Zootaxa 4175 (1): 043–056
http://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://doi.org/10.11646/zootaxa.4175.1.4
http://zoobank.org/urn:lsid:zoobank.org:pub:C3EAF8D4-A0EE-4B32-9198-8B9BA4D57352

The larvae of *Micropterna coiffaiti* Décamps 1963, *Micropterna taurica* Martynov 1917, and *Potamophylax goulandriorum* Malicky 1974 (Trichoptera: Limnephilidae), including a key to the hitherto known Stenophylacini larvae of the Hellenic western Balkan region

JOHANN WARINGER[1] & HANS MALICKY[2]

[1]*Department of Limnology and Bio-Oceanography, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria. E-mail: johann.waringer@univie.ac.at*
[2]*Sonnengasse 13, A- 3293 Lunz am See, Austria*

Abstract

The paper gives a description of the hitherto unknown larvae of *Micropterna coiffaiti*, *Micropterna taurica*, and *Potamophylax goulandriorum* (Trichoptera: Limnephilidae). Information on the morphology of the larvae is given and the most important diagnostic features are illustrated. In the context of published keys, the larva of *Micropterna coiffaiti* keys together with *Micropterna sequax*, *Stenophylax mitis*, and *Stenophylax permistus*. Species can be easily diagnosed by presence/absence and the structure of posterior sclerites at the lateral protuberances, by the extent of head spinule fields, and by the number of posterolateral setae on abdominal dorsum IX. *Micropterna taurica* keys together with *Micropterna nycterobia*. This pair can be separated by the setae posterior of the dorsal protuberance which are lacking in *M. nycterobia* but present in *M. taurica*. Finally, *Potamophylax goulandriorum* keys together with *P. cingulatus*, *P. latipennis*, and *P. luctuosus*. Currently it is not possible to separate this species quartet morphologically. With respect to distribution, *M. coiffaiti* which has been reported from the Eastern Aegean islands in Greece, the Levant, Turkey, and Cyprus, whereas *M. taurica* ranges from Bulgaria and Greece (Crete, Karpathos, mainland Greece) to Cyprus and Turkey. *Potamophylax goulandriorum* is known from mainland Greece and Macedonia only. In addition, ecological characteristics are briefly discussed, and a key to the hitherto known Stenophylacini larvae of European Ecoregion 6 (= Hellenic western Balkan region) is included.

Key words: 5th instar larvae, description, identification, distribution, caddisfly

Introduction

Despite recent tendencies to synonymize genera *Micropterna* Stein 1874 and *Stenophylax* Kolenati 1848, the valid status of the former genus has been retained by Malicky (2004, 2005) and in other European and national records (*e.g.*, Graf *et al.* 2008; Ibrahimi *et al.* 2013) because frequent changes of long-accepted names are deemed to be detrimental to the consistency of species lists and the aspired stability in nomenclature. Nevertheless, the monophyletic status of both genera has still to be evaluated. Based on this decision, Malicky (2004, 2005) listed 17 valid European species of genus *Micropterna*, some of them brachypterous (*e.g.*, *M. baduka* Mey & Müller 1979). In the context of larval taxonomy, we are aware of larval descriptions of only the following four species: *Micropterna lateralis* (Stephens 1837), *M. nycterobia* McLachlan 1875, *M. sequax* McLachlan 1875, and *M. testacea* (Gmelin 1789) (Wallace *et al*. 2003; Waringer & Graf 2011; Sáinz-Bariáin & Zamora-Muñoz 2012). A key for the identification of *Stenophylax* (including *Micropterna*) larvae of the lberian Peninsula was presented by Sáinz-Bariáin & Zamora-Muñoz (2012). In addition, *M. fissa* McLachlan 1875 has been briefly described and figured by Moretti (1983), but this information does not allow inclusion of the species in existing keys. The remaining *Micropterna* species are still unknown in the larval stage. Within genus *Potamophylax* Wallengren 1891, 18 species were included in the "Atlas of European Trichoptera" of Malicky (2004, 2005) and another 13 species were described since then by Oláh *et al*. (2011, 2013) and Oláh & Kovács (2014). Within this genus, the larvae of

Accepted by J. Morse: 8 Sept. 2016; published: 12 Oct. 2016

nine species are known so far (Higler & Solem 1986; Higler 2005; Lepneva 1966; Wallace *et al*. 2003; Waringer & Graf 2011; Waringer *et al*. 2013).

Several years ago co-author Hans Malicky managed to collect fifth instar larvae, pupae and many adults of both sexes of *Micropterna coiffaiti* Décamps 1963, *M. taurica* Martynov 1917, and *Potamophylax goulandriorum* Malicky 1974 on the Greek islands of Rhodes and Crete and on the Olympian massif on the Greek mainland. This material enabled us to infer reliable diagnostic characters for the larval descriptions and to use this information for the construction of a key to the hitherto known Stenophylacini larvae of the Hellenic western Balkan region.

Material and methods

Larval and adult material was sampled by Hans Malicky at the following locations and dates: *Micropterna coiffaiti* Décamps 1963: Greece, Rhodes, west of Profitis Ilias, sinter spring (27°56'E, 36°16'N, 500 m a.s.l.) on 3 March 1982; *Micropterna taurica* Martynov 1917: Greece, Crete, near Spili (24°34'E, 35°12'N, 700 m a.s.l.) on 26 April 1971; *Potamophylax goulandriorum* Malicky 1974: Greece, Olympian massif, east of Karia, (22°26'E, 40°00'N, 800 m a.s.l.) on 20 July 1974. Adults were collected using an aerial hand net and a light trap, and a hand net was used to collect the larvae. The material was preserved in 70% ethanol. The larvae were studied and photographed using a Nikon SMZ 1500 binocular microscope with DS-Fi1 camera and NIS-elements D 3.1 image stacking software for combining 8–39 frames in one focussed image. Species association was enabled by the well-known, distinct distribution patterns of the three species in Europe (*M. coiffaiti*: only on the easternmost Greek islands closest to the coast of Asia Minor; *M. taurica*: Crete, Karpathos, and two locations on the eastern Greek mainland; *P. goulandriorum*: mountains of the Greek mainland), preventing confusion with other closely related species and the fact that mature larvae, pupae, and adults were collected at the same locations. The larvae used for the descriptions are deposited in the collection of J. Waringer (Vienna, Austria); further larval, pupal and adult material is stored in the collection of H. Malicky (Lunz am See, Austria). We used the morphological terminology by Wiggins (1998), Wallace *et al*. (2003), and Waringer & Graf (2011). In addition, 3 to 7 specimens of each species listed in Table 1 (collection of J. Waringer, Vienna, Austria) were used as comparative material.

Results

Description of the fifth instar larva of *Micropterna coiffaiti*

Biometry. Body length of final instar larva ranging from 12.5 to 20.9 mm, head width from 1.60 to 1.77 mm (n = 4).

Head. Head capsule smooth, oval in shape and hypognathous with orange brown to medium brown coloration. Muscle attachment spots on frontoclypeus and parietalia moderately distinct (Figs. 1–2). With roundish area of head spinules dorsal of each eye at setal positions 13–16 (nomenclature by Wiggins 1998; Fig. 2, dotted oval). Yellowish ring present around eyes (Fig. 2). Head capsule with complete set of 18 pairs of primary setae (Figs. 1, 3); along coronal suture, with two additional pairs of setae (Fig. 1: x, y). Frontoclypeus bell-shaped, with narrow central constriction (Fig. 1). Antennal base roundish, situated halfway between eye and anterior head margin (Fig. 1, white arrow). Antennae short, each consisting of 1 short cylindrical base and 1 short flagellum. At each parietal, 10 dorsal and 2 ventral primary setae present, with setae #5, 9, and 14 long and conspicuous (Fig. 1). Each side of frontoclypeus with 6 primary setae, 3 of them along anterior border (#1–3). Labrum medium brown, with setal brush and primary setae #1–3 at anterolateral margins and primary setae #4–6 on dorsal area (Figs. 1, 2). Ventral apotome amphora-shaped, medium brown with dark anterior center; postgenal suture approximately 20–25% of apotome length (Fig. 3). Each mandible with 5 terminal teeth along its edge (some of them visible in Fig. 2); in addition, ridges present in central concavity. Mandible base black, sometimes each with paler terminal section (Fig. 2).

Thorax. Pronotum yellowish brown with medium brown muscle attachment spots and with smooth surface (Figs. 4, 5). Its posterior and postero-lateral margins thickened and darkly striped (Fig. 4). Pronotal transverse groove at end of anterior 3rd distinct (Fig. 4b). Along anterior border three setal rows present: (1) dense fringe of

short, curved, fine, yellow short setae (Fig. 5c); (2) widely-spaced, continuous row of intermediate curved, pale setae (Fig. 4d); and (3) widely-spaced, continuous row of long, straight, dark setae (Fig. 4e). In total, 65–70 setae of varying lengths distributed over each pronotal half. Prosternal horn present (Fig. 4a). Central pentagonal prosternite conspicuous and medium brown, with darker posterior half (Fig. 6);

Mesonotum completely covered by 2 yellowish brown sclerites; their posterolateral and posteromedian margins darkly sclerotized (Fig. 5). Counts for mesonotal setae on each sclerite are as follows (nomenclature *sensu* Wiggins 1998): anterior setal group *sa*1: 15–18, posterior group *sa*2: 22–25, lateral group *sa*3: 30–35.

Metanotum partially covered by 3 pairs of yellowish brown sclerites with dark brown muscle attachment spots (Fig. 7). Anterior metanotal sclerites (sclerites of setal area 1, or *sa*1 *sensu* Wiggins 1998) narrow and transversally elongate; their intermediate separation slightly smaller than length of each of them (Fig 7); with 18–23 setae per sclerite. Posterior metanotal sclerites (sclerites of setal area 2, or *sa*2 *sensu* Wiggins 1998) broadly triangular, with 12–15 setae per sclerite and dense group of setae between them. Lateral metanotal sclerites (sclerites of setal area 3, or *sa*3 *sensu* Wiggins 1998) narrow, elongated and curved, each with approximately 25 setae concentrated at anterior third of sclerite (Fig. 7). Large setal group present between each lateral (*sa*3) and posteromedian sclerite (*sa*2) (Fig. 7).

Legs yellowish brown with dark brown muscle attachment spots and numerous setae on coxae, trochanters, and femora (Figs. 8–10); tibiae and tarsi with only small number of setae; all femora each with only 1 proximodorsal seta present (Fig. 9, black arrow; in Fig. 10, this seta lost from photographed specimen). Coxa, femur, and tibia of each foreleg much wider than those of mid- and hind legs. Additional setae present on anterior and posterior faces of mid- and hind femora (*e.g.*, Fig. 9, white arrows) not restricted to ventral third of respective femur. Ventral trochanteral brush at distal section of each trochanter present on all legs. Groups of additional setae present at proximal section of all trochanters (Fig. 11, black arrows). Rows of minute spines present along ventral edges of femora; pairs of ventral-edge setae pale on fore femora, but dark on mid- and hind femora (Figs. 8–10).

Abdomen. Abdominal segment I with 1 dorsal and 2 lateral fleshy protuberances (Figs.7, 12). Dorsal setal areas *sa*1, *sa*2, and *sa*3 (*sensu* Wiggins 1998) fused, thereby creating continuous transverse row of setae on small basal sclerites anterior to dorsal protuberance (Figs. 7, 12); without setae posterior to dorsal protuberance (Fig. 12). Without posterior sclerites on lateral protuberances (Fig. 12, black arrow). On abdominal sternum I, setal areas *sa*1 and *sa*2 fused, creating continuous central field of setae, many of them with medium-sized, brown basal sclerites widely separated from each other; setal areas *sa*3 situated ventral of lateral protuberances and separated from *sa*1 and *sa*2 (Fig. 13). On abdominal dorsum VIII, number of posterodorsal setae (*pds*) typically 16, with 6 long and remainder short (Fig. 14 pds). Only 1 posterolateral seta present on each half of abdominal dorsum IX (Fig. 15, black arrow).

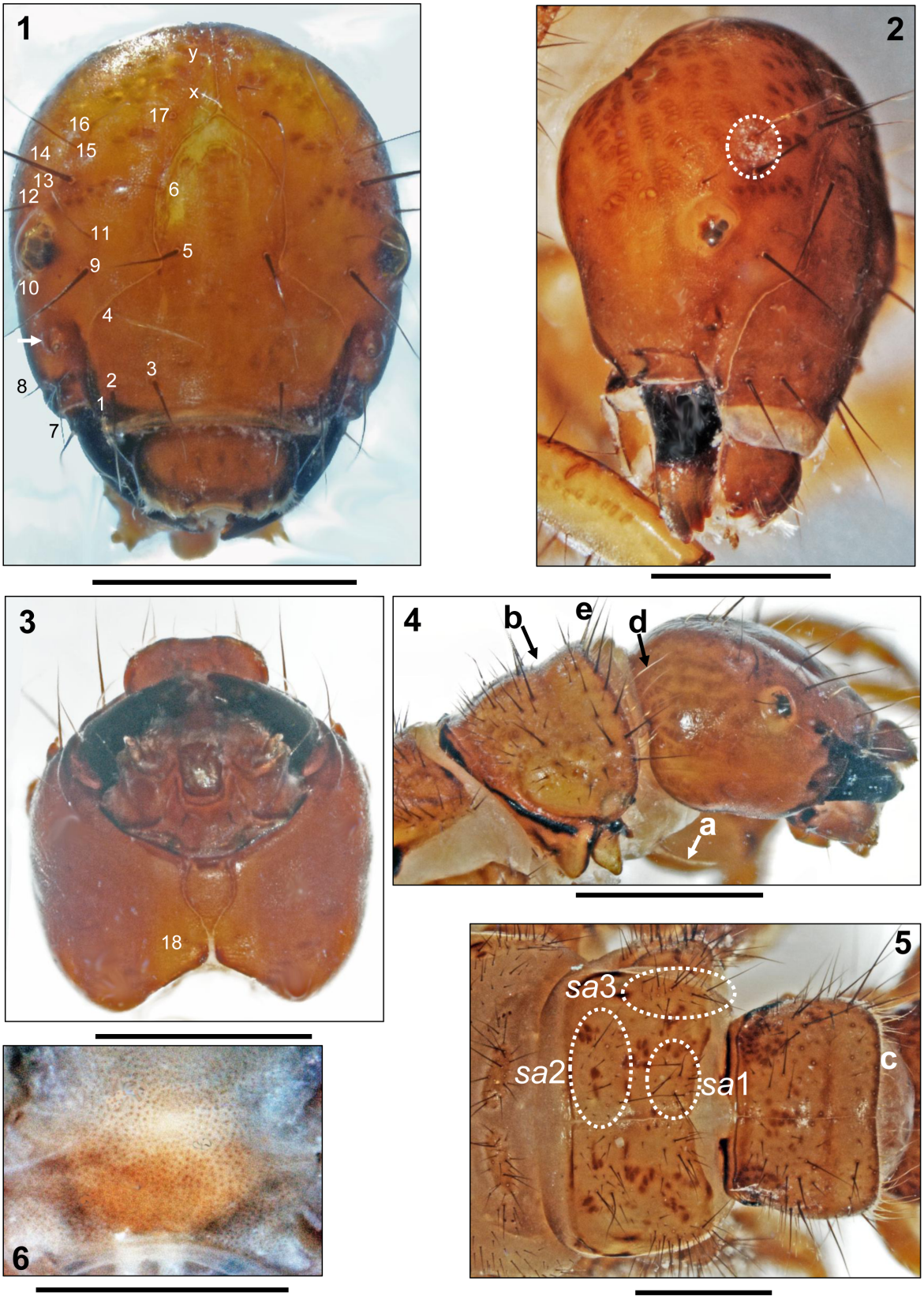
All gills single filaments (Figs. 12, 13). Dorsal gills present at most from 2nd segment (presegmental position) to 7th segment (presegmental position). Ventral gills ranging from 2nd (presegmental) to 7th segment (postegmental). Lateral gills present from 2nd (presegmental) to 4th segment (postsegmental position). Lateral fringe extending from anterior border of abdominal segment III to end of abdominal segment VIII. Median brown sclerite on abdominal tergum IX semicircular (Figs. 14, 15); along its posterior border, 9–10 long and several shorter setae present, 1 of these long setae having position of central intermediate seta. Anal prolegs of limnephilid type, yellowish brown, with medium brown muscle attachment spots. Anal claws light to medium brown, claw dark brown and each with 1 small accessory hook (Fig. 15).

Case。 Larval case 16.0–18.1 mm long (n = 4), slightly curved, tapered (width at anterior opening 3.7–4.5 mm and at posterior opening 2.3–3.0 mm), consisting of leaf fragments and mix of detritus and mineral particles of unequal size (Fig. 16).

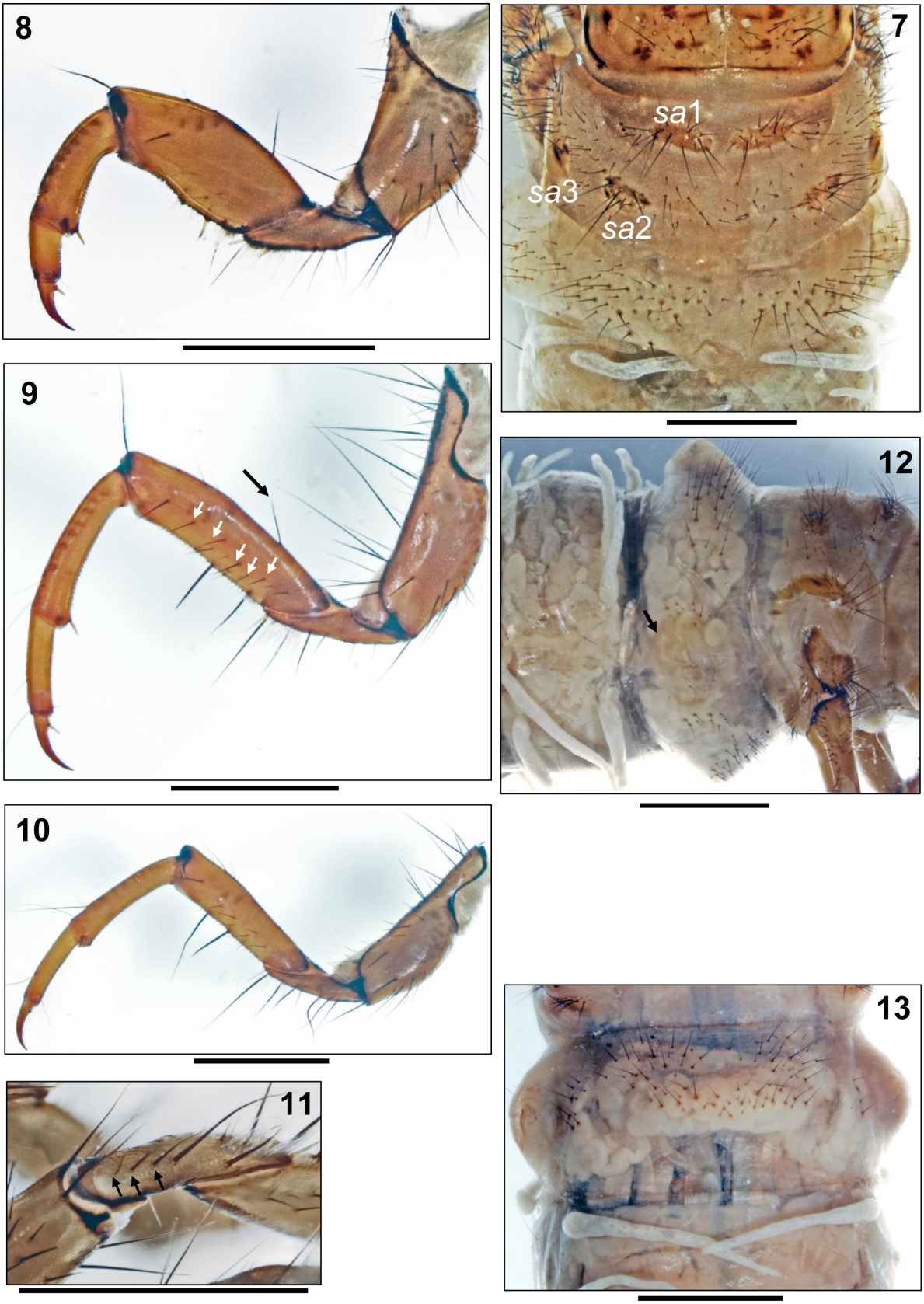
Description of the fifth instar larva of *Micropterna taurica*

Biometry. Body length of final instar larva ranging from 14.3 to 17.6 mm, head width from 1.37 to 1.53 mm (n = 5). All morphological characters identical to those of *M. coiffaiti* except as noted below.

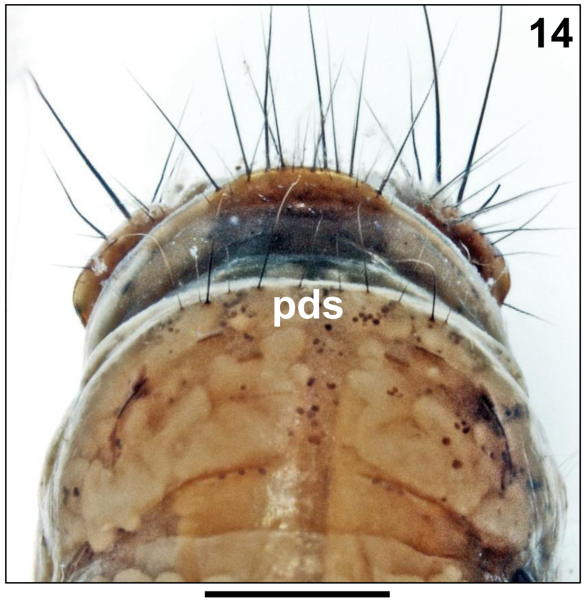
Head. Head capsule medium brown with paler areas at both sides of coronal suture. Head spinules covering large areas of frontoclypeus and parietalia (Figs. 17, arrows in Fig. 18). Postgenal suture approximately 25–30% of ventral apotome length.

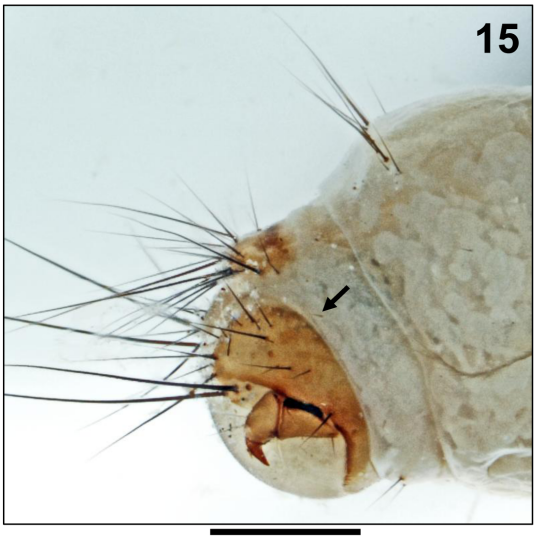


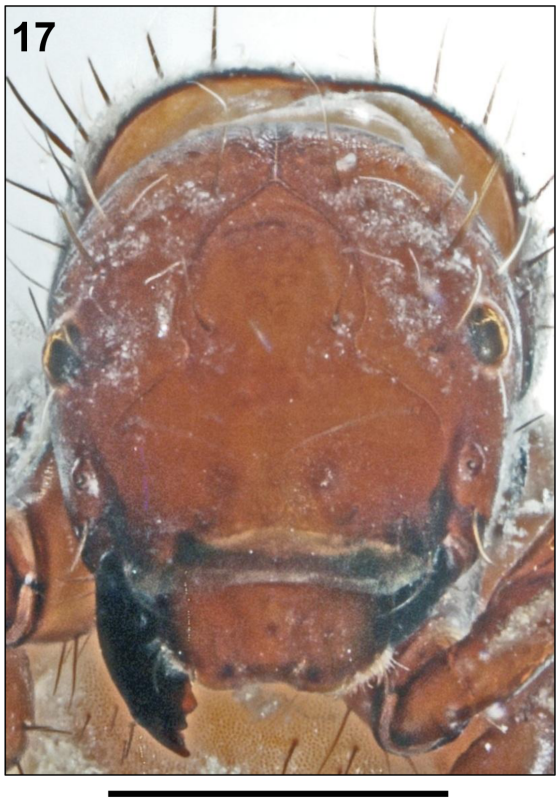
FIGURES 1–6. *Micropterna coiffaiti* Décamps 1963, 5th instar larva. **1,** Head, dorsal (small white and black numbers: setal positions #1–17, *x*, and *y* on frontoclypeus and right parietal; #17: only setal base visible, seta missing; white arrow: antenna). **2,** Head, right lateral (dotted oval: spinule area). **3,** Head, ventral (small white number: position of base of seta #18; seta missing). **4,** Head and pronotum, right lateral (a: prosternal horn; b: pronotal transverse groove; d: intermediate pale setae; e: long dark setae). **5,** Pro- and mesonota, dorsal (c: short, pale setae; *sa*1–*sa*3: setal areas 1–3). **6,** Prosternum. Scale bars: 1 mm (except 5: 0.5 mm).

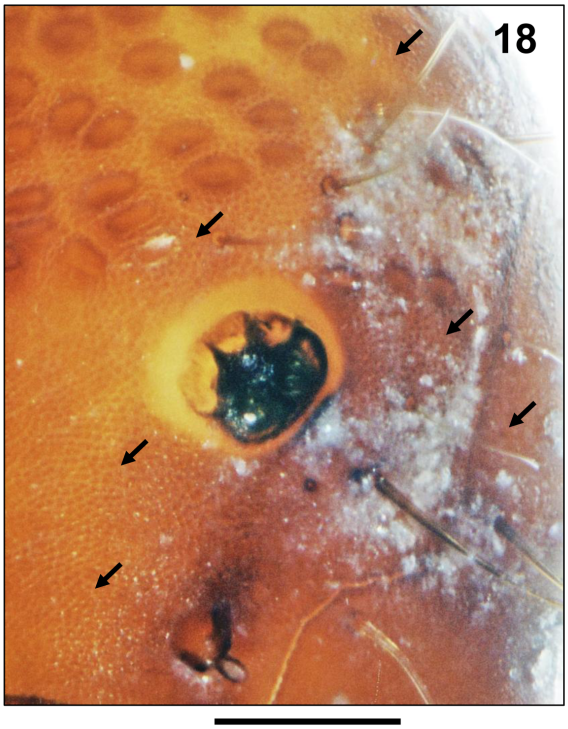


FIGURES 7–13. *Micropterna coiffaiti* Décamps 1963, 5th instar larva. **7,** Metanotum and abdominal segment I, dorsal (*sa*1–*sa*3: setal areas 1–3). **8,** Right foreleg, anterior face. **9,** Right midleg, anterior face (black arrow: proximodorsal seta; white arrows: additional face setae). **10,** Right hind leg, anterior face. **11,** Detail of left midleg trochanter, ventral (black arrows: additional setae on proximal section of trochanter). **12,** Metathorax and anterior abdominal segments, right lateral (black arrow: no posterior sclerite on lateral protuberance). **13,** Sternum of abdominal segment I, ventral. Scale bars: 1 mm.

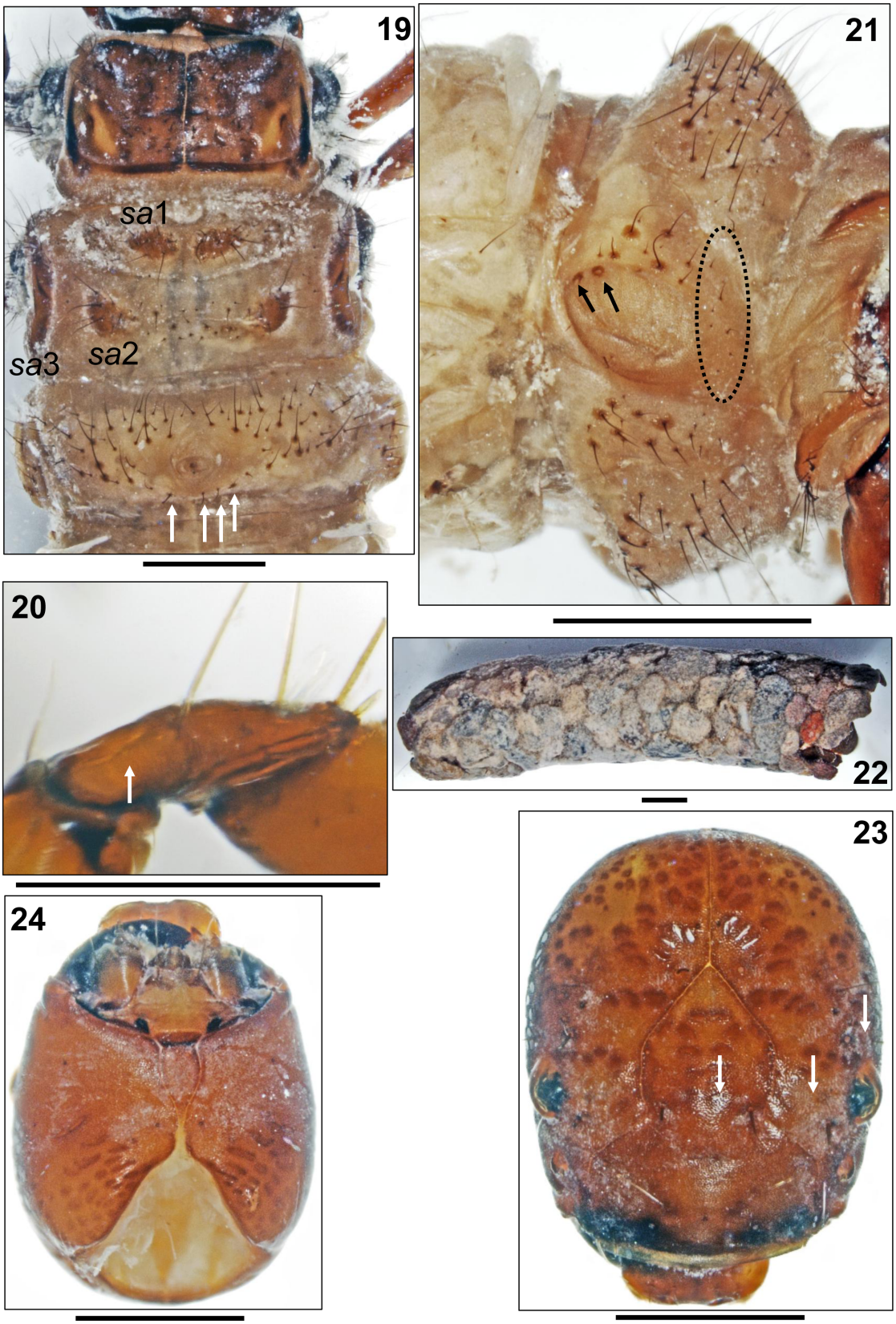








FIGURES 14–16. *Micropterna coiffaiti* Décamps 1963, 5th instar larva. **14,** Dorsa of abdominal segments VIII and IX, dorsal (pds = posterodorsal setae). **15,** Tip of abdomen, right lateral (black arrow: posterolateral seta). **16,** Larval case, right lateral. Scale bars: 1 mm. **FIGURES 17–18.** *Micropterna taurica* Martynov, 1917, 5th instar larva. **17,** Head, dorsal, with whitish sediment particles attached to large-scale microspinule areas. **18,** Head, right lateral, detail of large-scale microspinule areas at frontoclypeus and parietalia (black arrows). Scale bars: 1 mm (except 18: 0.5 mm).



FIGURES 19–22. *Micropterna taurica* Martynov, 1917, 5th instar larva. **19,** Meso- and metanota and abdominal dorsum I, dorsal (*sa*1–*sa*3: setal areas 1–3; white arrows: setal group posterior of dorsal protuberance). **20,** Detail of left midleg trochanter, ventral (white arrow: no additional setae on proximal section of trochanter). **21,** Abdominal segment I, right lateral (dotted oval: setal band anterior of lateral protuberance; black arrows: small posterior sclerites). **22,** Larval case, right lateral. **FIGURES 23–24.** *Potamophylax goulandriorum* Malicky 1974, 5th instar larva. **23,** Head, dorsal (white arrows: spinule areas). **24,** Head, ventral. Scale bars: 1 mm.

Thorax. In total, 70–80 setae of varying lengths distributed over each pronotal half. Central pentagonal prosternite very distinct, dark to medium brown, with light brown lateral sclerites.

Mesonotum with dark border except anterolateral corners (Fig. 19). Counts for mesonotal setae on each sclerite are as follows: anterior setal group *sa*1: 13–16, posterior group *sa*2: 15–18, lateral group *sa*3: 18–25. Anterior metanotal sclerites with 13–16 setae per sclerite, posterior metanotal sclerites with 11–13 setae per sclerite, and lateral metanotal sclerites with 17–22 setae each, concentrated at anterior third of sclerite (Fig. 19).

Proximal section of all trochanters without additional setae (Fig. 20, white arrow). Pairs of ventral-edge setae pale on femora of fore- and midlegs; femora of hind legs with proximal ventral-edge seta pale and distal seta dark.

Abdomen. Abdominal tergum I with dorsal setal areas *sa*1, *sa*2, and *sa*3 fused, thereby creating continuous transverse row of setae on small basal sclerites anterior and also posterior (white arrows) of dorsal protuberance (Fig. 19). Lateral protuberances each with 2 small posterior sclerites without setae but each sclerite with central hole (Fig. 21, black arrows). With setal band anterior of lateral protuberance (Fig. 21, dotted oval). Abdominal dorsum VIII with 16 long posterodorsal setae. Dorsal gills present at most from 2nd segment (presegmental position) to 6th segment (presegmental position). Ventral gills ranging from 2nd (presegmental) to 7th segment (pregmental). Lateral gills present from 2nd (presegmental) to 4th segment (postsegmental position). With 2 central intermediate setae on abdominal dorsum IX.

Case. Larval case 13.8–15.9 mm long (n = 5), bag-like, slightly curved and slightly tapered (width at anterior opening 3.7–4.3 mm and at posterior opening 3.0–3.5 mm), consisting of mineral particles fitted together smoothly (Fig. 22).

Description of the fifth instar larva of *Potamophylax goulandriorum*

Biometry. Body length of final instar larva ranging from 19.2 to 20.5 mm, head width from 1.90 to 2.10 mm (n = 3). All morphological characters identical to those of *M. coiffaiti* except as noted below.

Head. Head capsule orange brown (Fig. 23) with head spinules present in large patches medially and posteriorly of the eyes and also at central section of frontoclypeus. Ventral apotome slender, amphora-shaped, postgenal suture approximately 20–22% of apotome length (Fig. 24).

Thorax. In total, 50–60 setae of varying lengths distributed over each pronotal half. Mesonotum with posterolateral, posteromedian and anteromedian margins darkly sclerotized (Fig. 25). Counts for mesonotal setae on each sclerite are as follows: anterior setal group *sa*1: 10–15, posterior group *sa*2: 17–22, lateral group *sa*3: 15–20. Anterior metanotal sclerites very narrow, their intermediate separation larger than width of each of them (Fig. 25); with 15–18 setae per sclerite. Posterior metanotal sclerites broadly triangular, with 13–15 setae per sclerite and sparse group of setae between them; lateral metanotal sclerites with approximately 20 setae concentrated at anterior third of sclerite. Sparse setal group present between each lateral and posteromedian sclerite (Fig. 25).

Without additional setae on anterior and posterior faces of mid- and hind femora and without groups of additional setae at proximal section of all trochanters.

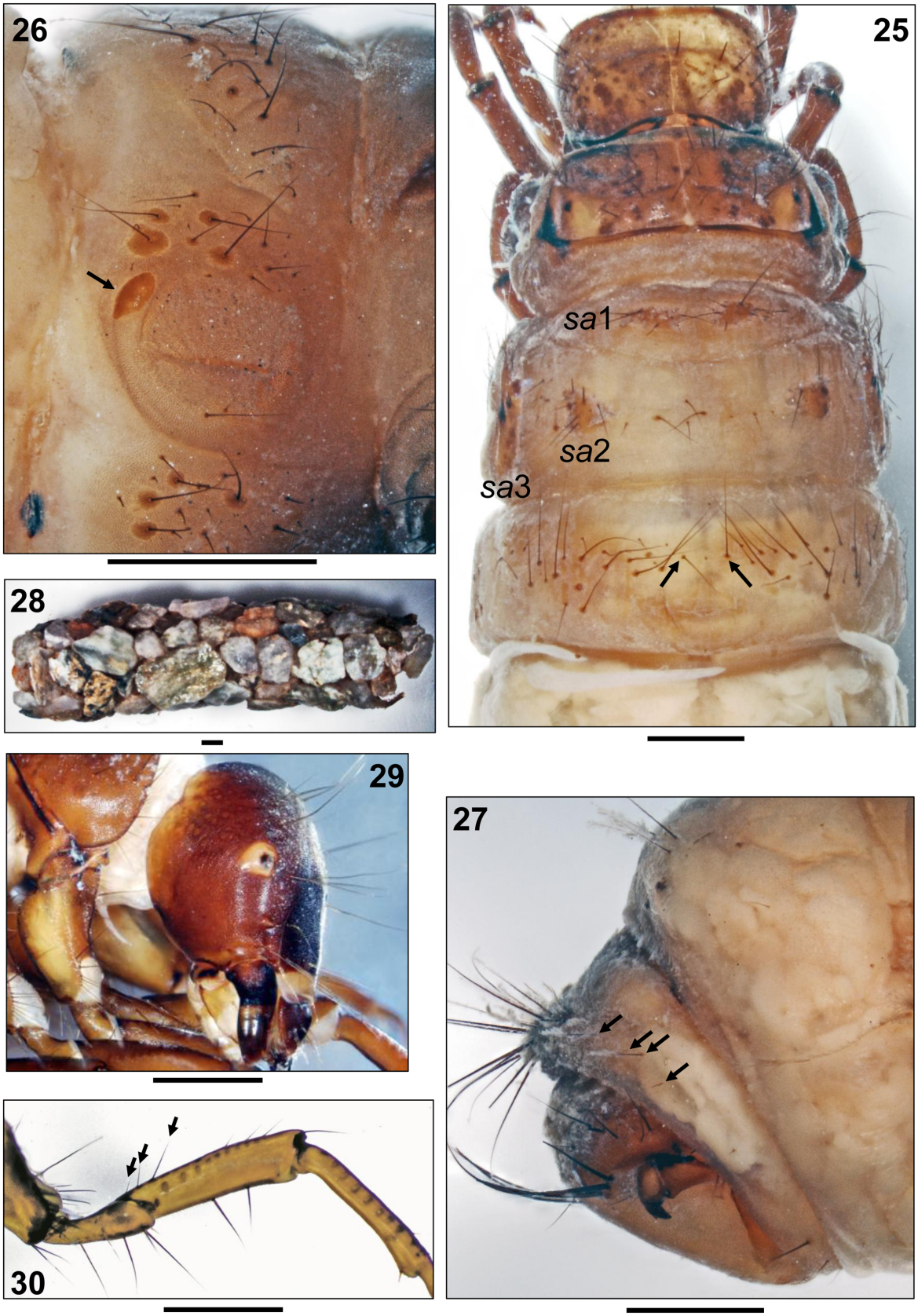
Abdomen. Transverse row of setae on small basal sclerites anterior to dorsal protuberance (Fig. 25, black arrow); some setae also present posterior of dorsal protuberance (covered by latter in Fig. 25). With large posterior sclerites on lateral protuberances (Fig. 26, black arrow). Several posterolateral setae present on each half of abdominal dorsum IX (Fig. 27, black arrows).

Lateral fringe extending from posterior third of abdominal segment II to end of abdominal segment VIII. Posterior border of sclerite of abdominal segment IX with 9–10 long and several shorter setae, 1 or 2 of these long setae having position of central intermediate setae.

Case. Larval case 20.5–23.7 mm long (n = 3), very slightly curved and almost untapered (width at anterior opening 5.6–6.8 mm and at posterior opening 4.4–6.0 mm), consisting of mix of mostly mineral and sometimes detrital particles of unequal size (Fig. 28).

Morphological diagnosis of fifth instar larvae of *Micropterna coiffaiti*, *M. taurica*, and *Potamophylax goulandriorum* from those of other European Trichoptera

A summary of morphological features for the identification of European caddisfly families was given by Waringer & Graf (2013). Within the framework of the limnephilid key by Waringer & Graf (2011), *Micropterna coiffaiti*, *M. taurica*, and *Potamophylax goulandriorum* are separable from other species by possessing the following features:



FIGURES 25–28. *Potamophylax goulandriorum* Malicky 1974, 5th instar larva. **25,** Thorax and abdominal segment I, dorsal view (*sa*1–*sa*3: setal areas 1–3; black arrows: setae anterior of dorsal protuberance). **26,** Abdominal segment I, right lateral (black arrow: large posterior sclerite). **27,** Tip of abdomen, right lateral (black arrows: posterolateral setae**). 28**, Larval case, right lateral. **FIGURE 29.** *Allogamus pertuli* Malicky 1975, 5th instar larva. Head, right lateral. **FIGURE 30.** *Halesus digitatus* (Schrank 1781), 5th instar larva. Right hind leg, posterior view (black arrows: proximodorsal setae). Scale bars: 1 mm.

TABLE 1. Synopsis of characters separating the morphological groups of the currently known Stenophylacini larvae (5th instars) of European Ecoregion 6 (= Hellenic western Balkan region). The Chaetopterygini larvae of this Ecoregion are still unknown.

Species group/character	Only single-filament gills present	Hind femur with several proximo-dorsal setae	With setae anterior of lateral protuberance	Lateral protuberance with large posterior sclerite	Mandibles with terminal teeth	Only one posterolateral seta present on 9th abdominal segment	References
Mesophylax aspersus	no	no	no	no	yes	no	Wallace *et al*. 2003
Mesophylax impunctatus							Wallace *et al*. 2003
Halesus digitatus	yes	yes	no	yes	yes	yes	Panzenböck & Waringer 1997
Allogamus pertuli	yes	no	yes	yes	no	yes/no	Waringer *et al*. 2012
Micropterna testacea							Waringer *et al*. 2013
Micropterna nycterobia	yes	no	yes	no	yes	yes	Waringer *et al*. 2013
Micropterna taurica							**present paper**
Potamophylax nigricornis	yes	no	yes	yes/no	yes	no	Waringer *et al*. 2013
Potamophylax pallidus							Waringer *et al*. 2013
Micropterna coiffaiti	yes	no	no	no	yes	yes/no	**present paper**
Micropterna sequax							Waringer *et al*. 2014
Stenophylax mitis							Waringer *et al*. 2014
Stenophylax permistus							Waringer *et al*. 2014
Potamophylax cingulatus	yes	no	no	yes	yes	no	Wallace *et al*. 2003
Potamophylax latipennis							Wallace *et al*. 2003
Potamophylax luctuosus							Waringer & Graf 2011
Potamophylax goulandriorum							**present paper**
Allogamus uncatus	yes	no	no	yes	yes	yes	Waringer & Graf 2011

- gills consisting of single filaments only; dorsal gills present (Fig. 12);
- metanotum covered by three pairs of small sclerites (Fig. 7);
- mandibles with terminal teeth (Fig. 2)
- head capsule oval, not dorsally flattened, without dense hair cover and without rim around frontoclypeus (Figs. 1, 2);
- hind femora each with only 1 proximo-dorsal seta (as in Fig. 9, black arrow).

In the context of the Stenophylacini species of Ecoregion 6 where larvae are known, *Micropterna coiffaiti* keys together with *M. sequax*, *Stenophylax mitis* McLachlan 1875, and *Stenophylax permistus* McLachlan 1895 (Table 1). In this species group, each lateral protuberance has 1–3 small sclerites without setae but each with one central hole (as in Fig. 21, black arrows) in *S. permistus*, whereas such sclerites are lacking in the remaining 3 species (Fig. 12, black arrow). In *M. sequax*, the tiny head spinules cover large areas of parietalia and frontoclypeus (as in Fig. 18) but are restricted to 2 small areas behind the eyes in *S. mitis* and *M. coiffaiti* (Fig. 2, dotted oval). Finally, only 1 posterolateral seta is present on each half of abdominal dorsum IX in *M. coiffaiti* (Fig. 15, black arrow) whereas several are present in *S. mitis*.

Micropterna taurica keys together with *M. nycterobia* (Table 1) where the lateral protuberance again has 1–3 small sclerites without setae but each has one central hole (as in Fig. 21, black arrows). In this species group a setal band is present anterior of the lateral protuberance (Fig. 21, dotted oval). Directly posterior of the dorsal protuberance, setae are lacking in *M. nycterobia* but present in *M. taurica* (Fig. 19, white arrows).

Finally, *Potamophylax goulandriorum* keys together with *P. cingulatus* (Stephens 1837), *P. latipennis* (Curtis 1834), and *P. luctuosus* (Piller & Mitterpacher 1783); in this species group setae anterior of the lateral protuberance are lacking, and a large posterior sclerite at the lateral protuberance as well as several posterolateral setae on abdominal segment IX are present. Currently it is not possible to separate this species quartet morphologically.

Key to the hitherto known fifth instar Limnephilidae larvae with single filament gills (plus genus Mesophylax) of Ecoregion 6. Species included belong to tribe Stenophylacini; the Chaetopterygini larvae of this Ecoregion are still unknown.

1. Pronotum without transverse rim at anterior third but fitted with dorsal humps or ridges . . . . . **Drusinae** (not included in this key)
- Pronotum with transverse rim at anterior third and without dorsal humps or ridges (Fig. 4b) 2
2. Gills consisting of 2–4 filaments and additional single filaments 3
- Gills consisting of single filaments only (Fig. 12) 4
3. Number of pale setae on ventral edge of each fore femur is 2 . . . . . ***Mesophylax impunctatus*** McLachlan 1884
- Number of pale setae on ventral edge of each fore femur is 3 . . . . . ***Mesophylax aspersus*** (Rambur 1842)
4. With band of setae anterior of the lateral protuberance (Fig. 21, dotted oval) 5
- Without band of setae anterior of the lateral protuberance (Fig. 12) 8
5. Cutting edge of mandibles without teeth (Fig. 29) 6
- Cutting edge of mandibles with teeth (Fig. 2). 7
6. Additional face setae present on mid- and hind femora (as in Fig. 9, white arrows) . . . . . ***Micropterna testacea*** (Gmelin 1789)
- Without additional face setae on mid- and hind femora . . . . . ***Allogamus pertuli*** Malicky 1974
7. Additional face setae present on mid and hind femora (as in Fig. 9, white arrows) 13
- Without additional face setae at mid and hind femora . . . . . ***Potamophylax nigricornis*** (F.J. Pictet 1834), ***P. pallidus*** (Klapálek 1899)
8. Hind femora each with several proximo-dorsal setae (Fig. 30) . . . . . ***Halesus digitatus*** (Schrank 1781)
- Hind femora each with only 1 proximo-dorsal seta (Fig. 9, black arrow) 9
9. Lateral protuberances without sclerites (Fig. 12, black arrow). 10
- Lateral protuberances each with 1–3 small posterior sclerites without setae and each sclerite with one central hole (Fig. 21, black arrows) . . . . . ***Stenophylax permistus*** McLachlan 1895
- Lateral protuberances each with large posterior sclerite (Fig. 26, black arrow) 12
10. Head spinules covering large areas of parietalia and frontoclypeus (as in Figs. 17, 18) . ***Micropterna sequax*** McLachlan 1875
- Head spinules restricted to 2 small areas behind each eye (Fig. 2). 11
11. Only 1 posterolateral seta on each half of abdominal dorsum IX (Fig. 15, black arrow); with additional setae on proximal section of each trochanter (Fig. 11) . . . . . ***Micropterna coiffaiti*** Décamps 1963
- Several posterolateral setae on each half of abdominal dorsum IX; without additional setae on proximal section of each trochanter . . . . . ***Stenophylax mitis*** McLachlan 1875

12. Only 1 posterolateral seta on each half of abdominal dorsum IX (as in Fig. 15, black arrow). . . . . ***Allogamus uncatus*** (Brauer 1857)
- Several posterolateral setae on each half of abdominal dorsum IX . . . . . ***Potamophylax cingulatus*** (Stephens 1837), ***P. goulandriorum*** Malicky 1974**,** ***P. latipennis*** (Curtis 1834), ***P. luctuosus*** (Piller & Mitterpacher 1783)
13. Without setae directly posterior of dorsal protuberance; head width 1.67–1.93 mm . . . . . ***Micropterna nycterobia*** McLachlan 1875
- With small groups of setae directly posterior of dorsal protuberance (Fig. 19, white arrows); head width 1.37–1.53 mm . . . . . ***Micropterna taurica*** Martynov 1917

Discussion

Generally, distribution patterns of *Micropterna* and *Stenophylax* species are not well documented, because adults are mostly on the wing in late autumn when collecting activity is rather poor. This also applies to *M. coiffaiti* has been reported from Greece, the Levant, Turkey, and Cyprus. In Europe, the species is restricted to the easternmost Greek islands close to the shore of Asia Minor. Within the Eastern Aegean archipelago, which harbours Trichoptera species fitting the inventories of Asia Minor, *M. coiffaiti* has been recorded from Lesbos among its 36 known caddisfly species, Chios (22 species), Samos (32 species), and the island of Rhode (20 species; Malicky 1975).

Micropterna coiffaiti inhabits mostly mineral substrates in lentic sections of oxygen-rich intermittent streams. Larvae and pupae quickly develop during the winter months with adults emerging in spring. Adults undergo a diapause during which the ovaries of the females mature; when the adults leave their hideaways in autumn, their summer-dry breeding habitats are re-wetted by autumn rains, ready for oviposition. Pre-diapausing adults frequently migrate to caves to aestivate in sheltered environments or spend summers together with *Limnephilus* species high in the mountains. Due to adult diapause from late spring to early autumn, the species has greatly extended its adult period (Malicky 1973; Graf *et al*. 2008). Hybrids between *M. coiffaiti* and *M. sequax* have been reported by Malicky & Sipahiler (1993).

Larvae are shredders and feed on particulate organic matter. Interestingly, Kock (2002) observed in genus *Micropterna* that larvae leave their aquatic habitat after sunset and start feeding on algae-covered, dry stone surfaces.

Micropterna taurica is known from Bulgaria, Greece, Cyprus, and Turkey. In Greece, Hans Malicky collected this species on the island of Crete, on Karpathos, and at two sampling sites on the eastern coast of mainland Greece (Kokkino Nero in the vicinity of Ossa and Chania, east of Pelion). This species was abundant only on Crete and the most frequent species collected in a light trap near Sisses. The island of Crete harbours 40 Trichoptera species, 12 of them endemic species. From a zoogeographical point of view, the caddisfly fauna of Crete shares many species with the Greek mainland and only occasionally with Asia Minor. As in *M. coiffaiti*, *M. taurica* undergoes a diapause during the summer months. Adults prefer cave entrances with low light intensities as hideouts, often in thousands of individuals, because the cool and damp climate prevents dehydration and death in the hot, dry Mediterranean summer outside; in addition, darkness and low air temperatures retard egg development of the females (Malicky & Winkler 1974). Experiments by the co-author have shown that during dispersal flights the cave entrances are found only by chance and not intentionally; when adults reach the vicinity of a cave entrance, the cool, damp air guides the caddisflies inside. McLachlan (1880) was the first who published a list of troglophilic caddisfly species, and a number of French, Spanish, and Algerian cave records of *Stenophylax* species were given by Ulmer (1920). In a study of 140 caves in Italy, Moretti & Cianficconi (1982) observed that 124 caves were inhabited by aestivating Stenophylacini species. This was also observed in France and Romania where most aestivating subtroglophilic species belong to genera *Stenophylax*, *Micropterna*, and *Mesophylax* (Décamps & Magné 1966; Negrea & Boitan 2001).

Normally, caddisfly larvae pupate in the last instar larval case after adding some larger stones at both ends and fixing the posterior or both ends on a stable substratum. However, in *M. taurica*, and occasionally also in some other species such as *P. nigricornis*, *A. uncatus*, *H. digitatus*, *M. sequax*, and *M. nycterobia*, a separate new pupal case is constructed from mineral particles distinctly coarser than the particles used for larval cases (Malicky 2000).

Potamophylax goulandriorum is known from Greece and Macedonia only (Kumanski & Malicky 1999), with many records scattered throughout the mountains of the Greek mainland. The species is univoltine and on the wing

from July to November, peaking in October. Larvae inhabit oxygen-rich springs and springbrooks bordered by pastures, brush or deciduous woods at 700–1200 m a.s.l. with water temperatures between 5 and 10°C.

Acknowledgements

This paper is a product of the project "The Drusinae (Insecta: Trichoptera) in a world of global change" (project number P23687-B17, PI: J.Waringer) funded by the Austrian Science Fund (FWF). We are also grateful to John C. Morse and Marta Sáinz-Bariáin for their helpful comments on the manuscript.

References

Brauer, F. & Löw, F. (1857) *Neuroptera austriaca. Die im Erzherzogthum Österreich bis jetzt aufgefundenen Neuropteren nach der analytischen Methode zusammengestellt, nebst einer kurzen Charakteristik aller europäischen Neuropteren-Gattungen*. Gerold, Wien, 80 pp.

Curtis, J. (1834) XXVI. Descriptions of some hitherto nondescript British species of may-flies of anglers. *The London and Edinburgh Philosophical Magazine and Journal of Science*, 4, 120–125.

Décamps, H. (1963) Note sur quelques espèces de Trichoptères trogloxènes. *Annales de spéléologie*, 17, 577–583.

Décamps, H. & Magné, J. (1966) Contribution a l'étude de *Micropterna fissa* McL. et des Trichoptères cavernicoles (*Stenophylax*, *Micropterna*, *Mesophylax*). *Annales de Limnologie*, 2, 527–535. http://dx.doi.org/10.1051/limn/1966011

Gmelin, J.F. (1789) *Caroli a Linné, Systema Naturae*. *Editio XIII. Tomus I. Pars III*. impensis Georg. Emanuel. Beer, Lipsiae, 484 pp. [pp. 1033–1516]

Graf, W., Murphy, J., Dahl, J., Zamora-Muñoz, C. & López-Rodríguez, M.J. (2008) Volume 1—Trichoptera. *In:* Schmidt-Kloiber, A. & Hering, D. (Eds.), *Distribution and Ecological Preferences of European Freshwater Organisms.* Pensoft Publishers, Sofia, Moscow, pp. 1–388.

Higler, L.W.G. & Solem, J.O. (1986) Key to the larvae of North-West European *Potamophylax* species (Trichoptera, Limnephilidae) with notes on their biology. *Aquatic Insects*, 8, 159–169. http://dx.doi.org/10.1080/01650428609361247

Higler, B. (2005) *De Nederlandse Kokerjufferlarven. Determinatie and Ecologie*. KNNV Uitgeverij, Utrecht, 159 pp.

Ibrahimi, H., Gashi, A., Grapci-Kotori, L. & Kučinić, M. (2013) First records of the genus *Micropterna* Stein, 1873 (Insecta: Trichoptera) in Kosovo with distributional and ecological notes. *Natura Croatica*, 22, 147–155.

Klapálek, F. (1899) Prilozi k poznavanju faune Trichoptera i Neuroptera Bosne i Hercegovine. *Glasnik zemaljskog muzeja u Sarajevu*, 11, 323–337.

Kock, C. (2002) Untersuchungen zum amphibischen Fraßverhalten und dessen Tages-Nachtrhythmik bei *Melampophylax mucoreus* and *Micropterna* spp. in temporären Gewässern. Available from: http://www.limnology.uni-muenster.de/etc/experieco/lit/.../Kock_2002.pdf (accessed 12 April 2016).

Kolenati, F.A. (1848) Genera et species trichopterorum. Pars prior. *Acta Regiae Bohemoslovenicae Societatis Scientiarum*, *Prague*, 6, 1–108.

Kumanski, K. & Malicky, H. (1999) A survey of the genus *Potamophylax* Wallengren 1891 in the Balkan Peninsula, with the description of two new species (Trichoptera: Limnephilidae). *Braueria*, 26, 27–30.

Lepneva, S.G. (1966) Fauna SSSR, Rucheiniki, Lichinki i kukolki podotryada tse'noshchupikovykh [Fauna of the U.S.S.R., Trichoptera, larvae and pupae of Integripalpia]. Vol. II. No. 2. *Trudy Zoologicheskogo Instituta Akademii Nauk SSSR, Moscow/Leningrad*, New Series, 95, 1–560. [translated by the Israel Program for Scientific Translations, Jerusalem, 1971]

Malicky, H. (1973) Trichoptera Köcherfliegen. *In:* Helmcke, J.-G., Starck, D. & Wermuth, H. (Eds.), *Handbuch der Zoologie. Teil 29.* Walter de Gruyter, Berlin, New York, 113 pp.

Malicky, H. & Winkler, G. (1974) Untersuchungen über die Höhlenimmigration von *Micropterna nycterobia* (Trichoptera, Limnephilidae). *Oecologia*, 15, 375–382.

Malicky, H. (1975) Die Köcherfliegen Griechenlands. Übersicht und Neubeschreibungen. *Annales Musei Goulandris*, 2, 105–135.

Malicky, H. & Sipahiler, F. (1993) Köcherfliegen (Trichoptera) aus der Türkei, mit Bemerkungen zu weiteren mediterranen Köcherfliegen. *Mitteilungen der schweizerischen Entomologischen Gesellschaft*, 66, 457–478.

Malicky, H. (2000) Which caddis larvae construct a new case for pupation? *Braueria*, 27, 19–20.

Malicky, H. (2004) *Atlas of European Trichoptera. 2nd Edition*. Springer, Dordrecht, 359 pp.

Malicky, H. (2005) Ein kommentiertes Verzeichnis der Köcherfliegen (Trichoptera) Europas und des Mediterrangebietes. *Linzer biologische Beiträge*, 37, 533–596.

Martynov, A.V. (1917) Trichoptera of Crimea. *Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de Petrograd*, 21, 165–199.

McLachlan, R. (1875) *A Monographic Revision and Synopsis of the Trichoptera of the European Fauna. Vol. 3.* John van Voorst and Friedlander & Sohn, London and Berlin, 36 pp. [pp. 109–144]

McLachlan, R. (1880) *A Monographic Revision and Synopsis of the Trichoptera of the European Fauna. Vol. 9. Supplement 2*. John van Voorst and Friedlander & Sohn, London and Berlin, 72 pp. [pp. 13–84]

McLachlan, R. (1884) *A Monographic Revision and Synopsis of the Trichoptera of the European Fauna. First Additional Supplement.* John van Voorst and Friedlander & Sohn, London and Berlin, 76 pp.

McLachlan, R. (1895) *Stenophylax concentricus*, auct. (*nec* Zett.), renamed *S. permistus*. *The Entomologist's Monthly Magazine*, *Second Series*, Vol. VI (Vol. XXXI.), 139–140.

Mey, W. & Müller, A. (1979) Neue Köcherfliegen aus dem Kaukasus. *Reichenbachia*, 17, 175–182.

Moretti, G. & Cianficconi, F. (1982) Aggiornamento sulla tricotterofauna cavernicola italiana. *Lavori della Società Italiana di Biogeografia*, 7, 207–237.

Moretti, G.P. (1983) *Tricotteri (Trichoptera). Guide per il riconoscimento delle specie animali delle acqueinterne italiane 19. Series Guide Specie Animali delle Acque Interne Italiane*. Consiglio Nazionale delle Ricerche, Roma, 155 pp.

Negrea, S. & Boitan, V. (2001) An ecological and biogeographycal overview of the terrestrial and aquatic subterranean environments from Romania. *Travaux du Muséum National d'Histoire Naturelle* (*Grigore Antipa*), 43, 367–424.

Oláh, J., Lodovici, O. & Valle, M. (2011) A new species of *Potamophylax* (Trichoptera, Limenphilidae) from Albania. *Braueria*, 38, 13–14.

Oláh, J., Andersen, T., Chvojka, P., Coppa, G., Graf, W., Ibrahimi, H., Lodovici, O., Previšić, A. & Valle, M. (2013) The *Potamophylax nigricornis* group (Trichoptera, Limnephilidae): Resolution of phylogenetic species by fine structure analysis. *Opuscula Zoologica*, 44, 167–200.

Oláh, J. & Kovács, T. (2014) New species and records of Balkan Trichoptera III. *Folia Historico-Naturalia Musei Matraensis*, 38, 97–131.

Panzenböck, M. & Waringer, J. (1997) A key to fifth instar larvae of *Halesus radiatus* Curtis 1834, *Halesus digitatus* Schrank 1781 and *Halesus tesselatus* Rambur 1842 (Trichoptera: Limnephilidae), based on Austrian material. *Aquatic Insects*, 19, 65–73.
http://dx.doi.org/10.1080/01650429709361638

Pictet, F.-J. (1834) *Recherches pour Servír à l'Histoire et à l'Anatomie des Phryganides*. chez Abraham Cherbuliez, rue de la Cité, Geneva, chez J.-B. Baillière, rue de l'Ecole de médecine, No 13 bis, Paris & même maison, Regent street, No 219, Londres, 235 pp.
http://dx.doi.org/10.5962/bhl.title.8547

Piller, M. & Mitterpacher, L. (1783) *Iter per poseganam sclavoniae provinciam mensibus junio, et julio anno MDCCLXXXII*. Typis regiae universitatis, Budae, 147 pp.

Rambur, M.P. (1842) *Histoire Naturelle des Insectes*. *Névroptères*. Librairie Encyclopédique de Roret, Paris, 534 pp.

Sáinz-Bariáin, M. & Zamora-Muñoz, C. (2012) The larva and life history of *Stenophylax nycterobius* (McLachlan, 1875) (Trichoptera: Limnephilidae) in high mountain streams (Sierra Nevada, Spain) and key to the Iberian larvae of the genus. *Zootaxa*, 3483, 71–81.

Schrank, F. de P. (1781) *Enumeratio insectorum Austriae indigenorum*. Klett & Franck, Wien, 550 pp.

Stein, J.P.E.F. (1874) Beitrag zur Kenntniss der Phryganeiden des Altvaters und einiger anderer. *Entomologische Zeitung. Herausgegeben von dem entomologischen Vereine zu Stettin*, 35, 244–253.

Stephens, J.F. (1836–1837) *Illustrations of British entomology*; *or*, *a synopsis of indigenous insects*: *containing their generic and specific distinctions*; *with an account of their metamorphoses*, *times of appearance*, *localities*, *food*, *and economy*, *as far as practicable. Vol. VI. Mandibulata*. Baldwin & Cradock, London, 240 pp.

Ulmer, G. (1920) Trichopteren und Ephemeropteren aus Höhlen. *Deutsche Entomologische Zeitschrift*, 1920, 303–309.
http://dx.doi.org/10.1002/mmnd.192019200304

Wallace, I.D., Wallace, B. & Philipson, G.N. (2003) Keys to the case-bearing caddis larvae of Britain and Ireland. *Freshwater Biological Association Scientific Publication,* 61, 1– 259.

Wallengren, H.D.J. (1891) Skandinaviens Neuroptera. Andra afdelningen: Neuroptera Trichoptera (Phryganea L.). *Kongliga Svenska vetenskaps-akademien*, 24, 1–173.

Waringer, J. & Graf, W. (2011) *Atlas of Central European Trichoptera Larvae*. Erik Mauch Verlag, Dinkelscherben, 468 pp.

Waringer, J., Graf, W. & Malicky, H. (2012) The larvae of *Allogamus antennatus* (McLachlan 1876), *Allogamus mendax* (McLachlan 1876) and *Allogamus pertuli* Malicky 1975 (Trichoptera: Limnephilidae) with notes on ecology and zoogeography. *Zootaxa*, 3351, 27–38.

Waringer, J., Graf, W. & Malicky, H. (2013) Problems associated with extrapolating ecological traits to higher-than-species level exemplified in the description of the larvae of *Potamophylax haidukorum* Malicky, 1999, *Potamophylax winneguthi* (Klapálek, 1902) and *Melampophylax austriacus* Malicky, 1990. *Limnologica*, 43, 441–450.
http://dx.doi.org/10.1016/j.limno.2013.02.001

Waringer, J. & Graf, W. (2013) Key and bibliography of the genera of European Trichoptera larvae. *Zootaxa*, 3640 (2), 101–151.
http://dx.doi.org/10.11646/zootaxa.3640.2.1

Waringer, J., Graf, W. & Malicky, H. (2014) The larvae of *Stenophylax mitis* McLachlan 1875 and *Allogamus hilaris* (McLachlan 1876a) (Trichoptera: Limnephilidae), with notes on ecology and zoogeography. *Zootaxa*, 3780 (2), 375–387.
http://dx.doi.org/10.11646/zootaxa.3780.2.9

Wiggins, G.B. (1998) *Larvae of the North American Caddisfly Genera* (*Trichoptera*)*, 2nd Edition*. University of Toronto Press, Toronto, 457 pp.