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MAYFLIES OF THE GENUS *Heptagenia* WALSH (EPHEMEROPTERA, HEPTAGENIIDAE) OF THE USSR *

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Until recently, the volume of genus *Heptagenia* was understood differently by different authors. Only during recent years have all authors agreed to accept the volume of this genus as applicable to the Palearctic Region. However, satisfactory definition of the genus has not been available in the literature until now. This definition of the genus is given below, which permits us to separate it from other groups of the Heptageniinae. The characteristics of Palearctic subgenera of *Heptagenia* are listed here only in the key to species based on larvae.

The types of the new species and new subspecies are preserved in the Zoological Institute, Academy of Sciences of the USSR, Leningrad.

GENUS *Heptagenia* WALSH, 1863

Larva. Labrum much broader than long (in distinction from *Chrygma*). Maxilla with ventral row of bristles parallel to the inner margin (in distinction from *Ecdyonurus*). Maxillary palpi moderately developed, with small rudiment of segment III (in distinction from Tribe Rhythrogenini—*Chrygma*, *Rhythrogena* s. str., *Epeorus* s. str., *Iron*, and *Belovius*). Superlingua of hypopharynx laterally bent at apex (in distinction from Rhythrogenini). Labial glossae not broadened apically (in distinction from *Chrygma*). Labial palpi without bifurcated bristles (in distinction from Rhythrogenini). Gills mobile, capable of making fast rhythmic movements (in distinction from *Chrygma* and Rhythrogenini). Femora without regular series of long strong bristles (in distinction from all other genera). Three caudal filaments (in distinction from *Epeorus* s. str., *Iron*, and *Belovius*) with whorls of strong bristles at hindmargin of each segment (in distinction from Rhythrogenini).

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Adult. Mesonotum with distinct transverse groove in anterior part—Fig. 77 (in distinction from *Epeorus*). At least in Palearctic species lateral parapsidal grooves terminating in hindpart of mesonotum, merging with medial parapsidal groove—Fig. 77 (in distinction from Rhythrogenini). Prosternum with transverse rib separating convex basisternum from concave furcasternum—Fig. 66 (in distinction from all other genera). Medial depression of furcasternum of mesothorax strongly narrowed anteriorly—Fig. 66, metathoracic nerve ganglion located hindpart (in distinction from *Ecdyonurus*).

KEY TO SPECIES OF *Heptagenia* OF THE USSR

1. LARVAE*

- 1 (4). Gills of pair VII without fibrillose part. Longitudinal rib on last segment of labial palpus terminating at considerable distance from segmental apex and from shield of scratching bristles (Fig. 6). Glossae semicircular (Fig. 4, 5, 16). Claws with serrated inner margin (Fig. 7). (Subgenus *Kageronia* Mats.)
- 2 (3). Anterior margin of head with deep notch (Fig. 1). Gills narrow (Fig. 8-11). Claw more than 3 times as long as wide (Fig. 7). Caudal filaments in distal part pubescent with swimming hairs. Cerci on inner side, paracerci on lateral sides (Fig. 15) *H. (K.) orbicoida* sp. n.
- 3 (2). Anterior margin of head without notch. Gills sharply broadened in proximal half (Fig. 17). Claw less than 2.5 times as long as wide. Caudal filaments without swimming hairs *H. (K.) fuscogrisea* (Retz.).
- 4 (1). All gills with fibrillose part. Last segment of labial palpus with longitudinal rib terminating near segmental apex very close to field of scratching bristles (Fig. 37). Glossae of different shapes. Claws with smooth inner margin.
- 5 (6). Glossae not bent. Lingua of hypopharynx half the length of superlingua, superlingua with even outer margin. Mandibles short, with strong teeth (subgenus *Dacnogenia*) *H. (D.) ocoerularis* (Subgenus *Heptagenia* Walsh).
- 6 (5). Glossae bent (Fig. 36). Lingua and superlingua near hypopharynx almost equally long, superlingua with a sharply bent outer margin (Fig. 35). (Subgenus *Heptagenia* Walsh).
- 7 (10). Pronotum and sometimes also mesonotum with pair of sharp tubercles (Fig. 34).
- 8 (9). Maxilla with 9-11 pectinate bristles. Europe. *H. (H.) longicauda* (Steph.).
- 9 (8). Maxilla with 5-6 pectinate bristles. Far East *H. (H.) gwynnicka* Below.
- 10 (7). Thoracic tergites without bristles.
- 11 (12). Abdomen with small posterolateral spine, distinctly prominent behind hindmargin of segment (in ventral view) (Fig. 25). Body slender, with long abdomen and small legs (Fig. 19). *H. (H.) chinensis* Ulm.
- 12 (11). At least abdominal segment I-VII without distinct posterolateral spines. Body broader, with large legs (as in Fig. 27).
- 13 (14). Labrum narrow, maximum width only 1.5 times its basal width (Fig. 48) *H. (H.) flavata* Rost.

*Larvae of *Heptagenia* (subgen.?) sp. n. 1 are unknown.

- 14 (13). Maximum width of labrum twice that of basal width (Fig. 49-51).
 - 15 (16). Labrum with strongly recurved hindmargins (Fig. 51). Glossae with roundish apex, outer margin convex near apex (Fig. 47). Cerci and paracercus with similar pigmentation *H. (H.) sulphurea* (Wull.)
 - 16 (15). Margins of labrum not recurved (Fig. 49, 50). Glossae pointed, outer margin near apex straight or slightly concave (Fig. 46). Paracercus more or less darker than cerci, at least near base.
 - 17 (18). Gill leaflet of pair I small, equal to unbranched part of fibrillose lobe of gill, shorter than half of leaflet (Fig. 38) *H. (H.) perflava* Brod.
 - 18 (17). Gill leaflet of pair I normally developed, double length of unbranched part of fibrillose lobe of gill, equal to 2/3 length of pair II (Fig. 42) *H. (H.) lutea* sp. n.
2. IMAGO AND SUBIMAGO
- 1 (2). Abdominal tergites yellow, tergites II-VI with contrasting black spots, tergites VII-IX only with pale traces of such spots (cf. Below, 1981; Fig. 1) *H. (Hepzageria) gervonia*.
 - 2 (11). Abdominal pattern different; without contrasting black pattern sharply distinguished on tergites II-VI and VII-IX *H. (Hepzageria) gervonia*.
 - 3 (4). Pronotum with 2 pairs of contrasting black spots (Fig. 77) 3.
 - 4 (3). Pronotum without 2 pairs of spots, either with one pair of spots, or with noncontrasting pattern, or entirely pale *Hopthogonia* (subgen.?) sp. n. 1.
 - 5 (6). First segment of foretarsus in ♂s more than half length of segment II. With lateral processes in distal part of nonfalcated base (cf. Bogoscu and Tabacaru, 1962; Fig. 4). Femora usually with 2 more or less distinct brown bands almost at equal distance from each other and from base and apex. Wings of subimago gray with brown border on cross veins in most of forewing *H. (Kageronia) fuscogriseola* 5.
 - 6 (5). First segment of foretarsus in ♂s much less than 1/2 length of segment II. Penis without lateral processes on unbranched base. Femora either without bands, or with bands in middle and near apex. Wings of subimago without dark border of crossveins at least behind R *H. (Kageronia) fuscogriseola*.
 - 7 (8). Eyes in ♂s separated by distance nearly equal to eye width. Penis without dorsolateral spines (Fig. 56). Lateral parts of abdomen (regions 2, 3, 4, 7, 8 in Fig. 55) brown, darker than middle part (region 1 in Fig. 55). Sides of sternites darker than middle part. Wings of live subimago unicolorous gray, without yellow tinge *H. (H.) longicauda*.
 - 9 (12). Abdominal tergites with dark medial stripe (region 1 distinctly darker than region 2 of Fig. 55), or entire dorsal surface of tergites dark red.
 - 10 (11). Dorsal surface of tergites with red or pink pattern and longitudinal dark red stripe in region 1 darker than pink regions 8 and 4 (Fig. 65), rarely entire dorsal surface dark red. Crossveins in C and Sc fields in adults black.

- 11 (10). Dorsal surface of tergites with dark brown pattern: regions 1 and 8 dark brown, unicolorous, region 4 in form of distinct brown oblique stripe (Fig. 62). Crossveins of imago not darker than longitudinal vein in anterior part; pterostigma always of same color as proximal part and C and Sc field; yellowish wings of living subimago yellowish gray *H. (H.) chyanetis*.
 - 12 (9). Abdominal tergites without dark medial stripe (region 1 not darker than region 2), dorsal surface of tergites without red coloration.
 - 13 (14). Dorsal surface of abdominal tergites with contrasting brown color (regions 1, 2 and 8 in Fig. 55), sides yellow. Femora with small brown dot near midpoint. Crossveins in C and Sc fields of forewings of imago pale yellow. In living subimago C and Sc fields yellow, remaining alar surface gray *H. (Daenigeria) coeruleans*.
 - 14 (13). Abdominal tergites without contrastingly colored dorsal surface; either light with exception of region 9, or with brown pattern in regions 1-4, 6-9. Femora either with diffused reddish middle spot, or unicolorous. C and Sc fields in forewings of imago with brown or black crossveins. Wings of living subimago unicolorous, yellow or yellow-gray.
 - 15 (16). Penis lobes closely placed, with long medioapical spine (Fig. 67). Abdomen yellow, with dark region 9 (Fig. 70) or with brown pattern in regions 1-4 and 6-9 (Fig. 71) *H. (Hopzageria) sulphurea*.
 - 16 (15). Penis lobes spaced out medioapical spine short (Fig. 74, 76, 80). Abdomen yellow, sometimes with dark region 9.
 - 17 (18). Crossveins in proximal part of Sc field of forewing strongly broadened toward Sc (Fig. 75) *H. (H.) lutea*.
 - 18 (17). Crossveins in proximal part of Sc field of forewing not or only slightly broadened toward Sc (Fig. 72, 73, 79).
 - 19 (20). Crossveins in proximal part of costal field of forewing in imago sharply bent and thickened near Sc (Fig. 72, 73). Medioapical spinule of penis medially bent (Fig. 74) *H. (H.) perflava*.
 - 20 (19). Crossveins in proximal part of costal field of forewing in imago less bent (Fig. 79). Medioapical spinule of penis not bent medially (Fig. 80) *H. (H.) longicauda*.
- Hepzageria (Kageronia) orycticola* Kluge, sp. n. (Figs. 1-15, 56).
- NOTE.* Body color, especially legs, varies with age and sex. Eyes with deep ochraceous margin. Head coloration: frons and vertex brown, with brownish yellowish tinge. Labial palps yellowish. Remaining structural details of oral apparatus as in *H. fuscogriseola*. Thoracic tergites with distinct light-colored spots. Femora narrow, light-colored, with 2 dark crossbands, with sparse row of short strong bristles at hindmargin, without long hairs. Tarsus unicolorous, slightly darker than tibia. Claws narrow with serrated inner margin bearing 2 subapical denticles.
- Abdomen without sharply demarcated spots, tergites usually with pair of broad longitudinal dark stripes along lateral margins and with light-colored lateral margins. Gills narrow, those of pairs I-VI pointed, with small bundle of respiratory filaments at base, caudal filaments almost unicolorous, brown, often darker than abdomen, all segments not darkened. Inner cercal margins and lateral paracercal margins with small swimming hairs.

Subimago, Mesonotum light-colored, with contrasting dark brown pattern. Wings uncolored, gray. Remaining coloration as in adult.

Imago ♂. Dorsal surface of head brown, yellowish toward front, ocelli bordered with dark brown. Eyes wide apart, distance between them almost equal to eye width (dorsal view). Dorsal surface of thorax dark brown, ocher on sides and ventral surface, with brown spots. Legs yellowish or brownish, femoral and tibial segments more or less darkened. Proportions of femoral length to tibial length and tarsal segments in holotype as follows: in forelegs as 50:60:6:26:24:16:8, in midlegs as 42:42:3:5:4:3:7, and in hindlegs as 40:40:3:4:4:3:7. Wings transparent, brown at extreme base; veins brown, crossveins of pterostigma unbranched.

Abdominal tergites brown, broadly dark brown color near lateral margins, with light lateral margins, with 2 or 3 indistinct light longitudinal streaks in middle. Sternites light-colored, brown near lateral and hindmargins. Genitalia brownish yellow, uncolored. Styliger convex; penis with slightly broadened lobes, without dorso-lateral spines, with thick pointed titillators. Caudal filaments brownish, uncolored.

Imago ♀. Body light-colored, yellowish ocher. Ratio of femoral length to tibia and tarsal segment of forelegs 50:50:4:12:10:7:9. Wings not darkened at base, veins light-colored, yellowish. Each abdominal tergite with pair of large diffused brown spots near lateral margins.

Dimensions	Length ♂, Imago ♀, Imago
Body length (mm)	up to 12 6.5-8 6.5-12
Length of forewing (mm)	— 7-8 9-10
Length of caudal filaments (mm)	up to 12 13 ?

Biology. Larvae collected in small pits with stationary water, silty bottom, and outgrowths of sedge; the pits were formed by crossing of the road rut by a stream with clean cold water. With this is associated its name (*orbitticola*—living in a rut).

Material. Khabarovsk Territory, 6 km E of Obluch'e, Udaromy Siding, tributary of Lisvyanka River (3rd hollow), 28-29.VIII.1976 (A. Mikhnev and N. Stalchenkova), 7 ♂, 6 ♀—Imagoes, 1 larva; same place, 26.VII-3.VIII.1984 (N. Klyugov), 1 imago, 8 (holotype), 2 imagoes, 8s, 2 subimagines, 8s (all reared from larvae), 10 larvae, 1 imago, ♀. Chita Province: Olenguy River basin Narymka River 5 km upstream of Elizavetino Sta., 13.VIII.1981 (V. Zherikhin), 1 imago, ♂; Bel'zino, 31.VII.1925 (Vinogradov), 1 imago, ♂.

Comparison. The new species is closest to *H. kizhada* Natsumura, 1931. The ♂ imago differs from that of *H. kizhada* (as described by Imanishi, 1935) by the absence of a notch on the styliger, simpler structure of the penis, and different color of abdominal tergites and sternites (lateral parts dark in *H. orbitticola* sp. n., whereas in *H. kizhada* the middle part is darkened. The ♀ of the new species differs from that of *H. kizhada* by the absence of a dark band at the hindmargin of each abdominal tergite and the presence of large dark lateral spots on the tergites. The larva differs from that of *H. kizhada* in the shape of the paraglossae, which, as emphasized by Imanishi, are pointed in *H. kizhada* (Fig. 16; Imanishi, 1936: 540, Fig. 1), and in that the tibia is slightly longer than the femur (in *H. kizhada*, according to the description of Imanishi, slightly shorter than the femur).

Heptagenia (Kagenonia) fuscoargyrea (Retzius, 1783) (Fig. 17).

Heptagenia volikovi Eaton, 1870.

Ecdyonurus convergens Aro, 1910.

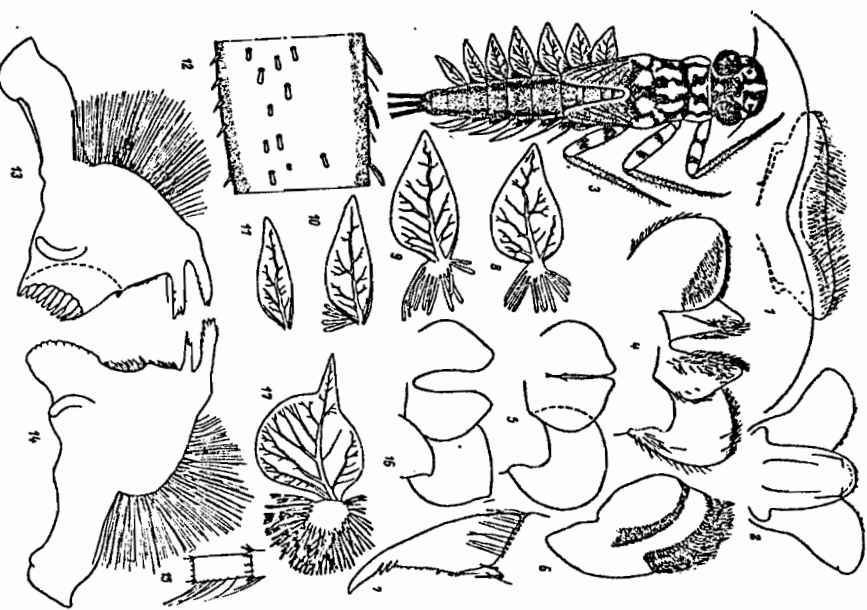


Fig. 1-17. *Heptagenia (Kagenonia)* spp. Larvae. 1-15) *H. (K.) orbitticola* sp. n. (1, 5, 7, 8-12): holotype); 1) anterior margin of head and labrum; 2) hypopharynx; 3) habitus; 4) labium (on left, dorsal view; on right ventral view); 5) same, exuvium (on left, dorsal view); 6) 2nd segment of labial palpus in ventral view; 7) claw; 8-11) gills of I, II, VI and VII pairs; 12) part of femur (outer margin in dorsal view); 13, 14) left and right mandibles in dorsal view; 15) area of left cercus in dorsal view; 16) labium (after Imanishi, 1936); 17) *H. (K.) fuscoargyrea* (Retz.). Gills of pair II.

Ecdyonurus rossicus Tshernova, 1928.

Ecdyonurus convivialis Tshernova, 1928.

Larva. Described by De Geer, 1752; Macan 1958; Bogoescu and Tabacaru, 1962; Landa, 1969.

Imago. Described by De Geer, 1752; Bogoescu and Tabacaru, 1962; Landa, 1969.

Distribution. Entire Europe, recorded for Siberia (Brodskiy, 1930). Possibly a Transpalearctic species.

Material. Environs of Tomsk: 9.VI.1901 (Shafir), 1 imago ♂; 1912 (Agentova). One imago, ♀, Enns, district and Kikmalyovskoye, 2.V.1915 (Mal'kh), 1 imago, ♂; Blysk; left bank of Blyz River, 5.V-20.VII.1938 (Toropov), 130 ♂, 1 ♀ imagines; Evenkiya, lower Tunguska River near Turukhansk, 7.VII.1982 (K. Est'kov), 6 imago ♂. Besides, imagines and larvae from the European part of the USSR.

Heptagenia (Daemagenia) oenulans Rostock, 1878 (Fig. 57-60).

Heptagenia gollida Eaton, 1885.

Larva. Described by Eaton, 1883-1888.

Imago. Described by Eaton, 1883-1888.

Distribution. Europe, found in Krasnoyarsk Territory (Baykova, 1972).

Material. Armenia, Araks River near Yegri, 30.VI.1956 (Zhil'tsova), 20 larvae of various ages. Georgia, Kara River near Zages (near Tbilisi), 25.VIII-1.VIII (Sici) 1985 (N. Klyuge), 2 ♂, 4 ♀ imagines, 1 ♀ subimago (all reared from larvae), 20 larvae.

*Heptagenia (Heptagenia) chinensis** Ulmer, 1919 (Fig. 18-25, 61, 62).

Larva (described for the first time). Body more slender than in other species of the subgenus *Heptagenia*, with relatively shorter legs and long abdomen. Head variegated, anterior part with light middle stripe and light paired spots; hypodermal pattern of pair of dark brown minute spots before eyes may be developed. Oral apparatus typical of *Heptagenia* s. str. Maxilla with 8-9 pectinate bristles.

Thoracic tergites with distinct light longitudinal stripes and spots, primordia of wings with light streaks between veins; hypodermal pattern of pair of dark brown spots may be developed on pronotum. Femur narrow, outer margin with short strong bristles and long hairs. Legs light, femora with dark basal spot, 2 disrupted dark bands, articulation of femur and tibia distinct, tibia with discontinuous dark band in middle, tarsus slightly darkened in proximal part. Abdominal tergites with light paired spots; besides, hypodermal pattern may be developed more or less, consisting of sharp dark brown, oblique, lateral, longitudinal middle stripes and dark brown border along hind margin. Sternites light. Gills broad, roundish, with very large fibrillose lobe. Cerci light, paracercus dark brown.

Subimago (first description). Mesonotum light, with contrasting dark brown pattern. Wings gray or yellowish gray. In other respects coloration as in imago.

Imago. Described by Ulmer 1919; Baykova, 1972.

Distribution. NE China, Far East of the USSR.

Material. Khabarovsk Territory, 1984, collection of N. Klyuge: Amur Channel, Bychikhra, 18.VIII-8.IX, 5 ♂ and 2 ♀ imagines, 1 ♂ and 1 ♀ subimagines (all reared from larvae), 30 larvae, 80 ♂ and 10 ♀ imagines, 1 ♀ subimago; Amur River near Slavyanka, 6-17.VIII, 1 young larva.

*Cited as "*chinense*" although International Code of Zoological Nomenclature requires "*chinensis*."

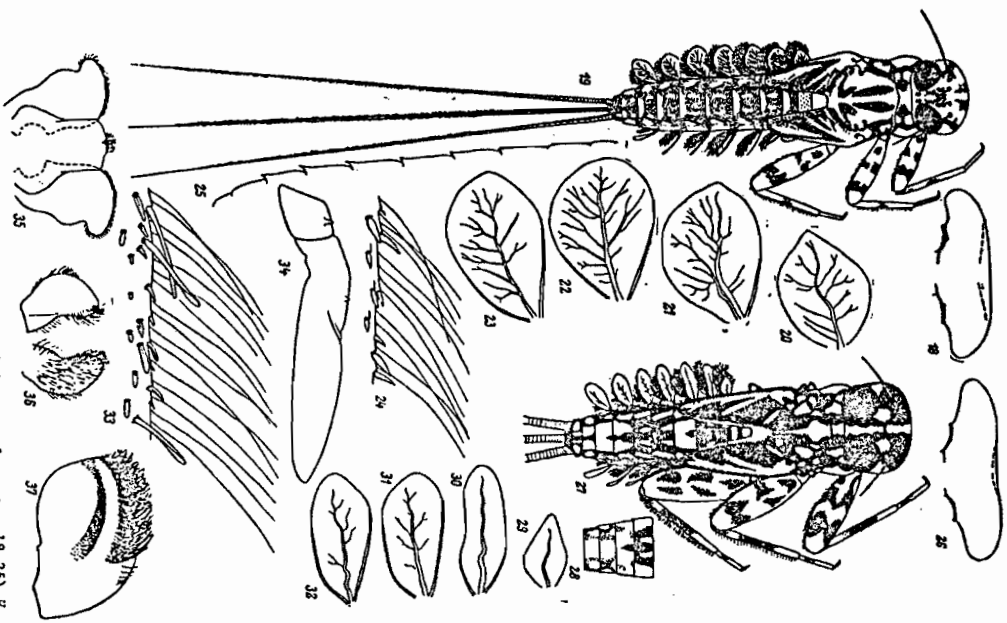


Fig. 18-37. *Heptagenia (Heptagenia)* spp., larvae. 18-25) *H. (H.) chinensis* Ulm.; 26-37) *H. (H.) guanzica* Belov.; 18, 26) labrum; 19, 27) habitus; 28) VI-IX abdominal tergites (light colored specimens); 20-23 and 29-32) Gill leaflets of I, II, VI and VIII (fibrillose part not shown); 24, 33) hind margin of femur; 25) lateral margin of abdomen; 34) pronotum and mesonotum in lateral view; 35) hypopharynx; 36) glossae (left, lateral view; right, ventral view); 37) 2nd segment of labial palpus in ventral view.

BIOLOGY. At the time of a strong flood, larvae were collected in shallow water from flooded grass. Most probably, they remain near the bank. The flying intensity of adults increased strongly from 2.VIII to 6.IX, whereas the flight intensity of *H. flavata* decreased over the same period. Most probably, maximum flight occurs in early autumn.

Heptagenia (Heptagenia) flavata Kuroki, 1878 (Fig. 48, 53-56).

Ephemera citriza Hummel, 1825 (nomen oblitum), SYN. N.

† *Heptagenia bipunctata* Esben-Petersen, 1916.

Heptagenia arsenjevi Tshernova, 1952.

Until now the name *E. citriza* was erroneously considered (Eaton, 1882-1886; 268) as a junior synonym of *H. sulphurea* (Mull.). Lectotype of *E. citriza* (designated here): subimago ♂ with the label "Ephemera citriza mhl." preserved in Zoological Institute, Academy of Sciences of the USSR, Leningrad. As is clear from the original description and study of the lectotype, *E. citriza* is a senior synonym of *H. flavata*. But since the former name has the status of nomen oblitum, and the latter name is in the general usage, the name accepted at present should not be changed, and the case should be referred to the International Commission on Zoological Nomenclature.

The synonyms of *H. arsenjevi* and *H. flavata* described from the Far East were established by Baykova (1972).

There is large variation in the color of larvae and imago of *H. flavata* collected by us from Amur. Variations of color of the insects collected from Amur are given below, and the affinity of all specimens to *H. flavata* was confirmed by rearing imagines from larvae and studying the larval exuvia as well as imagines.

Larva. Body usual for species of subgenus *Heptagenia* (Fig. 27), dark brown or ochre with light pattern. Head usually with contrasting light middle stripe (Fig. 27); this stripe may be continuous or disrupted, rarely totally absent. A pair of light spots or stripes along sides. A pair of light minute spots present or absent near anterior margin of head before antennae. Labrum narrow. Maxilla with 10-14 pectinate bristles.

Thoracic tergites with sharp tubercles. Pronotum and mesonotum variable, may be of type shown in Fig. 27. Wing primordia without large contrasting streak, as shown in Fig. 27. Femora light, with variable complex dark pattern, either consisting of zigzag crossbands or isolated spots. Tibia light, usually with dark base and broad dark band or with longitudinal dark spot. Tarsi darkened almost entirely or in proximal part of outer field. Bristles on femur typical of subgenus *Heptagenia* (Fig. 33).

Color of abdominal tergites most characteristic: almost similar pattern on tergites III-IX, consisting of 1-2 pairs of submedial light spots bordering wide medial dark stripe all along abdomen; sides of tergites with small light spots. Some times lateral parts of tergite as dark as medial part and longitudinal stripe not prominent, color of abdomen resembling that frequently found in *H. sulphurea*. Sometimes pattern of different tergites differing strongly, light submedial spots on some tergites very large, on tergites IV and VIII fused, and abdominal pattern indistinguishable from that of *H. gurganica* (Fig. 27). Caudal filaments dark at base, light toward end, usually without regular alternation of dark and light rings; rarely 2 dark and 2 light rings alternate in middle part of caudal filaments, as in *H. sulphurea sulphurea* and *H. sulphurea f. dalecarlica* (Fig. 54).

Subimago. Thoracic tergites with contrasting dark brown pattern. Wings initially bright yellow, hindwing often dark gray along hindmargin, sometimes forewing also gray along hindmargin. Black crossveins appear in process of development. Yellow color not preserved in alcohol.

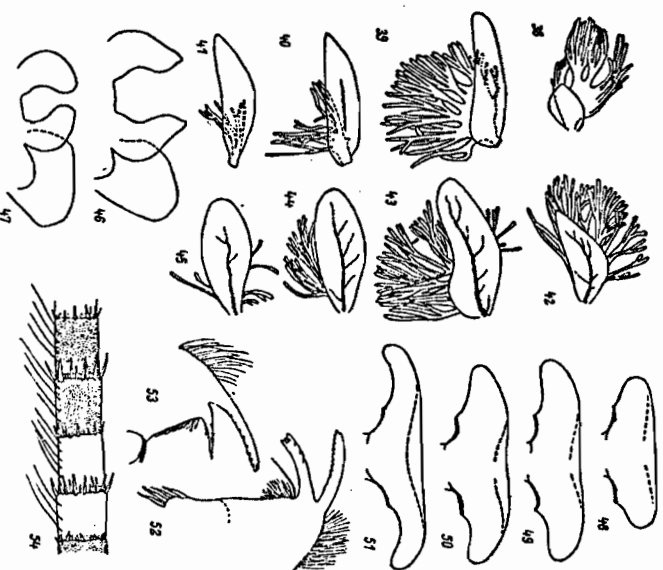


Fig. 38-54. *Heptagenia (Heptagenia) spp.*, larvae. 38-41, 49) *H. (H.) perflava* Brod.; 42-46, 50) *H. (H.) lutea* sp. n. (42-45, 50--holotype); 47, 51-53) *H. (H.) sulphurea albicauda* subsp. n. (51-53--holotype); 48) *H. (H.) flavata* Kuroki; 54) *H. (H.) sulphurea f. dalecarlica* Bergs.; 38-41, and 42-45) larvae of pairs I, II, VI and VII; 46, 47) labium; 48-51) labrum; 52) right mandible; 53) left mandible; 54) part of cercus.

Imago. Body yellow, head with black spots, thorax with crimson (raspberry) spots. Femur with crimson bands in middle and apex; tarsus often brown. Veins C, Sc and R yellow, crossveins of C and Sc fields black, thickened; C and Sc fields yellow in proximal part, reddish in distal part, rarely entirely yellow. Abdomen with crimson pattern, with distinct dark middle stripe, rarely entire dorsum of abdomen dark crimson. In one specimen, abdominal tergite IX entirely black, sharply distinct from others. Caudal filaments with sharp crimson rings.

Distribution. Palearctic.

BIOLOGY. Larvae mostly remain on submerged stumps and logs in more or less rivers in plains and foothills.

Material. Kabarovsk Territory, Amur River near Slavyanka, Amur Channel near Bychikha, Khov River near Bichovaya, 6.VIII-8.IX.1984 (N. Kluge), 18 ♂ and 26 ♀ imagines, 8 ♂ and 8 ♀ imagines (all reared from larvae). Also numerous larvae, subimago and imagines from the European part of the USSR, Ciscaucasia, Kazakhstan, Siberia, Far East, and Mongolia were studied (collected by various persons).

Heptagenia (Heptagenia) gurenica Belov, 1981 (Fig. 26-27).

Larva (first description). Body dark brown or ochre, with light pattern. Head with contrasting light middle stripe, continuous or disrupted; pair of light stripes along sides of head before eyes, and light spots of various shape and in varying number in middle and hindparts of head. Labrum broader than in *H. flava*, but narrower than in *H. subflava*. Maxillae with 5-6 pectinate bristles.

Pronotum and mesonotum with pair of sharp tubercles each. Pattern of pronotum and mesonotum variable. Wing primordia with contrasting light streaks. Femur light with variable dark pattern. Tibia light, with dark base and dark band. Tarsus dark in proximal part.

Abdomen with contrasting pattern varying in different tergites: tergites III, V, VI and X darkest, and I, IV and VIII lightest. Gills narrow, with large fibrillose part. Caudal filaments dark or light, paracercus may be slightly darker than cerci.

Subimago (first description). Wings dark, without yellow tinge. Color of abdomen, legs, and caudal filaments as in imago.

Adult. Described by Baylov, 1981.

Description. Lower Amur.

Biology. Larvae collected at stumps together with *H. flava*.

Material. Khabarovsk Territory, 1984, collected by N. Kluge: Amur River near Slayanka (downstream from Troitskiy), 10-17.VIII, 1 ♀ imago, 1 ♀ subimago (reared from larvae), 2 larvae, 1 ♀ subimago; Amur Channel near Bychikha, 18-27.VIII, 3 larvae, 2 ♀ subimagines, 3 ♀ imagines. Amur River near Khabarovsk, 4.VII.1986 (O. Baykova), 1 ♀ imago.

Heptagenia (Heptagenia) lutea Kluge, sp. n. (Fig. 42-46, 50, 75, 76).

Heptagenia perflava: Zhadin 1940; Kasymov, 1972 (non *H. perflava* Brodsky, 1930).

Larva. Body dark brown or ochre, with light pattern. Head frequently with or without light middle stripe in anterior part. Labrum broader than in *H. flava*, but narrower than in *H. subflava*. Maxilla with 8-9 pectinate bristles. Thoracic tergites without sharp tubercles, with light spots. Wing primordia with light streaks. Femur light, with dark pattern consisting of zigzag dark bands and 2 proximal spots or with 2 bands. Tibia and tarsus light, sometimes darkened at base, tibia also sometimes darkened in middle. Bristles of femur typical of species of subgenus *Heptagenia* (Fig. 33).

Abdominal tergites with paired submedial longitudinal minute light spots bordering dark middle stripe, sometimes these light spots fused with light hindedges; sides of tergites with light spots. All gill leaves well developed, leaf of pair I almost 2/3 length of pair II. Fibrillose part of all gills well developed. Paracercus brownish at base, light in distal part, cerci light.

Subimago. Wings of ♂ and ♀ bright yellow (rapidly discolored in alcohol) black thick crossveins well distinct in C and Sc fields from very base.

Imago ♂. Body light yellow. Eyes and ocelli gray. Thoracic tergite rusty above. Black spot above hindcoxa. Legs yellow, femur with reddish band near apex and middle part, and with blackish dot near apex at inner margin. Foretibia with blackish apex. Tips of tarsus and claws gray. Ratio of femoral length to tibia and tarsal segments in holotype: in forelegs as 36:70.5:23:22.15:10, in middle legs as 38:53.5:3:3:3:8, and in hindlegs as 62:55.4:4.5:4:3:8. Wings transparent. C

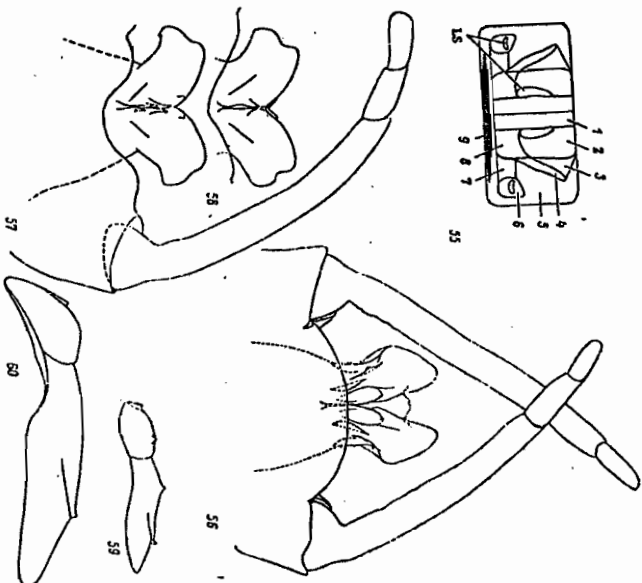
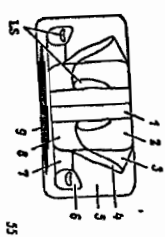


Fig. 55-60. *Heptagenia* Walsh. 55) Diagram of pattern on abdominal tergite VI and imago (explanation in key to species of genus *Heptagenia* on basis of imagines, 18—light spot). 56) *H. (Agarvornia) orbicicola* sp. n. (holotype) genitalia of imago. 57-60) *H. (Decmogenia) coezulana* Rost.; 57, 58) genitalia of imago (different specimens from Kura River); 59, 60) pronotum and mesonotum of young larvae of different age, shown at same scale (from Araks River).

and Sc fields on forewing yellowish, bulla dark brown. Veins C, Sc and R yellow, remaining longitudinal veins yellowish brown. Crossveins black or dark brown. Crossveins in proximal half of C field straight or bent, thickened, broadened at place of union with Sc. Crossveins of pterostigma simple or anastomosed. Crossveins of proximal half of Sc field triangular, strongly broadened towards place of fusion with Sc.

Abdomen pale yellow, narrow brownish crossband at hindmargin of each tergite not reaching lateral margins of tergites. Tergites VIII-X rusty, sternites whitish. Genitalia light; styliger with broad notch; penis lobes wide apart, strongly broadened laterally, medioapical sclerite short, not protruding. Tifillators short, erect. Caudal filaments pale yellow, with sharp dark brown rings at joints.

Imago ♀. Color as in ♂, but without rusty spots on thoracic and abdominal tergites.

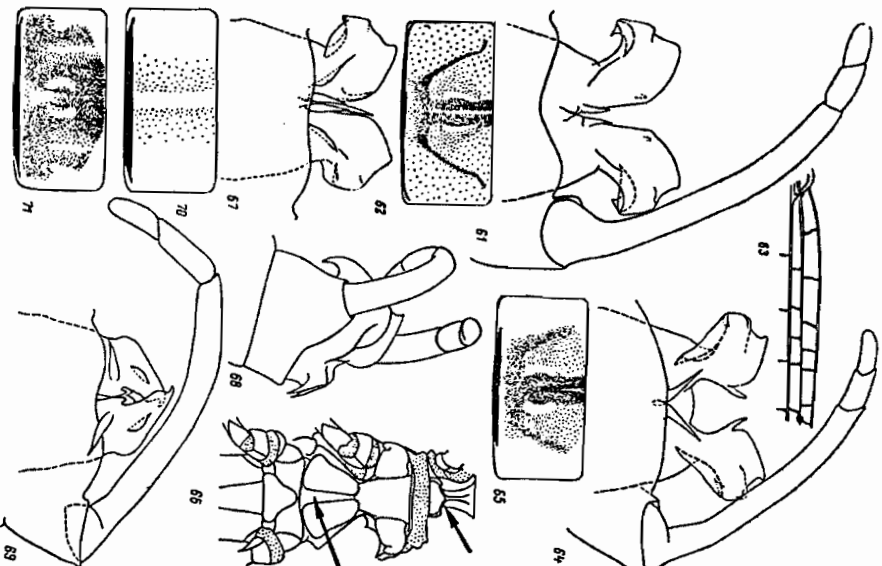


Fig. 61-71. *Heptagenzia* (*Heptagenzia*) spp., ♂ imagines. 61, 62) *H. (H.) chitrensis* Ulm.; 63-66) *H. (H.) fuxia* Roat. (Par Esac); 67-71) *H. (H.) sulphurea albicauda* subsp. n. (67, 70--holotype), 61, 64, 67) genitalia in ventral view; 62, 65, 70, 71) abdominal ter-gite VI in preparation; 63) proximal part of anterior margin of forewing; 66) thoracic sternites (characters of genus *Heptagenzia* shown by arrows); 68) genitalia in compressed condition in lateral view; and 69) same in ventral view.

Dimension	Larva	♂, Imago	♀, Imago
Body length (mm)	up to 14	11-12	11-15
Length of caudal filaments (mm)	up to 20	25-30	19-27

72

Biology. Larvae collected in a river of foothill type, in an area with relatively weak currents, under silted stones.

Material: Georgia: lower reaches of Agaryl River near Sagumariskiy restricted forest, 25.VII-2.VIII.1985 (N. Klyuge), 7 imago ♂ (including holotype), 4 imago ♀, 1 subimago ♀ (all reared from larvae), 43 larvae, Kura River near Zages, 25.VII-1.VIII.1985 (N. Klyuge), 6 larvae; Tbilisi, 29.VI.1905 (Satunin), 1 imago ♀; bank of Rioni River, 5 km upstream from Kutaisi, 3-4.IX.1935 (V. Zhadin), 2 imago ♂. Armenia: Erevan, 18.V.1925 (H. Ryabov), 1 imago ♂; same place, Kandan River (Zangaz), 20.IX.1935 (V. Zhadin), 6 larvae; Azerbaijan: Geok-Tapa (near Khanlar) (A. Shelkovnikov), 1 imago ♀; same place, 29.VI and 26.VII.1915 (L. Blinck), 1 ♂ and 1 ♀ imago; Aesh (A. Shelkovnikov), 3 ♂ and 2 ♀ imagines. Crimea: Simferopol', 25.V.1899 (A. Bazhenov), 1 imago ♀. Iran: Gorgan (Astrabad), 20 and 26.IV.1914 (Kirichenko), 1 imago ♂, 1 subimago ♀.

Comparison. The adult of the new species is similar in body color to *H. longicauda* and *H. perflava* and differs from them in the shape of crossveins in the proximal half of the Sc field of the forewing and in structural details of the penis (from *H. longicauda* by shorter tritillator and stronger lateral extension of penis lobes and from *H. perflava* by the absence of medially bent middle sclerites. The larva of the new species differs from that of *H. longicauda* by the absence of tubercles on the back, and from *H. perflava* by normally developed pair of leaf I the gills. The larva of *H. lutea* sp. n. is similar to that of *H. flava* in body color, but differs by broader labrum, more distinct light streaks on wing primordia, and in the paracercus being darker than the cerci at the base.

Heptagenzia (Heptagenzia) perflava Brodsky, 1930 (Figs. 38-41, 49, 72-74).

Heptagenzia kazakhstanica Tshernova, 1930, SYN. N.

Heptagenzia platysma Tshernova, 1941, SYN. N.

Stigmoneur's amseiti Demoulin, 1964, SYN. N.

The species was described by Brodsky (1930) on the basis of ♂ and ♀ (imagines) from Uzbekistan. The lectotype is here designated: a ♂ imago preserved in the Zoological Institute of the Academy of Sciences of the USSR, Leningrad. *H. kazakhstanica* was described by Tshernova (1930) on the basis of an imago ♂ from Tajikistan, the distinctness of *H. perflava* is indicated by the genital structure and proportions of hindtarsus (according to the original description, the ratio of the length of the 1st segment to the length of the 2nd segment in *H. perflava* is as 10:11, and in *H. kazakhstanica* is as 8:7). Actually this ratio can not be measured unequivocally with such precision, as the segments are short, broad and obliquely truncated. The upper sides of segments I and II in the hindleg of the *H. perflava* lectotype, present in preparation, are equal to each other with the precision of 1/20 of their length, and in more precise measurement the segment I is longer than II. The differences in the patterns of genitalia of *H. perflava* and *H. kazakhstanica* are associated with varying position of the penis lobes at the time of fixation.

H. platysma was described by Chernova (1941) on the basis of the larvae from the Ili River. In Tajikistan we collected larvae corresponding to the description of *H. platysma*, and adults corresponding to the description of *H. perflava* were reared from them.

Stigmoneur's amseiti was described by Demoulin (1964) on the basis of an imago ♀ from Afghanistan. The difference from *H. perflava* was indicated on the basis of smaller dimensions (8-10 mm, whereas *H. perflava*, according to the original description, is 11 mm long), more bent crossveins in the C field of the forewing and proportions of the parts of the legs (shorter foretibia and longer 2nd segment of hindtarsus). Actually the shape of crossveins is very variable: cf. Figs. 72, 73; in specimens from the Vahs River described by us, there are also branched and numerous incomplete veins. The proportions of the parts of the legs was not given precisely in the

73

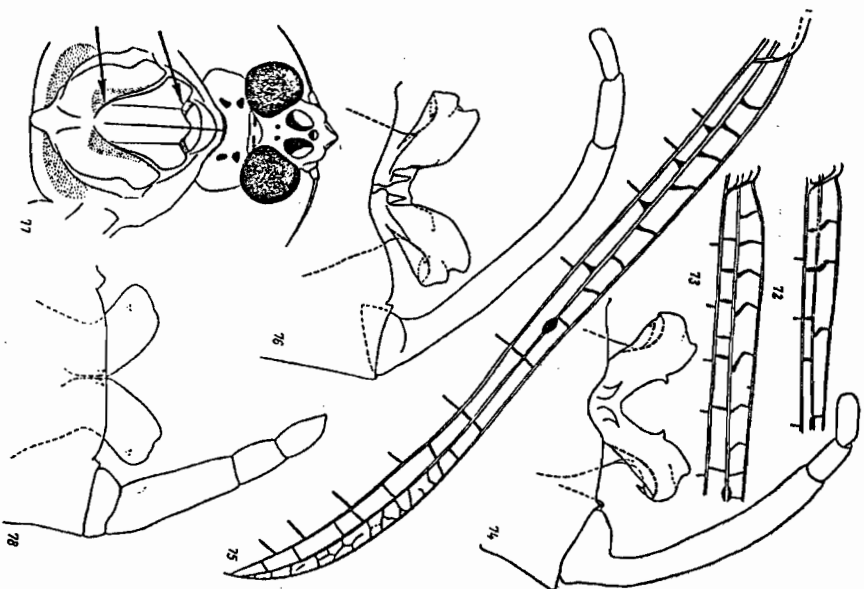


Fig. 72-78. *Heptagenia* Walsh., imago and subimago. 72-74) *H. (Heptagenia) perljana* Brod.; 72) proximal part of anterior margin of forewing of imago ♂; 73) same of ♀; 74) genitalia of imago; 75, 76) *H. (H.) luda* sp. n. (holotype); 75) anterior margin of forewing; 76) genitalia of imago; 77, 78) *Heptagenia* (subgen.?) sp. n. 1, ♂ subimago: 77) head and thorax (arrows indicate characters of genus *Heptagenia*); 78) primordia of genitalia.

original description of *H. perljana*. The ratio of femoral length to tibia and segments of foretarsus was reported erroneously, actually it should be as 48:32:4:20: preserved in preparation). Proportions of the hindtarsus are given above.

Larva. Body ochre-brown, with light pattern. Head uncolored before antennae, without light spots, very rarely unpaired light spot near forewing. Labrum broader

than in *H. flava*, but narrower than in *H. sulphurea*. Maxilla with 6-8 pectinate bristles. Other parts of oral apparatus as in other species of subgenus *Heptagenia*.

Thoracic tergites without sharp tubercles, with light spots, wing primordia with light streaks. Femur light, with dark pattern of zigzag dark band and 2 proximal spots. Tibia and tarsus light, sometimes darkened at bases, tibia also sometimes darkened in middle. Femoral typical of species of the subgenus *Heptagenia* (Fig. 33).

Abdominal tergites with paired submedial longitudinal minute light spots, sometimes fused with light hodge on tergites VIII-IX, light spots on sides of tergites. Usually dark middle stripe quite distinct. Gill leaflets long and narrow, fibrillose part large, leaflet of pair I rudimentary, very short. In the description of *H. platyema*, it is shown as of the same length as leaf IV (Chernova, 1941; Fig. 1). Judging from all information available, an error has taken place here and instead of leaf I one of the subsequent leaves is illustrated. The preparation from which the diagram was made has only 3 gills (all shown in Fig. 1), and it is not clear as to which segments they are and to which specimen they belong, as *H. platyema* is described on the basis of a large series of larvae. Paracercus brown, cerci light.

Subimago (first description). Wings of ♀ bright yellow, in ♂ yellow-gray (discolored in alcohol); crossveins in anterior part of wing initially not thickened and not colored, thereafter acquiring characteristic shape and black color.

Imago. All femora with reddish band in middle and at apex (discolored in alcohol). Other characters as in original descriptions of *H. perljana* and *H. kazakhstanica* (Brodsky, 1930; Tchernova, 1930).

Distribution. Central Asia and Eastern Kazakhstan. Recorded erroneously for Transcaucasia (Zhadan, 1940; Kasimov, 1972).

Biology. Larvae found on stumps in large rivers.

Material. Tadzhikistan, Vahs River upstream from Garavuti, 27.VII-2.VIII, 1981 (N. Kiyuge, E. Novikova), 5 ♂ and 1 ♀ imagines, 1 ♀ imago (all reared from larvae), 26 larvae. Turkmenia, Amurdar'ya River below Charzhou, 7.V.1978 (N. Kiyuge), 1 larva. Kazakhstan, 1978, collections of N. Kiyuge: Lepsa River near Lepsa, 3.VI, 16 larvae; Tenteck River near the Uch-Artalla, 7.VII, 7 larvae, Uzbekistan, Tashkent Botanical Garden, 4.VI.1924 (A. Hartynov), 1 ♂ and 1 ♀ subimagines. Kirgizia, Lake Issyk-Kul', Sara-su River, 22.VII, 3.VIII.1928, 4 larvae.

Heptagenia (Heptagenia) sulphurea (Muller, 1776).

Heptagenia dalecarlica Bengtsson, 1912.

Heptagenia goldschmidtii Tchernova, 1932 (cf.: Eaton, 1883-1888).

Bengtsson (1912) described *H. dalecarlica* from Sweden on the basis of imago ♂s, separating it from *H. sulphurea* on the basis of several small characters. He subsequently described the larva of this species, in which the mandibles differ from *H. sulphurea* as from their mirror reflection (Bengtsson, 1917). Sarristo and Savolainen (1980), on the basis of material studied from different countries of northern Europe, concluded that *H. sulphurea* and *H. dalecarlica* are distinct species and indicated, besides differences in the structure of the mandibles, fine differences in the shape of the labrum, hypopharynx, labium and gill leaves (particularly pair VII) for their larvae. They also described in detail differences between the adults of these species on the basis of proportions of the parts of the hindtarsus, shape of eyes in ♂s and shape of styliger and penis in ♂ and ♀ genitalia, but none of these characters make it possible to determine those species unequivocally on the basis of a single specimen.

The material examined by us from different regions of the USSR does not support

Table 1
Number of larvae of 2 forms of *Heptagenia* examined from different regions of the USSR

Locality and year	<i>f. sulphurea</i>	<i>f. dalecarlica</i>
Kama River (1979, 1936), Dnepper (1927), Latvia (1960)	52	—
S and G Ural (1925, 1967)	11	—
N and Polar Ural—Pechora, Ilych and Shugra Rivers and their tributaries (1924, 1978, 1980)	162	—
Leningrad Prov.: Lindulovka River near Koshchino (1979)	30	3
Lake Ladoga, Karelia, Murmansk Prov. (1921, 1933, 1948, 1977)	—	96
Irtysk River near Ust'-Kamenogorsk (1957)	3	—
Evenkia, Taymyra River (1982)	12	—
Envyrons of Krasnoyarsk, Mana River (1956)	9	3
Taymyr Auton. Prov., Kotuy River basin (1979)	—	118
Vitim River (1969)	—	2
Jewish Auto. Prov., Bira River (1965)	—	2
Magadan Prov. (1978), Kamchatka (1959)	3	—

the conclusion that *H. sulphurea* and *H. dalecarlica* are distinct species differing in a complex of characters. The only distinct property unequivocally distinguishing *H. sulphurea* and *H. dalecarlica* is the structure of the mandibles. Henceforth, we shall designate as "left-sided" the structure in which the mandible with both large teeth is on the left (as in most *Heptagenia* species, including *H. sulphurea*), and as "right-sided" the structure in which the mandible with both teeth is on the right: in Leningrad District (Lindulovka River), and other characters do not correlate with the structure of mandibles, as was described by Saaristo and Savolainen. For example, a single larva may have "left-sided" mandibles (as in *H. sulphurea*), pointed gill leaves (as in *H. dalecarlica*) and labrum and labium, as in *H. dalecarlica*. An impression is created that all the larvae from Lindulovka River, in spite of differences in mandibular structure, belong to the same species and opposite asymmetry is an individual character in the present case. The larvae collected from some regions have only one type of mandibles. For example, all larvae from Central Russia, Northern and Polar Ural and Evenkia examined by us are "left-sided" and all larvae from the collection of Ladoga (Ladoga expedition of 1933) and from Taymyr Autonomous Province, and Maritime and Khabarovsk Territories are "right-sided". Evidently, this is the only species in which, besides the populations with both conditions of mandibles manifested, there are also populations in which only one condition, "left-sided" or "right-sided," has firmly been established. We shall include the individuals with "left-sided" mandibles under *H. sulphurea* f. *sulphurea*, and those with "right-sided" mandibles under *H. sulphurea* f. *dalecarlica*, and those with subspecies from the southern Far East: *H. sulphurea* f. *dalecarlica*. We also separate a new subspecies from the southern Far East: *H. sulphurea albicauda* subsp. n. We use the names *sulphurea* and *dalecarlica* tentatively for these forms, although these names were first given for the species described only on the basis of imagines, whereas these forms do not differ on the basis of imagines. Also, the description of *H.*

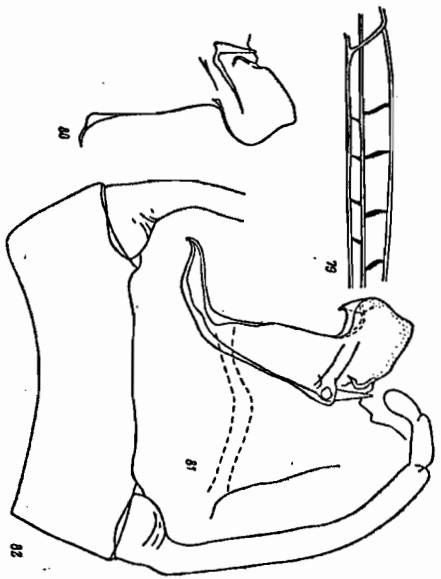


Fig. 79-82. *Heptagenia longicauda* (Steph.), imago
 79) Proximal part of anterior margin of forewing of lectotype (diagram provided by P. K. Barnard, British Museum of Natural History); 80-82) specimens from Poland: Raba River near Krakow, 3.IX.1969, collected by R. Sowa (diagrams provided by R. Sowa); 80) right half of penis in ventral view; 81) same in dorsal view; 82) styliger.

sulphurea was very brief and does not permit us to separate this species from many others (for example, *H. flavus*).

H. soldatovi was described on the basis of larvae collected from Transbaikalian and Khabarovsk Territories. A lectotype has been designated: a specimen from Transbaikalian Region, from which the figures for the original description were made (Chernova, 1952; Fig. 36-40); preparation of labrum, hypopharynx, mandibles, maxilla, and gills with the label "Eduyovirus soldatovi sp. n. Kizhmeskiy Im. Typus, O. Chernova. Shilka near Stetensk." Judging from the description, the larva is identical to that of *H. sulphurea* (Baykova, 1972). It was indicated in the description of *H. soldatovi* that "the caudal filaments are bicolored—2 light rings alternating with 2 dark rings." It can be seen in the preparation of the lectotype, as in the figure of original description that the mandibles are "right-sided." Thus it is *H. sulphurea* f. *dalecarlica*. Among the paratypes of *H. soldatovi* are members of *H. sulphurea albicauda* subsp. n. from the Khabarovsk Territory.

Heptagenia (Heptagenia) sulphurea albicauda Kluge, subsp. n. (Fig. 47, 51-53, 67-71).

Larva. Mandibles "right-sided". Caudal filaments unicolorated, light (in distinction from other members of *H. sulphurea*, in which caudal filaments at least in distal part, have regular alternation of light and 2 dark segments). Remaining characters of larvae and adult as in typical *H. sulphurea*.

Distribution. SE Khabarovsk Territory, Maritime Territory.

Material. Khabarovsk Territory, Khor River, Bichevaya, 4-8.IX.1984 (N. Kluge), 4 ♂ (among them holotype), 2 imago ♂, 3 subimago ♀ (all reared from larvae), 5 larvae; Khor River, 1950-1951, 28 larvae (a very pale pattern of caudal filaments

typical of *H. sulphurea sulphurea* was noted in one of them), 31 larvae with broken caudal filaments. Amur below Hago near Arkhamskoi's k. 20.VII.1947, 1 larva (paral-locotype of *H. soldatovi*); Dzhani River below fall of Ula River, 17.VII.1947--3 larvae (paralocotypes of *H. soldatovi*, 2 with broken caudal filaments). Maritime territory, Ussuri, Novo-Chuguevka Sta., 27-29.VIII.1980 (N. Kiyugo), 1 subimago (reared from larva).

Heptagenia (Heptagenia) longicauda (Stephens, 1835) (Fig. 79-82).
H. flavipennis (Dufour, 1841).

Chernova reported this species from the Oka River, identified by O. A. Chernova as *H. flavipennis*. These belong to *H. sulphurea*. Thus, the occurrence of *H. longicauda* in Central Russia needs to be confirmed.

Larva. Described by Sowa, 1971.

Adult. Described by Eaton, 1883-1888; Klimins, 1942.

Distribution. Western Europe.

Heptagenia (subgen.?) sp. n. 1 (Fig. 77, 78).

Subimago, ♂ and ♀. Body pale yellowish. Head with pair of dark minute spots behind ocelli. Pronotum with 4 contrasting dark spots. Mesonotum with poorly developed pattern usual for subimago of *Heptagenia* species. Abdomen, legs, cerci without pattern. Penis lobes of ♂ strongly divergent toward apex, with short filaments. Length of forewings 14 mm.

Material. Tajikistan, environs of Khoroq, Botanical Garden, summer 1970 (E. Andreeva), 1 ♂ and 1 ♀ subimagines.

Comparison. It differs from all known species in the USSR by the presence of two pairs of dark spots on the mesonotum (other species may have only one pair of sharp or diffused spots).

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