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Revision of the Western Palaearctic Diplazontinae (Hymenoptera, Ichneumonidae)

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Abstract

I revise the subfamily Diplazontinae to include 99 Western Palaearctic species, review morphological characters useful for species delimitation and identification, and clarify the status of some morphologically similar taxa using molecular approaches. Illustrated, dichotomous keys to the Western Palaearctic genera and species of the subfamily are presented, and the utility of the molecular markers CO1 and ITS2 for species delimitation in Diplazontinae is discussed. Seven new species are described, *Diplazon flixi* **sp. nov.**, *Diplazon nordicus* **sp. nov.**, *Diplazon parvus* **sp. nov.**, *Diplazon zetteli* **sp. nov.**, *Eurytyloides umbrinus* **sp. nov.**, *Sussaba roberti* **sp. nov.**, and *Woldstedtius bauri* **sp. nov.** The Nearctic *Sussaba cultriformis* (Ashmead), formerly a subspecies of *Sussaba dorsalis* (Holmgren), is raised to species rank. The following taxa are valid species and hereby removed from synonymy: *Episemura ensata* (Bauer), **stat. rev.**; *Homotropus frontorius* (Thunberg), **stat. rev.**; *Syrphoctonus desvignesii* (Marshall), **stat. rev.**; *Syrphophilus scabriculus* (Holmgren), **stat. rev.**; and *Tymmophorus suspiciosus* (Brischke), **stat. rev.** Nineteen new synonyms are established: *Bioblapsis mallochi* Rotheray of *Bioblapsis cultiformis* (Davis), **syn. nov.**; *Bioblapsis tricincta* Ashmead of *Syrphophilus scabriculus* (Holmgren), **syn. nov.**; *Diplazon bachmaieri* Diller of *Diplazon angustus* Dasch, **syn. nov.**; *Diplazon fechteri* Diller of *Diplazon cascadensis* Dasch, **syn. nov.**; *Homocidus brevis* Hedwig of *Homotropus pictus* (Gravenhorst); *Homocidus rubiginosum* Schmiedeknecht of *Enizemum scutellare* (Lange), **syn. nov.**; *Homocidus simulans* Stelfox of *Homotropus collinus* (Stelfox), **syn. nov.**; *Homotropus crassicrus* Thomson and *Homotropus nudus* Dasch of *Homotropus dimidiatus* (Schrank), **syn. nov.**; *Homocidus asyntactus* Schmiedeknecht of *Homotropus crassicornis* Thomson, **syn. nov.**; *Homocidus subopacus* Stelfox and *Homotropus quadrangularis* Dasch of *Homotropus frontorius* (Thunberg), **syn. nov.**; *Homocidus impolitus* Stelfox of *Homotropus pallipes* (Gravenhorst), **syn. nov.**; *Homotropus incisus* Thomson and *Homotropus reflexus* Morley of *Homotropus pectoralis* (Provancher), **syn. nov.**; *Tryphon nigricornis* Zetterstedt, a former synonym of *H. dimidiatus* Schrank, is a synonym of *Homotropus pictus* (Gravenhorst), **syn. nov.**; *Homotropus fraudulentus* Dasch and *Homotropus neopulcher* Horstmann of *Syrphoctonus desvignesii* (Marshall), **syn. nov.**; *Homotropus eximius* Habermehl of *Syrphoctonus tarsatorius* (Panzer), **syn. nov.** The following new combinations are established: *Bioblapsis cultiformis* (Davis), **comb. nov.**; *Homotropus collinus* (Stelfox), **comb. nov.**; *Homotropus dimidiatus* (Schrank), **comb. nov.**; *Homotropus frontorius* (Thunberg), **comb. nov.**; *Homotropus pectoralis* (Provancher), **comb. nov.**; *Homotropus strigator* (Fabricius), **comb. nov.**; *Homotropus sundevalli* (Holmgren), **comb. nov.** The present revision is the first comprehensive treatment of the Western Palaearctic Diplazontinae, provides the basis for taxonomic, faunistic, ecological and evolutionary studies in these hoverfly parasitoids, and exemplifies an integrative approach to systematics and taxonomy.

Key words: identification key, species delimitation, parasitoid wasps, alpha-taxonomy, barcoding, cytochrome oxidase 1 CO1, internal transcribed spacer 2 ITS2, molecular, morphology, systematics

Introduction

Parasitoid wasps are among the most species-rich and at the same time most under-studied insect taxa (Quicke 1997; Jones *et al.* 2009). Even in the well-known fauna of the Western Palaearctic, new species are discovered at a regular pace, and most groups are still in need of thorough revisions. Consequently, identification of most parasitoid specimens can only be achieved by specialists. This situation is partly due to high levels of

Nevertheless, it can be said that the morphological and molecular data complemented each other quite well in this revision of the subfamily Diplazontinae, and both data partitions provided valuable information for proposing sound species hypotheses and testing previously proposed species and genera. The ITS2 sequences examined did not only reveal some nucleotide substitutions that could be used to distinguish between closely related species but also some species-specific indels which probably represent molecular synapomorphies. However, using reciprocal monophyly as a criterion, both ITS2 and, even more, CO1 failed in multiple cases where morphology provided good evidence for the existence of multiple species. Molecular taxonomy without morphology, let alone automated procedures for species discovery (e.g., Pons *et al.* 2006; Vogler & Monaghan 2007), would have severely underestimated species numbers in many cases because of extensive non-monophyly and overlapping intra- and interspecific distances in several species. This was often even the case when the molecular data, adequately interpreted, added to the evidence for the existence of multiple species, e.g. in cases where monophyly was only reached in one of the two putative species, as in the genus *Tymmophorus*. But the limited performance of both markers cannot be viewed as being the rule in Diplazontinae, as molecular methods were only invoked in cases where morphology was somewhat unclear, at least in one sex. The groups of species examined in more detail might thus represent especially young speciation events.

Non-monophyly in single-gene trees by good biological species has been shown to be very common in several groups, e.g. concerning 36% of species in diving beetles (Bergsten *et al.* 2012). A similar number has previously been reported in other studies with broader taxonomic sampling (Funk & Omland 2003). However, reciprocal monophyly might not be necessary for molecular species delimitation. Recently developed methods are instead based on coalescent approaches and multiple markers (Yang & Rannala 2010), and can provide estimates of likely species delimitation which do not require reciprocal monophyly of the taxa. For the current study, however, the limited sampling did not seem to justify the application of such methods, and both marker and specimen sampling should be expanded in the future. In any case, a careful evaluation of multiple sources of evidence, including morphology, appears to be the only way to arrive at sound species hypotheses in parasitoid wasps and other organisms (Schlick-Steiner *et al.* 2010).

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