three-quarters to seven-eighths as long as second and subequal to third; fourth and fifth joints progressively shorter than the third. Tarsus about one and a quarter times as long as tibia. Claws dissimilar. Tarsi on middle and hind legs missing. An opaque orange stain in stigmatic area of fore wing; a very small dark brown stain at extreme base of each wing. Abdomen rather bright red-brown; venter only

* Determined by Prof. O. A. Johannsen, Cornell University.

slightly paler than dorsum. Posterior third of each segment deeper brown, so that abdomen appears banded. Posterior margin of metanotum and of each of the two basal abdominal tergites narrowly black. Genitalia as in fig. 12. Tails deep red-brown at base, becoming paler distally; indistinctly darker at joinings in basal half.

Locality: L 31. Lhabaps; June 23, 1932. Alt. 11,855 ft.

This species appears to be distinct from all others thus far described from the Palearctic region in structure of genitalia.

Genus IRON Eaton.

Iron sp.

Three immature nymphs of a large species of this genus were taken, at one station only. Body of nymph 14 mm.; tails 13 mm. additional. Head widest near anterior margin. Labrum differs from that of typical *Iron* nymphs of the *longimanus* group in that it is distinctly widest at the anterior margin; almost straight across this margin, except for a median indentation; and the lateral margins slope distinctly inward toward the base. Femoral flange rather short and blunt. A small, rounded, purple-black spot on dorsal surface of each femur. Claws with two pectinations. Posterolateral spines on abdominal segments 1-7 rather short, as in typical nymphs of the *longimanus* group. Gills of first pair unusually large, meeting beneath body of nymph and extending forward so as to cover most of the thoracic sternum. On each gill of the remaining pairs a much thickened oblong pad on the ventral surface of the anterior margin bears a short thumb-like projection. Thickened ventral area around outer margin quite prominent. Abdominal tergites reddish brown with conspicuous black markings: transverse band along anterior margin; black median triangle based on anterior margin, its apex not quite attaining the posterior margin; a rather broad, oblique, lateral band, from which a short streak extends toward the postero-lateral angle.

Locality: L 31. Lhabaps, under stones; June 22, 1932. Alt. 11, 855 ft.

*Allies of the Genus Iron.*A. "Single-spine" *Iron* ally.

Nymphs of this species were found at three stations. Body of one mature nymph, 9 mm.; tails 7 mm. additional. Mouth-parts as in typical *Iron* nymphs of the *longimanus* group. In general appearance quite similar to such nymphs, but bearing a row of mid-dorsal spines on abdomen. These spines are present on tergites 1-8: shortest on 1 and 8, longest on 4 and 5; each is directed backward. Head widest across the middle. Femoral flange short, obtuse; no dark spot on mid-dorsal surface of femur. Claws with two minute pectinations. Postero-lateral spines on abdominal segments 1-7 very short. Gills of first and last pairs meet beneath body of nymph. A very short rudiment of the middle tail is present. Entire body yellowish white except for paired brownish-black marks on each side of median line at anterior margins of abdominal segments 3-9. Described from nymph taken at L 46.

An immature nymph from L 6 has relatively longer and sharper mid-dorsal spines; general colour light reddish brown. Otherwise similar to specimens from L 46. Two small red-brown nymphs, immature, from L 31, have mid-dorsal spines similar to the L 46 nymph; femora with an oblong brownish mark on dorsal surface; ventral ganglia of thorax and abdomen darkened.

Localities:

L 6. Stream at Kalatse; May 29, 1932. Alt. 9700 ft.

L 31. Lhabaps, under stones; June 23, 1932. Alt. 11,855 ft.

L 46. Stream just below Phobrang; July 8, 1932. Alt. 15,215 ft.

B. "Double-spine" *Iron* ally.

Nymphs of this species were taken at four stations. Mature nymph, body 11 mm.; tails 7 mm. additional. Aside from the dorsal spines quite similar to *Iron* nymphs of the *longimanus* group. Head widest across middle. Femoral flange short, obtuse. Dorsum of each femur largely brown, this colour interrupted by a dagger-shaped, whitish, median mark in basal half. Claws with three pectinations. Postero-lateral spines on abdominal segments 1-7 short. Thorax and abdomen reddish brown. Dark transverse marks on anterior margin of each tergite in median area. A pair of submedian spines on abdominal

segments 1-6; on tergites 7-9 a *single median spine*. Paired spines on tergite 1 very short, and separated by a space approximately equal to the length of the segment at middle line; those on 2 slightly longer but as widely separated. Progressively longer and closer together on tergites 3-6; on 5 spines touch at base, on 6 they are grown together basally. The single spines on tergites 7-9 are rather long and stout and directed backwards. Gills of first and last pairs meet beneath body of nymph. A very minute conical remnant of the middle tail is present. Described from specimen taken at K 57.

An immature nymph from K 65 differs from the above description in that the single spines are present on segments 8 and 9 only, while double spines occur on segments 2-7. The spines on 7 are grown together for at least half of their length.

A very young nymph from K 77 possesses paired dorsal spines on segments 2-9. From these discrepancies as to the number of paired and single spines borne by nymphs of different ages it seems probable that the three single spines present on segments 7-9 of the mature nymph have resulted from gradual fusion of closely placed paired spines, such as occur on the very young nymph.

Localities:

K 57. Sind River, Kangan, Kashmir, 1810 m. under stones at edge; May 16, 1932. Alt. c. 5795 ft.

K 65. Halfway between Gund and Sonamarg. (a) Backwater, not more than 10 m. per minute under stones. (b) Over 20 m. per sec. under stones. May 18, 1932. Alt. c. 8000 ft.

K 77. Dras stream; May 22, 1932. Alt. 10,144 ft.

L 11. Stream east of Nurla; May 31, 1932. Alt. c. 9900 ft.

It is probable that both the "single-spine" and the "double-spine" nymphs allied to *Iron* represent undescribed genera of the Heptageniidae.

Genus HEPTAGENIA Walsh.

Two nymphs taken by the expedition may be of this genus. The first, called *Heptagenia* sp. A, seems rather closely allied to the *flavescens-elegantula* group of Nearctic fauna; the second, designated as *Heptagenia* sp. B, is an ally of the *maculipennis* group.

Heptagenia sp. A.

A single half-grown female nymph. Body 9 mm.; tails 11 mm. In type of mouth-parts very similar to the Nearctic species *H. marginalis* and *H. elegantula*. Differs from these and related species as regards the shape of the head; this is slightly emarginate at middle of frontal margin, quite distinctly narrowed toward the posterior margin, and with eyes set closer together and further back on the head, reminiscent of the genus *Iron*. Pronotum widest near anterior margin. Legs very large and long for size of body. Hind femur, when extended backwards, reaches to middle of ninth abdominal segment. A few short spines and a fringe of longer hairs on hind margin of each femur; many short spines on upper surface. Fringes of hairs on tibiae along posterior margins and along middle area of inner surface in distal portion. Fore tibia subequal to femur; hind tibia very slightly shorter than femur.

Gills present on segments 1-7. Filamentous portions well developed on all seven pairs; upper lamellate portions of all pairs are lacking from the single specimen. Subanal plate large, slightly emarginate at middle of apical margin. Tails three. General colour dark red-brown; tibiae, tarsi, and tails yellowish.

Locality: L 24. Edge of River Indus, Spithug; June 17, 1932. Alt. 10,730 ft.

Heptagenia sp. B.

A single nearly mature female nymph. Body 4 mm.; tails missing. Head large for size of body, as in nymphs of the Nearctic *maculipennis* group. Mouth-parts very similar to species of that group. Pronotum widest near middle. Claws pectinate, each bearing about four small spines near distal portion. Posterior margins of femora fringed with long hairs. Short postero-lateral spines present on abdominal segments 4-9. A single pair of gills remains, on segment 4. Filamentous lower portion well developed. Upper lamellate portion likewise well developed; rounded, somewhat wider than long, tracheation indistinct. General colour of body light red-brown; numerous small pale spots on head and thorax. Legs yellowish, with dark bands. Posterior

margins of abdominal tergites dark brown. Tips of wing-pads extend backwards as far as the seventh abdominal segment.

Locality: P 14. 4 metres north of Havelian. North-West Frontier Prov.; pool in stream bed; March 17. 1932. Alt. c. 3000 ft.

Family Bætidæ.

Subfamily SIPHILONURINÆ.

Genus AMELETUS Eaton.

Female imagos of the genus *Ameletus*, differing from all known species of this genus by reason of the persistent mouth-parts, were taken at two stations in Kyam. Female subimagos considered to be of the same species are from Phobrang. Nymphs, which because of the subimaginal mouth-parts visible beneath the last nymphal skin seem to be of the same species, were found at Kyam. These nymphs possess mouth-parts and gills typical of the genus *Ameletus*. There seems no reason to doubt that the imagos, subimagos, and nymphs are of the same species. The persistent mouth-parts of the winged stages indicate that the species is very primitive—indeed, it may be that *Ameletus primitivus* should be considered as primitive as *Tasmanophlebia* of New Zealand. It is doubtful, however, whether the mouth-parts of the imago and subimago can be considered functional.

Ameletus primitivus, sp. n.

Female imago. Body 17 mm.; wing 17 mm.; tails 20 mm. Head blackish brown; frontal shelf paler than vertex, with olive-brown tinge. Shaped as in fig. 14. Lateral view of head, showing persistent mouth-parts, in fig. 15. Labial palp and labrum shown in figs. 18 and 22. Antennæ concolorous with head. Lateral and posterior portions of pronotum greyish; median area dark brown. Meso- and metanota blackish brown. A wide greyish area on pleura, anterior to base of fore wing; intersegmental areas pale; remaining portions blackish brown. Prosternum pale brown. Meso- and metasterna a dark red-brown, somewhat paler than notum. Femora dark brown with olive tinge; hind

femur rather paler, with yellowish cast. Fore tibia concolorous with femur, tarsus paler red-brown. Second joint of fore tarsus longest; fourth the shortest; basal and third joints subequal, distal slightly longer than basal or third joints. Tibiæ of middle and hind legs yellowish; tarsi light red-brown. Hind tarsus slightly longer than tibia. In hind tarsus second joint longest, fourth shortest, third slightly longer than fourth, basal slightly longer than third, distal almost as long as second. Claws dissimilar on all tarsi (fig. 20).

Fore wing relatively wider than in Nearctic species of *Ameletus*; less narrowed at base. Humeral cross-vein not darkened; one or two faint folds in wing-membrane basad of this brace-vein may be present. In apical half of fore wing cross-veins are numerous and regularly spaced, as in species of *Ameletus* from eastern North America. (In most species from western North America, including the type-species, *A. subnotatus* Etn., these cross-veins are less numerous and arranged in irregular series so as to leave relatively large spaces between each series.) Vein M_2 definitely turns downward to meet Cu_1 , as in most species of *Ameletus* examined (in a few species the vein M_2 ends basally, with no definite tendency to turn either up or down). In the hind wing the costal angulation is low and rounded except in one wing examined; even in this wing it is much less acute than is typical for species of Nearctic *Ameletus*. Stigmatic cross-veins of fore wing partially anastomosed, forming two short rows of cells, of which the row nearer the costal margin is the smaller. Costal and subcostal cross-veins very weak, almost obsolescent, in basal and middle areas of wing. Wings hyaline; venation yellowish brown. Both wings stained with dark brown at extreme base; on hind wing this brown stain may extend out on to the wing-membrane, in area behind the radial sector.

Abdominal segments 2-6 subhyaline; basal and apical segments opaque. Segment 1 largely blackish brown. Basal portions of tergites 2-10 yellowish with a distinct olive tinge; posterior half largely olive-brown. A darker brown triangular patch, its base near the posterior margin, occupies most of the median area of tergites 2-5; apex of each triangle almost attains the anterior margin,

where it may appear to be divided into two parts. On tergites 6-9 two olive-brown submedian streaks take the place of this triangle. On tergite 6 these streaks extend almost to the anterior margin; on tergites 7-9 they extend only about three-quarters the length of the segment. A brownish triangle occupies the postero-medial portion of tergite 10. Laterally on tergites 2-8 a dark streak parallels the pleural fold; postero-lateral angles brown. Sternites only slightly paler than tergites. Dark brown ganglionic patches on sternites 3-6. On each basal and middle sternite a pair of opaque, whitish, submedian streaks; on each basal sternite a pair of small, dark brown dots near middle area; antero-laterad of each dot a pair of small, comma-shaped, brown spots on each side. Subanal plate short, extending only about half the length of sternite 10; a V-shaped cleft at its apex. Tails reddish brown, paler distally; a pair of obscure brownish rings at each joining, not at all prominent. A very short, conical, unsegmented stub, not extending to the apical margin of segment 10, represents the rudimentary middle tail.

Localities:

L 61. Kyam; July 24, 1932. Found dead on surface of pool in swamp. Two specimens, wings of each badly torn. Alt. c. 15,500 ft. (Label in vial reads "K 61, Kiam," apparently in error.)

L 58. Kyam; July 20, 1932. Dead on surface of pool, hot spring. Fragments of two specimens. Alt. 15,630 ft.

L 59. Kyam; July 20, 1932. Rivulet under stones. Fragments of thorax and one pair of wings only. Evidently this adult had fallen into the water. Alt. 15,500 ft.

Female subimago. Body 17 mm.; wings and tails missing. One specimen; legs imperfect, wings missing except for a small basal area. It is probably the subimago of the above-described species. Very similar to imago except for differences noted. Mesonotum olive-brown. Two large greyish patches laterally on metanotum. Abdomen appears more distinctly banded dorsally than the imago, the dark posterior half of each tergite a more continuous dark band; median dark triangles less distinct; intersegmental areas pale, appearing

like a narrow grey band on posterior margin of each tergite. Dark ventral markings not yet developed. Labrum less well developed than in imago; labium and maxillæ somewhat better developed (figs. 19 and 21).

Locality: L 46. Stream just below Phobrang; July 8, 1932. Alt. 15,215 ft.

Nymph. Body of male 17 mm.; of female 18 mm.; tails 6-7 mm. Two mature nymphs, male and female, probably belong to the same species as the adults just described. The outer cuticle came off readily from the head of the mature female nymph, revealing the persistent mouth-parts of the subimago; the subimagonal mouth-parts were also visible through the cuticle of the male nymph.

Head and thorax dark olive-brown; wing-pads and abdomen reddish brown; mesonotum tinged with reddish brown. Legs olive-brown. Femur and tibia of fore leg darker than other joints. Fore tarsus and tibiæ and tarsi of other legs yellowish brown; the distal end of each tarsus distinctly chestnut-brown. Claws light red-brown, darker at tips. Short postero-lateral spines on abdominal segments 2-9; those on middle segments slightly longer than apical ones. Basal segments of abdomen with a bluish-brown tinge; all other segments reddish brown. Median dorsal line narrowly pale; bordered on each side by a dark submedian streak not quite reaching the anterior margin; on middle tergites these dark streaks may become triangular. Lateral dark streaks or elongate patches on each tergite, halfway to pleural margin; posterior half of each tergite obscurely darker than other portions. A faint greyish median band extends the length of the abdomen ventrally. A comma-shaped whitish mark in antero-lateral angle of each sternite. Obscure pale, oblique, submedian streaks from anterior margin of each. Gills single, present on segments 1-7. Irregularly obovate, the inner margin being distinctly cordate. Outer margin thickened and bearing a few short spines; a narrow dark band across each gill, about one-third of distance from inner margin. Tracheation rather indistinct, profuse, tending toward a palmate condition; tracheæ look like a faint grey tracery. See fig. 16 for appearance of gill from

middle segment. Tails yellowish at extreme base and again at tip; elsewhere dark red-brown; joinings not darkened; no dark cross-bands. Genitalia of male nymph shown in fig. 17.

Locality: L 60. Kyam; July 25, 1932. Under stones in stream. Alt. 15,500 ft. Male and female nymphs, mature.

A single nymph from L 31 may be of the same species. Body 17 mm. General colour much as in the mature nymphs just described, but paler. Dorsal abdominal markings consist of distinct, oblique, dark brown streaks, extending from anterior margin; lateral dark streaks as in other specimens. Ventrally anterior margins of sternites narrowly dark brown; a small dark brown spot in antero-lateral angle of each.

Locality: L 31. Lhabaps; June 22, 1932. Under stones in a quiet pool in stream. Alt. 11,855 ft.

Holotype.—Female imago; L 61, Kyam; July 24, 1932. Yale North India Expedition. In private collection of the author.

Paratypes.—One female imago; same data as holotype. One female subimago; L 46, stream just below Phobrang; July 8, 1932. One male and one female nymph; L 60, Kyam; July 25, 1932. Yale North India Expedition. In private collection of author.

Ameletus sp.

A single immature nymph, probably representative of another species, was taken at L 47, stream below Chagra, on July 9, 1932. Alt. 16,331 ft.

Subfamily *EPHEMERELLINÆ*.

Genus *EPHEMERELLA* Walsh.

Ephemerella sp.

Immature nymph. Body 7 mm. A member of the *fuscata* group. Frontal shelf present, covering mouthparts; notch on each side, into which bases of antennæ are fitted; a short blunt projection above base of each antenna on inner margin. Anterior to median ocellus a low rounded projection. Occipital tubercles present, moderate in size, conical. Surfaces of pro- and mesonota very irregular, but lacking true tubercles or spines;

a rounded protuberance, not a true tubercle, near middle of lateral margin of pronotum. Anterior margin of fore femur toothed or serrate; tibial spine blunt at tip, extends less than half the length of the tarsus. Posterior margins of femora of middle and hind legs with small serrations; a few fine serrations also on posterior margin of fore femur near base. Well developed, paired, submedian spines on tergites 2-9; the two rows of spines converge slightly toward the apical tergites. Short postero-lateral spines on middle and apical segments, those on segment 8 concealed apically on margin of tergite. Gills present on segments 3-7; none are operculate. General colour of body light red-brown. Irregular darker mottling on thoracic notum. A dark longitudinal line follows the inner margin of gills on middle tergites. Ventrally large, black, irregular blotches mark each thoracic ganglion; smaller rounded, dark blotches over the basal and middle ganglia of abdominal sternites. Tails missing, except short basal stubs.

Locality: L 11. Stream east of Nurla; May 31, 1932. One specimen. Alt. c. 9900 ft.

Subfamily CÆNINE.

Genus CÆNIS Stephens.

Cænis srinagari, sp. n.

Male subimago. Body 3 mm.; wing 3 mm. Frontal margin of head marked with yellow; all other portions dark red-brown with dusky shading. Thoracic notum, large areas on pleura, and lateral portions of sternum dark red-brown; median area of sternum yellowish. Fore femur light red-brown. Remainder of fore leg and all of middle and hind legs yellow; no dark markings. Abdomen yellowish. On each basal and middle tergite a large, blackish, rectangular patch on each side of pale median line. On apical tergites lateral extensions from these dark patches reach the pleural fold and extend along it for part or all of its length. Fine pale dots are sprinkled over the dark areas on apical tergites. Tergite 10 red-brown; lateral dark patches in postero-lateral angles only; median line black, divided into a Y apically. Sternites yellow. Tails deep yellow. Genitalia as in fig. 13.

Locality: Gagirbal, Srinagar; April 9, 1932.

Female imago. Body $3\frac{1}{2}$ mm.; wing $3\frac{1}{2}$ mm. Head as in male; antennæ yellowish brown. Pronotum light red-brown, heavily shaded with blackish. Mesonotum and pleura as in male; sternum yellowish. Legs yellow, no dark markings. Entire middle area of abdominal tergites overlaid with purplish black, leaving median line, intersegmental areas, and lateral margins yellow. No evident dark stigmatic markings, but traces of grey shading laterally on apical tergites. Sternites yellow. Tails yellow, light red-brown at extreme base.

Locality: Gagirbal Pond; April 11, 1932. Two specimens.

Holotype.—Male subimago. Gagirbal, Srinagar; April 9, 1932. Yale North India Expedition. In private collection of the author.

Allotype.—Female imago. Gagirbal Pond, Srinagar; April 11, 1932. Yale North India Expedition. In private collection of author.

Paratype.—Female imago; same data as allotype. In private collection of author.

In type of genitalia this species resembles the European *C. macrura* Steph., but is considerably smaller. It is slightly smaller than *Cænis ulmeri* Brod. (7), and differs from that species in the much greater length of the forceps. *C. ulmeri*, however, occurs in Taschkent, not far from Gagirbal.

Subfamily BÆTINÆ.

Genus BÆTIS Leach.

The material representing this genus is inadequate in every case for specific determination. A single male imago is present but in a very fragmentary condition, the wings being almost completely lacking. Two female imagos, one minus wings and tails, might by reason of their large size belong to the species *B. heptapotamicus* Brod. (8) or *B. thermicus* Ueno (9). However, the hind wing of the larger specimen does not accord well with that of either of the above-mentioned species. Several mature nymphs were taken but were not associated with the imagos. The incompletely developed genitalia of the male subimagos cannot be used as the basis for determination of species.

Specimens of the genus *Baetis* were taken at the following localities :—

- K 65. between Gund and Sonamarg ; May 18, 1932. Immature nymphs.
 K 72, Matayan ; May 20, 1932. Immature nymphs.
 K 77, stream at Dras ; May 21, 1932. One nymph.
 K 86, Wakka Chu River, on clay-cliffs along river ; two miles from Kargil. No date given. Male subimago. Igu. Ladak ; Sept. 1932. Male subimago, defective.
 L 31. Lhabaps ; June 23, 1932. Male subimago.
 L 25. Leh ; June 21, 1932. Female nymph.
 L 34. Bao ; June 25, 1932. Mature nymph.
 L 46. Chagra ; Aug. 5, 1932. Male subimago.
 L 59, Kyam ; July 20, 1932. Female imago.
 L 72, Tokung ; Aug. 8, 1932. Male subimago.

Genus *BÆTIELLA* Ueno.

Bætiella ladakæ, sp. n.

Male imago. Body 4-4½ mm. ; wing 5½-6 mm. Head and thorax very dark red-brown ; pleural sutures blackish. Turbinate eyes deep orange-brown, rather small, upper surfaces almost circular in outline. Legs deep yellow (detached from specimens, so that it is not possible to differentiate between second and third pairs). Base of femur shaded with red-brown ; on some, brown shading also near apex (second or third leg). Claws and tarsal joinings brownish ; distal joint of tarsus dusky, its apical margin blackish ; brown markings at knee. Fore tarsus relatively short, about seven-eighths as long as the tibia and approximately equal to the femur in length. Second joint longest, third next in length, fourth shorter than third, distal joint subequal to third. On middle and hind legs femur almost as long as tibia ; tarsus about two-thirds as long as tibia ; tarsal joints in decreasing rank : 4, 1, 2, 3.

Wings hyaline ; venation red-brown. Granulations in apical portion of costal and subcostal spaces. A small brown spot at extreme base of main longitudinal veins ; on wing of one specimen a small brown spot at bulla, on subcosta. Cross-veins in disc of wing slightly thickened, heavier than longitudinals ; those in first space behind subcosta appear very narrowly margined. Three or four

simple stigmatic cross-veins, slightly aslant. Paired marginal intercalaries, distinct in all interspaces back of the second, in middle area, none in first interspace, a single one in second interspace; none in anal area, none in last two cubital spaces.

Abdominal segments 2-5 semihyaline, yellowish. A faint dusky line along pleural fold and on posterior margins; intersegmental areas paler. Segments 6-10 opaque, rather bright red-brown. Tails yellowish, with a faint dusky tinge; beyond the middle shaded lightly with reddish brown. Joinings faintly dusky. Long joint of forceps strongly bowed in basal third; no penis-cover present. Genitalia as in fig. 10.

Holotype.—Male imago. Igu, Ladak; Sept. 1932. Yale North India Expedition. In private collection of the author.

Paratype.—Male imago; same data as holotype. In private collection of author.

It is difficult to separate imagos of the closely allied genera *Pseudoclaeon* and *Bætiella*. A single Palearctic species of *Pseudoclaeon* (10), represented by females only, has been reported. The genus *Bætiella* has hitherto been known only from the type-species (11), taken in Japan. The two male imagos from Igu, Ladak, are here placed in the genus *Bætiella* (1) because of the total absence of a penis-cover; (2) because of the known distribution of the species of the two genera, *Pseudoclaeon* being largely Indo-Australian, Nearctic, and Neotropical; and (3) because nymphs which correspond to those designated as *Bætiella* were collected by the Expedition in Kashmir.

The description of *Bætiella japonica* Ueno differs in certain important points from that of the two males from Igu, Ladak; hence the latter must be considered a new species. These differences are (1) the colour of the thorax and apical abdominal segments, and (2) the presence of a pair of intercalaries in the first two interspaces in the genotype.

A single male nymph from Kashmir, here described as *Bætiella* sp., resembles the nymph of *B. japonica* in the presence of a slender hair or spine on each claw near the tip, in the appearance of the labrum, and, like

that species, has but two tails. The first two characters separate it from nymphs of the genus *Pseudoclaeon*, which are likewise two-tailed. There is no evidence that any specific relationship exists between this nymph and the males from Igu. Ladak. The absence of dark ventral markings would seem to preclude it from the species *B. japonica*.

Batiella sp.

Male nymph. Body 5 mm.; tails $4\frac{1}{2}$ mm. Head dark red-brown; sutures yellowish. Thoracic notum dark-brown, pronotum paler than mesonotum; median suture yellowish. Pleura yellowish except for a wide, semicircular, red-brown area above each leg. Sternum yellowish; a short, dark brown, transverse mark between the fore legs; other short dark marks near bases of all legs. Legs light red-brown. A deep brown "knee-spot" on femur and tibia; indistinct markings on upper surface of each femur, consisting of an incomplete median cross-band and a longitudinal stripe extending basad from this. Tibia paler than femur. Claw and apical half of tarsus darker red-brown; tibio-tarsal joining dark brown.

Abdominal tergites reddish brown, practically colorous with pronotum. Anterior margin of each very narrowly blackish in median area; posterior margins slightly darker brown. Intersegmental areas yellowish. A pair of submedian, round, dark spots near middle area on tergites 7-10. On tergites 4-6 a pair of obscure, dark, submedian, triangular marks lie nearer the anterior margin. On tergites 1-3 these marks are almost obsolete, but a small area at the median line on the posterior margin is darkened. Additional dorsal markings consist of a dark dash near the lateral margin of each tergite and a larger, obscure, dark blotch slightly nearer the centre of the anterior margin; these markings are most evident on the middle tergites. Venter very slightly paler than the dorsum; unmarked.

Gills greyish, each with a wide, brown, median stripe which does not quite attain the distal margin. Tracheæ completely obscured by this dark band. Gills obovate, slightly asymmetrical; a fringe of short hairs along the distal margin can be made out under moderately high

magnification. Tails two (a very short, conical rudiment of the middle tail is present also, as in *Pseudoclaeon*). Pale reddish brown except at base, where each is somewhat yellowish; joinings obscurely darker.

Locality: K 57. Sind River, Kangan, Kaskmir; May 16, 1932. Alt. c. 5795 ft.

Genus *CLÆON* Leach.

Claeon kashmiri, sp. n.

Male imago. Body $7\frac{1}{2}$ –8 mm.; wing 8 mm. Head pale reddish brown; indistinct dark mark at inner lower corner of eye; dark line between eyes. Turbinate eyes elongate-oval; orange. Antennæ light reddish brown; second joint narrowly dark-ringed at apex. Thorax reddish brown; posterior portion of prothorax brighter red-brown. Narrow dark line along anterolateral margin of mesonotum; narrow pale median and submedian streaks; axillary cords greyish. Scutellum black-margined; depressed area on each side darker brown; scutellum dark brown, tip yellowish. Metanotum dark red-brown, outlined with black; narrow pale median line and short submedian streaks. Pleura paler than notum; a few dark brown areas below wing-bases and around legs. Median area of prosternum narrowly outlined with black.

Legs yellowish. Fore femur reddish brown, black-ringed at apex. Claws and all joinings darker. In fore leg femur about three-quarters the length of tibia; tarsus slightly longer than tibia. Second tarsal joint equal to third plus one-third of fourth; fifth shortest. Joints rank: 2, 3, 4, 5, 1. Tarsus of hind leg subequal to tibia, which is about three-quarters of femur. Basal tarsal joint almost as long as second, third, and fourth combined; about twice as long as second joint. Second joint not quite as long as third; fourth subequal to second. Wings hyaline, faintly yellow-tinged; in some lights appear very faintly milky. Stigmatic area faintly milky; 4 or 5 cross-veins, very faint, slightly aslant.

Abdominal segments 2–6 semihyaline, pale reddish brown; on some specimens distinctly yellowish; venter slightly paler. Indistinct, oblique, submedian streaks from anterior margin on tergites 2–6; small dark brown marks laterally on each, those on tergites 3 and 6

larger than others. A double black line outlines the tracheæ along pleural fold; small black mark at each stigma. Brownish submedian streaks extend the length of each sternite; a very small dark mark laterally on each near pleural fold. Segments 7-10 opaque, darker red-brown. Darker markings not evident on tergites; median streaks on sternites present but obscured. Intersegmental areas of abdomen distinctly paler. Genitalia reddish brown basally, yellowish distally (fig. 11). Tails very pale reddish brown in basal half, silvery white apically. Joinings reddish to purplish brown; alternate joinings wider; near apex joinings not darkened.

Female imago. Body 9 mm.; wing 9-9½ mm. Head, thorax, and abdomen flesh-coloured. Second joint of antenna black-ringed at apex. A short, dark, median, transverse mark near middle of pronotum; behind this a pair of submedian dark dots. A dark transverse streak near posterior margin, on each side of the pale median line. Depressions on each side of scutellum dark brown; a short dark mark on each side of anterior margin. Postero-lateral angles of metanotum outlined with dark brown; a dark dot on each side near anterior margin. Two short, dark, transverse marks on metanotum, near leg-base.

Legs yellowish to flesh-coloured. Fore femur faintly darker. Claws and two distal joints of tarsus brown. All joinings brown; a black dot at inner apical angle of trochanter; a short black streak on inner margin of tibia near base. Basal tarsal joint of third leg very slightly more than twice as long as second joint; second twice as long as third; fourth and second subequal. Tibia three-quarters of femur; tarsus slightly longer than tibia. Wings very faintly yellow-tinged. Costal and subcostal spaces largely obscured by a pale reddish-brown band. Areas around cross-veins pale; at bulla a wider pale space. Small pale marks also along costal margin, quite numerous in some specimens. Basal costal space almost wholly pale for half a millimetre beyond humeral vein; two faint brown marks in this area on costal margin. Extreme base of radius and lower portion of humeral cross-vein purplish brown. Longitudinal veins reddish brown; cross-vein in first three

spaces wholly pale, elsewhere these veins are brown, and slightly heavier than longitudinals in middle area of wing.

Small, dark, wedge-shaped lateral marks, one near each antero-lateral and postero-lateral angle, on abdominal tergites 2-7; traces of darker submedian streaks, as in male. Pleural tracheæ outlined as in male. Ventrally a dark brown lateral line on sternites 2-8, halfway between median line and pleural fold; this line does not quite reach the anterior or posterior margin of each sternite. A small dark mark in postero-lateral angle of sternites 2-6; on 7 and 8 this becomes a dark transverse line joining the longitudinal dark streak (less distinct on 8). Tails missing from all specimens. Tails of female subimago appear similar to those of male.

Holotype.—Male imago. K 38, windows of house-boat between Srinagar and Shadipur; April 12, 1932. Yale North India Expedition. In private collection of author.

Allotype.—Female imago: same data as holotype. In private collection of author.

Paratypes.—Three male imagos: same data as holotype. One male imago: windows of houseboat between Sumbal and Wular Lake, April 14, 1932. Three female imagos: K 37, windows of houseboat at Gagirbal, April 11, 1932; K 50, window of hotel in Srinagar, April 23, 1932; Srinagar, May, 1932. In private collection of author.

In type of genitalia this species resembles *C. tadjikistanicus* Brod. (12); however, it is considerably larger than that species and differs in abdominal coloration.

Claeon sp. A.

Male nymph. Body 5½-6 mm.; tails 4 mm. Head cream-coloured; two brown submedian streaks. Maxillary palp three-jointed; labial palp three-jointed. Thoracic notum mottled with brownish. Legs wholly pale. Abdominal tergites 2, 3, 5, and 6 largely red-brown; brownish median markings on tergite 1; 7-10 pale, narrowly darker on posterior margins; 8 and 9 with indistinct, median, transverse markings. No dark markings ventrally. Gills pale greyish, tracheæ black; gills double, shaped like a palm-leaf; tracheation palmate.

Locality: Aden; Feb. 21, 1932. Two mature nymphs.

Claon sp. B.

Female nymph. Body 7-7½ mm.; tails broken. Head reddish brown; pale median stripe. Mouth-parts as in preceding species. Pronotum brown-mottled; no markings apparent on remainder of notum. Legs wholly pale. All abdominal tergites with median area of posterior margins darkened. A dark pyramidal spot occupies middle of tergite 1. Tergites 2, 5, and 6 with large, median, brown areas; pale, lateral, triangular areas; pale crescentic mark next to posterior margin. Tergite 3 similar, but dark median area much restricted. On tergites 7-9 a wide, dark, Y-shaped median stripe, head of Y near posterior margin. On 8 and 9 a curved brown band extends forward laterally from each arm of the Y. Tergite 10 wholly pale except for dark posterior margin. Venter unmarked. Gills as in preceding species, but tracheæ distinctly purplish black. Tails crossed by a dark band near apex.

Locality: K 34. Phashakuri, near Pampur; May 7, 1932. Four mature female nymphs. Alt. c. 5200 ft.

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