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Description of a gynandromorph specimen of *Hylaeus intermedius* Förster, 1871 (Hymenoptera: Apidae)

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Abstract

A gynander of *Hylaeus* (*Dentigera*) *intermedius* Förster, 1871 is described. Gynanders are specimens showing female as well as male characteristics. Whereas among bees (Apidae s.l.) gynandromorphy is a widespread phenomenon, only three cases of masked bee (*Hylaeus*) gynanders are known from previous publications. The described *H. intermedius* specimen fits best in the bilateral gynander category as the male and female features are almost symmetrically distributed on the left and right part of the body, respectively. The morphological analysis allows conclusions on secondary sexual characteristics in this still poorly known species.

Key words: *Hylaeus intermedius*, gynander, sexual dimorphism, Apidae, Colletinae.

Zusammenfassung

Ein Gynander von *Hylaeus* (*Dentigera*) *intermedius* Förster, 1871 wird beschrieben. Gynander sind Tiere, die sowohl männliche als auch weibliche Merkmale aufweisen. Während Gynandromorphie bei Bienen (Apidae s.l.) ein weit verbreitetes Phänomen darstellt, kennt man von früheren Arbeiten nur drei Fälle von Gynandern bei Maskenbienen (*Hylaeus*). Das beschriebene Exemplar von *H. intermedius* passt am besten in die Kategorie eines bilateralen Gynanders, weil die männlichen und weiblichen Merkmale fast symmetrisch auf die linke und rechte Körperhälfte verteilt sind. Die morphologische Analyse erlaubt Rückschlüsse auf die sekundären Geschlechtsmerkmale dieser noch weitgehend unbekannten Spezies.

Introduction

Gynandromorphy is a widespread phenomenon among Apidae and Hymenoptera in general. Many cases have been reported in the last decades (Apidae s.l. listed by Michez et al. 2009). Gordh & Headrick (2001) describe gynandromorphy as a condition in which male and female features are displayed in one individual. There are three major categories of gynanders: transversal, bilateral and mosaic – referring to the distribution of male and female tissues over the body (Michez et al. 2009).

Although Hymenoptera display haplo-diploidy, sex phenotypes are mostly determined by one gene locus, the so-called "single locus of complementary sex determination" (sl-CSD). Normally, females are heterozygotes (A_1A_2) and male hemizygotes (A_1 or A_2) for the mentioned allele (Van Wilgenburg et al. 2006). In cases of gynandromorphy the "male" body parts can be either hemizygous (A_1 or A_2) or homozygous (A_1A_1 or A_2A_2), depending on the underlying genetic mechanisms (Michez et al. 2009).

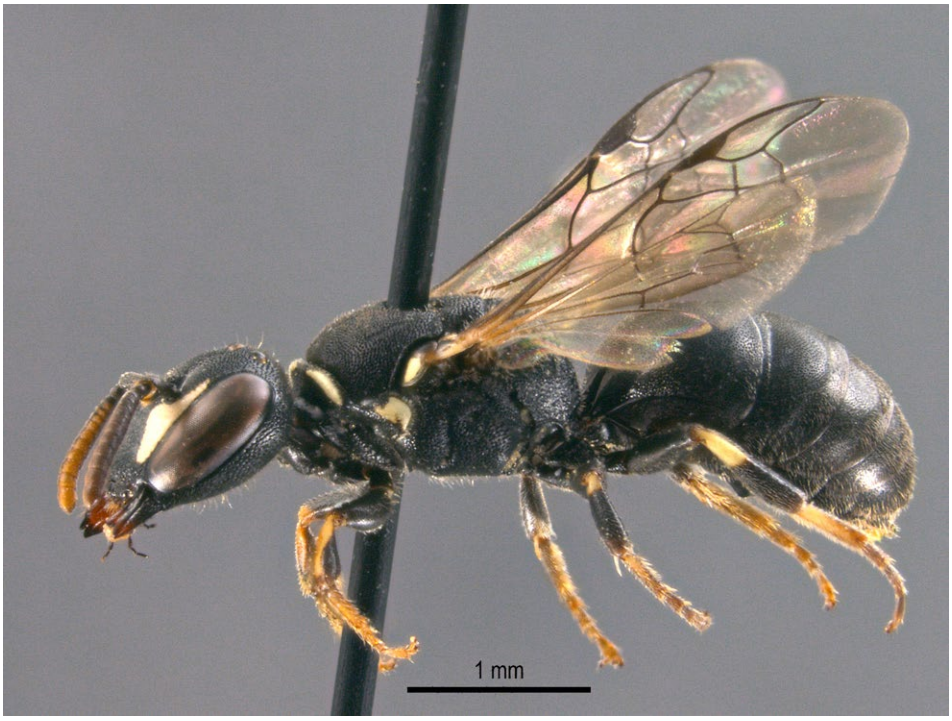

Fig. 1: Gynander of *Hylaeus intermedius*, lateral aspect showing left "male side".

Hylaeus (*Dentigera*) *intermedius* Förster, 1871 is a species of the *H. brevicornis* group and was only recently distinguished from the widespread *H. gredleri* Förster, 1871 (Dathe et al. 2016). The taxonomy of this species is still problematic, as a molecular analysis (Schmidt et al. 2015) has shown that "*H. intermedius*" – as it is presently defined by morphology – may consist of two species.

Material and methods

The paper describes a gynander of *Hylaeus* (*Dentigera*) *intermedius* Förster, 1871 collected on August 3rd, 2016 at the premises of the former Nordbahnhof in Vienna (ca. N 48°13.65', E 16°23.5', 160 m a.s.l., leg., det. & coll. H. Zettel). This area is one of the current bee hotspots in Vienna; about 180 bee species, including 22 species of *Hylaeus* were collected there in 2016 and 2017 (H. Zettel et al., unpubl.). Regrettably, the area is already partly under construction, and it seems that only a minor part can be kept for conservation.

The gynander individual was killed in ethyl acetate and pin-mounted. The genitalia were extracted from the metasoma to be studied in detail.

The species determination is based on morphology of the male part by using the key by Dathe et al. (2016) and supported by DNA barcoding – confirming it is *H. intermedius* with more than 99 % compliance with reference data of this species in BOLD (Barcode of Life database).

Tab. 1: Differences between left (male) and right (female) side of the *H. intermedius* gynander. Characters deviating from a typical bilateral gynander are underlined.

Character	Female	Male	Gynander
Head			
Clypeus	black	mostly yellow	entirely female
Side of face	black with narrow yellow stripes	mostly yellow	r: female; l: male
Antenna	12-segmented	13-segmented	r: female; l: male
Scape	narrow, black	moderately broadened, black or partly yellow	r: female; l: male
Mandible	3-toothed	2-toothed	r: female; l: male
Foveal groove	deeply engraved	hardly visible	r: female; l: male
Mesosoma			
Pronotal crest	swollen	narrow	r: female; l: male
Mesopleura	punctures more spaced, interspaces shagreened	punctures dense, interspaces smooth	r: female; l: male
Protibia	yellow stripe short	yellow stripe reaching apex	r: female; l: male
Metatarsus	black	yellow	r: female; l: male
Metasoma			
Tergites 1–4	T1–3 puncturation moderately dense, T1 interspaces almost smooth, T1–4 with (inconspicuous) latero-apical hair fringe	T1–3 puncturation dense, T1 interspaces distinctly shagreened, T1–4 without latero-apical hair fringe	r: female; l: male
Sternite 3	without tubercles	with pair of tubercles	r: female; l: male
Terminalia	sting apparatus	genitalia	entirely male

Results

Male and female characteristics of the *H. intermedius* gynander are more or less symmetrically distributed on the left half (male, Fig. 1) and right half (female) of the body (Tab. 1, Fig. 2a, b). Thus, the specimen can be placed in the bilateral gynander category.

Head (Fig. 3): Whereas the right half including the antenna, side of the face, scape, fovea, and mandible displays female features, the left part displays male features. Only the clypeus is completely female.

Mesosoma: There are differences in the colouration of right and left legs. The metatarsi of all left legs, as well as the protibiae are, like in males, more yellow than the metatarsi and protibiae of the right legs. Furthermore, the pronotal crest is more swollen on the right side, and the puncturation on the mesopleura differs between the right and left body part.

Metasoma (Fig. 4a, b): It is divided into a male and a female part. This can be clearly seen from a denser puncturation of metasoma tergites 1 to 3 and the shagreened interspaces of tergite 1 on the left part, which are typically male characteristics. Likewise, another male feature – a pair of tubercles on metasoma sternite 3 – is only present on the left part of the *H. intermedius* gynander. However, the sexual organ is completely developed as a male genital.

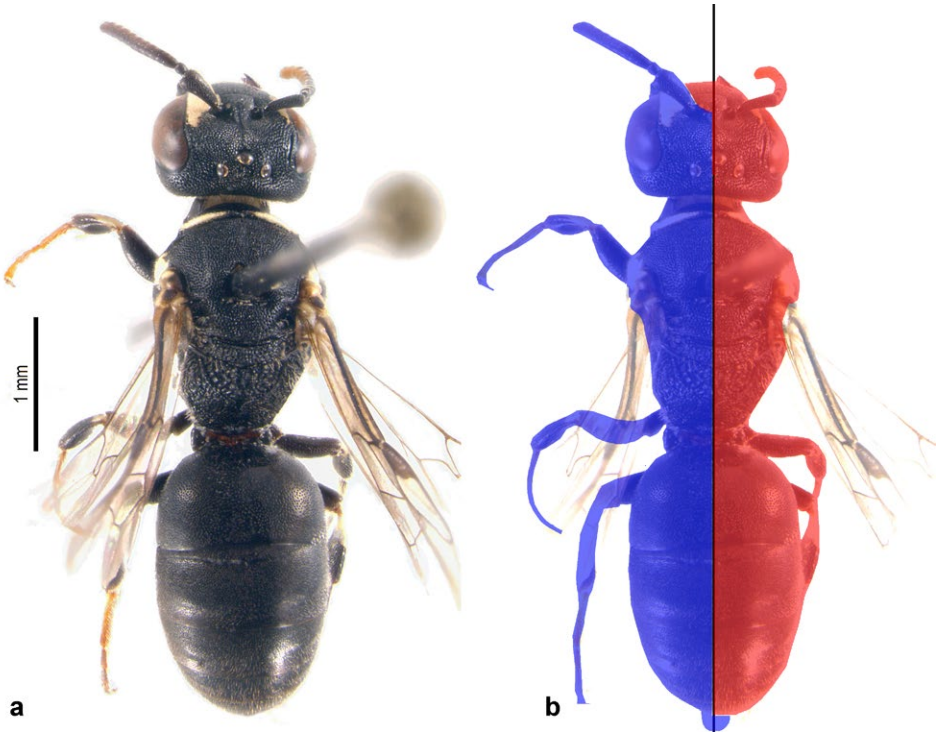

Fig. 2: Gynander of *Hylaeus intermedius*, dorsal aspect, (a) habitus and (b) male (blue) and female (red) body regions (dissected genitalia indicated in b, although not present in a).

Discussion

Although many cases of gynander bees have been reported in the past, the phenomenon seems to be rather uncommon within *Hylaeus*. Michez et al. (2009) refer to three publications describing gynanders of this genus: *H. brevicornis* Nylander by Morice (1915), *H. minuta* (Fabricius) by Noskiewicz (1923), and *H. albofasciatus* Friese by Stöckhert (1924). Due to taxonomic changes it is unclear to which exact species these gynanders may belong without having identified the original specimens by help of modern keys.

Whereas these three individuals were all placed in the transversal gynander category (Michez et al. 2009), the newly described *H. intermedius* gynander fits best in the bilateral gynander category. Most, but not all features are symmetrically distributed on the left and the right part of the body: The clypeus is completely female and the terminalia are entirely developed as male genitalia.

DNA barcoding of the gynander supported the morphological determination as *Hylaeus intermedius*. Molecular analyses by Schmidt et al. (2015) and by the first author (S. Schoder, unpublished) hypothesize, though, that "*Hylaeus intermedius*" in the present sense is not monophyletic: One clade, in which the investigated gynander fits, is located next to *H. gredleri*, and the other clade next to *H. kahri* Förster, 1871.

Fig. 3: Gynander of *Hylaeus intermedius*, head, frontal aspect.

Furthermore, a molecular examination of additional specimens (S. Schoder, unpublished) has shown that especially the identification of *H. intermedius* females by the morphological characters given by Dathe et al. (2016) is problematic due to the strong variation of sculpture (e.g., propodeal ridges) depending on the size of specimens. Among Central European species, females of *H. intermedius* can be clearly distinguished from *H. brevicornis* by a densely punctured frons, and from *H. imparilis* Förster, 1871 by head shape and smaller yellow head markings, while some discrete morphometric and sculptural differences between *H. intermedius*, *H. kahri* and *H. gredleri* are still under investigation by the first author. The described gynander may help to better understand the sexual differences in the taxonomically difficult *H. brevicornis* group and in *H. intermedius* particularly.

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Fig. 4: Gynander of *Hylaeus intermedius*, metasoma in (a) dorsal and (b) ventral aspect.

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