

TWO NEW SPECIES OF THE GENUS *BAETIS* LEACH, 1815 (EPHEMEROPTERA: BAETIDAE) FROM CYPRUS

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Abstract.— Two new species, namely *Baetis (Baetis) mirkae* sp. nov. (larva, female subimago, and male imago) and *Baetis (Rhodobaetis) irenkae* sp. nov. (larva and male imago), from Cyprus are described and their critical diagnostic characters illustrated. The former is a representative of the subgenus *Baetis* s. str. (the *B. lutheri* species-group) showing close relationships mainly to *B. (B.) lutheri* Müller-Liebenau, 1967 and *B. (B.) vardarensis* Ikononov, 1962; the latter is classified within the subgenus *Rhodobaetis* Jacob, 2003, being related mainly to *B. (R.) ilex* Zimmermann, 1978. Affinities of these new species to all representatives of respective related species-group and *Rhodobaetis* are discussed in detail and brief notes to their biology and distribution are presented. Based on data available so far, a detailed biogeographical analysis directed mainly to chorology and faunistic origin of 8 Palaearctic representatives of the *B. lutheri* species-group and 26 species of *Rhodobaetis* (incl. *B. irenkae* sp. nov. described below) is offered.



Key words.— Ephemeroptera, Baetidae, *Baetis*, *Rhodobaetis*, *Baetis lutheri* species-group, new species, Cyprus, Rhodos, taxonomy, distributional analysis.

INTRODUCTION

As far as we know, any special data concerning mayfly occurrence in the island of Cyprus in East Mediterranean have never been published. In May–June of 2004, rather incidental but extensive survey of aquatic invertebrates has been conducted at more than 30 freshwater localities and lenitic habitats of the island. The localities, however studied only in the spring-summer seasonal aspect, were selected in order to cover all altitudinal zones, all types of aquatic habitats and with regards to as much as possible even distribution throughout the island. Altogether approximately 12 Ephemeroptera species belonging to the genera *Epeorus* Eaton, 1881 and *Electrogena* Zurwerra

et Tomka, 1985 (family Heptageniidae Needham, 1901), *Caenis* Stephens, 1835 (family Caenidae Newman, 1853), and *Procloeon* Bengtsson, 1915 (subgenus *Pseudocentropilum* Bogoescu, 1947), *Cloeon* Leach, 1815 (subgenus *Cloeon* Leach, 1815 s. str.) and *Baetis* Leach, 1815 (family Baetidae Leach, 1815) have been identified so far. At least 5 species of the latter genus representing the subgenera *Baetis* Leach, 1815, *Rhodobaetis* Jacob, 2003, and *Nigrobaetis* Kazlauskas, 1987 have been found within this material. The objective of the present contribution is to (i) describe two of them, namely *Baetis (Baetis) mirkae* sp. nov. of the *B. lutheri* species-group as defined by Müller-Liebenau (1969) and *Baetis (Rhodobaetis) irenkae* sp. nov. of the subgenus *Rhodobaetis* Jacob, (2003),

both in larval and imaginal stage, (ii) discuss in detail their affinities to larvae and imagines (if described) of all Palaearctic representatives of respective species-group and *Rhodobaetis* with emphasis on critical diagnostic characters, (iii) mention briefly their biology and distribution with regards to possible endemism, and (iv) offer, on the basis of all available (mostly literature) data, a detailed biogeographical analysis of all Palaearctic representatives of the *B. lutheri* species-group and the subgenus *Rhodobaetis* directed to size and conjunctivity of their so far known area, vertical distribution and other chorological aspects, presumably polytypic nature of some species, their faunistic origin and distributional routes from the postglacial area changes point of view.

TAXONOMY

Baetis mirkiae sp. nov.

(Figs 1–29)

Etymology. The species is named for Mirka, younger daughter of the senior author to acknowledge her distinguished field assistance during sampling mayflies in Cyprus.

Description. Male imago. Size: body length: 5.4–5.8 mm; fore wings length: 5.3–5.8 mm; cerci length: 10.7–13.3 mm; tarsal segments: T1 = 0.64–0.67 mm; T2 = 0.50–0.52 mm; T3 = 0.30–0.34 mm; T4 = 0.20–0.24 mm; general relative tarsal segments length ratio: $1 > 2 > 3 > 4$ (Fig. 4).

General body color dark, light to dark brown. Head brownish with dark brown smudges. Antennae brown to dark brown, flagellum distinctly paler. Ocelli whitish-yellow at the apex with dark base. Eyes with distinct narrow longitudinal light stripe in central part between dark fields, surrounded by light ring. Turbinate eyes oval in dorsal view with convex external margin (Fig. 2), not stretched and narrow in lateral view (Fig. 1). Facetted surface yellowish-white to yellow. Apical part of shaft with light ring of same color or slightly paler, basal part with distinctly darker orange ring.

Thorax brown to dark brown with some paler maculation laterally and dorsally. Median protuberance well visible in anterior part of mesonotum (Fig. 1). Fore wings hyaline and transparent, pterostigma slightly opaque and milky, with 3–6 usually simple cross veins (occasionally some of them bifurcate). Venation pale, yellow to yellowish-brown. Hind wings hyaline, transparent, with three simple longitudinal veins and distinct costal process (Fig. 3). Fore legs only slightly darker, all femora without spots (Fig. 4).

Abdominal terga paler than thorax, light brown to brown, tergum I darker. Terga II–VI uniform, light-

brown. Terga VII–IX light brown laterally, yellowish brown in central part, tergum X with yellowish-brown central spot. Lateral sides of all terga additionally with some brownish maculation. Sterna paler than terga, yellowish-brown to light brown. Sterna I–VI with distinct brownish lateral spots near anterior part of segments. Sterna VII–VIII with longitudinal brownish spot. Sternum IX with wide central light spot. Genitalia light brown. Styliger with distinct central light spot. Basal segment of forceps light brown with elongate darker smudges at the base, apical part more slender than basal one, width/length ratio 0.7–0.8 (Figs 5, 6). Segment 1 conic, distinctly convergent apically. Intersegmental area between segments 1 and 2 well apparent. Segment 2 relatively narrow, without distinctly expanded apex, only slightly slender at the base. Segment 3 elongate; length ratio segments 2 + 3 of forceps/abdominal tergum IX (see also Novikova 1987: 82, Fig. 33.3) 0.95–1.20. Cerci yellow to brown, distinctly darker at the base, joints pale.

Female subimago. Size: body length: 5.7 mm; fore wings length: 5.9 mm; cerci length: 8.4 mm.

General body color yellowish-grey to light brown. Head uniform, light brown. Eyes and basal part of ocelli black. Antennae light brown. Thorax yellowish-brown to light brown with brownish longitudinal spots surround thoracic sutures. Wings yellowish grey. Venation greyish. Legs unicolorous, yellowish-brown, femora with diffuse brownish spot distally. Abdomen unicolorous, light brown, terga slightly darker laterally, two pairs of light central spots near anterior margins of sterna. Cerci light brown to yellowish-brown, darker at base, joints of segments pale.

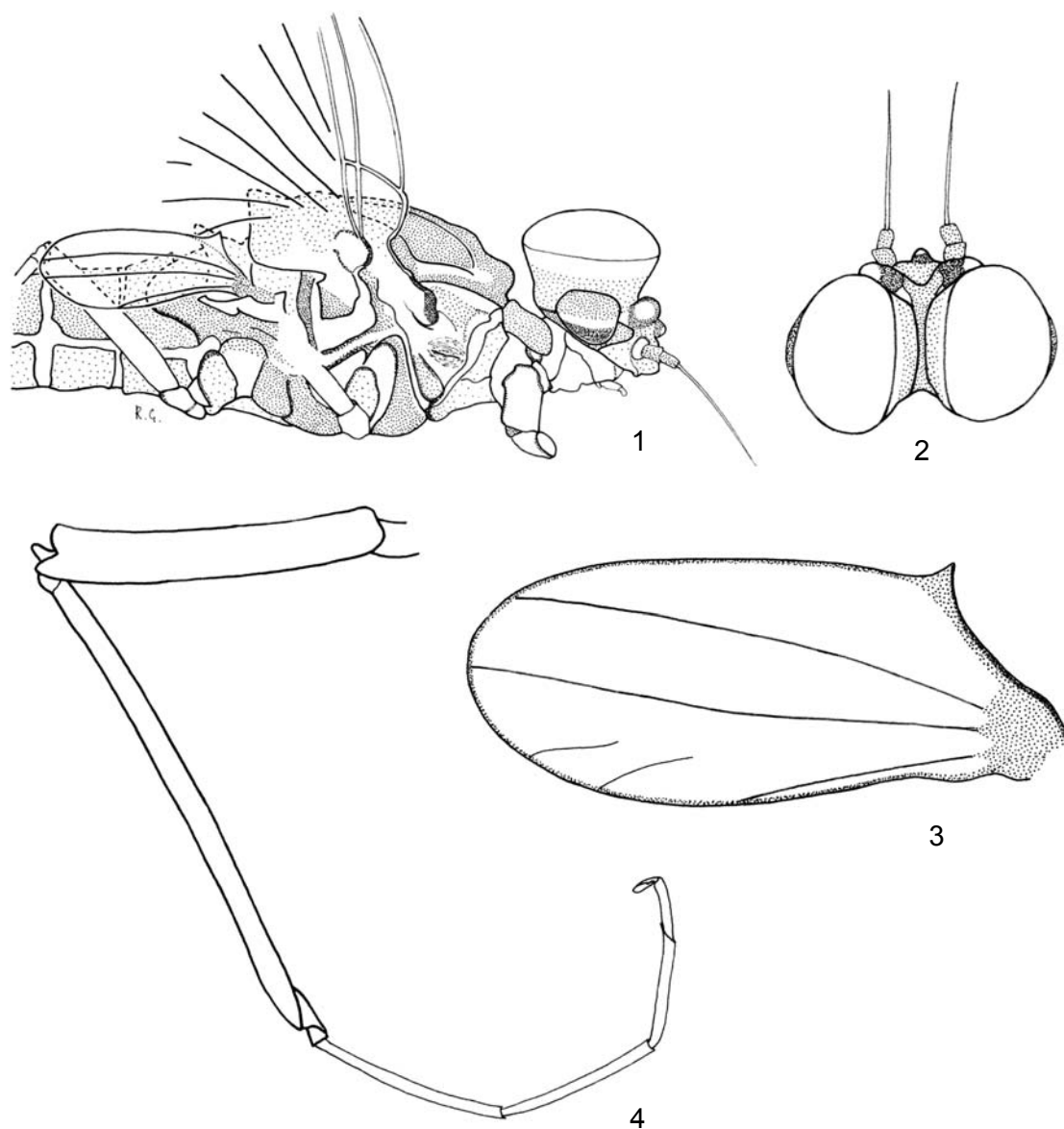
Mature larva. Size: body length: 4.2–6.0 mm (male), 4.7–6.3 mm (female); cerci length: 1.5–2.3 mm; paracercus rudimentary, 5-segmented.

General body color pale, whitish-yellow to light brown. Head yellow to light brown with darker maculation on clypeus and frons. Whole head surface covered with small spatulas and fine setae (Fig. 7). Eyes black, larval turbinate eyes light orange to orange, surrounded by yellowish ring. Antennae yellow to light brown, pedicel darker than scape and flagellum with numerous fine setae (especially in apical part), scape with sparse fine setae only (Fig. 8). Labrum distinctly wide (the width/length ratio 1.56–1.59), with 1 + 4–7 (mainly 5–6) long submarginal bristles and a few pointed setae laterally (Figs 9, 11). Mandible incisors as in Fig. 12. Apex of maxillary palpus segment 2 with single scale on rounded or spherical protuberance. Surface of maxillary palpus segments with numerous fine setae (Figs 15, 16). Segment 3 of labial palpus only slightly asymmetrical, rounded and relatively wide, segment 2 with smooth inner margin (without narrowing) (Figs 10, 13); length/width ratio of segments 2 + 3 (cf. also Novikova 1987: 82, Fig. 33.3) – 1.65–1.71.

Glossae and paraglossae wide; paraglossae with 3 regular rows of long bristles apically (Fig. 14).

Thorax pale, whitish yellow to light brown, with brown longitudinal spots on mesonotum. Pronotum with light spots centrally and laterally. Central part of pronotum with numerous small rounded and widened spatulas and fine hairs (Figs 17, 18). Metanotum unicolorous, light brown with diffuse maculation centrally and laterally. Median protuberance present on

anterior part of mesonotum. Ventral part of thorax with rounded, not sclerotized protuberances near base of middle and hind legs (Fig. 19). Legs pale, yellowish to yellowish brown. Femora with brownish elongated spot centrally, tibiae yellow, tarsi slightly darker with apical part and claws markedly darker, light brown to brown. Joints of legs segments brown to dark brown. Outer margins of femora with 2–3 rows of setae. Apical part of setae (especially in central and distal parts of



Figures 1–4. *Baetis mirkae* sp. nov., paratype, male imago. (1) Head and thorax (lateral view); (2) head (dorsal view); (3) hind right wing (dorsal view); (4) fore left leg (dorsal view).

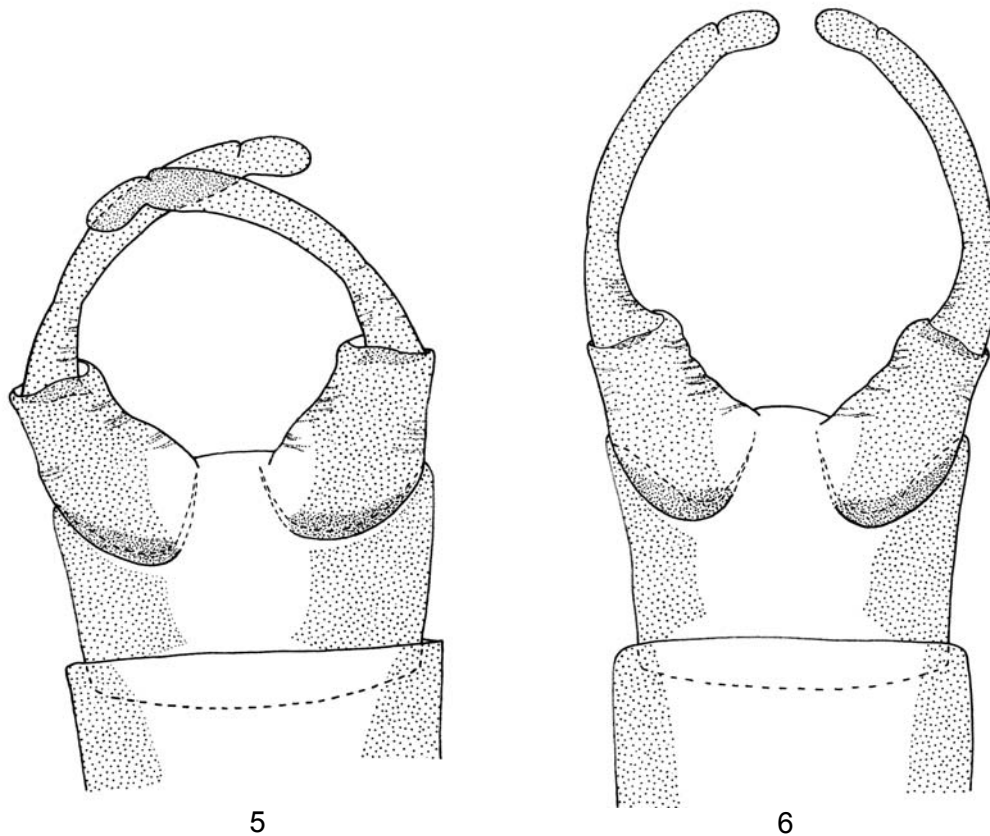
femora) evidently expanded, bluntly pointed, without brush of small hairs as in *B. lutheri* (Fig. 20). Inner margin of femora with small pointed spines. Both margins of tibiae and tarsi with pointed and bluntly pointed spines and fine setae. Surface of legs with numerous setae and small spatulas. Claw with 7–10 (rather 11) teeth and two fine subapical setae.

Abdominal terga pale, yellow to light brown with a pair of small dark brownish spots medially, light brown to brown spots laterally and median longitudinal stripe well apparent on all terga. Tergum I with two elongate dark spots near anterior and posterior margins, terga II–IX with more or less distinct two triangular spots near anterior part and narrow longitudinal spot near posterior margin, tergum X with diffuse brownish maculation medially. Posterior margin of terga with narrow or broad teeth rounded at the tip alternating with short

setae (Figs 21, 22). Surface of terga with numerous spatulas rounded at the tip with sub-parallel or slightly convergent lateral margins and fine setae (Figs 23, 24). Sterna generally uniformly yellow, with two pairs of diffuse light spots near anterior margins. Gills 1 and 7 asymmetric, approximately sub-equal (Figs 27–28). Gills 2–6 wider, slightly asymmetric with rounded distal portions (Fig. 29). Gill surface with small spatulas and fine setae (Fig. 25). Inner margin of paraprost plate with a few (generally 4–7) small obtuse teeth, occasionally hardly visible, surface with sparse fine setae. Paracercus rudimentary, 5-segmented (Fig. 26). Cerci yellow to light brown, slightly darker apically, joints dark.

Male subimago and female imago unknown.

Types material. Holotype: mature male larva, Cyprus, Lemesos District, Kuoris Potamos, Agios



Figures 5–6. *Baetis mirkae* sp. nov., paratypes, male imagoes, forceps (ventral view).

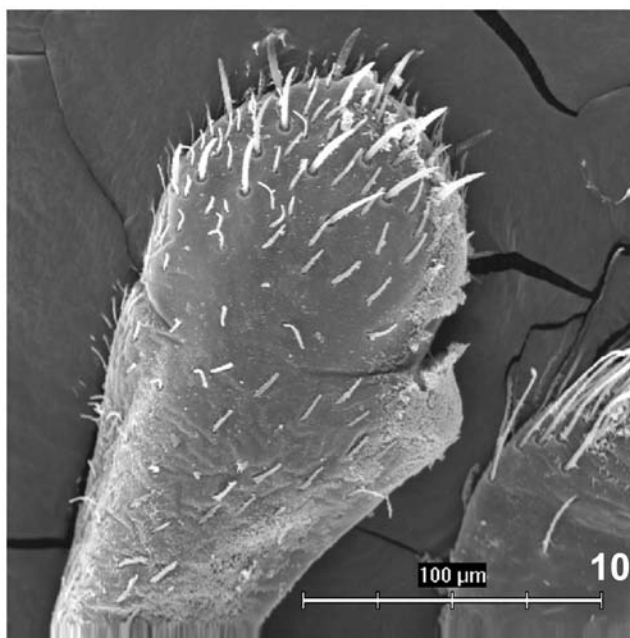
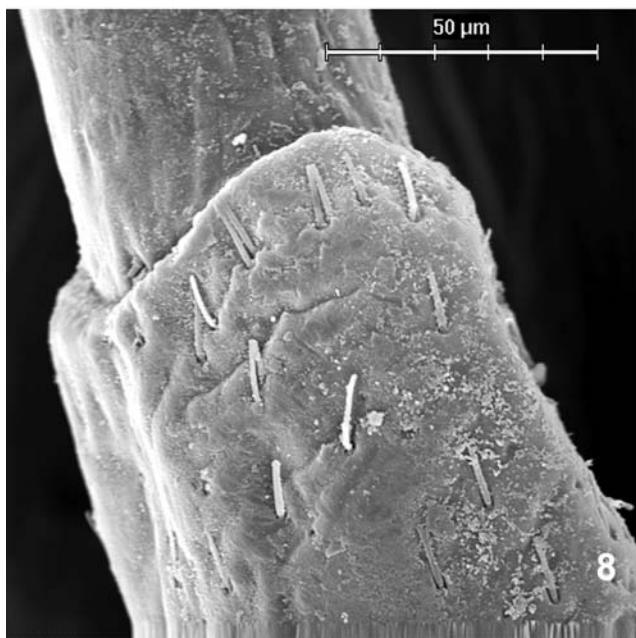
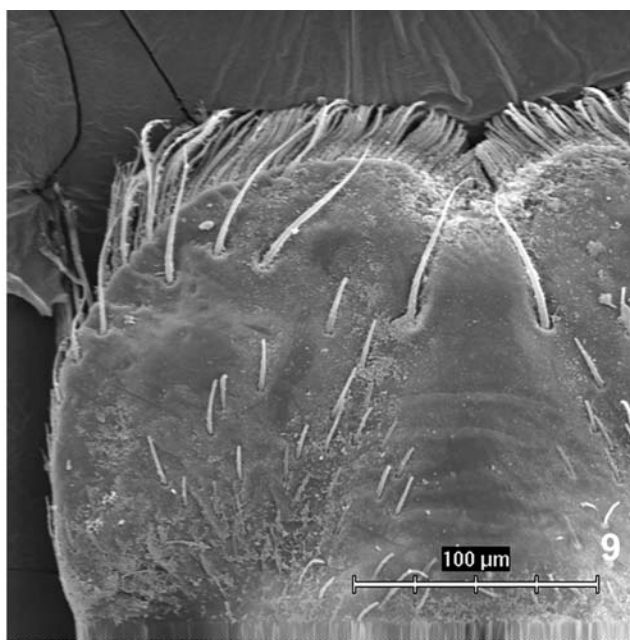
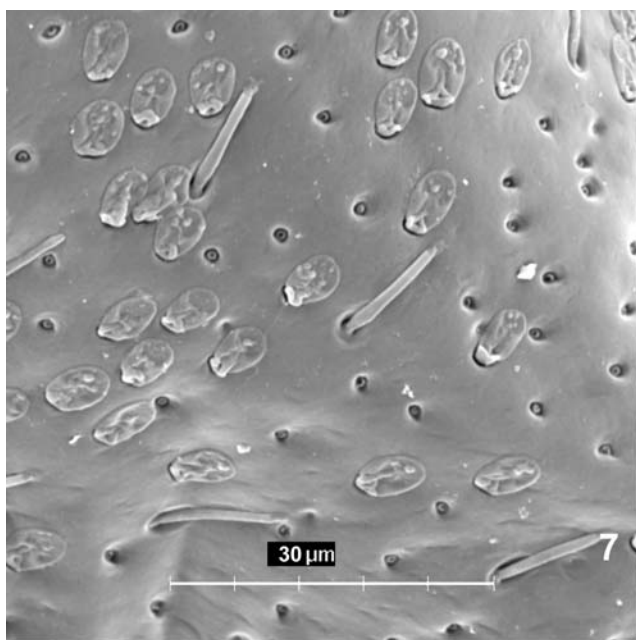
Georgios, 400 m a.s.l., May 24, 2004. Paratypes: 26 male imagoes, 1 female subimago, 153 larvae, same locality and collection date as holotype; 30 larvae, Cyprus, Lemosos District, Kryos Potamos, Pera-Pedi, 750 m a.s.l., May 23, 2004.

Material examined. 258 larvae, Greece, Rhodos Island, Argiros Potamos, Kalávarda, 30 m a.s.l. May 26, 2005.

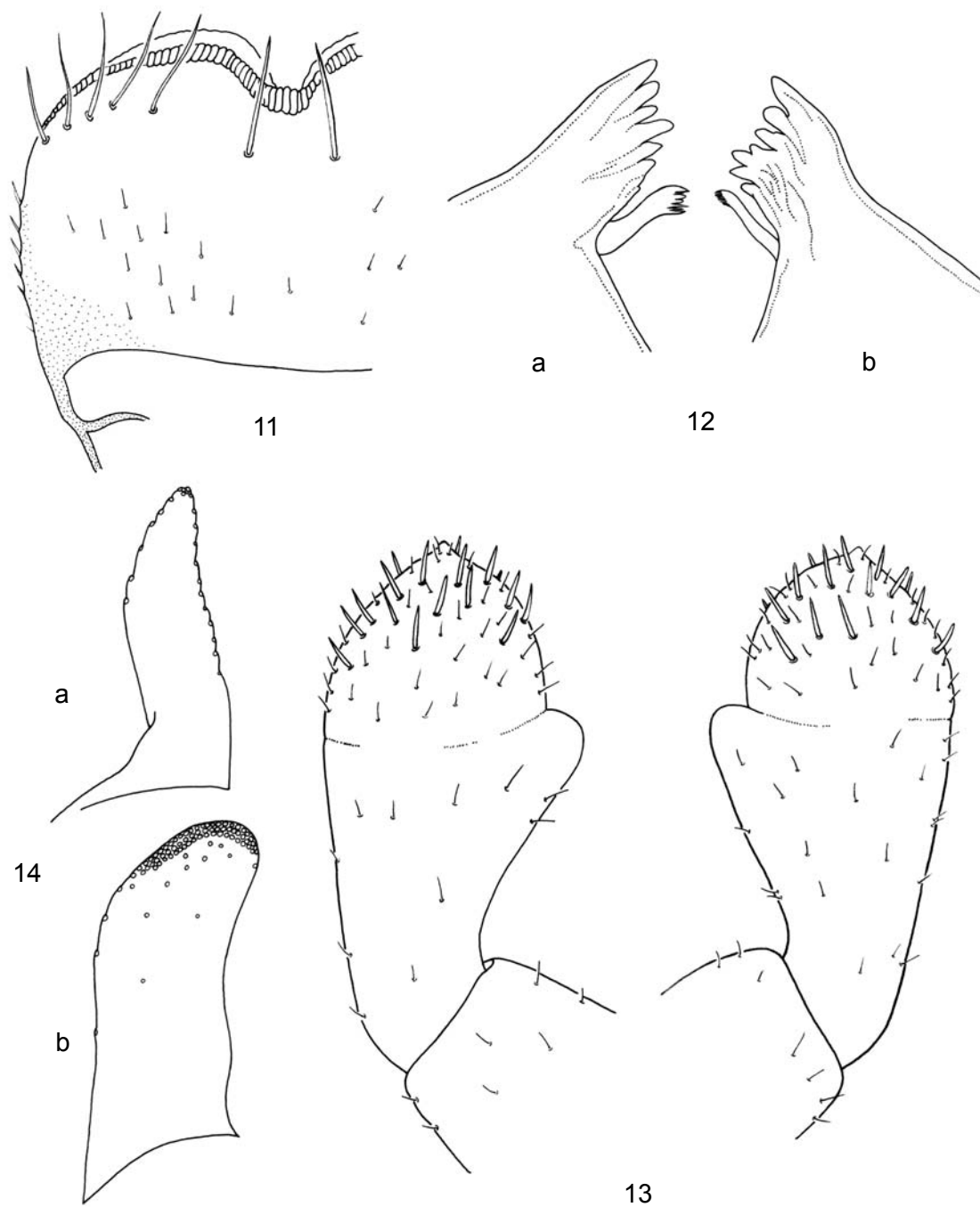
All material (preserved in 70 % alcohol) was collected by Irena, Miroslava & Tomáš Soldán. Some paratypes

on slides. Holotype and most paratypes deposited in collection of the Institute of Entomology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic; 20 larvae and 5 male imagoes (all paratypes) deposited also in the State Museum of Natural History, National Academy of Sciences of Ukraine, Lviv, Ukraine.

Differential diagnosis and affinities. *B. mirkae* sp. nov. can be distinguished from other representatives of the *B. lutheri* species-group (and also from all other Palaearctic species of the genus *Baetis* s. l. by



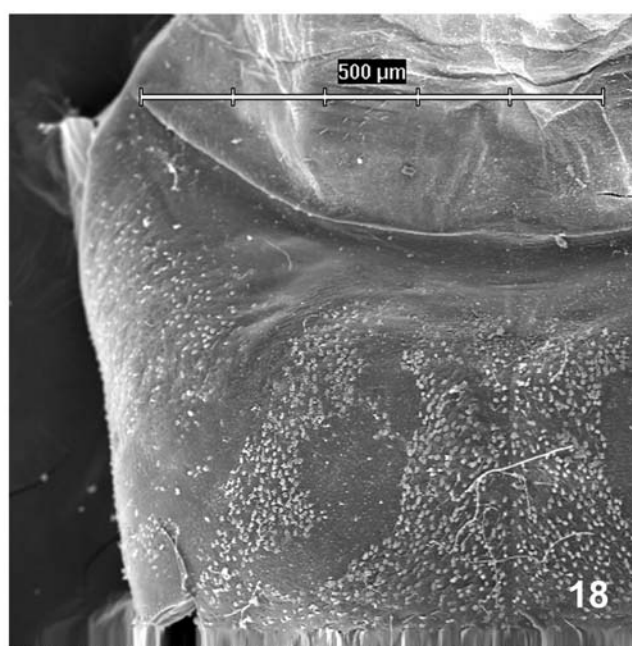
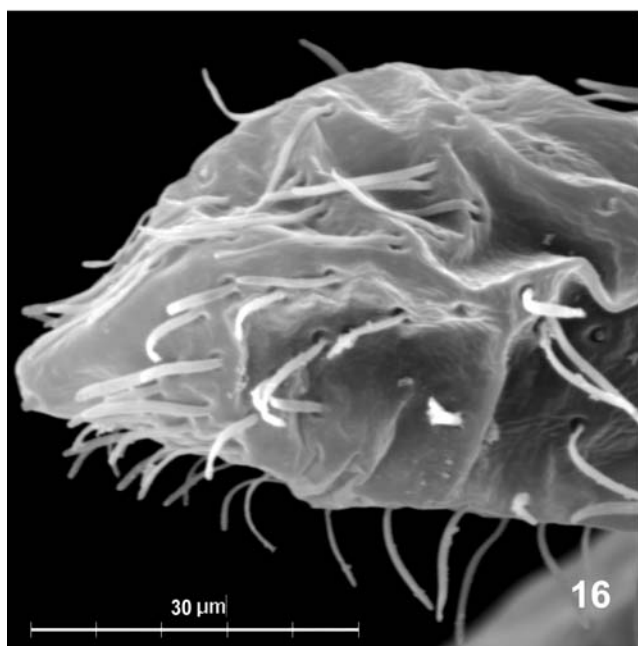
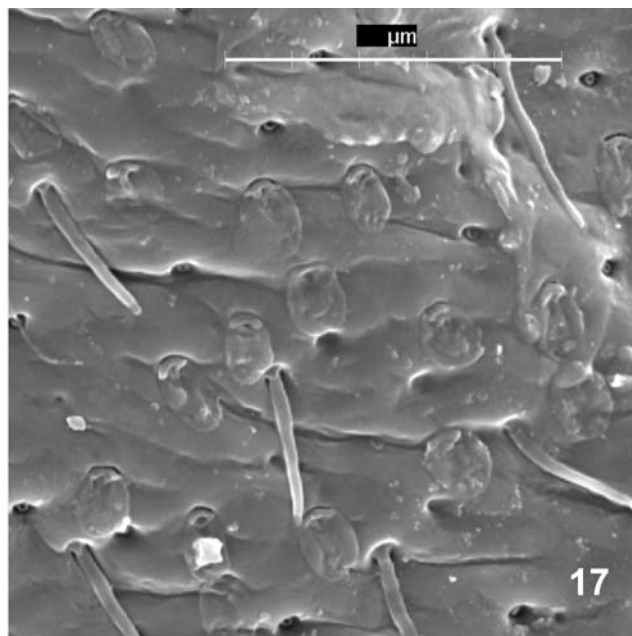
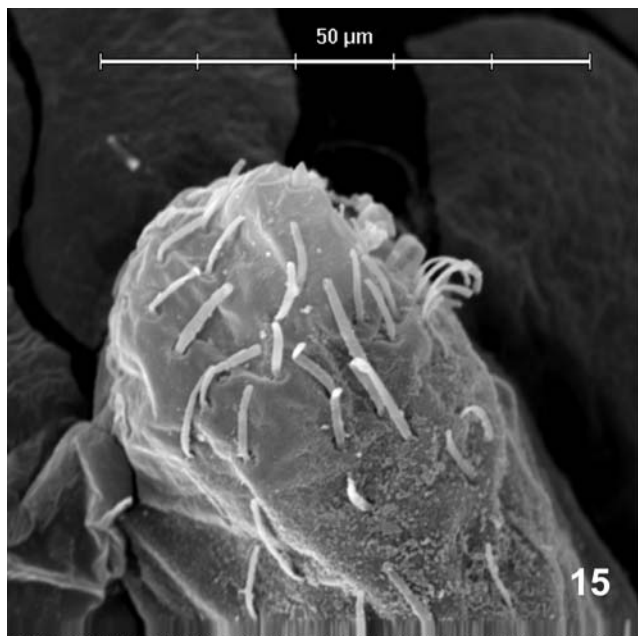
Figures 7–10. *Baetis mirkae* sp. nov., mature larvae. (7) Surface of head; (8) surface of pedicel; (9) labrum; (10) labial palpus.



Figures 11–14. *Baetis mirkae* sp. nov., mature larvae. (11) Labrum; (12) left (a) and right (b) mandibular incisors; (13) left (a) and right (b) labial palps; (14) glossa (a) and paraglossa (b).

the following combination of characters: in the male imago: (1) eyes with distinct narrow light stripe in central part between dark fields, surrounded by a light ring; (2) faceted surface of turbinate eyes yellowish-white to yellow; (3) shaft of turbinate eyes with two distinct rings: apical part with light ring of same color as the surface of turbinate eyes or slightly paler; basal orange ring, distinctly darker than apical one, as broad as 2/3 of the shaft high; (4) color of abdominal

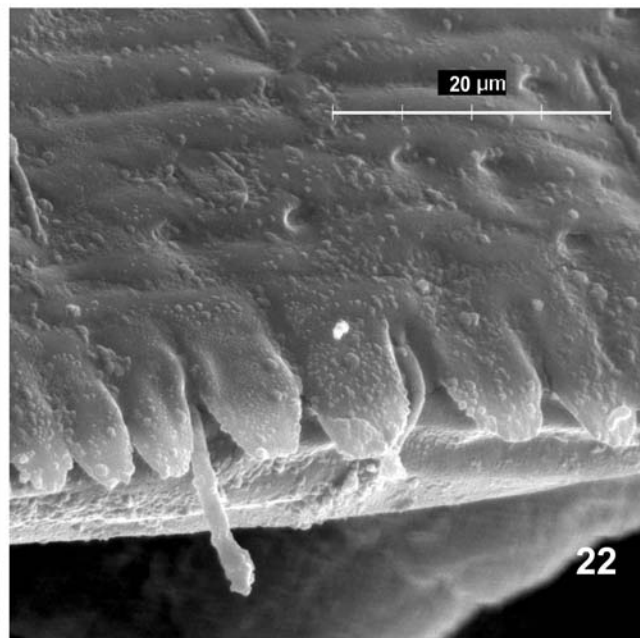
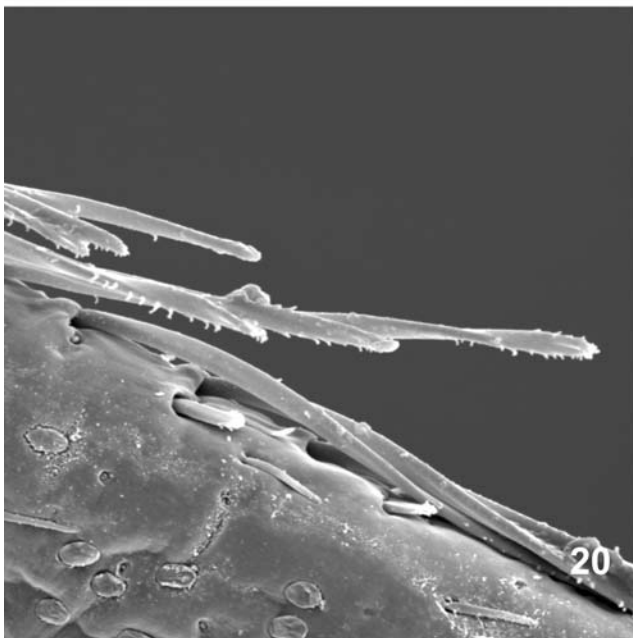
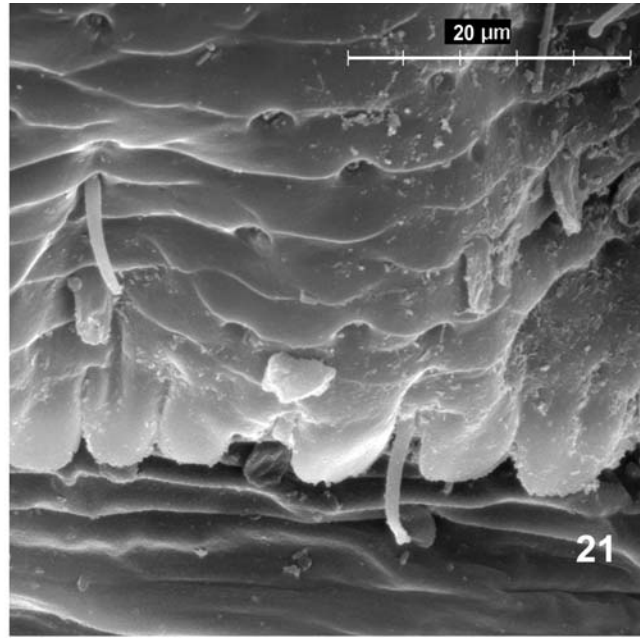
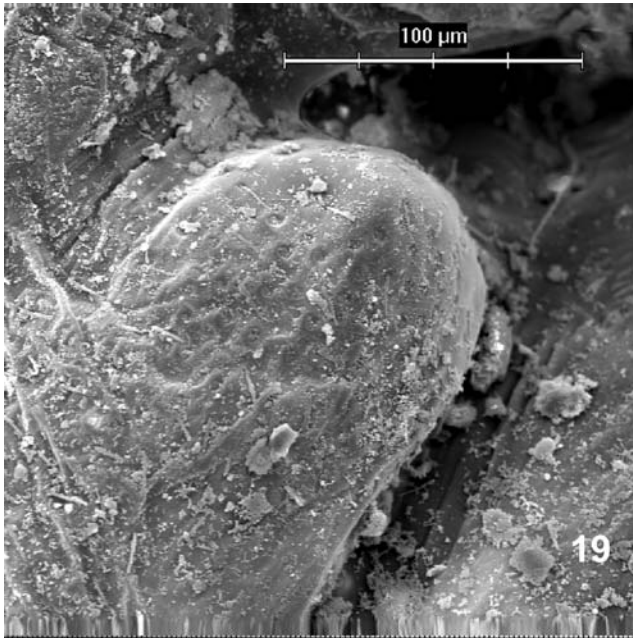
terga; (5) styliger with distinct central light spot; (6) basal segment of forceps light brown with elongate darker smudges at the base, with the width/length ratio = 0.7–0.8; (7) segment 1 of forceps conic; (8) segment 2 of forceps relatively narrow, without distinct widened part; (9) segment 3 elongated; (10) the ratio the length of forceps segments 2 and 3 of and length of abdominal tergum IX = 0.95–1.20; in larva: (11) labrum distinctly wide, with 1 + 4–7 (mainly 5–6) long submarginal



Figures 15–18. *Baetis mirkae* sp. nov., mature larvae. (15–16) Apical portion of the last segment of maxillary palps; (17) surface of pronotum; (18) arrangement of spatulas on the surface of pronotum.

bristles; (12) segment 3 of labial palps slightly asymmetrical, rounded and relatively wide; segment 2 with smooth inner margin (without narrowing); (13) the length/width ratio of segments 2+3 of labial palps = 1.65–1.71; (14) the tip of segment 2 of maxillary palps with one scale on rounded or spherical protuberance; (15) paraglossae with three regular rows of long bristles apically; (16) rounded, not sclerotized protuberances near the base of middle and hind legs; (17) proximal part of the inner margin of femora

with 2–3 rows of setae; (18) femoral setae widest and bluntly pointed at the apex, without small setae; (19) tarsal claw with 7–10 (rather 11) teeth and a pair of subapical fine setae; (20) posterior margin of terga with rounded narrow or broad teeth alternating with short setae; (21) gills 1 and 7 asymmetric, approximately sub-equal; (22) gills 3–6 wide, asymmetric, oval; (23) inner margin of paraproct plate generally with 4–7 small obtuse teeth; (24) paracercus 5-segmented.

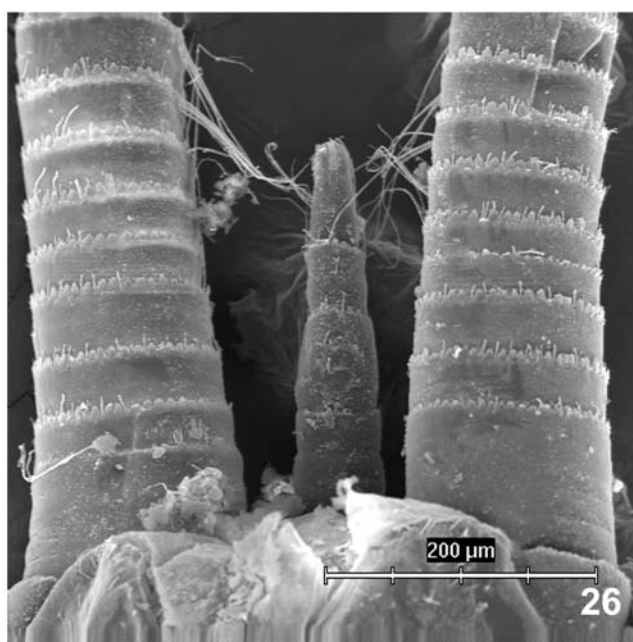
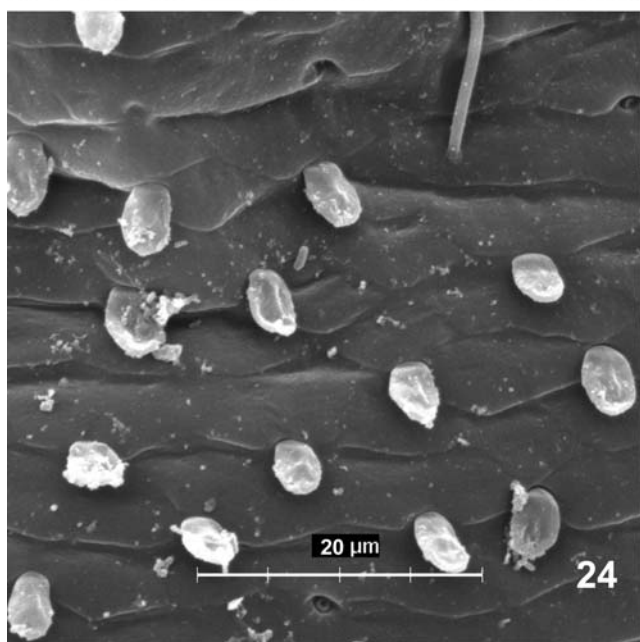
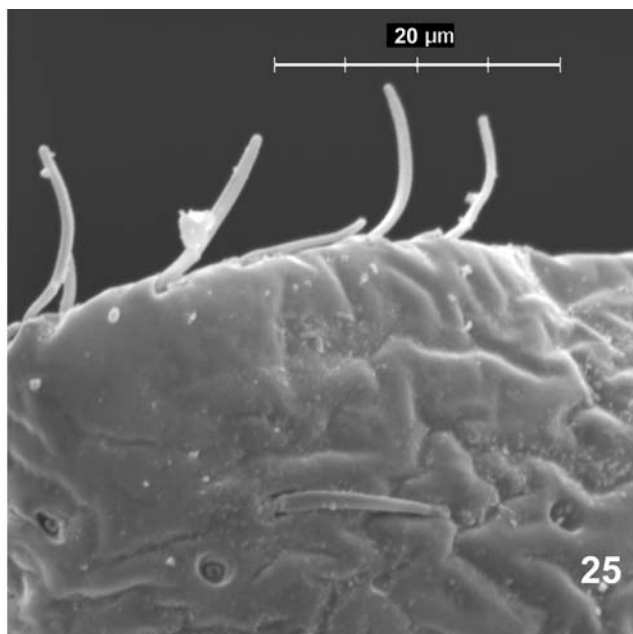
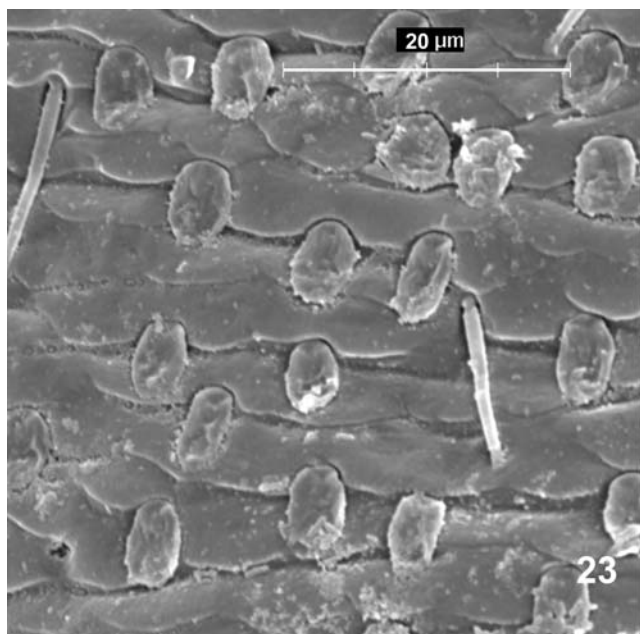


Figures 19–22. *Baetis mirkae* sp. nov., mature larvae. (19) Sclerotized protuberance near the base of middle leg; (20) detail of central part of femur; (21) posterior margin of abdominal tergum IV; (22) posterior margin of abdominal tergum VII.

Of altogether 5 West-Palaeartic species so far identified with the *B. lutheri* species-group (Müller-Liebenau 1969: 5, Kluge 1997: 176–220, Jacob 2003: 77), *B. mirkae* sp. nov. seems to be most related to *B. lutheri* Müller-Liebenau, 1967 and *B. vardarensis* Ikononov, 1962 showing very similar or identical arrangement of the characters (13, 14, 15, 19, 21, and 22). Some more characters (16 and 23), which are different in *B. vardarensis*, are shared with *B. lutheri*. Extralimital species, namely *B. petrovi* Tshernova,

1937 (larvae not yet described) and *B. praemontanus* Braasch, 1980 (adults not yet described) ranged to the *B. lutheri* species-group as well (Kluge 1997: 192, Jacob 2003: 120), are well distinguished from *B. mirkae* sp. nov.

Comparing males of *B. mirkae* sp. nov. to other *B. lutheri* species-group (males of *B. estrelensis* Müller-Liebenau, 1974 remain unknown) representatives, they are distinguished mainly by the following characters:



Figures 23–26. *Baetis mirkae* sp. nov., mature larvae. (23) Surface of abdominal tergum II; (24) surface of abdominal tergum V; (25) surface of gill IV; (26) paracercus.

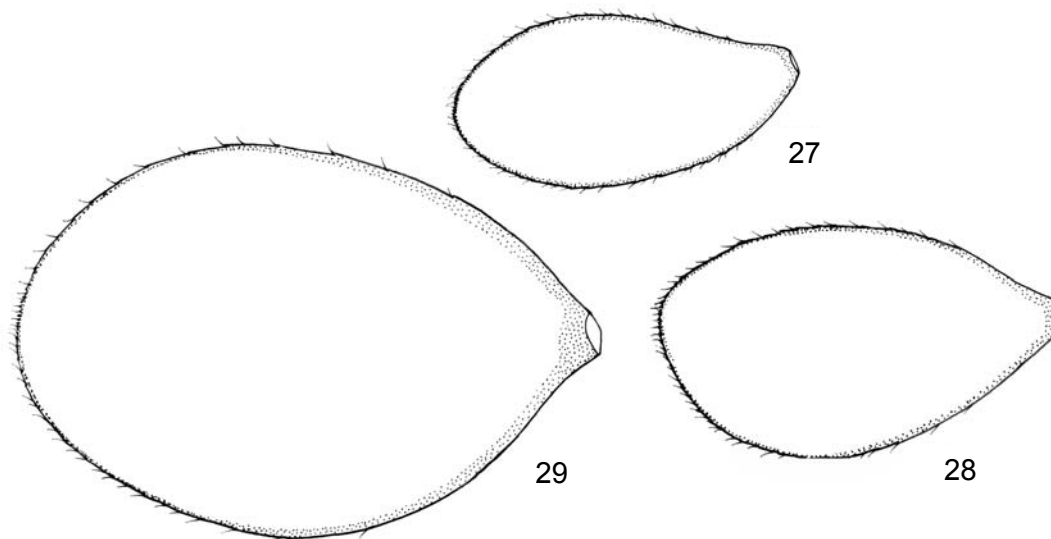
(1) Eyes with longitudinal paler ring in the middle, well preserved after more than 2 years fixation in alcohol (eyes unicolorous in all other species); yellowish-white to yellow color of turbinate eyes faceted surface (yellowish to reddish in *B. lutheri*, orange yellowish in *B. nigrescens* Navás, 1931, orange in *B. vardarensis*, lemon yellow with brownish shaft in *B. meridionalis* Ikonomov, 1954); dorsal part of turbinate eye apparently convex in lateral view like in *B. lutheri* (evidently more flat in *B. vardarensis*, cf. Grimm 1988: 237, Figs. 1 and 2); basal orange ring of shaft reaching to 2/3 of the shaft high like in *B. vardarensis* (basal 1/2 of shaft reddish brown in *B. lutheri*, cf. Grimm, l. c.); lateral margins of shaft distinctly concave, more concave than in *B. vardarensis* (straight or slightly convex in *B. lutheri*, cf. Grimm, l. c.);

(2) Styliiger with distinct central light diffused longitudinal band like in *B. lutheri* (predominantly pale with a pair of medial diffuse dark spots in *B. nigrescens*, Müller-Liebenau 1971: see her p. 17, Fig. 12) or with a pair of conspicuous oval dark brown spots near the bases of forceps in *B. vardarensis*, cf. Grimm (1988: 237, Fig. 3); all forceps segments light brownish, unicolorous (distal part of forceps whitish in *B. vardarensis* and *B. lutheri*, cf. Müller-Liebenau 1969: 66, Fig. 28), forceps with dark basal segment and dark transversal stripe in the middle in *B. nigrescens*, cf. Müller-Liebenau (1971: 17, Fig. 12); segment 2 not expanded distally like in *B. meridionalis*, cf. Puthz (1980: 348, Fig. 1), *B. nigrescens*, cf. Müller-Liebenau (l. c.) or *B. vardarensis*, cf. Grimm (l. c.).

In *B. lutheri*, segment 2 is evidently expanded, cf. Müller-Liebenau (1969: 66, Fig. 28).

Some difference can be found also in color patterns of male abdominal terga, e.g., terga VII–X yellowish brown and unicolorous, not much paler than terga II–VI in *B. lutheri*, contrary to terga VII–IX light-brown laterally, yellowish brown in central part, tergum X with yellowish-brown central spot and lateral sides of all terga additionally with some brownish maculation in *B. mirkae* sp. nov.

Concerning the larval characters, *B. lutheri* and *B. mirkae* sp. nov. are markedly distinguished from *B. vardarensis* mainly in the arrangement of meso- and metanotal lateral processes (character 16) which are heavily sclerotized, triangular and pointed at apex in this later species, see Müller-Liebenau (1974: 18, Fig. 4i) but not sclerotized and rounded in *B. lutheri* and *B. mirkae* sp. nov. This character is considered a critical one within the whole species-group (Müller-Liebenau 1974, Grimm 1988, Bauernfeind and Weichselbaumer 1991, Bauernfeind 1994, Studemann *et al.* 1992, Sartori *et al.* 1996, Bauernfeind and Humpesch 2001, Jacob 2003). The inner margin of the paraproct plate (character 23) bears several (3–5) irregular rows of small obtuse submarginal teeth in *B. vardarensis*, cf. Müller-Liebenau (1974: 18, Fig. 4g), but only 4–7 larger marginal teeth and small submarginal teeth in a single irregular row in *B. vardarensis* + *B. mirkae* sp. nov. Further difference is in the number of submarginal rows of setae on the proximal part of the inner margin of femora, character 17 (a single row in



Figures 27–29. *Baetis mirkae* sp. nov., mature larvae. (27) Gill 1; (28) gill 7; (29) gill 4.

B. lutheri, 2–3 rows in *B. mirkae* sp. nov.; numerous, about 4–5 rows, in *B. vardarensis*, cf. Müller-Liebenau (1974: 20, Figs 5a, 5b). *B. lutheri* + *B. mirkae* sp. nov. are distinguished from *B. vardarensis* also in color patterns, especially on abdominal terga. This is quite different in the latter species, completely lacking dark-pale spots except for weakly indicated longitudinal paler band in the middle, cf. Müller-Liebenau (1974: 20, Fig. 6) for details.

Besides abdominal terga color patterns (compare photographs by Müller-Liebenau 1967 and 1969: 67, Fig. 30) and some further morphological details (e.g., setation and spatulae distribution on head, labrum and pronotum or length/width ratio of labrum and segments 2+3 of labial palps), the larvae of *B. mirkae* sp. nov. are distinguished from closely related *B. lutheri* mainly in the characters (11, 12, 17- see above, 18, 20 and 24). The number of setae on labrum (1 + 4-7, usually 1 + 5-6, comparable with 1 + 4-6 in *B. vardarensis*) is generally lower than in *B. lutheri* (1 + 5-9, usually 1 + 6-9) (see character 11). Segment 3 of labial palps (character 12) in *B. mirkae* sp. nov. is apparently asymmetrical and more rounded in the distal portion (like in *B. vardarensis*, cf. Müller-Liebenau 1974: 18, Fig. 4e and Jacob 2003: 76, Fig. 8b) while being quite symmetrical and more pointed in *B. lutheri* (cf. Müller-Liebenau 1969: 67, Fig. 32e and Jacob 2003: 76, Fig. 8a). Setae on outer margin of the femora (character 18) are expanded and rounded apically (slightly club-shaped), without small setae in *B. mirkae* sp. nov., contrary to setae with parallel lateral margins terminated by a comb of small setae in *B. lutheri*, cf. Müller-Liebenau (1969: 69, Fig. 32i). Rounded narrow or broad teeth on posterior margins of middle abdominal terga (character 20) alternate with short setae or bristles in *B. mirkae* sp. nov., contrary to the arrangement of this character in *B. lutheri*, cf. Müller-Liebenau (1969: 71, Fig. 33). Finally, paracercus in *B. mirkae* sp. nov. is strongly reduced, 5-segmented, but well developed with numerous segments in both *B. lutheri* and *B. vardarensis*, reaching at least 1/2, more often 2/3 of cerci length, character 24 (see photographs by Müller-Liebenau 1969: 67, Fig. 30 and 1974, as long as 1/4–2/3 of cerci in *B. vardarensis* according to Jacob 2003).

Strongly reduced paracercus (character 24) approaches *B. mirkae* sp. nov. also to further representatives of the *B. lutheri* species-group, namely closely related *B. estrelensis* Müller-Liebenau, 1974 and *B. nigrescens* Navás, 1931. However, besides differences in numerous characters (e.g., 12, 13, 17, 18, 23) and color patterns, larvae of these species markedly differ in possessing conspicuous chagrined structures on pronotum (e.g., even in the form of “Rosettenbildung im Chagrin” by Müller-Liebenau 1974: 25, Fig. 10 in *B. estrelensis*), abdominal terga, paraproct plates, and femora (also on tibiae, tarsi and gills in

B. nigrescens, and gills in *B. estrelensis* moreover quite unique within the species-group, oblong-shaped or quadrate).

The taxonomic position of *B. meridionalis* remains quite unclear and most likely cannot be specified until further specimens are collected or type material is available (not specified, syntype series of mature larvae, 3 ♂♂, 2 ♀♀ originally in coll. Petar Ikonov, Mus. Skopje, Macedonia). Since its initial findings, larvae of this species have never been studied and respective revisions and keys (Müller-Liebenau 1969: 174 and Jacob 2003: 79) are based solely on data by Ikonov (1954, 1962). There is a little doubt whether the species even belongs to the *B. lutheri* species-group exhibiting missing scales or spines at apex of segment 2 of maxillary palps and subapical bristles on tarsal claws, divided right mandible incisors, arrangement of posterior margin of terga, paraproct plate and other characters seem to be also strange to the species-group in question. If not, these larval characters (14, 19, 23, and 25, paracercus well developed) distinguish *B. meridionalis* from *B. mirkae* sp. nov. and all other representatives of the *B. lutheri* species-group. Already Ikonov (1954: 103) indicated certain relationships to the “*scambus-biocolatus*” species-group. Müller-Liebenau (1969), although ranging *B. meridionalis* to the *B. lutheri* species-group, suggested certain relationship (e.g., very similar abdominal colour patterns) to the *B. buceratus* species-group. There is also a little doubt whether the larvae described by Ikonov (1954), adults described later (Ikonov 1962) and adult redescribed by Puthz (1980, as *Baetis* cf. *meridionalis*) are in fact conspecific. The figures by Ikonov (1962) redrawn also by Jacob (2003: 75, Fig. 7c) seem to be different in many respects (e.g., the cylindrical shape and relative length of basal forceps segment, shape of base of segment 2 and position of middle constriction). The latter characters distinguish *B. meridionalis* from *B. mirkae* sp. nov. (and all other representatives of the *B. lutheri* species-group as well).

Biology. Not known in detail. Larvae have been so far collected from submontane and montane streams within the island of Cyprus and from a small stream a lowland locality in Greece, island of Rhodos. At the former area, they showed the highest density, being apparently dominant in their quantitative presentation (about 30 %) within the mayfly standing crop at the type locality. On the contrary, they were not so abundant at a single locality in Rhodos where larvae of the genus *Caenis* evidently prevailed reaching up to 60% of mayfly standing crop. Larvae evidently preferred the places of streamline or those with moderate to fast current velocity (more than about 20–50 cm.s⁻¹) living solely on stony substrates (lithal) at depth of 5–40 cm. Flight period is undoubtedly in May–June, with about 1/3 of more than 200 larvae collected ready to emerge.

Nevertheless, quantitative presentation of young and half-grown larvae was relatively very high (about 50%). Larvae of *B. mirkae* sp. nov. were found at localities relatively poor in mayfly diversity. In Cyprus, only 2–3 other *Baetis* species lived at the type locality. In Rhodos, 3 more species, namely *Caenis* sp. of Caenidae, and *Baetis rhodani* Pictet (1843) and *Procloeon* (*Pseudocentropilum*) *fascicaudale* (Sowa, 1985) of the Baetidae were collected. This indicated either protracted flight period or second generations in late summer. Subimagines emerged from the water surface in early afternoon. Quite different environmental conditions have been found at the locality in Rhodos. The Argiros Potamos near Kalávarda is a “lowland” shallow small stream (about 1–3 m across) with an artificial concrete streambed. Larvae of *B. mirkae* sp. nov. lived mostly in the streamline but some of them inhabited also very sparse submerged vegetation. Contrary to the localities in Cyprus, mature larvae from Rhodos reached only about 2/3–1/2 of their body length.

Distribution and biogeographical analysis of Palaearctic representatives of the *B. lutheri* species-group. *B. mirkae* sp. nov. is known only from 2 localities from Cyprus and a single locality from Rhodos, Greece so far and thus might be considered endemic to some Mediterranean islands. However, we suggest to be careful in evaluating it in such a way since numerous originally “endemic” *Baetis* species were later found in other, often quite far removed areas and the occurrence in an island need not inevitably indicate an endemism. Moreover, a relatively very short distance of about 60 km between Cyprus and the mainland should be taken into account. Considering the *B. lutheri* species-group, this was also the case of *B. nigrescens* and *B. estrelensis*. The former, *B. nigrescens*, was originally described from small stream near Los Tilos, Gran Canaria, Spain (Navás 1931). The proper name of the stream cannot be identified; it is most probably one of tributaries of Barranco de Moya (Müller-Liebenau 1971: 22; “locus typicus in Morokko” quoted by Jacob (2003: 80) is obviously an error) and considered a Macaronesian endemite to some islands of the Canaries (see Müller-Liebenau 1971, Alba-Tercedor *et al.* 1987, Alba-Tercedor and Jáimez-Cuéllar 2003 for a complete list of localities). Later this species has been found also at several localities in Spain and Portugal (Müller-Liebenau 1974) and at further localities in the northeastern Spain (Puig 1984). Müller-Liebenau (1971: 22) mentioned also “... Vier Larven aus der coll. Fittkau aus der Algerischen Sahara dürfen ebenfalls dieser Art angehören”, but without any more detailed location. On the other hand, *B. estrelensis* seems to be probably a real endemite to the Iberian Peninsula (still considered a strict endemite only to the type locality area by Jacob 2003: 81). Despite a considerable collecting effort, it has been so far found only at the type

locality (Serra da Estrêlla, near Seia between S. Romão and Valecim 780 m, Prov. Beira Alta, Portugal, Locality No. FSP by V. Puthz, see Müller-Liebenau 1974: 26) and, much later, at several additional localities in Galicia, Spain by Pardo *et al.* (1991).

If we consider the *B. lutheri* species-group as originally defined by Müller-Liebenau (1969: 65) solely on the basis of morphological characters monophyletic also from the phylogeographic (phylographic) point of view, then at least two or three principal distributional centers of representatives of the *B. lutheri* species-group can be determined. There is no doubt that the recent area of all the species included is connected with the large Mediterranean refuge center and in some cases depended on postglacial recolonization (e.g., the Submediterranean species *B. lutheri* and *B. vardarensis* with northern area limits in Central Europe). The areas of all species in question seem to be more or less conjunctive and a monocentric origin can be considered. Judging from recent distribution, *B. nigrescens* with the area extension to the Macaronesia (see above) and *B. estrelensis* (probably restricted to the Iberian Peninsula, see above) most likely represent the Atlantomediterranean elements as suggested by Jacob (2003) and characterized in detail for *B. (Labiobaetis) atrebatinus* Eaton, 1870 (Baetidae), *Thraulius bellus* Eaton, 1881 (Leptophlebiidae Banks, 1900), *Ephemera glaucops* Pictet, 1843 (Ephemeridae Leach, 1815), and *Caenis luctuosa* (Burmeister, 1839) of the Caenidae by Haybach (2003). However, refuge center in of the Rhône (or the Po) as supposed by this author in the latter examples is not likely. *B. lutheri* is undoubtedly correctly considered Pontomediterranean (Balkan-Mediterranean sensu Aspök *et al.* 1991) element (Haybach 2003). The species is widely distributed all over southern and central Europe from the Iberian Peninsula to Turkey (Kazanci 1984), Georgia (Zimmermann 1981), Iraq (Al Zubaidi *et al.* 1987), Lebanon and Syria (Koch 1988), including the sympatric area of *B. lutheri georgianus* Zimmermann, 1981 described from Georgia (adult stage is unknown). According to Jacob (1972), *B. lutheri* might possibly represent a holoalpine species but this seems to be unlikely (cf. Haybach 1992). Concerning *B. vardarensis*, Jacob (1979) suggested Holomediterranean origin. However, according to Haybach (1998) the Pontomediterranean nature of its area seems to be more likely. The area of *B. vardarensis* is very similar to that of *B. lutheri* although, due to long-term confusion with the latter species, the total area is still unknown in detail. Similarly to *B. lutheri*, the sympatric subspecies, *B. vardarensis caucasicus* Zimmermann, 1981 has been described from Caucasus (Georgia and Armenia, adult stage unknown). Although very restricted and badly requiring further analysis, the area of *B. meridionalis* seems to be relatively larger. The species is known

only from several localities in Macedonia (see Ikonomov 1954, 1960, 1962 for their list), a single locality in Albania (see Puthz 1980) and also possibly from Turkey (see Kazanci 1984); however the latter findings probably need a revision (cf. Jacob 2003: 79). *B. mirkae* sp. nov. indicates the same (Pontomediterranean) origin as that of *B. lutheri*. On the other hand, the origin of *B. petrovi* and *B. praemontanus* still remains unclear. Any consideration on possible origin from some Asiatic faunistic centers (see Haybach 2003 for their definition with respect to the Ephemeroptera) would be a more speculation due to their areas being quite insufficiently known. According to up-to-date literature sources, *B. petrovi* exhibits a disjunctive area in Caucasus at type locality Nakhitshevan, Azerbaidzhan (Tshernova 1937) and possibly also in Asia Minor (Koch 1981), however the latter material needs to be re-examined. *B. praemontanus* is known only from its type locality in Kyrgyzstan (Braasch 1980).

Baetis irenkae sp. nov.

(Figs 30–57)

Etymology. The species is named for Irenka, elder daughter of the senior author to acknowledge her distinguished field assistance during sampling mayflies in Cyprus.

Description. Male imago. Size: body length: 8.2 mm; fore wings length: 8.4 mm; cerci length: 15.5–16.3 mm; tarsal segments: T1 = 0.82–0.90 mm; T2 = 0.80–0.84 mm; T3 = 0.55 mm; T4 = 0.30–0.35 mm; relative tarsal segments length ratio: $1 \geq 2 > 3 > 4$ (Fig. 33).

General body color yellow to light brown. Antennae light brown, flagellum slightly darker at the base. Ocelli whitish at the apex with black base. Eyes unicolorous grayish-black surrounded by yellowish ring. Turbinate eyes oval in dorsal view, relatively narrow, not contiguous, not stretched in lateral view, with convex outer margins in dorsal view (Figs 30, 31). Facetted surface orange, surrounded by whitish ring, shaft paler, with broad subapical orange-violet ring and with brownish-violet narrow ring at base.

Thorax pale, yellowish-brown to brown with dark brown smudges and spots surround thoracic sutures (Fig. 31). Pronotum brown with some light spots at the posterior margin. Mesothorax with longitudinal brown bands surround medioparapsidal and lateroparapsidal sutures (nomenclature of thoracic structures used here follows Kluge 1994, 2004). Metathorax brown with darker posterior margin. Fore wings hyaline and transparent, pterostigma slightly opaque, yellowish, with 9–11 simple or anastomosed cross veins. Venation yellowish to light brown. Hind wings hyaline, transparent, with three simple longitudinal veins and costal process. Legs pale, yellow to brown. Fore legs distinctly

darker than middle and hind ones, with yellowish-brown femora with diffuse brownish spot distally and light brown to brown tibiae and tarsi.

Abdominal tergum I darker, unicolorous dark brown, terga II–VI uniformly light brown without drawings, terga VII–IX with a pair of longitudinal brown spots near anterior, tergum X brown with two darker central spots. Genitalia yellowish-brown to brown. Basal segment of forceps nearly as long as wide (Fig. 32). Segment 1 distinctly wide at the base and slightly conic, inner margins not convex. Segment 2 relatively elongated and wide with expanded distal part reaching approximately 1/3 of total length and slightly concave inner margin. Segment 3 oval with distinctly truncate inner margin. Cerci light brown, slightly darker at the base, joints dark.

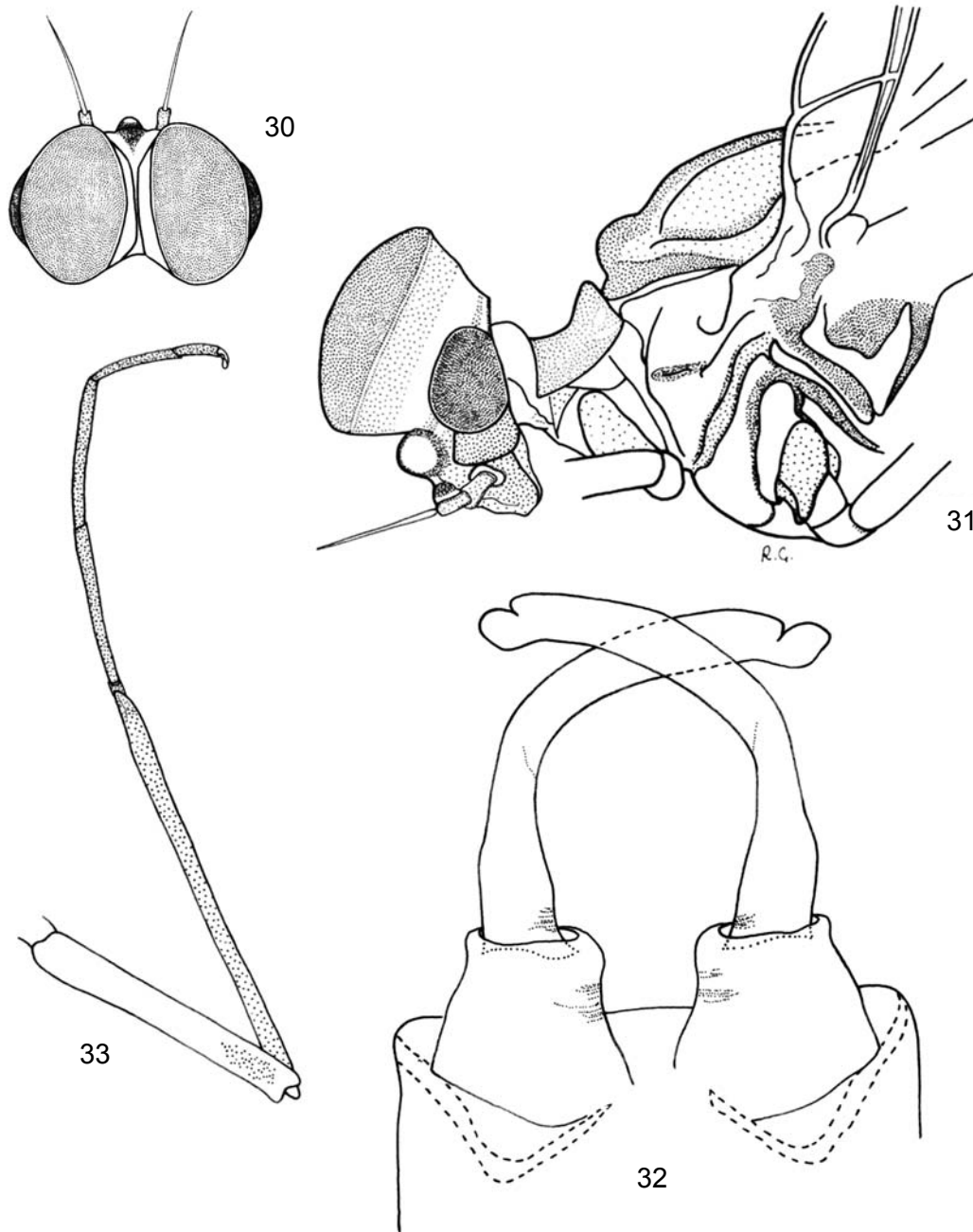
Mature larva. Size: body length: 6.2–8.0 mm (male), 6.4–8.3 mm (female); cerci length: 3.8–4.2 mm; paracercus length: 1.6–2.7 mm.

General color of body pale, yellow to light brown. Head yellowish brown to light brown. Surface of head with pointed scales, semilunar scale bases, fine setae and rather spatulas (Fig. 34). Larval turbinate eyes brown to orange-brown (occasionally brown-castaneous), surrounded by orange ring. Antennae yellowish-brown to light brown. Scape with small pointed scales, their semilunar bases and fine setae (Fig. 35). Pedicel with elongate, slender pointed or bluntly pointed scales, semilunar bases and fine setae, spines arranged mostly in a single irregular subapical row, further rather smaller pointed or bluntly pointed (spatulated) scales on pedicel surface (Fig. 36). Occasionally, pedicel surface with elongated spatulas rounded at the apex. Labrum relatively wide (width/length ratio 1.35–1.37), with 1 + 5–9 (mainly 7–8) long submarginal bristles and a few fine bristles laterally (Fig. 38). Segment 2 of maxillary palpus with a single small spine at apex or subapically (Fig. 42), surface of palps with numerous fine setae. Mandible incisors approximately quadrate with straight outer and anterior margins, and several rounded teeth on inner margins (Fig. 39). Segment 3 of labial palpus rounded, slightly asymmetrical, relatively wide (Fig. 40), segment 2 relatively broad with not concave inner margin; length/width ratio of segments 2+3 of labial palpus – 2.28 (cf. also Novikova 1987: 82, her Fig. 33.3). Glossae and paraglossae relatively broad (Fig. 41). Paraglossae with 5 (rather 4) regular rows of bristles.

Thorax yellowish-brown to light brown with contrasting rounded and longitudinal spots on pro- and mesonotum, and wings pads. Surface of thorax with numerous robust convergent scales, semilunar bases of scales and fine setae (Fig. 48). Legs yellowish-brown to brown. Femora with broad central brown spot, outer margins with dense row of long setae arranged in two (occasionally three) rows proximally, distal part with

sparse long setae. Marginal setae in proximal part of femora relatively narrow, convergent, mainly bluntly pointed at the tip (Fig. 43). Distal marginal setae short and massive, mainly bluntly pointed apically. Sub-apical scales pointed or bluntly pointed, sometimes

also elongate and rounded at the apex. Inner margin of femora with short pointed and bluntly pointed spines alternating with fine setae. Tibiae yellowish-brown, slightly darker distally, with marginal spines and sub-marginal pointed scales and fine setae. Tarsi light



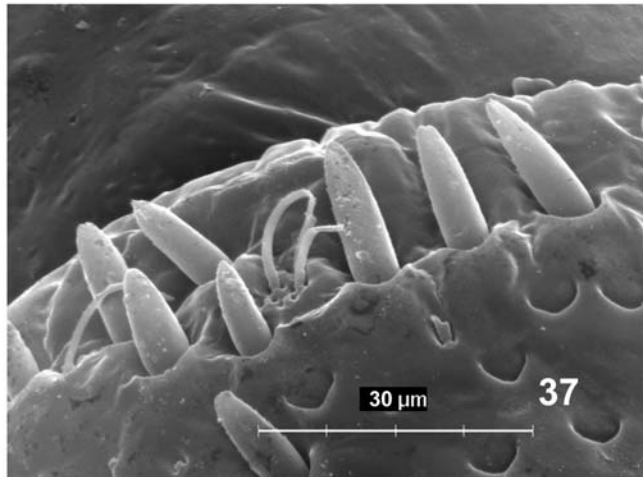
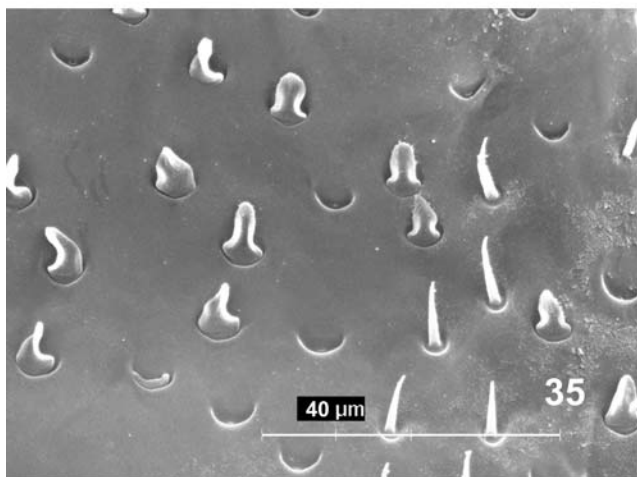
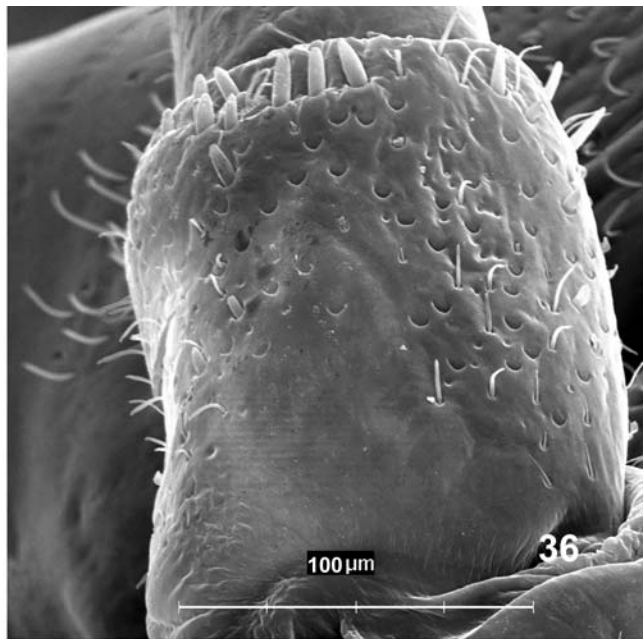
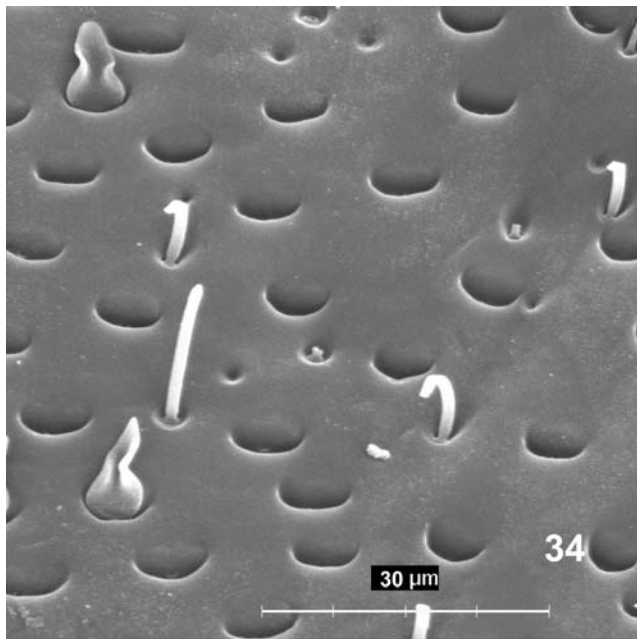
Figures 30–33. *Baetis irenkae* sp. nov., paratype, male imago. (30) Head (dorsal view); (31) head and thorax (lateral view); (32) forceps (ventral view); (33) fore left leg (dorsal view).

brown basally with distinctly darker apical part and pointed marginal spines, inner margin with few subapical broad bristles. Claw slender, elongated, slightly hooked apically, with 9–12 teeth, subapical setae absent (Figs 44, 55).

Abdominal terga yellowish-brown to light brown with lateral diffuse yellowish spots, medial longitudinal stripe well visible on terga I–IX. Terga III–VII with diffuse longitudinal spot, tergum IV with two dissolved triangular brown spots near the anterior margin, terga I–IX with additional two pairs of small central brownish spots. Tergum X uniformly light brown, with diffuse yellowish-brown spot near the posterior margin. Some brownish maculations present in anterior portion of terga I, II, III, VI, and VIII. Sterna yellowish-white to yellowish-brown, sterna V–IX slightly darker. Posterior

margins of terga I–II (III) with sparse isolated spatulas rounded or bluntly pointed at the tip, alternating with fine setae (Fig. 45). Terga III–VI (VII) with dense row of spatulas, alternating with fine setae (Fig. 46). Generally, central part of posterior margin of terga VII–VIII with dense row of spatulas, alternating with fine setae and 2–5 small triangular teeth, lateral parts of these terga with small triangular teeth alternating with a few sparse spatulas and fine setae. Terga IX–X with regular row of spatulas alternating triangular teeth and fine setae. Numerous robust and apically convergent scales, their semilunar bases and fine setae on surface of abdominal terga (Fig. 47).

Gills with prominent violet tracheation, diffuse reddish violet stippling in proximal and central position, and pigmented margins; gills 1 and 7 relatively

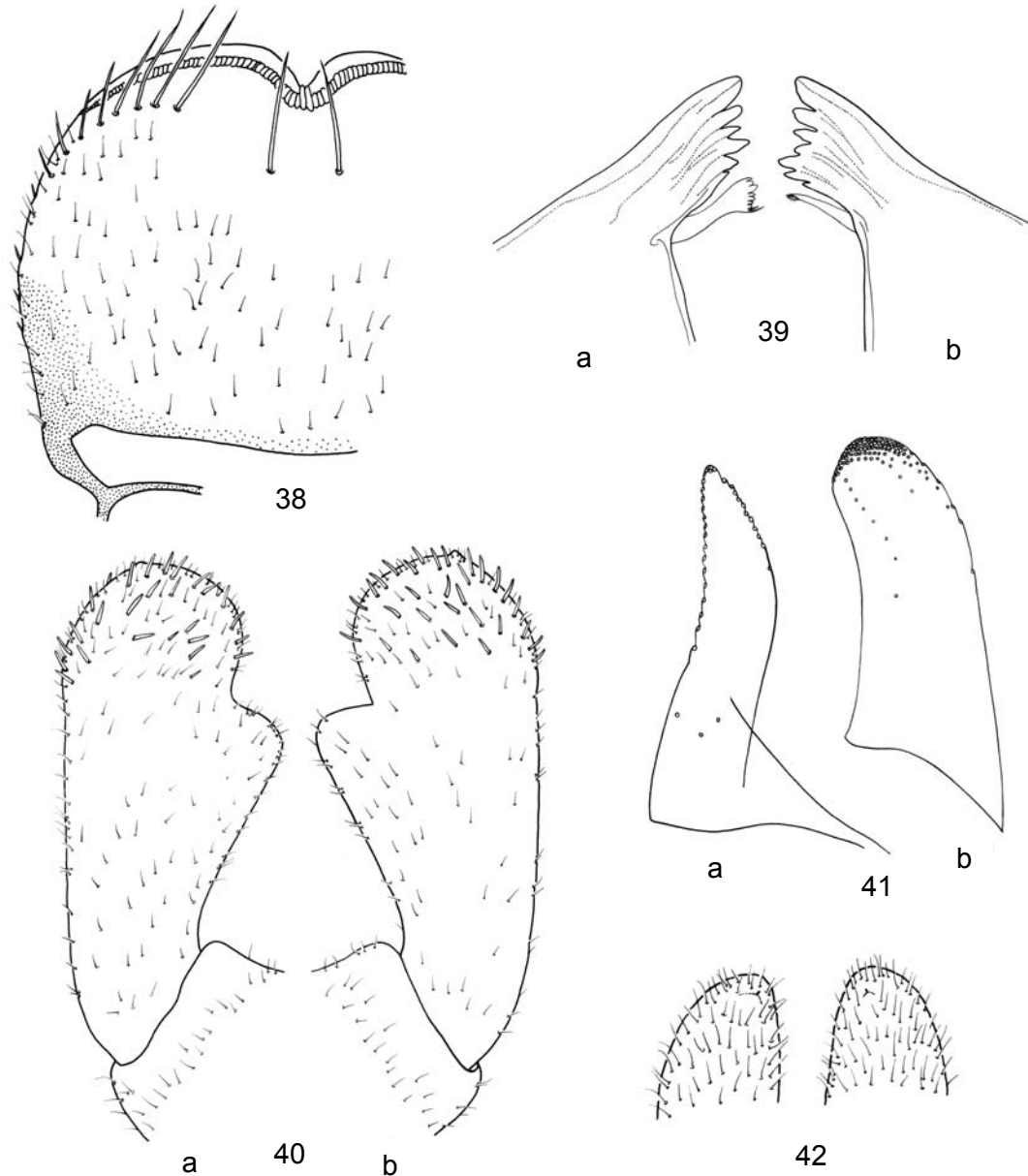


Figures 34–37. *Baetis irenkae* sp. nov., mature larvae. (34) Surface of head; (35) surface of scape; (36–37) surface of pedicel.

symmetric (Figs 51, 52); gills 2–5 distinctly asymmetric, elongate (Figs 53, 54). Outer margin of all gills with row of spines alternating with fine setae (Fig. 50). Inner margin of gill 1 without spines, with fine setae only (Fig. 51). Inner margin of gills 2–7 with 2–8 spines placed in central and distal part (Figs 49, 53, 54). Occasionally gill 7 only with a single small spine proximally.

Paraproct plate with 8–17 marginal teeth, surface with pointed or bluntly pointed spines, robust and apically convergent scales, their semilunar bases and fine setae (Figs 56, 57). Cerci yellowish-brown, distally darker, paracercus shorter by $1/3$ – $2/3$.

Male subimago, female imago and subimago unknown.



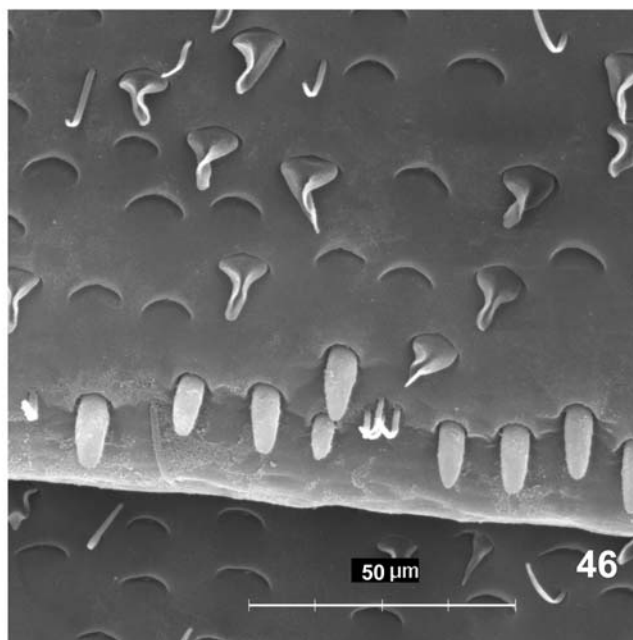
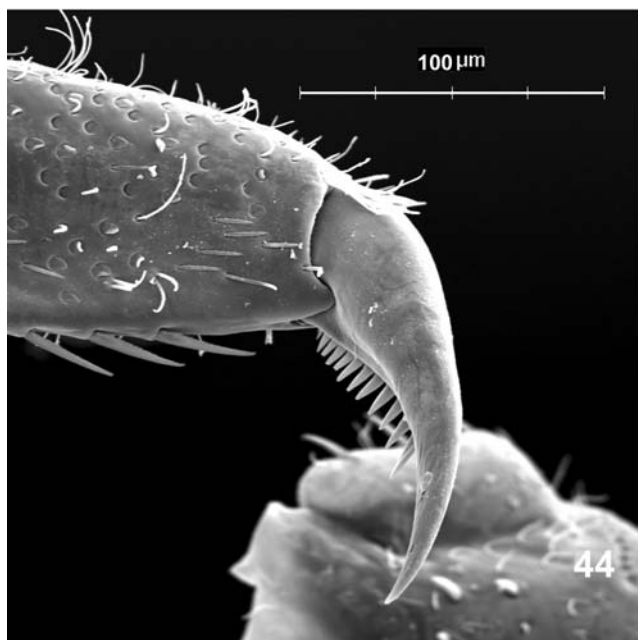
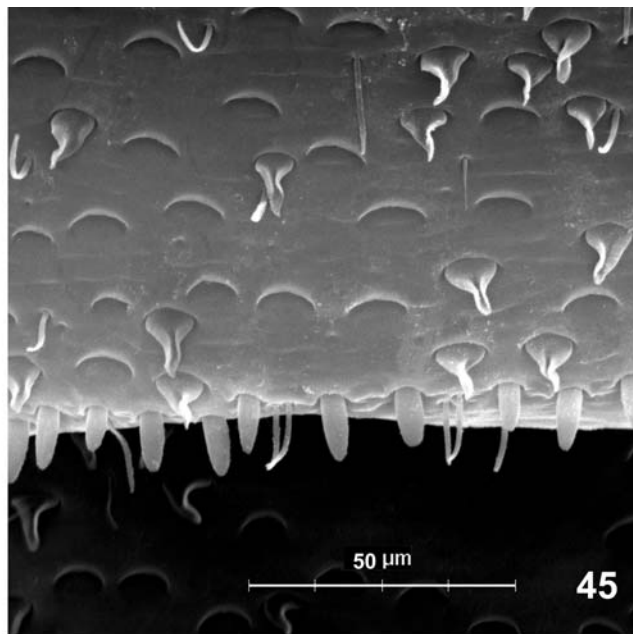
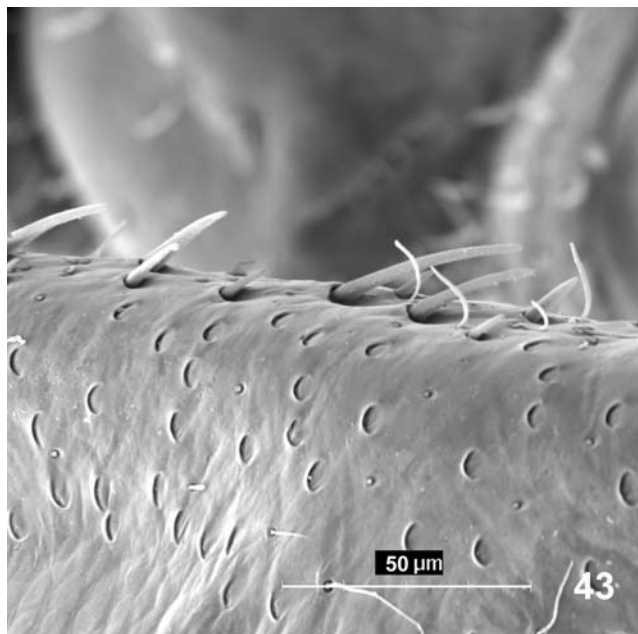
Figures 38–42. *Baetis irenkae* sp. nov., mature larvae. (38) Labrum; (39) left (a) and right (b) mandibular incisors; (40) left (a) and right (b) labial palps; (41) glossa (a) and paraglossa (b); 42 apical portion of the last segment of maxillary palpus.

Types material. Holotype: mature female larva, Cyprus, Lemesos District, Troodos Mts., Kryos Potamos, Kalidonia waterfalls, 1,150 m a.s.l., May 22, 2004. Paratypes: 1 male imago, 228 larvae, same locality and collection date as holotype; 77 larvae, Cyprus, Lemesos District, Troodos Mts., Chantara waterfalls, Foini, 1,050 m a.s.l., May 23, 2004; 23 larvae, Cyprus, Lemesos District, Troodos Mts., Kryos Potamos, Pera-Pedi, 750 m a.s.l., May 23, 2004.

Material examined. 20 larvae, same locality and collection date as holotype; 5 larvae, Cyprus, Lemesos

District, Troodos Mts., Chantara waterfalls, Foini, 1,050 m a.s.l., May 23, 2004.

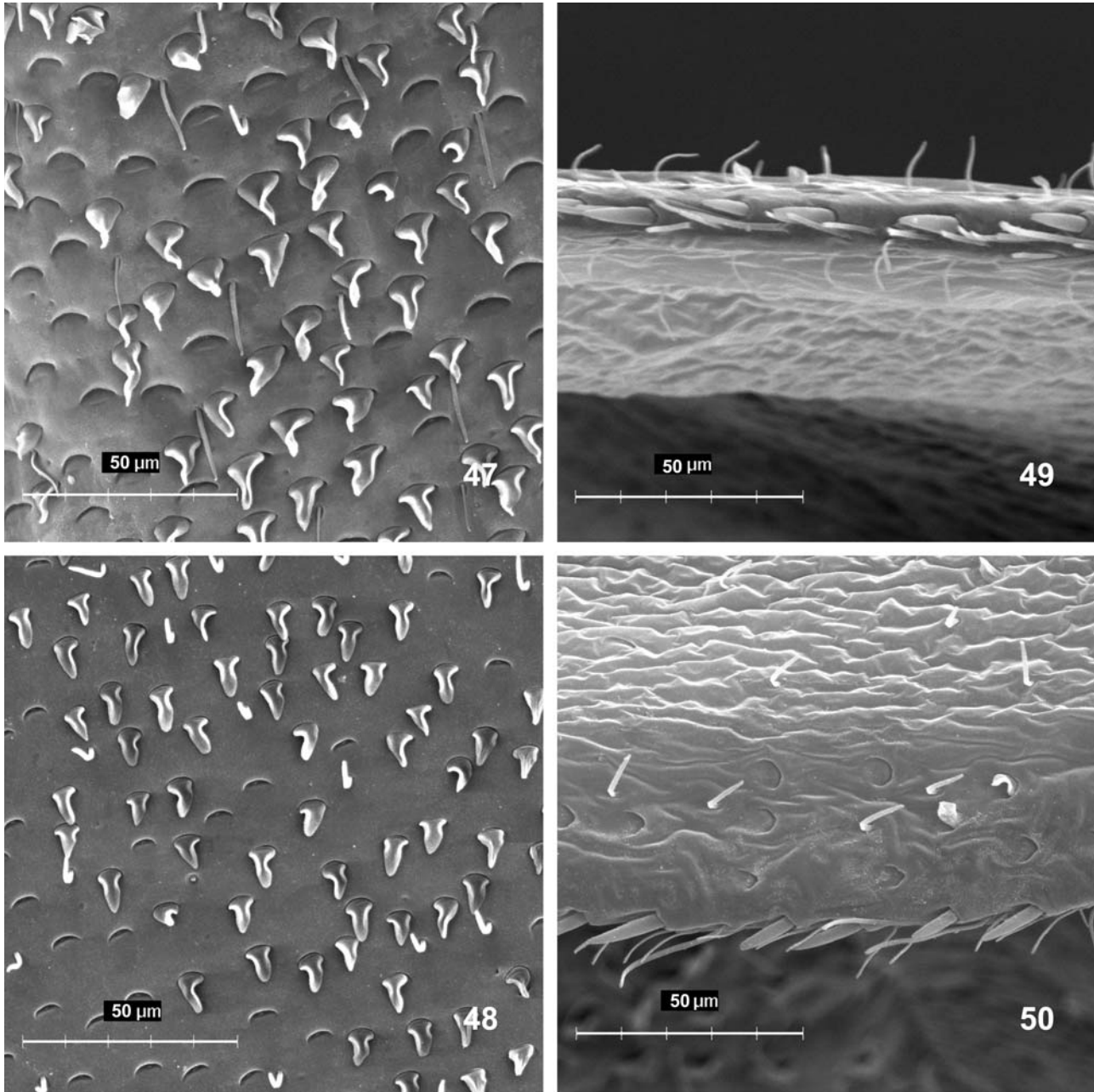
All material (preserved in 70% alcohol) was collected by Irena, Miroslava and Tomáš Soldán. Some of paratypes on slides. Holotype and most paratypes deposited in collection of the Institute of Entomology, Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic, 40 paratypes deposited also in the State Museum of Natural History, National Academy of Sciences of Ukraine, Lviv, Ukraine.



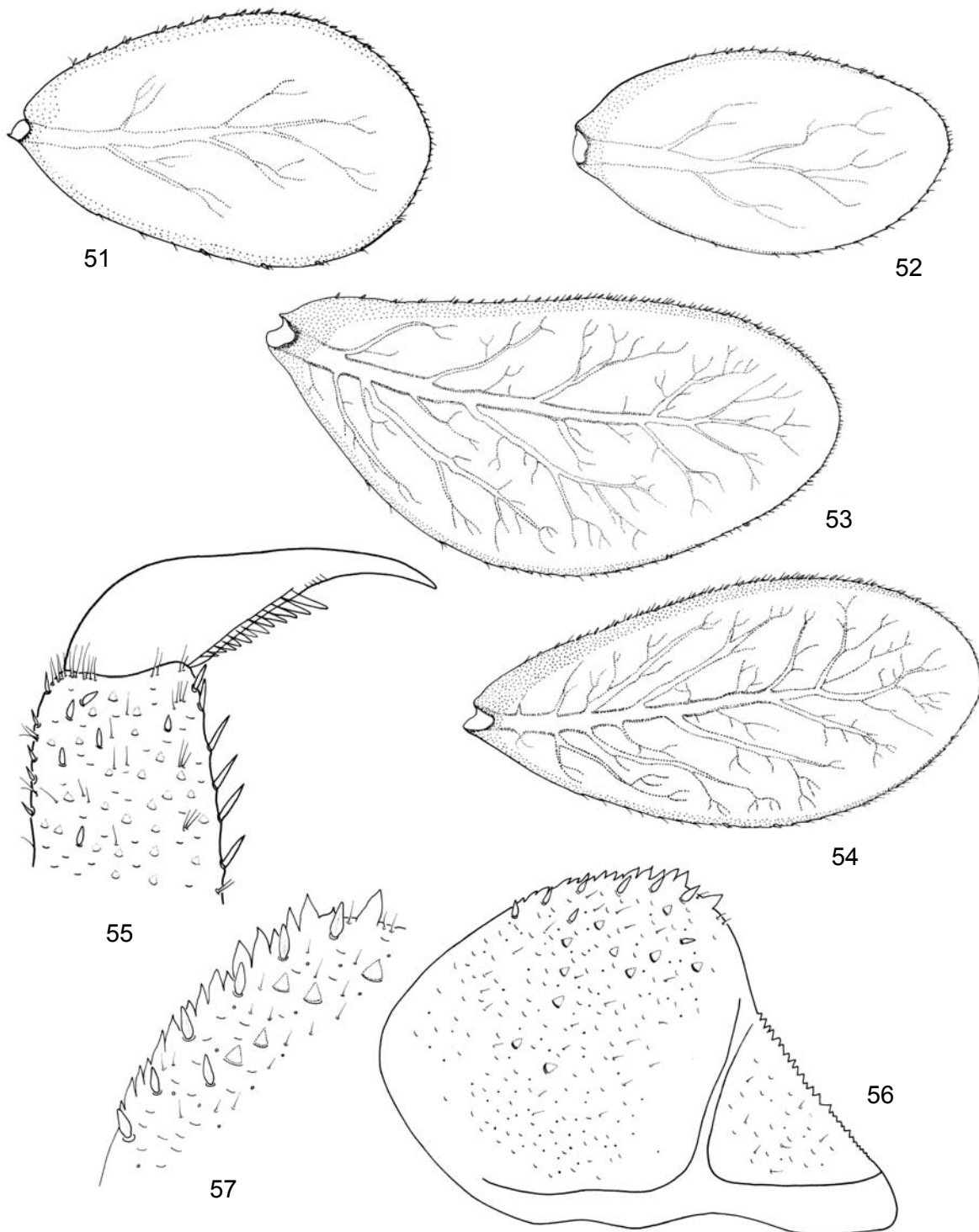
Figures 43–46. *Baetis irenkae* sp. nov., mature larvae. (43) Marginal setae of proximal part of femur; (44) tarsal claw; (45) posterior margin of abdominal tergum III; (46) posterior margin of abdominal tergum VII.

Differential diagnosis and affinities. As noted above, the subgenus *Rhodobaetis* Jacob, 2003 (the name *Rhodobaetis* Kazlauskas (1972: 337–338) is not available according to ICZN Article 13.3., cf. Hubbard, 1979: 1) consists of the original *B. rhodani* species-group as defined by Müller-Liebenau (1969) and now includes also the original *B. pseudothermicus* species-group as defined by Novikova (1987: 80). The critical distinguishing characters of both larvae and imagines of these groups are discussed in details

by Jacob (2003) and Godunko *et al.* (2004b). However, in comparison with originally only two representatives of the *B. rhodani* species-group, namely *B. rhodani rhodani* (Pictet, 1843) and *B. gemellus* Eaton, 1885, *Rhodobaetis* now exhibits very high species diversity, comprising as many as 21 species distinguished already by Jacob (2003), further 3 (+ 1) species which have been described (+ established within the species rank in the case of *B. sinespinosus*) quite recently (Beketov and Godunko 2005, Soldán



Figures 47–50. *Baetis irenkae* sp. nov., mature larvae. (47) Surface of tergum IV; (48) surface of thorax; (49) inner margin of gill 4; (50) outer margin of gill 4.



Figures 51–57. *Baetis irenkae* sp. nov., mature larvae. (51) Gill 1; (52) gill 7; (53) gill 3; (54) gill 5; (55) tarsal claw; (56) paraproct plate; (57) outer margin of paraproct plate.

and Godunko 2005, Soldán *et al.* 2005). Since altogether 26 characters (17 in mature larvae and 9 in male imagines) of 13 species are reviewed in the form of tabular summary by Godunko *et al.* (2004b: 243–246) we have restricted differential diagnosis of *B. irenkae* sp. nov. only to brief comments restricted to the most relative species, namely *B. ilex* Jacob et Zimmermann, 1978 and species described recently not treated in the above mentioned tabular summary.

B. irenkae sp. nov. can be distinguished from all *Rhodobaetis* species described so far by the following combination of characters. In male imago: (1) faceted surface of turbinate eyes orange, surrounded by a whitish ring; (2) shaft of turbinate eyes with broad subapical orange-violet stripe, base with brownish-violet narrow stripe; (3) basal segment of forceps nearly as long as wide; (4) segment 1 of forceps slightly conical; (5) segment 2 of forceps relatively elongate and wide, the widened distal part reaching approximately 1/3 of total length; (6) segment 3 of forceps with distinct truncate inner margin; in larva: (7) shape of scales and spatulas on frons, pedicel and scape surface; (8) labrum relatively wide with 1 + 5–9 submarginal bristles; (9) apical or subapical part of segment 2 of maxillary palps with one small spine; (10) segment 3 of labial palps rounded, slightly asymmetrical, relatively wide; (11) paraglossae with 4–5 regular rows of bristles; (12) external margin of femora with long setae arranged in two or three rows proximally; (13) tarsal arrangement claw with 9–12 teeth; subapical setae are absent; (14) coloration of abdominal terga; (15) *decoration* of posterior margins and surface of abdominal terga; (16) gills 1 and 7 relatively symmetric, gills 2–5 distinctly asymmetric and elongate; (17) gills 2–7 with row of spines on both margins; (18) paraproct plate with 8–17 marginal teeth; (19) paracercus shorter by 1/2–2/3 than cerci.

Besides other characteristics (e.g., relative length of paracercus, presence/absence of subapical setae on claws, see Godunko *et al.* 2004b for details) a key character to distinguish larvae of the subgenus *Rhodobaetis* (except for larvae of only one species, namely *B. gemellus* (Eaton, 1885, *Trans. Linn. Soc. London*, (2) 3: 163, nec sensu Müller-Liebenau 1969, *Gewäss. Abwäss.*, 48/49: 5, cf. Thomas 1999: 24) is the arrangement of gills.

While spines on the outer (external) margin of gills are absent in numerous species (e.g., *B. bisri* Thomas et Dia, 1983, *B. canariensis* Müller-Liebenau, 1971, *B. gadeai* Thomas, 1999, *B. pseudogemellus* Soldán, 1978, *B. pseudorhodani* Müller-Liebenau, 1971 and *B. rhodani rhodani*, representatives of the *B. pseudothermicus* species-group and all of 4 species described or established quite recently) or very rare (e.g., to 1–3 solitary spines in some specimens of *B. baksan* Soldán, 1977), there are only two species within the

subgenus *Rhodobaetis*, namely *B. irenkae* sp. nov. and *B. ilex*, characterized by a presence of the row of pointed spines on both margins of gills 2–7 (Zimmermann 1978, Godunko *et al.* 2004b). The new species can be markedly separated from *B. ilex* by the paler coloration of abdominal terga III–IV (in contrast to dark colored terga in *B. ilex*); relatively wide labrum, with width/length ratio 1.35–1.37 (in contrast to markedly elongated labrum of *B. ilex* with width/length ratio approximately 1.15–1.17; cf. our Fig. 38 and Fig. 3 by Zimmermann and Jacob 1978: 83); relatively wide segment 3 of labial palps (in contrast to slender segment 3 of labial palps in *B. ilex*; cf. our Figs 40a and 40b and Figs 7 and 8 by Zimmermann and Jacob 1978: 83); the presence of mostly 5 rows of bristles on the tip of paraglossae (in contrast to 4 rows in *B. ilex*; cf. our Fig. 41b and Fig. 9 by Zimmermann and Jacob 1978: 83). Further differences can be found also in the number and shape of scales on the scape (relatively numerous small pointed scales and their semilunar bases in *B. irenkae* sp. nov., almost absent elongate scales in *B. ilex*; cf. our Fig. 35 and Fig. 14 by Zimmermann and Jacob 1978: 83) or pedicel surface (mostly rounded apically in *B. irenkae* sp. nov., bluntly pointed in *B. ilex*; cf. our Figs 36–37 and Fig. 14 by Zimmermann and Jacob 1978: 83), in relative length of paracercus shorter by 1/2–2/3 than cerci in *B. irenkae* sp. nov. (longer than 1/2 of cerci in *B. ilex*) and in usual number of tarsal teeth (9–12 in *B. irenkae* sp. nov., 11–18 in *B. ilex*). Otherwise, *B. irenkae* sp. nov. shows some more remote relationships also to *B. baksan* from Caucasus, *B. ingridae* Thomas et Soldán, 1983 from Corsica, and *B. chelif* Soldán, Godunko et Thomas, 2005 from Algeria (see Godunko *et al.* 2004b for details of critical distinguishing characters of these species).

Unfortunately, imagines cannot be compared since those of *B. ilex* remain unknown (similarly, adult stage of further species, i.e. *B. bisri*, *B. ingridae*, *B. khakassikus* Beketov et Godunko, 2005 and *B. pseudogemellus* also have not been described). Adults of *B. irenkae* sp. nov. are distinguished from most species mainly by color of turbinate eyes (e.g., except for *B. milani* Godunko, Prokopov et Soldán, 2004 and *B. rhodani tauricus* Godunko et Prokopov, 2003), by the presence of marginal ring on faceted surface of turbinate eyes (eyes without ring in *B. canariensis*, *B. chelif*, *B. gadeai* and *B. pseudorhodani*) and especially very short expanded distal part of segment 2 of forceps reaching approximately only 1/3 of its total length (1/2–2/3 of total length of segment 2 in other species). For more detail, see tabular summary of adult male characters by Godunko *et al.* (2004b).

Biology. Not known in detail. Larvae have been collected only at submontane and montane streams within the island. They showed the highest density, being apparently dominant in their quantitative presentation

(about 30%) within the mayfly standing crop at the type locality. Larvae evidently preferred the places of streamline or those with moderate to fast current velocity (more than about 20–50 cm.s⁻¹) living solely on stony substrates (lithal) at depth of 5–40 cm. They were collected only at localities exhibiting relatively higher mayfly diversity (and other benthic insects as well), i.e. collected together with those of *Epeorus* (*Ironopsis*), *Electrogena*, and *Baetis* (*Baetis* s. str., *Nigrobaetis*). Flight period undoubtedly in May–June, about 1/3 of more than 200 larvae collected were ready to emerge. Nevertheless, quantitative presentation of young and half-grown larvae was relatively very high (about 50%). This indicated either protracted flight period or second generations in late summer. Subimagines emerged in early afternoon.

Distribution. So far known only from the Kryos Potamos [river], Pera-Pedi (750 m), Chantara waterfalls [stream], Foini, 1,050 m a.s.l., and the type locality, Kryos Potamos [stream] at Kalidonia waterfalls, elevation of 1,150 m a.s.l in the Troodos Mts, Lemesos District, Cyprus.

Distribution and biogeographical analysis of Palaearctic representatives of the subgenus *Rhodobaetis*. Fundamental distributional data of most species (exactly 22 of 26, i.e. those described/re-described before the end of 2004) of the subgenus *Rhodobaetis* have been summarized by Godunko *et al.* (2004b: 241–243, see this paper also for detailed list of references). Consequently, we have concentrated, within these paragraphs, rather to classification of respective species into groups with respect mainly to their area size, trying to describe also the area of species described after 2004. However, true distribution of some species, like, e.g., *B. gemellus*, *B. chelif*, and *B. khakassicus* still remains poorly known so that their classification is preliminary, and these possible “endemites” might exhibit in fact much larger area. That is why we prefer to wait until further area records are published to evaluate most species of *Rhodobaetis* from the faunistic elements and distributional routes approach. For the same reason we omitted to evaluate extralimital species, not taking into account that *Rhodobaetis* is evidently distributed also at least in the Oriental region (and most probably also in the Afrotropic region, some Australian species can be classified very close to *Rhodobaetis* as well). For instance, there is unclear (if even valid) Oriental species *Baetis noshaqensis* Uéno, 1966 (Res. Kyoto Univ. Sci. Exp. Karakoram and Hindukush, 8: 316) living also in Palaearctic Afghanistan and further species showing the same relationship from North India (see species-list by Hubbard and Peters 1978) or Taiwan (cf. Kang *et al.* 1994) or species examples cited by Jacob (2003). From the point of view of recent knowledge, the following area size categories can be distinguished, as follows

(ranged in the sequence according to decreasing area size):

(1) Species with very large areas. There is the only species, namely *Baetis bicaudatus* Dodds, 1923 distributed in more than a single biogeographic area. Holarctic species, in the Nearctic showing western boreal distributional type (Moriyama and McCafferty 1979) as defined by Allen (1973) and Edmunds *et al.* (1978). It is distributed from British Columbia and Alberta to New Mexico showing quite conjunctive area. In the Palaearctic, in northern part of Asia, originally collected in the Far East of Russia (Tshernova *et al.* 1986) later found all over Siberia with the area extension to northern Ural (Kluge 1997) and Japan, Hokkaido, Honshu (Ishiwata 2001), south to Mongolia (Enkhtaiwan and Soldán 2008). This species seems to be of the polycentric origin with undoubtedly postglacial migration route however the direction of which remains unclear. Perhaps, its Nearctic-Palaearctic direction is more likely than Palaearctic-Nearctic one owing to the Palaearctic area restricted to the easternmost parts of the realm a historically continuing westward extension while, on the other hand, the Nearctic subarea is more or less conserved for a long time.

(2) Species with large area, Transpalaearctic or Palaearctic one. At present there is the only species that can be classified within this group, namely *B. rhodani rhodani*, however the subspecific status of some populations (at least those from eastern area part) remains unclear and most of *Baetis* species having larvae with marginal spines were (and still are in some cases) indiscriminately named *Baetis “rhodani”*. Palaearctic distributional type was supposed also Jacob (1972, 1979), Malzacher (1981), Haybach (1998, 2003), Studemann *et al.* (1992), Sartori and Landolt (1999) and Soldán and Zahrádková (2000) considered the species West-Palaearctic or Eurosiberian only. There is no doubt that the species is widely distributed all over continental Europe and adjacent areas. It has been recorded from the whole Fennoscandia (including Fennoscandian parts of Russia) in the north, really all European countries (except for Monaco, Vatican and San Marino) including the British Island and numerous Mediterranean Sea island (Balearic Island, Sicily, Corsica and Sardinia, Crete and some other islands in the Aegean Sea). Some still not revised findings are recorded also from Morocco, Algeria, Tunisia, Turkey, Iraq, Syria and Afghanistan (cf. e.g., Jacob 1972, 2003, Puthz 1978, Haybach 1998, Godunko *et al.* 2004b and Soldán and Zahrádková 2000, the latter for a detailed list of references). Western area limits lie undoubtedly in the island of Madeira; earlier findings and actual distribution of these population are summarized and treated by Soldán and Godunko (2005). The species is evidently missing in the Azores (cf. Brinck and Sherer 1961) and its distribution on some Mediterranean

islands and North Africa might concern some other species of *Rhodobaetis*. The species seems to be distributed in Turkey (Kazanci 1984) but its occurrence in Asia Minor and the Caucasus remains unclear, for the same reason. Eastern area limits are unknown, *B. rhodani rhodani* is reported from the Ural Mountains (Kluge 1997) and from the Kamtchatka Peninsula (Levanidova 1972, 1982 and Tshernova *et al.* 1986) but the latter records seems to be unlikely and needs a revision.

B. rhodani is an arboreal faunistic element (Soldán and Zahrádková 2000), belonging to most abundant and wide-spread mayfly species in Europe. Although the faunistic centre of its distribution can be hardly identified and its polycentric character is very likely (cf. Haybach 1998, 2003), and the species probably spread from numerous refuges in south Europe area northwards, following the withdrawing last glaciation. It simultaneously might colonized North Africa and possibly some portion of the Middle East area.

As noted above, there are evidently several subspecies of this polytypic species, most of them yet to be described. For instance, one yet known, *B. rhodani tauricus* Godunko et Prokopov, 2003 has been identified recently in the Crimean Peninsula (see Godunko and Prokopov 2003 for list of localities). On the other hand, the populations from Madeira definitively belong to the nominotypic subspecies, because there are no morphological differences either in larvae or imagines (Soldán and Godunko 2006).

(3) Westpalaeartic species with presumably larger areas. Besides *B. rhodani*, provided that its area is Westpalaeartic, there are, first of all, two species, the distribution of which remains unclear, namely *B. gemellus* and *B. gadeai* Thomas, 1999. The former, originally described from the Alps in Italy, France and Switzerland (type locality Champéry, 4000 ft, Wallis, Switzerland, "A common alpine species..." according to Eaton 1885: 166), was later synonymized with *B. rhodani rhodani*. Then removed from synonymy by Müller-Liebenau (1969) on the basis of study of the material from France and Romania. However, she apparently did not compare this material with the lectotype in the collection of the British Museum (Natural History) in London (designated by Kimmins 1960: 288). Since these populations originated from localities about 2,000 km apart, they might not be conspecific and, moreover, according to Thomas (1999), Müller-Liebenau's (1969) redescription concerns different species (newly named *B. gadeai*) than "true" Eaton's *B. gemellus*. So far, nobody has managed to collect "true" *B. gemellus* at any of the original Eaton's localities. Comparison of type material has never been done, and the relationships of both (most probably sympatric) species, i.e. *B. gemellus* and *B. gadeai*, with remaining known populations of "*B. gemellus*"

remains unclear (some of them might even belong to quite different species of *Rhodobaetis*). Similarly to *B. rhodani*, also the name *Baetis gemellus* has been indiscriminately applied to all species for which the larvae of which possess no or few gill margin spines.

According to Thomas (1999), *B. gadeai* is abundant and frequent in the Pyrenées in France and Spain, e.g., from Rio Gallego of the latter country (type locality of *B. gadeai* is "Gave de Brousset (Vallée d'Ossau) à 1400 m"). The species might be endemic to this area as suggested by Thomas (1999). Due to the still opened question of true identity of "*B. gemellus*", all other distributional data, which might actually represent different species, should be checked. Provided that both species are conspecific, the species is distributed from the Iberian Peninsula (Puig 1984, Müller-Liebenau 1974, Alba-Tercedor and Jáimez-Cuéllar 2003), Italy (Gaino and Spanò 1979), Switzerland (Sartori and Landolt 1999) through the Alps, Central European Highlands (Puthz 1978, Soldán 1978), Balkan (Galdean 1992, Russev 1993) to Turkey and the Caucasus (Gori and Tbilisi in Georgia) (Kazanci 1984, Zimmermann 1981) occurring also in Fennoscandia (Engblom 1996). Distribution type is unclear, but Haybach (1998) suggested a possible holoalpine origin.

(4) Central Asian species include two subgroups. The first one (Central Asian species s. str.) seems to be restricted mostly to Kyrgyzstan, Kazakhstan, Uzbekistan and Tajikistan involving *B. issyksuensis* Brodsky, 1930, *B. mycetopsis* Brodsky, 1930, *B. heptapotamicus* Brodsky, 1930, and *B. oreophilus* Kluge, 1982 (see Kluge 1982, 1983 and Novikova 1987 for list of localities and references). The second group, that might be called also Euro-Westasian species, evidently shows western area extension at least to Crimea involves *B. braaschi* Zimmermann, 1980, originally considered the Crimean endemite (see Godunko and Prokopov 2003 and Godunko *et al.* 2004a, 2004a for a complete list of respective localities and references no all of these species). Faunistic origin of them is rather unclear. Although all of them seem to be monocentric, the origin from any of the Asian faunistic centres (i.e. from the Eurosiberian, Mongolian, and Amur one) defined by Haybach (2003) is probably unlikely. Moreover, these species might represent an eremial faunistic element (the element strange to most Palaeartic representatives of the order) colonizing higher elevations secondarily within early postglacial period.

(5) Eastpalaeartic species involve mostly representatives of the *B. pseudothermicus* species-group consisting of *B. thermicus* Uéno, 1931, *B. pseudo-thermicus* Kluge, 1983, and *B. silvaticus* Kluge, 1983. The former species, originally considered a widely distributed Japanese endemite (Hokkaido, Honshu, Shikoku, Kyushu and Okinawa), is now reported also from Russia (Kuril Islands) and Korea (Ishikawa 2001)

the latter two species have been described from the Primorie Territory of Russia Federation. Actual area size and/or possible degree of endemism of these species remain unknown in detail; all substantial data published so far (including lists of localities) have been summarized by Kluge (1983) and Novikova (1987).

(6) The Westpalaeartic species “sensu stricto”, i. e. Macaronesian endemites, namely *B. canariensis* and *B. pseudorhodani* known only from the Canary Islands, Spain and *B. atlanticus* Soldán et Godunko, 2006 restricted to the island of Madeira, Portugal. The former two species have been collected only in Tenerife, La Palma, La Gomera, and Gran Canaria. The other Canary Islands were apparently not colonized, due to lack of respective running waters. Complete lists of all respective localities have been presented by Müller-Liebenau (1971, 1973), Alba-Tercedor *et al.* (1987), Malmquist *et al.* (1993), and Alba-Tercedor and Jáimez-Cuellar (2003) or Soldán and Godunko (2006), respectively. Concerning the occurrence other *Baetis* species in this area, only species actually living in the Canary Islands is *B. nigrescens* of the *B. lutheri* species-group (spread also in the Iberian Peninsula and Maghreb, see above).

The earlier Eaton's (1885: 186) record on the *Baetis rhodani* imagines occurrence in Tenerife might in fact concern *B. canariensis* (rather than *B. pseudorhodani*), earlier records on *B. pseudorhodani* in Madeira by Stauder (1991, 1995) represent a misidentification for *B. atlanticus* (cf. Soldán and Godunko 2006). As noted above, “true” *B. rhodani* does not live in the Canaries while it does mostly in higher elevation in Madeira.

(7) Endemic species, or, more precisely, species with distribution still unknown in detail. These endemites, if really so, can be characterized in roughly three subgroups according to position of their really small area within the Palaeartic region which in fact follows the species with larger areas, namely Westpalaeartic (3), Central Asian (4) (here the area shifted to Caucasus and Westmediterranean) and East Palaeartic (v).

The first subgroup (a) consists of westernmost species, namely *B. sinespinosus* Soldán et Thomas, 1983 and *B. chelif* Soldán, Godunko et Thomas, 2005, and shows their area in the West-Palaeartic (Maghreb). Contrary to the latter species known only from the type locality in Algeria, the latter one, *B. sinespinosus* undoubtedly possesses much larger area being known from the humid zone of the Atlas (Atlas Tellien) in Algeria but completely missing in subarid zone (Hautes Plateaux, Atlas Saharien) (see Soldán and Thomas 1983 for list of localities). There is no doubt that at least some findings determined as *B. rhodani* and *B. rhodani sinespinosus* e.g., by Kráinem (1986, Bull.

Mens. Soc. Lin. Lyon, 55, 3: 96), Boumaïza and Thomas (1986, Arch. Inst. Pasteur Tunis, 63, 4: 567) or Gagneur and Thomas (1988, Bull. Soc. Hist. Nat. Toulouse, 124: 213) might actually belong just to *B. sinespinosus* and the presence of “true” *B. rhodani*, although very likely in this area, should be re-evaluated.

The second subgroup (b) involves Mediterranean endemites, namely *B. ingridae* from Corsica, *B. bisri*, from Lebanon, and *B. irenkae* sp. nov. from Cyprus. Degree of their endemism remains unknown, but all of them are known only from their type localities or other localities very nearby.

Additionally, there are two species of *Rhodobaetis* considered the Caucasian endemites. *B. illex* shows a little larger and quite conjunctive area, being known from numerous localities in Central Caucasus (Russia), and from Georgia and Armenia (Jacob and Zimmermann 1978). On the contrary, *B. baksan* is known from the area somewhat restricted mainly by the Teberda River basin at the northern slopes of Caucasus. However, these species have been found also in northern Iraq, in the Euphrate (Firat) River basin, at the localities quite isolated by geographical barriers from the north slope of Caucasus (Al-Zubaidi *et al.* 1987). If the respective material really represents this species (identification presented preliminary, cf. Al-Zubaidi *et al.* 1987: 180, “*Baetis* ex gr. *rhodani*”), then the explanation of disjunctive area might be offered. On the other hand, this “disjunctivity” can be simply explained also by a lack of knowledge, as shown in numerous representatives of *Rhodobaetis*.

The third subgroup consists of a single species, *B. khakassicus* known only from the Republic of Khakassia, Russian Federation. This species represents the first *Rhodobaetis* discovered in Siberia or Russian Far East/Japan. Due to a relatively low level of knowledge, further species might be expected in this area.

The remaining Palaeartic species, *B. pseudogemellus*, however in fact living in the transitory Palaeartic-Afrotropic region seems to be a little isolate with respect to its rather remote area. There are no more data except those concerning the type locality, Mist oasis Erkwit on the coast of the Red Sea in Sudan (cf. Soldán 1977).

To conclude, we really wish the research on biogeography of *Rhodobaetis* to continue. There is no doubt that postglacial radiation (or recovery from respective refuges) was extremely intensive just in *Rhodobaetis*. This can be documented by an extreme increase of knowledge within the second half of the past century. Initiated by only two representatives of this original *Baetis rhodani* “species-group” (Müller-Liebenau 1969) enriched immediately by the Canary Islands endemites (Müller-Liebenau 1971), the group comprised 6 representatives soon (Jacob and Zimmermann 1978) up to reaching 26 species involved at

present. Thus the subgenus represents a very suitable model also for phylogeographic studies since post-glacial radiation of “subgroups” seems to be quickly followed (at least as to the chorology is concerned) by respective “series of endemites”.

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