Zootaxa 3893 (2): 232–242
www.mapress.com/zootaxa/
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Article

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

http://dx.doi.org/10.11646/zootaxa.3893.2.4
http://zoobank.org/urn:lsid:zoobank.org:pub:047ECBC9-289E-49CD-B434-5D02C6F054C0

Taxonomy of *Eumenes punctatus*-complex (Hymenoptera: Vespidae: Eumeninae) from Korea with DNA barcoding and key to Far Eastern species of the genus *Eumenes* Latreille, 1802

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Abstract

Based on DNA barcoding analysis and morphological comparison, new synonymy is proposed for *Eumenes punctatus* de Saussure, 1852 =*E. asioboreus* Kim & Sk. Yamane, 2001, **syn. nov.** Independent status of the Far Eastern species *E. rubrofemoratus* Giordani Soika, 1941 from the transpalearctic *E. coarctatus* (Linnaeus, 1758) is supported, suggesting their recent origin with comparatively low genetic divergence. A revised key to the Far Eastern species of the genus *Eumenes* is provided. Distribution of *E. quadratus* Smith, 1852 is corrected and *E. rubrofemoratus* Giordani Soika, 1941 is newly recorded from South Korea. For future taxonomic comprehension of the Far Eastern *Eumenes*, problematic species pairs requiring additional molecular tests are hereby suggested and discussed.

Key words: Eumeninae, *Eumenes punctatus*-complex, DNA barcoding, new synonymy, key

Introduction

The members of the genus *Eumenes* Latreille 1802 are solitary predatory wasps of the subfamily Eumeninae which is the primary lineage of the family Vespidae. Generic monophyly is well established based on the following inferred synapomorphies: one apical spur on mid tibia, petiolate metasoma, short and rounded propodeal valvula, dorsally rounded propodeal orifice, and absence of pretegula carina (Carpenter & Cumming 1985).

The genus *Eumenes* is cosmopolitan in distribution (Vecht & Fischer 1972; Vecht & Carpenter 1990), and fifteen species are so far known in the Far East (Kim & Sk. Yamane 2001). Among them, *Eumenes micado, E. coarctatus, E. fraterculus, E. labiatus, E. mediterraneus, E. pedunculatus, E. punctatus, E. quadratus, E. rubronotatus, E. septentrionalis, E. transbaicalicus,* were well established by their distinct external features together with male genital structures (Kim & Sk. Yamane 2001). However, identities of several species might be still problematic. The taxonomic status of *E. rubrofemoratus* Giordani Soika, 1941 and *E. coarctatus* (Linnaeus, 1758) was debatable whether they were valid species to each other (Kim & Sk. Yamane 2001) or in subspecific relation (Kurzenko 1995). Such was also the case for *E. rubronotatus* and *E. aquilonius* (as subspecific relation in Sk. Yamane 1977 *vs.* as valid species in Kim & Sk. Yamane 2001). Also, our recent re-examination of external morphologies including male genital structure together with flight periods of *E. punctatus* Saussure 1852 and *E. asioboreus* Kim & Sk. Yamane 2001 allowed us to recognize the probable ill-founded establishment of *E. asioboreus*.

With PCR amplified partial mitochondrial cytochrom c oxydase subunit I (mtDNA COI) gene sequence corresponding to the DNA barcoding region proposed by Hebert *et al.* (2003), we tested the taxonomic validity of the three species, i.e. *E. punctatus, E. asioboreus* and *E. rubronotatus* that are closely realated in external features. Also, the same gene region of *E. coarctatus* (of European material; GenBank accession number HQ947781) and *E. rubrofemoratus* (amplified herein) was compared.

 Accepted by A. Lelej: 29 Oct. 2014; published: 8 Dec. 2014

tergum 2 of *E. asioboreus* and *E. aquilonius* smaller and sparser (often feeble and fine, and always spaced at least by puncture diameter) than those of *E. punctatus* and *E. rubronotatus* (touching one another). Therefore, taxonomic determination of *E. punctatus*-complex, of which species are endemic to the Far East and actually composed of two pairs of sibling species (i.e. *E. punctatus*-*E. asioboreus* and *E. rubronotatus*-*E. aquilonius*), by Kim & Sk. Yamane (2001) was based on morphological differences between two species in each sibling pair, together with additional biogeographic characteristics revealed after establishment of subspecies *E. rubronotatus aquilonius* Sk. Yamane, 1977.

Application of DNA barcoding to species identification was very helpful, and, if successful, it furnished with more critical taxonomic clues than by morphological interpretations (Hebert *et al*. 2003). Despite the inherent limits of using exclusive Korean materials, the result of this study is supportive that DNA barcoding be a helpful tool for future *Eumenes* taxonomy in this region. For resolving long-standing problems of the Far Eastern *Eumenes* taxonomy, applications of DNA barcoding on the following pairs are necessary. 1) Korean and Japanese *E. roubronotatus* for their conspecificity. We cannot find distinctive difference in external features including genital structure between Korean and Japanese specimens of this species, but the Japanese specimens often have body punctures larger and deeper than Korean ones. 2) Japanese *E. aquilonis* and Japanese *E. rubronotatus* for their specific status, and Korean and Japanese *E. aquilonis* for their conspecificity. Considering the result of new synonymic status of *E*. *asioboreus* in this study, it is highly possible that *E. aquilonis* may be merely a climatic form of *E. rubronotatus* in Japan, and a phenological form in Russian Far East and Korea. 3) According to the original descriptions of Giordani Soika (1941) and the later taxonomic discrimination of Kim and Sk. Yamane (2001), taxonomic distinction between *E. labiatus* and *E. kiangsuensis* might be a same case as the *E. punctatus* and *E. asioboreus* pair herein in terms of both degrees of morphological differences and phenological features, thus also entailing another molecular test.

Acknowledgements

We deeply appreciate to Dr. A.S. Lelej (Institute of Biology and Soil Science, Russian Academy of Sciences, Vladivostok, Russia) and Dr. H.Y. Han (Yonsei University, Weonju, Korea) for their valuable suggestions and English editing on earlier manuscript. This work was supported by a grant from the National Institute of Biological Resources (NIBR) to J.K. Kim, funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR 201401203).

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APPENDIX. Examined specimens of *Eumenes rubrofemoratus* from South Korea.

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