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A new species of Limnephilidae (Insecta: Trichoptera) from the Western Alps (Insecta: Trichoptera)

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Abstract

A new species of the alpine caddisfly genus *Conisorophylax* (Trichoptera, Limnephilidae, Stenophylacini) and the female of the recently described *C. vinconi* Graf & Malicky 2015 are described. The new species *C. lepontiorum* sp. nov. is a microendemic of the South-Western Alps and differs from its congeners in the shape of the superior and inferior appendages and the unique setation of the aedeagus, absent in all other *Conisorophylax* species. The female of *C. vinconi* is characterized by the unique formation of the anal tube. Potential effects of alpine orogenesis, phenology and climatic oscillation on speciation of aquatic insects inhabiting high-altitude habitats are discussed. The description of *C. lepontiorum* sp. nov. accentuates the significance of the Western Alps as harbours of aquatic insect biodiversity, and demonstrates the necessity of faunal and taxonomic studies in Europe – a supposedly well-explored region.

Keywords

Conisorophylax; female; larva; Italy; caddisfly; description

Introduction

The South-Western Alps have been identified as periglacial refuges and centres of endemism for a large number of taxa (Ansell *et al.* 2008; Balletto *et al.* 2005; Engelhardt *et al.* 2011; Haubrich & Schmitt 2007; Huemer 2011; Iserbyt *et al.* 2008; Parisod & Besnard 2007; Schönswetter *et al.* 2005; Wohlgemuth 2002). In aquatic insects, particularly cold-stenotopic or mountainous groups exhibit high diversity in the region, both taxonomically and genetically (cf. Engelhardt *et al.* 2008; Pauls *et al.* 2006; Vinçon & Ravizza 1996, 1998). Further, the southern slopes of the South-Western Alps were identified as centre of endemism in the cold-stenotopic caddisfly genus *Conisorophylax* (Graf *et al.* 2015a).

Originally described in 1955 based on characters of the male wing and genitalia, and, interestingly, the female genitalia (Schmid 1955), this genus currently comprises eight

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species, four of which are local endemics in the South-Western Alps (Kimmins & Botosaneanu 1967; Malicky 2004, 2005, 2008; Graf et al. 2008; Graf et al. 2015a). *Conсорophylax* larvae are considered to mainly behave as shredders, and inhabit crenal to epirhithral sections of alpine to montane streams (Graf et al. 2008). To the present knowledge, larvae of the genus are characterized by a bicolored prothorax, and cannot be identified on species-level (Waringer & Graf 2011).

In this contribution, we describe a new species of the genus, *Conсорophylax lepontiorum* sp. nov., and the female of the recently described *C. vinconi* Graf & Malicky 2015.

Material and Methods

Adult specimens were collected using sweep nets. Collected specimens were stored in 96% EthOH. Morphological characteristics of male and female genitalia were examined in KOH-treated, cleared specimens. Comparative material from the authors' collections enabled the identification of the new species. Nomenclature of male genitalia follows Nielsen (1957, for *Stenophylax stellatus* (Curtis 1834), synonym of *Potamophylax latipennis* Curtis 1834), using the simplifying terms 'superior appendage' for the lateral process of segment X, and 'intermediate appendage' for the median and posterior process of segment X. Nomenclature of female genitalia follows Previši et al. (2014, for *Ecclisopteryx dalecarlica*). Illustrations were prepared according to Thomson & Holzenthal (2010): Briefly, pencil drawings of the cleared specimens were produced using a camera lucida mounted on a compound microscope, and digitally edited and "inked" with Adobe Illustrator (v. 16.0.4, Adobe Systems Inc.)

Description of the female of *Conсорophylax vinconi*

Material—1 female: Italy, Quincinetto, Scalero, 45.554000°N 7.804200°E, 1500 m asl, 11.×.2014, leg. Vincon.

Diagnosis—The female of *C. vinconi* is most similar to the females of *C. montivagus* but differs in exhibiting (1) a rounded anal tube in dorsal view, (2) a long mesal protrusion of the anal tube. Females of *C. montivagus* have a quadrangular anal tube in dorsal view with a short mesal protrusion.

Description. Female—General appearance light brown (in alcohol), tergites and sternites light brown; cephalic and thoracic setal areas cream-coloured; cephalic, thoracic and abdominal setation light brown; legs light brown; haustellum and intersegmental integument cream-coloured; wings light brown to brown, translucent, setation on veins and membrane light brown, length of each forewing 12.8 mm. Female maxillary palps each pentasegmented, tibial spur formula 1,3,4.

Female genitalia (Fig. 1A-C). Anal tube (fused segments IX and X, according to Nielsen 1980) in lateral view suboval with lateral indentation separating proximal and distal part, distally a short dorsal mesal protrusion and a long lateral protrusion projecting caudad; in dorsal view proximally wide, bulbous, distal part distinctly separated by lateral and dorsal indentations, consisting of isocles-trapezium-shaped mesal protrusion and digitate lateral

protrusions; in ventral view the proximal part with a rounded cranial protrusion and several small indentations, distally mesal protrusion tubular, open. Supragenital plate in lateral view with a lateral dorsal rounded protrusion and a subtriangular, dorsally curved ventral protrusion, in ventral view complex, lateral protrusions rounded, quadrangular, ventral protrusion subtriangular. Vulvar sclerite not distinctly separated from sternite VIII; in lateral view stout, subtrapezoidal with a small rounded lateral protrusion; in ventral view trilobate, all lobes approximately of equal length and width.

***Conсорophylax lemontiorum* sp. nov. Graf & Vitecek**

Holotype—1 male: Italy, Omegna, Campello Monti, Valstrona Valley, 45.941873°N 8.209528°E, 1900m asl, 12.×.2014, leg. Vincon.

Diagnosis—The new species is a *Conсорophylax* most similar to *C. piemontanus* Botosaneanu 1967, *C. delmastroi* Malicky 2004 and *C. vinconi* Graf & Malicky 2015, but exhibits (1) terminal laterally positioned setae on the aedeagus, (2) gradually tapering parameres, (3) dorsocaudally bilobed superior appendages, (4) inferior appendages bearing a broad, unbifurcated tip that is flat in caudal view. *Conсорophylax piemontanus* has no setae on the aedeagus, rounded suboval superior appendages and a more-narrow tip of the inferior appendages in lateral view that is wide in caudal view. *Conсорophylax delmastroi* has no setae on the aedeagus, long setae on the distinctly tapering parameres, rounded suboval superior appendages and a slightly bifurcated tip of the inferior appendages in lateral view that is wide in caudal view. *Conсорophylax vinconi* has no setae on the aedeagus, rounded capitate superior appendages, distally abruptly constricted parameres and a slightly bifurcated tip of the inferior appendages in lateral view that is wide in caudal view. The other *Conсорophylax* species are easily delineated as they exhibit a distinct dorsal digitate protrusion of the inferior appendages.

Description—General appearance dark brown (in alcohol), tergites and sternites dark brown; cephalic and thoracic setal areas cream-coloured; cephalic, thoracic and abdominal setation light brown; legs light brown; haustellum and intersegmental integument cream-coloured; wings light brown to beige, translucent, setation on veins and membrane light brown, length of each forewing 14.5 mm. Male maxillary palps each trisegmented, tibial spur formula 1,3,4. Male genitalia (Figs. 2A–E). Tergite VIII (VIII) light brown, with dorsolateral loosely spinose area in posterior 2/3rds extending to bilobed caudal densely spinose area. Dorsal third of segment IX (IX) reduced to narrow transverse bridge, ventral 2/3rds broad, with distinct lateral indentation and triangular anterior protuberance in lateral view, seemingly fused with inferior appendages. Superior appendages in lateral view approximately suboval, dorsocaudally bilobed; in dorsal view suboval, distinctly curved laterally, medially indent; in caudal view suboval, distinctly curved laterally, medially concave. Intermediate appendage basally divided into separate vertical plates on either side of the anus, each triangularly suboval in caudal view, in lateral and caudal view with a rounded protrusion projecting caudally in the ventral 1/3rd; each dorsal process of intermediate appendages in lateral view long, subhorizontal, distally tapering with a sharp tip. Inferior appendages in lateral view broad, stout, fused with segment IX, each with a dorsal portion directed somewhat caudad; in dorsal view stout with distinct, subtriangular

dorsal portion; in caudal view slender, irregular, dorsal portion directed medially. Aedeagus in lateral view curved dorsad with a row of terminal setae and a dorsodistal membranous portion; in dorsal view tip bifurcate with setae positioned laterally and membranous portion wider than sclerotized portion. Parameres in lateral view slightly tapering distally, slender, curved dorsally with a terminal tip bearing several small spines; in dorsal view distally slightly curved laterad.

Female, pupa, larva, and egg unknown.

Etymology—Named for the Lepontii, a people inhabiting the region in the first century B.C., who spoke a distinct continental celtic language, Lepontic, and developed unique letters for its' documentation.

Distribution, biogeography & evolution—Members of the genus *Conсорophylax* exclusively occur in the Alpine arc and the majority of species is endemic to very small areas (Graf *et al.* 2015a) (Fig. 3). Although the exact distribution ranges of the species are not exactly defined, six of the eight known species are micro-endemics *sensu* Graf *et al.* (2008) by being restricted to single catchments or mountains throughout the Alps. Additionally, the southern slopes of the Western Alps were found to harbour four distinct micro-endemics on a very small geographical scale, each in a single catchment less than 100 km apart. The new species was found a mere 65 km North-North East of the type locality of the easternmost South-Western Alpine *Conсорophylax* species, *C. vinconi* (Fig. 3). Thus, the currently known speciation patterns of *Conсорophylax* in the South-Western Alps (Graf *et al.* 2015a, this study) suggest a complex evolutionary history potentially driven by glacial oscillations, geological processes and particular species traits. Intriguingly, present-day distribution of South-Western Alp *Conсорophylax* micro-endemics (*C. corvo* Malicky 2008, *C. delmastroi*, *C. piemontanus* Botosaneanu 1967, *C. vinconi*) correlates surprisingly well with historic (Miocene-Pliocene) river courses in the region (Pfiffner 2010) (Fig. 3).

Discussion

Speculations on evolution of *Conсорophylax* and specific speciation drivers

We assume that early diversification of the group dates back to late Miocene – early Pliocene when larger rivers had begun to excavate their valleys in the newly upfolded Alps. However, ancestral forms potentially inhabiting small streams could have adapted to decreasing temperatures from the Mid-Miocene onwards, entering more suitable habitats as they became available as springs in the newly-shaped valleys. Additionally, climatic oscillations potentially enhanced speciation by separating local populations. Susceptibility to climate-induced vicariance might well be intimately correlated to phenology of a taxon, and potentially enhances speciation in cold-stenotopic crenobiont to crenophilous taxa with early or late emergence (such as *Conсорophylax* sp., some Drusinae, some Leuctridae (Graf *et al.* 2008; Graf *et al.* 2015b)), postulating climatic oscillations to obstruct dispersal over a sufficiently long period of time. Assuming a global cooling (as likely effective in the middle Miocene and intensifying in the Pliocene (Barron & Keller 1982; Flower & Kennett 1994; Pfiffner 2010)), mechanisms resulting in the separation of populations could include snow coverage of larval habitats – trapping newly emerged adults of early or late emerging taxa

and thus isolating populations, or subsiding of springs and small streams – resulting in a loss of bridging habitats, or lower daytime air temperatures (cf. Waringer 1991; Briers et al. 2003) – reducing potential dispersal rates. Supposing such vicariant events to occur at high frequencies, independent evolution of populations would result in the formation of distinct species. Also, glaciation of the Alps and localized survival of independently evolving populations is likely to have affected speciation in the genus (cf. Malicky 2006). Such mechanisms could potentially have shaped diversification of *Conosorophylax*, leading to the observed distribution patterns in the South-Western Alps. Thus, the genus *Conosorophylax* might represent an ideal model to study orogenesis- and climatic-oscillation-driven speciation of high-altitude aquatic insects. Primitively, one could infer a time-calibrated phylogeny of the group, and assess putatively existing coincidences of divergence times between clades and known historic geographic or climatic processes.

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Figure 1.
Female genitalia of *C. vinconi*. A, right lateral; B, ventral; C, dorsal. Scale bar denotes 1 mm. Del. Vitecek.

Figure 2. Male genitalia of *C. lepontiorum* sp. nov. A, right lateral; B, aedeagus, dorsal; C, aedeagus, right lateral; D, caudal; E, dorsal. Scale bar denotes 1 mm. Del. Vitecek.

Figure 3. Distribution map of *Consorophylax* species. Two species (*C. consors*, *C. styriacus*) are comparatively widely distributed across the Alpine arc, whereas the other species are regional or micro-endemics. Dotted lines indicate late Miocene to early Pliocene river courses as estimated in Pfiffner (2010).