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Ecdyonurus austriacus nataliae n. ssp., a new subspecies of the *Ecdyonurus helveticus*-group from Ukraine (Ephemeroptera: Heptageniidae)

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ABSTRACT. A new subspecies, *Ecdyonurus austriacus nataliae* ssp. n., belonging to the *helveticus*-group, is described and illustrated at all stages (imagines, subimagines, nymphs and eggs) from material collected in the Gorgany Mts. in the Eastern Carpathians, Ukraine. The new subspecies is closely related to *Ecdyonurus austriacus austriacus* Kimmins. Its affinities, distribution and ecology are discussed.

Key words: entomology, taxonomy, Ephemeroptera, Heptageniidae, new subspecies, nymph, imago and subimago, egg, distribution, ecology, Eastem Carpathians, Ukraine.

INTRODUCTION

Species of the *Ecdyonurus helveticus*-group are characterized by the lack of long and dense setae on the distal part of larval hypopharynx, and by the presence of a laterally elongated apical sclerite of the penis lobes of imago (HEFTI & TOMKA 1986, STUDEMANN et al. 1992). Some taxonomical revisions and descriptions of new species from the *E. helveticus*-group were published (KIMMINS 1958, BOGOESCU & TABACARU 1962, JACOB & BRAASCH 1984, HEFTI et al. 1986, 1989, 1991, BELFIORE & BUFFAGNI 1994, BAUERNFEIND 1997). The Central European fauna of the *E. helveticus*-group includes 12 taxa (HEFTI et al. 1989). Five species known from literature are found in the Ukrainian Carpathians. *Ecdyonurus subalpinus* (KLAPÁLEK, 1907) from the Gorgany Mts. was described by KLAPÁLEK (1907). In

the same paper, KLAPÁLEK cited *Ecdyonurus helveticus* (EATON, 1885) from the Chornogora Mts. *Ecdyonurus picteti* (MEYER-DÜR, 1864) from the Chornogora mountain range was described as *Heptagenia nigrescens* (DZIĘDZIELEWICZ & KLAPÁLEK 1908a, 1908b) and as *Ecdyonurus nigrescens* (MIKULSKI 1936). Some data about the distribution of species of the *E. helveticus*-group in the Ukrainian Carpathians were also presented by DZIĘDZIELEWICZ (1907, 1919), MIKULSKI (1935), PAWŁOWSKI (1959), GODUŃKO (1997, 1999), and GODUNKO (1998). Recently, a new subspecies belonging to the *E. helveticus*-group from the Gorgany Mts. in the Eastern Carpathians, Ukraine has been found and described.

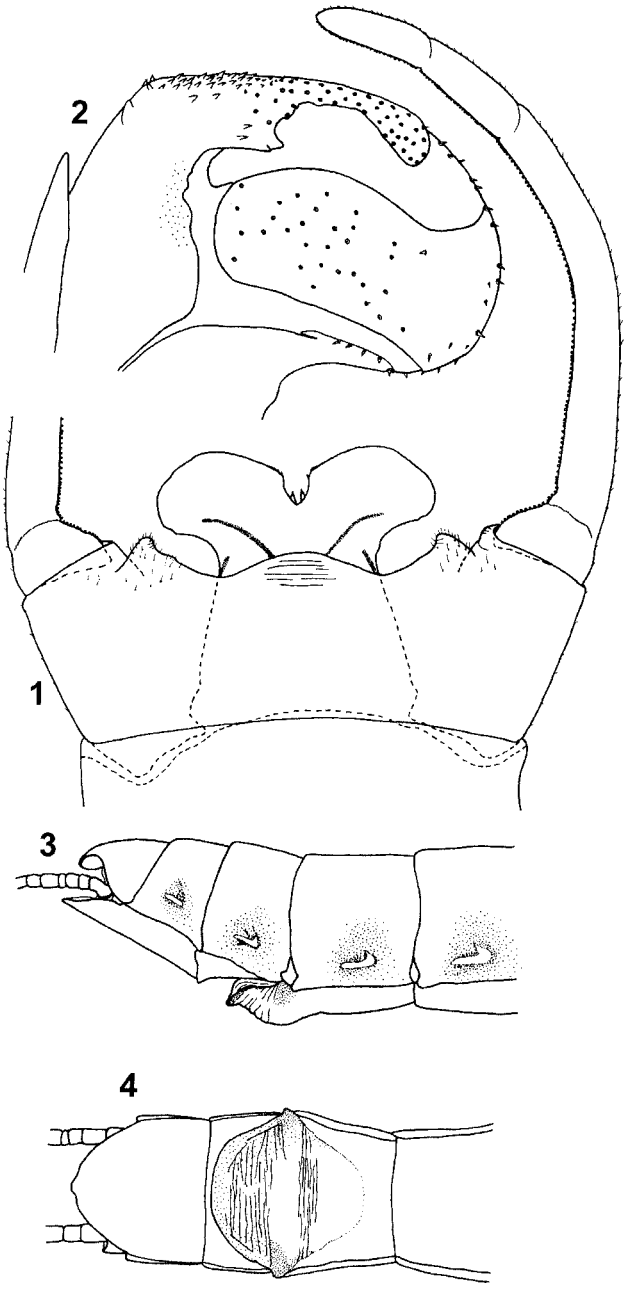
Ecdyonurus austriacus nataliae n. ssp.

ETYMOLOGY

The new subspecies is named in honor of NATALIA O. GODUNKO, wife of the first author.

MALE IMAGO

Size: body length: 13.4-15.7 mm; fore wings: 13.6-14.5 mm; cerci: 28.2-35.1 mm. Head light brown with a lighter margin and yellowish-gray spots. Scapus and pedicle yellowish-brown. Eyes light gray with a submarginal dark band. Ocelli white at the apical part with a brownish band in border. Thorax light brown. Fore legs of the same coloration as the thorax; tibia and tarsi brownish, generally paler than the femora; coxa and trochanter light yellowish-brown. Middle and hind legs paler, yellowish-brown, unicolorous; tibia and tarsi paler, yellowish and light yellowish-brown; femora yellowish-brown, light brownish-gray distally; coxa and trochanter of the middle and hind legs slightly darker. Fore wings hyaline, transparent, light milk color, grayish, unicolorous; venation dark, well visible; C, Sc and R paler, yellowish-brown; other longitudinal and transversal veins darker, brownish-castaneous; costal and subcostal area milky; pterostigmatic area brownish and opaque. Hind wings of the same color as the fore wings, with dark venation. Abdomen yellowish-brown, sometimes with small reddish-brown spots in the lateral part; lateral part of the terga with the typical pattern of the *E. helveticus*-group (as in female imago, Fig. 3); surface of the terga with two small visible paler spots in the central part; posterior margins of the terga slightly darker; sterna paler, yellowish-brown with well visible dark violet nerve ganglia and four small spots (two in the central part and two laterally oriented). Genitalia: styliger plate brown, posterior margin with two strong protuberances. In dorsal view the outlines of the penis lobes are rounded and slightly stretched laterally. The distal borders of the lobes are rounded (Fig. 1). The inner margin of the apical sclerite has one strong stout tooth directed towards the center of the lobe (sometimes with two strong stout teeth) and with some small submarginal teeth. The lateral sclerite is large without deep narrowing in the external part and softly



1-4. *Ecdyonurus austriacus nataliae*: 1-2. Male imago: 1-male genitalia, ventral view; 2 - penis lobe, dorsal view; 3-4. Female imago: 3 - posterior part of abdomen, lateral view; 4 - posterior part of abdomen, ventral view

rounded in the internal part; the basal sclerite usually supports one well visible tooth and 2-4 irregular small teeth. A small protuberance is often presented outside the penis stem (Fig. 2). Cerci brown.

FEMALE IMAGO

Size: body length: 11.9-14.6 mm; fore wings: 19.6-23.7 mm; cerci: 13.3-16.4 mm. General color of the body brownish with reddish-brown spots on the lateral part of the abdominal and thoracic segments, darker as with the imago male. Head brown with yellowish-gray and reticulated dark spots. Eyes brownish-gray with a submarginal dark band. Ocelli brownish-gray. Thorax dark, brownish-gray, sometimes brownish-castaneous. Fore legs of the same coloration as the thorax. Middle and hind legs yellowish-brown with darker tarsi. Fore wings hyaline, transparent; venation dark, well visible; costal and subcostal zones light yellowish; pterostigmatic area milky, sometimes brownish. Hind wings hyaline with dark venation. Terga brown and brownish-castaneous with reddish spots laterally. Sterna of the same coloration as the terga, with dark nerve ganglia. The drawing on the surface of the sterna is similar to that of the male imago. Subgenital plate relatively wide; posterior margin slightly rounded. An apical outline of the subanal plate can be seen in Figs. 3, 4. Cerci brown.

MALE SUBIMAGO

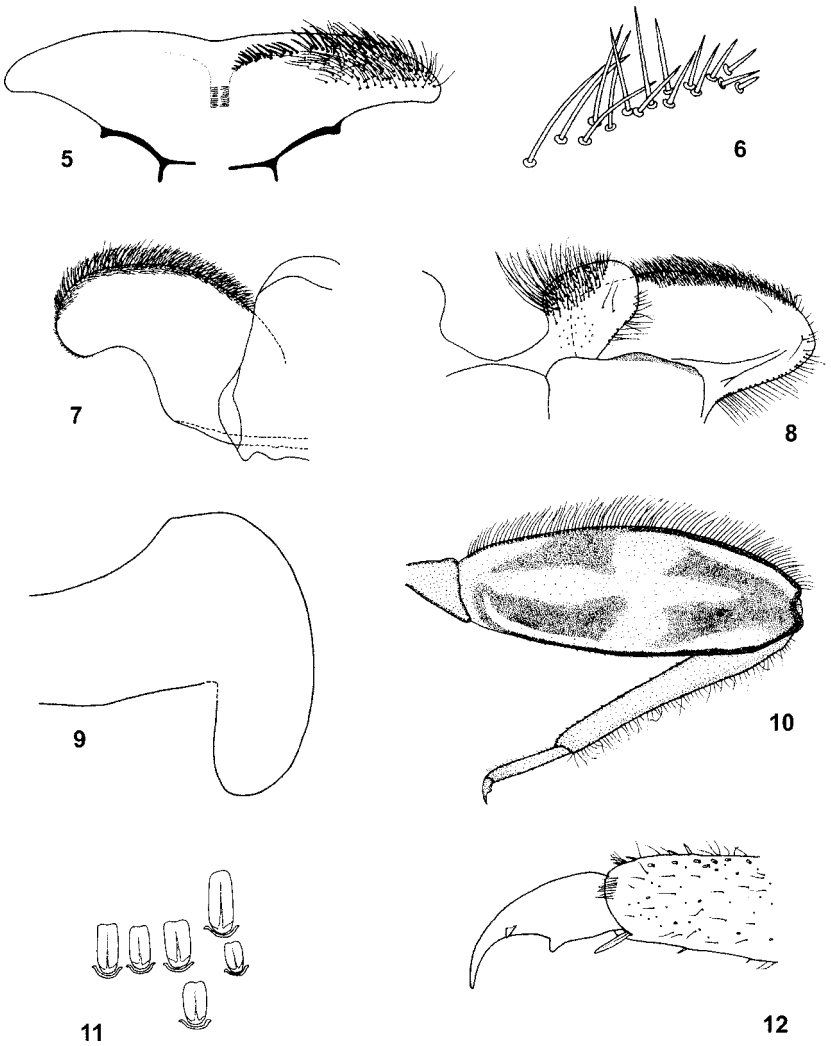
Size: body length: 13.9 mm; fore wings: 15.7 mm; cerci: 15.9 mm. General color of the body yellowish-brown with reddish-brown spots around the typical drawing on the abdominal terga. Thorax and legs with small reddish spots. Head grayish-brown with paler spots on margin; antennae brownish with a lighter scapus; eyes and ocelli gray. Dorsal part of the thorax yellowish with brown and yellowish-brown bands; lateral and ventral part yellowish-brown; segments of the thorax are contrasted with darker abdominal segments. General color of legs yellowish brown; fore legs darker with paler tarsi; middle and hind legs light, grayish on the dorsal part of the femora. Fore wings opaque with yellowish-gray venation; well visible drawing formed by transversal, intensive grayish bands (zigzag type) pointed at the distal part. Hind wings with only one paler band. Terga brownish-gray with a drawing on the surface similar to the male imago. Sterna yellowish with dark nerve ganglia. General coloration of genitalia yellowish-gray with darker forceps. In dorsal view, the outlines of the penis lobes are rounded and slightly stretched laterally. Base of forceps with two strong lateral protuberances. Cerci light brown.

FEMALE SUBIMAGO

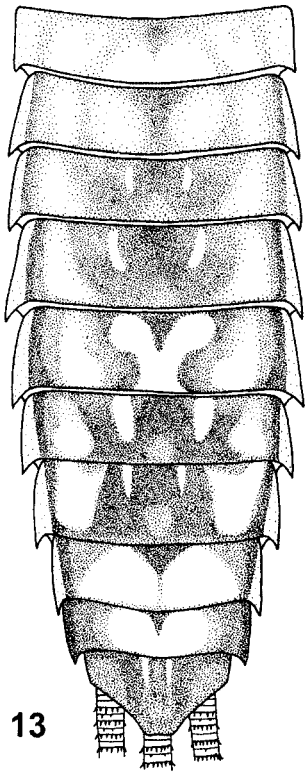
Size: body length: 12.1-14.2 mm; fore wings 15.5-16.8 mm; cerci 11.9-15.9 mm. General color similar to the male subimago. Reddish-brown spots are presented on the lateral part of the thoracic and abdominal segments, as well as on the femora.

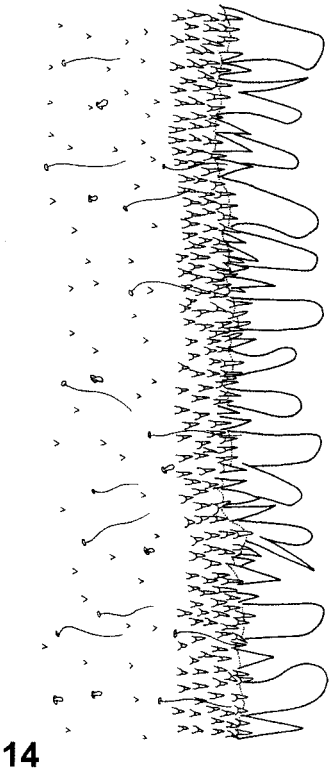
MATURE NYMPH

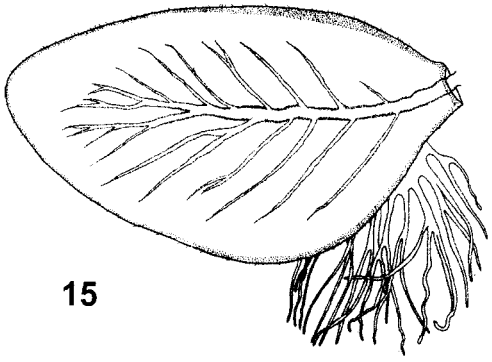
Size: body length: 10.3-15.5 mm; caudal filaments: 9.5-11.0 mm. General color of body yellowish-brown to brown, with a light grayish tinge. Head relatively wide, yellowish-brown to brown, with paler spots or a light zone on the anterior part. Antennae brown. Labrum relatively wide with well developed

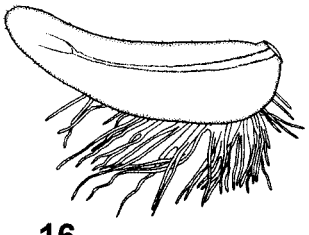


5-16. *Ecdyonurus austriacus nataliae*, nymph: 5 - outline of labrum; 6 - bristles on the ventral side of labrum; 7 - hypopharynx; 8 - fragment of labium with glossa and paraglossa; 9 - lateral pronotum expansion; 10 - hind leg; 11 - spines of central part of dorsal surface of the femora; 12 - tarsal claw









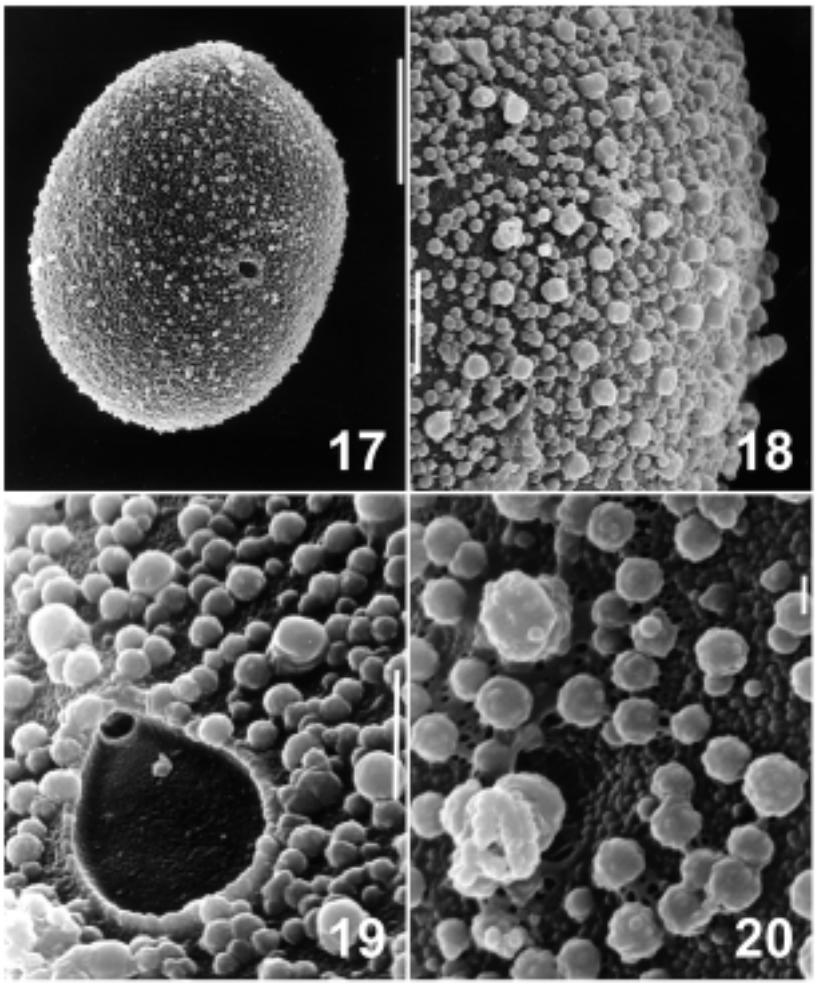
13-16. *Ecdyonurus austriacus nataliae*, nymph: 13 - abdomen, dorsal view; 14 - central part of posterior margin of fifth abdominal tergum; 15 - first gill; 16 - fourth gill

lateral projections and a slight depression in the middle of anterior margin (Fig. 5). The bristles in the rows on the ventral side of the labrum are rather slender. The first 1-4 bristles are shorter than the others (Fig. 6). Basal part of superlinguae of hypopharynx relatively wide and massive (Fig. 7); the pilosity of the hypopharynx is typical of the *E. helvetius*-group. Maxilla: 5-11 fine bristles on the fore margin of the first segment of maxillary palpus; more than 40 bristles along the outer margin; more than 30 bristles on dorsal side of the galea-lacinia. Glossa of labium as in Fig. 8; paraglossa massive with a rounded outer lateral projection. External margins of glossae and paraglossae with numerous fine setae. Thorax: general coloration yellowish-brown to brown with small reddish spots on the surface. Pronotum with paler spots and bands. External outline of the lateral pronotum expansion not regularly curved and rounded distally. Apex of the pronotum expansion strong, directed towards the body (Fig. 9). Legs yellowish-brown to brown with darker tarsi. Femora sometimes with small brownish-red spots. Femora slender and long. Length/width ratio of hind femora on average 2.84 (s = 0.203; n = 20). Surface of femora with a more or less visible drawing (four dark spots on a paler background, as in Fig. 10). Femoral spines rounded at the apex, generally in the form of a spatula (Fig. 11). Ventral side of posterior margin of hind femora with 23-34 (mean 28) spines and a rather short setae. Tarsal claws generally with 1-2 teeth (seldom 0-3) (Fig. 12). Abdomen: general color yellowish-brown to brown with small reddish spots. Lateral expansion of the abdominal segments short and pointed. Surface of the terga with a more or less distinct drawing: I-II segments relatively paler and centrally smudged; III-IV segments uniformly colored, with two paler spots on central part of the segment and two paler spots laterally; V segment sometimes lighter, with one central paler spot and two paler spots laterally; VI-VII segments uniformly colored, with three small paler spots placed centrally and two paler spots laterally; VIII-IX segments uniformly colored, with a big central paler spot and a darker lateral part of the segments; X segment generally dark, with only two small paler spots (Fig. 13). Posterior margins of the terga with two kinds of spines: the first is rather small and pointed at the apex; the second is large, extended and rounded at the apex in the form of a spatula, sometimes with a laterally pointed one from a common basis (Fig. 14). Surface of the terga with small pointed and rounded spines and long fine setae. Gills milky to yellowish in color, sometimes slightly grayish or reddish-brown. Gill 1 relatively long (Fig. 15); gill 4 wide and asymmetrical (Fig. 16). Length/width ratio of the 4th gill on average 1.93 (s = 0.153; n = 20). Caudal filaments brown to dark brown.

EGG

Egg oval. Size: length:173-181µm; width 107-115 µm (Fig. 17). Chorionic surface with a clear pattern (tubercles and attachment structures). Small rounded tubercles (0.8-1.6 µm in diameter) are quite densely and evenly distributed on the chorionic surface. There is a delicate granular ground matrix covering both the

chorionic surface and the tubercles (Fig. 18). Attachment structures are characterized by knob-terminated coiled threads (KCTs) (KOSS & EDMUNDS 1974). They are small, unanimous in size (2.2-2.7 µm in diameter) and cover the whole chorionic surface of the egg quite densely (4.4-8.0 µm distance between them) (Fig. 20). There are no concentrations of KCT attachment structures on the poles of the egg. Three to five micropyles can be found in the subequatorial area. Sperm guide ovoidal, 8.5-10.4 µm in length and 6.5-7.7 µm in width; a micropylar opening is situated to the side. Micropylar rim thin, with a few sparsely distributed tubercles (Fig. 19).



17-20. *Ecdyonurus austriacus nataliae*, egg: 17 - general outline of the egg, scale bar = 50 µm; 18- chorionic surface, scale bar = 10 µm; 19 - micropyle, scale bar = 5 µm; 20 - detail of chorionic surface with tubercles and attachment structures (KCTs) (ground matrix visible), scale bar = 1 µm (JEOL JSM 5410 scanning microscope)

MATERIAL EXAMINED

Holotype: 1 male imago, Ukraine, Ivano-Frankivs'k Region, Gorgany Mts., Natural Reserve "Gorgany", the Dzhurdzhi brook, 900-950 m. a.s.l., 48°29'14" E, 24°19'21" N, 23-26.VII.2000, leg. R.J. GODUNKO, M. KŁONOWSKA-OLEJNIK, K. PRZYBYŁA & P. ZASĘPA. Paratypes: 4 male imagines (reared from larvae, partly on microscopic slides), 9 female imagines, 2 female subimagines (reared from larvae, partly on microscopic slides), 6 subimaginal skins, 2 nymphal exuviae, 28 nymphs, from same locality and date. Other material: 4 larvae, Ukraine, Ivano-Frankivs'k Region, Gorgany Mts., Natural Reserve "Gorgany", the Dzhurdzhi brook, 900-950 m. a.s.l., 24.VII.1997, leg. R.J. GODUNKO & M. KŁONOWSKA-OLEJNIK; 9 nymphs, same locality, 20.VI.1999, leg. R.J. Godunko; 7 female imagines, 1 male subimago, 4 female subimagines, 3 subimaginal skins, 96 nymphs (partly on slides), same locality, 28.VI.2000, leg. R.J. GODUNKO, M. PUTZ & M. ŠTROJSOVÁ; 5 nymphs (partly on slides), Ukraine, Ivano-Frankivs'k Region, Gorgany Mts., Natural Reserve "Gorgany", the Dovzhynets'stream, Ozirnyi district, 800-900 m. a.s.l., 48°22'48" E, 24°17'57" N, 22.VII.1997, leg. R.J. GODUNKO & M. KŁONOWSKA-OLEJNIK; 10 nymphs (partly on slides), same locality, 29-30.VII.1998, leg. R.J. GODUNKO; 10 nymphs, same locality, 25.VII.2000, leg. R.J. GODUNKO & M. KŁONOWSKA-OLEJNIK; 8 nymphs, Ukraine, Ivano-Frankivs'k Region, Gorgany Mts., Bohdan stream, 750 m a.s.l., 48°21'40" E, 24°28'42" N, 18.VII.1999, leg. R.J. GODUNKO, M. KŁONOWSKA-OLEJNIK, K. PRZYBYŁA & P. ZASĘPA. All specimens were preserved in 75% alcohol. The holotype and some of the paratypes are housed in the collection of the State Museum of Natural History, National Academy of Sciences of Ukraine, L'viv, Ukraine. Other material can be found in the second author's collection at Jagiellonian University, Cracow, Poland.

AFFINITIES

E. austriacus nataliae belongs to the *E. helveticus*-group due to the following characteristics: 1) distal part of larval hypopharynx without long and dense setae; 2) lateral expansion of larval abdominal segments short and directed in parallel to the axis of the body; 3) apical sclerite of the penis lobes of imago laterally elongated; 4) lateral part of the adult terga with a characteristic pattern. *E. austriacus nataliae* is closely related to *Ecdyonurus austriacus austriacus* KIMMINS, 1958 especially in adult stages. Genitalia of male imagines of *E. austriacus nataliae* partly resemble *E. austriacus austriacus* but can be distinguished by: 1) inner margin of apical sclerite with one (sometimes with two) strong stout tooth directed towards the center of the lobe and with some small submarginal teeth; 2) lateral sclerite softly rounded in the internal part; 3) penis lobes are less stretched laterally; 4) the color and size of body and wings. The combination of these characteristics clearly distinguishes *E. austriacus nataliae* from all the East European species of the *E. helveticus*-group. *E. carpathicus* SOWA, 1973 and *E. subalpinus* are both separable from *E. austriacus nataliae* because of the following characteristics: 1) penis lobes are more stretched laterally with more spherical outline; 2) the lateral sclerite is relatively slender with a deep narrowing

in the external part (SOWA 1973, HEFTI et al. 1989). The shape of basal sclerite of the penis lobes distinguishes *E. austriacus nataliae* from *E. picteti* as the latter species bears strong large teeth, projected perpendicularly to the axis of symmetry of the penis lobes (HEFTI & TOMKA 1986, HEFTI et al. 1989). The lateral sclerite of the penis lobes of *E. helveticus*, in contrast to *E. austriacus nataliae*, is slender with a deep narrowing in the external part (HEFTI et al. 1987).

The male and female subimagines of *E. austriacus nataliae* resemble *E. austriacus austriacus* in terms of general body and wing color (KIMMINS 1958, HEFTI & TOMKA 1986), but is distinguished by: the size of the body and wings; and the character of the sclerites of penis lobes in male subimago (similar to male imago). The fore wings of *E. austriacus nataliae* present a distinct zigzag pattern. Other species of the *E. helveticus*-group have no zigzag pattern on the fore wings or, if it is visible (as in *E. austriacus austriacus, E. helveticus, Ecdyonurus parahelveticus* HEFTI, TOMKA & ZURWERRA, 1986 and *E. picteti*) its color is not intensive. The wings coloration of a new subspecies is similar to that of the specimens in populations of *E. subalpinus* KLAPÁLEK, 1907 from the Czech Republic (SOLDÁN, personal communication). On the contrary, no such relationships have been observed in the *E. subalpinus* populations from the East Carpathians.

In the nymphal stages *E. austriacus nataliae* is easily distinguishable from other species belonging to the *E. helveticus*-group. The tergo-abdominal spines of larvae of *E. austriacus nataliae* are of the same type as *E. austriacus austriacus*, *E. parahelveticus*, and *Ecdyonurus alpinus* HEFTI, TOMKA & ZURWERRA, 1987 (HEFTI & TOMKA 1986, HEFTI et. al. 1986, 1987), i. e. large and apically rounded, but their shape and arrangement are very characteristic. Additionally, *E. austriacus nataliae* differs from *E. austriacus austriacus, E. parahelveticus* and *E. alpinus* by the number and shape of the teeth on the tarsal claws, the shape of the labrum, hypopharynx and tergo-abdominal spines and by the drawing of the abdomen and legs (HEFTI & TOMKA 1986, HEFTI et al. 1986, 1987, 1989). Eggs of *E. austriacus nataliae* are different from the other species of the *E. helveticus*-group. A study in light microscopy showed that the most common chorionic organization is densely granulated, and the granules are concentrated on both poles of the eggs (HEFTI & TOMKA 1986, HEFTI et al. 1986, 1987, 1989). It seems probable that this concentration concerns KCTs attachment structures. In *E. alpinus, E. austriacus austriacus, E. helveticus* and *E. parahelveticus* KCTs attachment structures are distinctly concentrated at two poles of the eggs (HEFTI & TOMKA 1986, HEFTI et al. 1986, 1987). KCTs in *E. zelleri* (EATON, 1885) egg poles are less frequent (HEFTI et al. 1987). Only *E. picteti* has KCTs concentration at one pole of the egg (HEFTI & TOMKA 1986). Thus, *E. austriacus nataliae* with no concentration of KCTs attachment structure at the egg poles is easily distinguishable from previously mentioned species.

DISTRIBUTION AND ECOLOGY

E. austriacus nataliae has been found in small mountain brooks and streams between 700-1200 m a.s.l., 1-4 m width and 0.2-1.5 m depth, with cold water (in summer ~10°C) and current velocity higher than 1 m/s. The bottom is covered with boulders and cobbles, and the banks are high and shaded by subalpine forest. The species occurs up to the timberline, the most frequently - between 800-900 m a.s.l.. In these localities *E. austriacus nataliae* lives together with *Ameletus inopinatus* EATON, *Baetis alpinus* (PICTET), *B. melanonyx* (PICTET), *Rhithrogena iridina* (KOLENATI), *R. gorganica* KLAPÁLEK, and *E. subalpinus*. *E. austriacus nataliae* is a univoltine winter species (Uw) with one generation per year (CLIFFORD 1982). Population overwinters in the nymphal stage. The larvae occur gradually and grow during the winter. The flying period extends from June to August-September. *E. austriacus nataliae* has been found only in the Eastern Carpathians, Gorgany Mts., Bystrytsya Nadvirnyans'ka river-basin (tributaries of the Dnister river; two localities) and in the Prutets' Yablons'kyi river-basin (tributaries of the Prut river; one locality). MIKULSKI (1935), in his paper about the Ephemeroptera species of the Chornohora Mts., described and illustrated the larval abdomen of "*Ecdyonurus sp. larvae* (*subalpinus*?)" and "*Ecdyonurus sp. larva*". Some details are similar to the drawing of the abdomen of *E. austriacus nataliae* (Figs. 1, 2, 4) but other characteristics needed to determine this taxon are absent in MIKULSKI's description. Moreover, at that time, *E. austriacus nataliae* was not found in the Chornohora mountain range. Thus, *E. austriacus nataliae* seems to be an endemic of the Eastern Carpathians.

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