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# DNA barcoding and male genital morphology reveal five new cryptic species in the West Palearctic bee *Seladonia smaragdula* (Vachal, 1895) (Hymenoptera: Apoidea: Halictidae)

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## Abstract

Several forms or variants have long been recognized in the West Palearctic sweat bee *Seladonia smaragdula* (Vachal, 1895). Using DNA barcoding and morphological characters, primarily of the male genitalia, these variants are here recognized and described as five new species: *S. gemmella* Pauly **sp. nov.**, *S. submediterranea* Pauly **sp. nov.**, *S. orientana* Pauly & Devalez **sp. nov.**, *S. phryganica* Pauly & Devalez **sp. nov.**, and *S. cretella* Pauly & Devalez **sp. nov.** Also, we designate a lectotype for *Halictus smaragdulus* Vachal, consider *Seladonia butea* (Warncke, 1975) and *S. morinella* (Warncke, 1975) as nomina dubia, and discuss the identity of the *Seladonia* specimens from Australia currently determined as *S. smaragdula*.

**Key words:** Australia, integrative taxonomy, invasive species, new species

## Introduction

*Seladonia* Robertson, 1918 (Halictidae: Halictini) consists of approximately 65 species occurring across the Holarctic, Sub-Saharan and Oriental Regions; one species has been recorded as invasive in Australia (Gollan *et al*. 2008). Herein we follow Pesenko (2004) and Pauly (2008; 2015) in treating *Seladonia* at the genus level, not as a subgenus of *Halictus* Latreille, 1804 (Michener 2007). Several variants or forms have long been known in *S. smaragdula* (Vachal, 1895), a rather common species in the Mediterranean Basin (Figs 1, 2), occurring in Europe from Portugal to Greece, and in North Africa from Morocco to the Sinai Peninsula in Egypt; eastwards, this species extends to the Middle East, Central Asia and the Boro Horo Mountains in Xinjang, China. It has a scattered distribution in Central Europe, where it is mostly restricted to warm areas. Adult males and females often forage on flowers of Asteraceae, Apiaceae and Lamiaceae. The nesting biology and social behaviour are unknown; however, phenological data and variations in the size of the female head suggest some degree of eusociality (Pesenko *et al*. 2000).

Blüthgen (1923; 1955) pointed out that "this species forms numerous subspecies and it needs a revision". Ebmer (1976; 1987; 1988) also considered *S. smaragdula* as a highly variable species ("Eine der variabelsten Arten der Westpaläarktis ohne geographische Subspezies auszubilden"). Females of these forms resemble each other and cannot be identified by morphological characters alone. However, the genitalia of males show consistent differences, which allowed Pauly & Rassel (1982) to distinguish five morphs provisionally named forms A to E.

In the present work, we use morphological and genetic data in order to evaluate the status of the forms A–E recognized by Pauly & Rassel (1982). The analysis of DNA sequences can complement morphological investigations for species delimitation and have been used to reveal cryptic bee species, such as those in the *Colletes succinctus* (Linnaeus, 1758) (Kuhlmann *et al.* 2007) and the *Bombus lucorum* (Linnaeus, 1761) groups (Murray *et al.* 2008). Recently, Schmidt *et al.* (2015) used DNA barcoding, a standard approach based on a

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