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Andrena (*Micrandrena*) *dourada* nov.sp. from Porto Santo, Madeira Archipelago, Portugal

A. KRATOCHWIL & E. SCHEUCHL

A b s t r a c t : *Andrena* (*Micrandrena*) *dourada* nov.sp. from Porto Santo, Madeira Archipelago, Portugal is described. A. diagnosis of this species differing from that of its closest relative, *A. wollastoni* COCKERELL 1922 (endemic to Madeira Island), is presented. Different morphological features are primarily found in body length, wing length, facial fovea index, clypeus length, stigma length and propodeum length. *A. wollastoni* and *A. dourada* share high morphological similarity with *A. tiaretta* WARNCKE 1974 distributed in southern Spain, North Africa, Israel and Syria. This is especially true for male genitalia morphology. We group *A. wollastoni* and *A. dourada* in the subgenus *Micrandrena*, but some morphological features of the subgenus *Distandrena* occur. Further information regarding distribution, habitats, flight time and flower-visiting behaviour of *A. dourada* is given and evolutionary and biogeographical aspects are discussed.

K e y w o r d s : Andrenidae, endemism, biogeography, colonization, Palaearctic.

Introduction

The volcanic Madeiran Archipelago, situated about 560 km away from Morocco and 978 km from Lisboa (Portugal), consists of Madeira Island, Porto Santo Island and three smaller islands (Ilhas Desertas). A first revision of the bees of the Madeiran Archipelago (KRATOCHWIL et al. 2008) established the presence of only 16 bee species including 8 endemic species (5 on species level and 3 on subspecies level); two further species were interpreted as introduced. A detailed analysis has shown that there are some differences between the bee faunas of Madeira Island (728 km²) and Porto Santo Island (42 km²). This is remarkable, because the shortest linear distance between Porto Santo and Madeira is only 45 km. In contrast to some species occurring on both islands, e.g. *Amegilla quadrifasciata maderae* (SICHEL 1868), *Bombus maderensis* ERLANDSSON 1979, *Lasioglossum villosulum* (KIRBY 1802), *Lasioglossum wollastoni* (COCKERELL 1922), there are some species with a parasympatric (separated) distribution: *Andrena maderensis* COCKERELL 1922 (endemic to Madeira) – *A. portosanctana* COCKERELL 1922 (endemic to Porto Santo), *Osmia madeirensis* van der ZANDEN 1991 (endemic to Madeira) – *O. latreillei iberoafricana* (PETERS 1975) (native in Porto Santo, but also on the continents Europe and Africa).

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Until now, *Andrena wollastoni* COCKERELL 1922, has been reported for both islands (FELLENDORF et al. 1999, KRATOCHWIL et al. 2008). Remarkably, COCKERELL (1922) mentioned that "a single female, collected by my wife in Porto Santo, is referred to *A. wollastoni*, though it is distinctly smaller and otherwise slightly different…..Possibly a series would indicate a separate form." We compared *A. wollastoni* specimens collected from Madeira with specimens from Porto Santo and detected a new species for Porto Santo differing in its morphological characteristics considerably from *A. wollastoni*.

In a first step we characterise *A. wollastoni* concerning morphology, distribution, habitats, flight time and flower-visiting behaviour. Then we give a critical analysis of the subgenus classification of *A. wollastoni*. Afterwards we describe the new species *A. dourada* with its differing morphological features and give some ecological information (habitats, flower-visiting behaviour). A diagnosis distinguishing the two species follows. We discuss the morphological similarity of *A. wollastoni* and *A. dourada* compared to *A. tiaretta* WARNCKE 1974, add some biogeographical aspects and consider their origin in terms of the evolutionary background.

Material and methods

The specimens studied were collected by A. Kratochwil and A. Schwabe (hand netting, pantraps white, yellow, blue). In the case of *A. wollastoni* we were able to analyse 30 females and six males, in the case of the new species *A. dourada* 11 females and four males. Five further males of *A. wollastoni* included in our analysis had been collected by R. Hentscholek. These five males were obtained as loans from the Biology Centre of the Upper Austrian Provincial Museum Linz.

The following features were considered (terms according to MICHENER 2007, TADAUCHI & XU 1995 and ARIANA et al. 2009): body length (BL): in mm from antennal base to tip of pygidium; wing length (WL): length of forewing including tegula; tergite 1-5 (T1-5); head length (HL): from top of vertex to lower margin of clypeus excluding process of labrum; head width (HW); mesosomal width (MsW): between outer rims of tegulae; metasomal width (MtW): maximum width of terga from dorsal view; ocellocular distance (OOD); postocular distance (POD); ocelloccipital distance (OCD), maximal length of facial fovea (FVL); maximal width of facial fovea (FVW); length of flagellomeres 1-3 (FL1-3): measured on ventral surfaces of flagellomeres when antenna stretched forward; puncture diameter (Pd); labrum process width at the top (LBW); pterostigma length (PSl); propodeum basal area length (PBAl); SD = standard deviation.

Boxplots were constructed by Excel 2010. The bottom and top of the box are the 25th and 75th percentile (lower quartile and upper quartile), and the band near the box is the median (50th percentile), the point is the arithmetic average. The ends of the vertical lines or "whiskers" indicate the minimum and maximum data values.

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Species descriptions

1. *Andrena* (*Micrandrena*) *wollastoni* (COCKERELL 1922)

S t a t u s : *A. wollastoni* belongs to a taxonomically difficult subgenus; there is a necessity for intensive evaluation of the taxonomical status of most of all species. WARNCKE (1968) divided *A. wollastoni* into three subspecies: *A. w. wollastoni* COCKERELL 1922, *A. w. acuta* WARNCKE 1968 (Teneriffa, La Palma), *A. w. gomerensis* WARNCKE 1993 (El Hierro, La Gomera) und *A. w. catula* WARNCKE 1968 (Gran Canaria). If we assume that the differentiation of WARNCKE (1968) in three subspecies is correct, *A. w. wollastoni* COCKERELL 1922 could be considered as a Madeiran endemic subspecies. WARNCKE (1968) gave some differentiating morphological features, but in the case of *A. w. wollastoni* COCKERELL 1922, only two females and one male were investigated.

Whether these three taxa are subspecies or species has to be evaluated by a more detailed analysis of the Canarian specimens. In the following we consider *A. wollastoni* as a species of its own. The status of *A. w. acuta* WARNCKE 1968 (Teneriffa, La Palma), *A. w. gomerensis* WARNCKE 1993 (El Hierro, La Gomera) und *A. w. catula* WARNCKE 1968 (Gran Canaria) should be evaluated.

Former Descriptions

In the first description by COCKERELL (1922) females and males were differentiated only on the basis of some morphological features:

"Female. – Like *Andrena minutula* KIRBY, but area of metathorax dull and granular, with sculptures hardly visible under a lens, mesothorax less punctured; stigma larger and darker."

"Male. – Recorded by E. Saunders from the Mount, Funchal (Eaton); the specimens are in the British Museum. He remarks that they are apparently *minutula*, a form with the mesonotum rugulose and with very distinct shallow punctures, with the long-haired face characteristic of the first brood."

GUSENLEITNER & SCHWARZ (2002) gave a more detailed description (translated from the German version): "Especially characteristic is the fine-grained, nearly unpunctured or weakly punctured mesonotum and the fine tongue-shaped labrum process (variation in subspecies). The central area of propodeum is large, mostly homogeneously grainy shagreened with centrally orientated weakly developed sutural structures. The tergite structure is very variable reaching from clearly shagreened to nearly unshagreened and therefore strongly shining. The depressions of tergite 3 and tergite 4 are clearly deepened. Some specimens show at the margins of tergite 1 the beginning of bar development. Males and females can be characterised by dorsal thorax structure. The smooth surface and borderline of the depressions are conspicuous. The genital structure is not complex similar to *A. minutula* but with some differences in the shape of gonostyli."

GUSENLEITNER & SCHWARZ (2002) included in this description all known subspecies according to WARNCKE (1968).

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Up-to-date description

Female. BL 7.63 mm (SD 0.32), WL 6.31 mm (SD 0.21).

C o l o u r . Head (Fig. 1): black, flagellum black (dark brown); mandible with distal half reddened. Mesosoma: black; femur tibia, basitarsus black; mediotarsi pars parte reddish brown; wings subhyalin, veins and pterostigma reddish brown, in rare cases brown; tegulae posterior part translucent, reddish brown, anterior part black. Metasoma: T1-4 black, with black to dark reddish brown depression zone, depression zone (T4) T5 translucent, reddish brown.

P u b e s c e n c e . Head (Fig. 1): with yellowish-white hairs; in the paraocular area yellowish-white hairs reaching from the malar area to the subantennal socket; near fovea brownish hairs, hair length different; clypeus with shorter yellowish-white hairs, not dense, similar to supraclypeal area; distal end with two very long hairs; paraocular area with dense longer yellowish-white hairs (in general double length of clypeal hairs), near facial fovea with long brownish hairs; scapus and antennal socket with longer brownish and yellowish hairs; genal area with dense long yellowish-white hairs similar to paraocular area; genal area near compound eye hairs often brownish; facial fovea with brown hairs; vertex with some yellowish-white longer hairs. Mesosoma: only some brownish central located hairs; mesoscutum with lateral longer and denser brownish hairs; scutellum with lateral shorter (half the length of mesoscutum) and denser brownish hairs; mesepisternum with long yellowish-white hairs (double length of the hairs of the genal area); propodeal corbicula existent with long yellowish-white marginal hairs, some hairs in the centre; trochanteral and femoral flocculus well developed with yellowish-white hairs; tibial scopa with yellowish-white hairs, but dorsoventral with brownish hair tips in more than half the area of the scopa and in the basal area totally brownish. Metasoma: tergites scarcely hairy, some longer hairs in the margin area; T4 with longer yellowish-white hairs, no distinct hair bands, but hair rows between tergite and tergite depression (T2-3 fragmentary developed); T5 laterally with dense yellowish-white hairs and in the centre with dense brownish hairs reaching to the pygidium.

S t r u c t u r e . Head (Fig. 1): HL/HW = 0.83 (SD 0.02); HW:MsW:MtW = 1.0:1.0:1.0; vertex narrow, as wide as ocellar diameter, surface structure with granulate punctures; face above antennal fossae with longitudinal rugulae, interrugal space shiny; OOD:POD:OCD = 4.8:4.0:1.0; FL1:FL2:FL3 = 2.1:1.0:1.1; inner margin of eyes weakly converging; facial fovea FVL = 1.00 (SD 0.02), FVW = 0.21 (SD 0.02), FVL/FVW = 4,84 (SD 0.55); facial fovea at the base narrow; clypeus convex, shiny and smooth, without impunctate median line, shallow punctures (Pd = 28 µm), IS 14-84 µm, clypeus length: 0.60 mm (SD 0.05); labrum process as a rule trapezoid (partly emarginated, slight emarginated or not emarginated, rarely trapezoid-liguliform or at the end of the process left and right side thickened), LBW = 0.09 mm (SD 0.02). Mesosoma (Fig. 2): mesonotum fine-grained, nearly unpunctured or weakly punctured, mesoscutum and scutellum smooth and shiny, very scattered punctures (Pd = 14 µm); mesoscutum with developed parapsidal lines; PSl = 0.86 mm (SD 0.03); propodeum rugose primarily in the centre and in the dorsolateral area, with very short basal lamina and sutural structures in the centre, no lateral boundary line, PBAl = 0.44 mm (SD 0.03). Metasoma: smooth and shiny, very scattered punctures (Pd = 14 µm); posterior depression of (T1)T2-5.

Male. BL 6.38 mm (SD 0.39), WL 5.61 mm (SD 0.23).

C o l o u r . No differences from female.

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P u b e s c e n c e . Head (Fig. 3): with dominantly white hairs, hair length slight different; clypeus with long white hairs, not dense, similar to supraclypeal and paraocular area (hairs yellowish-white); near facial fovea with long brownish hairs; scapus and antennal socket with long brownish and yellowish hairs; genal area with dense long white hairs similar to paraocular area; vertex with yellowish-white or brownish hairs. Mesosoma: some yellowish-white long hairs; mesoscutum with lateral long and dense yellowish hairs (some brownish hairs could be intermingled); scutellum with shorter (half the length of mesoscutum) yellowish hairs; mesepisternum with long white hairs (one and a half length of the hairs of the genal area). Metasoma: tergites scarcely hairy, some longer hairs in the margin area; T4 with longer yellowish-white hairs, no distinct hair bands, but very fragmented hair rows between tergite and tergite depression (T2-3 fragmentary developed); T5 with yellowish-white hairs.

S t r u c t u r e . Head (Fig. 3): HL/HW = 0.83 (SD 0.02); HW:MsW:MtW = 1.1:1.0:1.0; vertex and face above antennal fossae similar to female; OOD:POD:OCD = 3.8:3.0:1.0; FL1:FL2:FL3 = 1.5:1.0:1.0; inner margin of eyes weakly converging; clypeus similar to female (Pd = 28 µm), IS 14-84(112) µm, clypeus length: 0.56 mm (SD 0.02); labrum process trapezoid, emarginated, left and right side thickened, LBW = 0.15 mm (SD 0.01). Mesosoma: mesoscutum and scutellum similar to female (Pd = 14 µm); PSl = 0.84 mm (SD 0.04); propodeum structure similar to female, PBAl = 0.36 mm (SD 0.01). Metasoma: structure similar to female (Pd = 14 µm); posterior depression of (T1)T2-5.

S p e c i m e n s e x a m i n e d (identity number, sex, locality, altitude above sea level, UTM coordinates, flower visiting behaviour, date of collection)**:** Females: MA95/37, MA95/38, MA95/39, MA95/40: 4♀♀, Madeira, Castelo, south of Camacha, 500 m, 32° 39' 51.20"N, -16° 50' 46.06"E, *Geranium maderense* YEO, 09.04.1995; MA95/41, MA95/42: 2♀♀, Madeira, Castelo, south of Camacha, 500 m, 32° 39' 51.20"N, -16° 50' 46.06"E, *Sinapis arvensis* L., 09.04.1995; MA95/43: MA95/44, MA95/45, MA95/46: 4♀♀, Madeira, Castelo, south of Camacha, 500 m, 32° 39' 51.20"N, -16° 50' 46.06"E, *Sisymbrium officinale* (L.) SCOP., 09.04.1995; MA95/48: 1♀, Madeira, Castelo, south of Camacha, 500 m, 32° 39' 51.20"N, -16° 50' 46.06"E, *Sonchus oleraceus* L., 09.04.1995; MA05/39: 1♀, Madeira, Ponta de Sao Lourenço, 100 m, 32° 44' 44.01"N, -16° 43' 20.74"E, *Rapistrum rugosum* (L.) ALL., 26.03.2005; MA05/68: 1♀, Madeira, Eirinha above Serra de Água, 480 m, 32°43'54.22"N, -17°01'30.19"E, *Crepis vesicaria* L. subsp. *haenseleri* (BOISS. ex DC.) P.D. SELL, 27.03.2005; MA05/128, MA05/129: 2♀♀, Madeira, Câmara do Bispo, south of Quinta Grande, 350 m, 32°39'17.50"N, -17°01'02.02"E, *Leontodon taraxacoides* (VILL.) MERAT; MA05/178: 1♀, Madeira, west of Ponta do Garajau, south of Caniço, 80 m, 32°38'23.20"N, -16°51'13.01", *Crepis vesicaria* L. subsp. *haenseleri* (BOISS. ex DC.) P.D. SELL, 30.03.2005; MA05/188: 1♀, Madeira, Funchal, in front of Jardim Botanico, 300 m, 32°39'41.27"N, -16°53'41.25"E, *Melanoselinum decipiens* (SCHRAD. & J.C. WENDL.), 30.03.2005; MA05/297: 1♀, Madeira, above Paul do Mar, ER 212, 30 m, 32°45'29.52"N, -17°13'41.76"E, *Raphanus raphanistrum* L. subsp. *raphanistrum*, 03.04.2005; MA05/358: 1♀, Madeira, Ponta de Sao Lourenço, 80 m, 32°44'40.19"N, -16°43'22.21"E, yellow pan trap, 06.04.2005. MA05/366, MA05/367: 2♀♀, Madeira, south of S. Jorge, ER 101, 200 m, 32°49'31.59"N, -16°53'56.82"E, *Ageratina adenophora* (SPRENG.) R. KING & H. ROB., 06.04.2005; MA05/368, MA05/369, MA05/370: 3♀♀, Madeira, south of S. Jorge, ER 101, 200 m, 32°49'31.59"N,-16°53'56.82"E, *Aichryson villosum* (AITON) WEBB & BERTHEL., 06.04.2005; MA05/371, MA05/372: 2♀♀, Madeira, south of S. Jorge, ER 101, 200 m, 32°49'31.59"N, -16°53'56.82"E, *Raphanus raphanistrum* L. subsp. *raphanistrum*, 06.04.2005; MA05/372: 1♀, Madeira, south of S. Jorge, ER 101, 200 m, 32° 49' 31.59"N, -16° 53' 56.82"E, *Raphanus raphanistrum* L. subsp. *raphanistrum*, 06.04.2005; MA05/380: 1♀, Madeira, Referta south of Porto da Cruz, 200 m, 32°45'18,77"N, -16°49'07,14"E, *Crepis vesicaria* L. subsp. *haenseleri* (BOISS. ex DC.) P.D. SELL, 06.04.2005; MA05/381: 1♀, Madeira, Referta south of Porto da Cruz, 200 m, 32°45'18.77"N, -16°49'07.14"E, *Chrysanthemum segetum* L., 06.04.2005; MA05/382: 1♀, Madeira, Referta south of Porto da Cruz,

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200 m, 32°45'18.77"N, -16°49'0'7.14"E, *Aeonium glandulosum* (AITON) WEBB & BERTHEL., 06.04.2005; MA05/383: 1♀, Madeira, Pico do Facho, Machico, 320 m, 32°43'22.49"N, -16°45'30.60'E, *Crepis vesicaria* L. subsp. *haenseleri* (BOISS. ex DC.) P.D. SELL, 06.04.2005. Males: MA05/42, MA05/48, MA05/53: 3♂♂, Madeira, Ponta de Sao Lourenço, 70 m, 32°44'42.29'N, -16°43'07.48"E. *Agyranthemum pinnatifidum* (L.F.) LOWE subsp. *succulentum*, 26.03.2005; MA05/137: 1♂, Madeira, Cabo Girão, south of Quinta Grande, 610 m, 32°39'27.08"N, -17°00'23.91"E, *Crepis vesicaria* L. subsp. *haenseleri* (BOISS. ex DC.) P.D. SELL, 28.03.2005; MA05/374: 1♂, Madeira, S. Jorge, 250 m, 32° 50' 03.66"N, -16° 54' 21.61"E, *Raphanus raphanistrum* L. subsp. *raphanistrum*, 06.04.2005; MA05/375: 1♂, Madeira, S. Jorge, 250 m, 32° 50' 03.66"N, -16° 54' 21.61"E, *Centranthus calcitrapae* (L.) DUFR. subsp. *calcitrapae*, 06.04.2005; H1, H2, H3, H4, H5: 5♂♂, Madeira, Ribeira da Janela, 650 m, 35.50N, -17.11E, 12.-16.05.2007, leg. R. Hentscholek.

Historical records

- WOLLASTON T.V. collected 1847 several females and males (Collection of Wollaston, University Museum, Hope Entomological Collections, Oxford)
- SICHEL (1867) identified males and females as *Andrena parvula* (KIRBY 1802), former synonym of *A. minutula* (KIRBY 1802).
- SAUNDERS (1903) described 2♂♂ collected by Reverend Alfred Edwin Eaton (1851-1929) at Monte (Funchal), 27.02.1902, and 2♂♂ and 1♀ collected by T.V. Wollaston. He characterised these specimens as *A. minutula* (KIRBY 1802). Comparing the specimens of T.V. Wollaston he found similarities in the Mesonotum sculpture of females with specimens of the 2nd generation from Britain, but in males with the 1st generation.
- COCKERELL (1922) gave the first description of *Andrena wollastoni* on the basis of 8 specimens collected by T.V. Wollaston und A.E. Eaton. 1♀ was collected by Cockerell visiting the synflorescences on a *Euphorbia* species (16.01.1921, Vila Baleira, Porto Santo). COCKERELL (1922) pointed out a relationship to *A. minutula*. The types should be found in the Natural History Museum, London, but there is no registration in the Entomological Database.
- ALFKEN (1940) identified six females as *Andrena verticalis* PÉREZ 1895, collected by Lundblad: 4♀♀. Rabaçal, 1080 m a.s.l., 01.07.-04.08.1935; 2♀♀, Caramujo, 1250 m a.s.l., 06.-14.08.1935.
- WARNCKE (1968) studied three specimens, 1♀ Santo António da Serra, 780 m a.s.l., July 1924 collected by Liebe and 1♂ and 1♀ from the year 1904 collected by Becker. In the Biology Centre of the Upper Austrian Provincial Museum Linz the ♀ collected by BECKER and the ♂ were deposited. Both were characterised by a violet circular label, a handwritten (brownish ink) label "Madeira, Becker 04" and a handwritten label (black ink) "*Andrena* spec.nov." and a printed label "*Andrena wollastoni* CKLL. det Dr. Warncke" (Fig. 4). This specimen was collected by Theodor Becker (1840-1928), a German civil engineer and entomologist primarily known as fly specialist (SPEISER 1920, LICHTWARDT 1928). Becker spent 4 weeks on Madeira in April 1904. Basing on the collection of dipters in this time, he contributed in 1908 a paper of Madeirean flies (BECKER 1908). Becker's collection is deposited in the Humboldt Museum of Berlin, Germany. The label "*Andrena* spec.nov." does not derive from Becker. We do not know anything of the label "*Andrena* spec.nov." A graphological analysis of the label would be helpful. We

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know nothing of a published or not published description before COCKERELL (1922). Other specimens of the Warncke collection, also labelled "*Andrena wollastoni* CKLL. det. Dr. Warncke", are two specimens "Santo da Serra 5. V. Frey", one of both with a label "Y 633", date of collecting unknown, a specimen labelled "Caramujo, Isla Madera, J. Mateu coll.", date of collecting unknown, and another specimen labelled handwritten "Madeira" (collector and date of collecting unknown).

- FELLENDORF et al. (1999) (67♀♀, 32♂♂): Funchal (about 300 m a.s.l.), Caniço (about 300 m a.s.l.), Gaula (about 200 m a.s.l.), Paul da Serra (about 1400 m a.s.l.), Porto Moniz (about 50 m a.s.l.); Achadas da Cruz (about 600 m a.s.l.), Ribeiro Frio (about 900 m a.s.l.), Fajã da Nogueira (500 m a.s.l.). Common on Porto Santo. 1♀, 1♂: Stuttgart State Museum of Natural History (Germany); one female, 1♂: Museu Municipal do Funchal (Madeira).
- Biology Centre of the Upper Austrian Provincial Museum Linz: 3♀♀ and 5♂♂, Ribeira de Janela (N 35.50, W 17.11), 650 m a.s.l., 12.-16.05.2007, leg. R. Hentscholek, det. A.W. Ebmer.

Subgenus classification of *A. wollastoni*

According to WARNCKE (1974) *A. wollastoni* is a member of the subgenus *Micrandrena* ASHMEAD 1899. But the females are characterised by some morphological features similar to those of species of the subgenus *Distandrena* WARNCKE 1968: existence of longitudinal grooved structures in the frons and in the supraclypeal and paraocular areas, the facial foveae narrowed below, the propodeal triangle with fine structures without obvious rugulae. Those morphological features occur only in very rare cases within the subgenus of *Micrandrena*. A wide difference from the species of *Micrandrena* is demonstrated in the sharp pointed penis valvae of *A. wollastoni*. For most of all species in the subgenus *Micrandrena* such a feature is missing (excluding e.g. *A. tiaretta* WARNCKE 1974, *A. fabrella* PÉREZ 1903).

Distribution and habitat characteristics

A. wollastoni shows the widest distribution of all bee species on Madeira Island. The range of altitudes reaches from sea level up to 1750 m a.s.l. More important frequencies are found in altitudes between sea level and 700 m a.s.l. According to the differentiation into thermotypes and ombrotypes (CAPELO et al. 2004), the localities where *A. wollastoni* has been documented correspond primarily to inframediterranean, lower thermomediterranean and (with minor frequency) upper thermomediterranean thermotypes. Concerning humidity high frequencies are reached in lower subhumid, upper subhumid and lower humid ombrotypes but also in upper humid ombrotype. The habitats document a wide spectrum from coast line to the hilltop of Pico do Arieiro at an altitude of 1750 m a.s.l.

Flight time

The flight activity lasts from January (first observation 16th January) to August (latest observation 18th August). *A. wollastoni* is active from January to May in lower altitudes,

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in higher altitudes (from 1000-1570 m a.s.l.) the activity starts in May. According to WARNCKE (1968) bivoltinism (1st generation: February - March, 2nd generation: May-July) seems possible. But another explanation could be that two different flight times in lower and higher altitudes exist. It is remarkable that in June, July and August with minor exceptions *A. wollastoni* is active only in higher altitudes.

Flower visiting

So far flower visits by females and males have been detected on 26 plant taxa belonging to 11 plant families (unpublished data from A. Aguiar, A. Kratochwil and J. Smit). The behaviour of pollen-collecting females is polylectic with dominance of Asteraceae. Native and endemic plants and their resources play a major role compared with introduced and cultivated plant species.

2. *Andrena* (*Micrandrena*) *dourada*

F e m a l e . BL 6.89 mm (SD 0.24), WL 5.80 mm (SD 0.24); habitus Fig. 5.

C o l o u r . Head (Fig. 6): black, flagellum black (dark brown); mandible with distal half reddened. Mesosoma: black; femur tibia, basitarsus black; mediotarsi pars parte reddish brown; wings subhyalin, veins and pterostigma reddish brown, rarely brown; tegulae posterior part translucent, reddish brown, anterior part black. Metasoma: T1-4 black, with black to dark reddish brown depression zone, depression zone (T4) T5 translucent, reddish brown. In colour there is no difference from *A. wollastoni*.

P u b e s c e n c e . Head (Fig. 6): with yellowish-white hairs, in the paraocular area yellowish-white hairs existing from the malar area and overtop in contrast to *A. wollastoni* the line of the subantennal socket, near fovea only some few brownish hairs, hair length different; clypeus with shorter yellowish-white hairs, not dense, similar to supraclypeal area; distal end with two very long hairs; paraocular area with dense longer yellowish-white hairs (in general double length as clypeal hairs) near facial fovea with long brownish hairs; scapus and antennal socket with long brownish and yellowish hairs; genal area with dense long yellowish-white hairs similar to paraocular area; facial fovea with brown hairs; vertex with some yellowish-white longer hairs. Mesosoma (Fig. 7) only some brownish centrally located hairs; mesoscutum with lateral longer and denser yellowish/brownish hairs; scutellum with lateral shorter (half the length of mesoscutum) and denser yellowish/brownish hairs; mesepisternum with long yellowish-white hairs (double length of the hairs of the genal area); propodeal corbicula existent with long yellowish-white marginal hairs, some hairs in the centre; trochanteral and femoral flocculus well developed with yellowish-white hairs; tibial scopa with yellowish-white hairs; in contrast to *A. wollastoni* with fewer dorsoventral brown hair tips or basal fewer brownish hairs. Metasoma: tergites scarcely hairy, some longer hairs in the margin area. T4 with longer yellowish-white hairs, no distinct hair bands, but hair rows between tergite and tergite depression (T2-3 fragmentary developed); T5 laterally dense yellowish-white hairs, in the centre dense brownish hairs reaching to the pygidium.

S t r u c t u r e . Head (Fig. 6): HL/HW = 0.83 (SD 0.24); HW:MsW:MtW = 1.1:1.1:1; vertex narrow, as wide as ocellar diameter, surface structure with granulate punctures; face above antennal fossae with longitudinal rugulae, interrugal space shiny; OOD:POD:OCD = 4.9:4.3:1; FL1:FL2:FL3 = 2.1:1:1; inner margin of eyes weakly

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converging; facial fovea FVL = 0.99 (SD 0.05), FVW = 0.19 (SD 0.02), FVL/FVW = 5.4 (SD 0.4); clypeus convex, shiny and smooth, without impunctate median line, shallow punctures (Pd = 28 µm), IS 14-84 µm, clypeus length: 0.56 mm (SD 0.04); labrum process (Fig. 8) in the rule liguliform (not emarginated rarely trapezoid-liguliform), LBW = 0.08 mm (SD 0.02). Mesosoma (Fig. 7): mesonotum fine-grained, nearly unpunctured or weakly punctured; mesoscutum and scutellum smooth and shiny, very scattered punctures (Pd = 14 µm), mesoscutum with developed parapsidal lines; PSl = 0.86 mm (SD 0.03); propodeum basal very homogeneous only in some specimens rugose (Fig. 9), no lateral boundary line, PBAl = 0.37 mm (SD 0.01). Metasoma: smooth and shiny, very scattered punctures (Pd = 14 µm); posterior depression of (T1)T2-5.

Male. BL 5.93 mm (SD 0.23), WL 5.33 mm (SD 0.22).

C o l o u r . No differences from female.

P u b e s c e n c e . Head (Fig. 10): with dominantly white hairs, hair length slight different; clypeus with long white hairs, not dense, similar to supraclypeal and paraocular area (hairs yellowish-white); near facial fovea with long yellowish-white, only some brownish hairs; scapus and antennal socket with long yellowish-white hairs; genal area with dense long white hairs similar to paraocular area; vertex with yellowish-white hairs. Mesosoma: some yellowish long hairs; mesoscutum with lateral long and dense yellowish hairs; scutellum with shorter (half of length of mesoscutum) yellowish hairs; mesepisternum with long yellowish-white hairs (double length of the hairs of the genal area). Metasoma: tergites scarcely hairy, some longer hairs in the margin area. T4 with longer yellowish-white hairs, no distinct hair bands, but very fragmented hair rows between tergite and tergite depression (T2-3 fragmentary developed); T5 yellowish-white hairs.

S t r u c t u r e . Head (Fig. 10): HL/HW = 0.83 (SD 0.05); HW:MsW:MtW = 1.1:1.1:1; vertex and face above antennal fossae similar to female; OOD:POD:OCD = 4.2:3.6:1; FL1:FL2:FL3 = 1.4:1:1; inner margin of eyes weakly converging; clypeus similar to female (Pd = 28 µm), IS 14-84(112) µm, clypeus length: 0.50 mm (SD 0.04); labrum process trapezoid, emarginated, left and right side thickened, LBW = 0.12 mm (SD 0.01). Mesosoma (Fig. 11): mesoscutum and scutellum similar to female (Pd = 14 µm); PSl = 0.76 mm (SD 0.03); propodeum structure similar to female, PBAl = 0.36 mm (SD 0.03). Metasoma: structure similar to female (Pd = 14 µm); posterior depression of (T1)T2-5. No differences in genital structure from *A. wollastoni* (Fig. 12).

D e r i v a t i o n o m i n i s : *A. dourada* (substantival apposition). The Portuguese word "dourada" means "golden" or "aureate". Porto Santo is also named "Ilha dourada", "golden island", because of the white-yellow-brownish sand colours of the landscape. We can also build a bridge to the white-yellowish colour of the pubescense of this new species.

T y p e m a t e r i a l : Holotype: PS12/117: ♀, Porto Santo, near restaurant "Panorama" above Casinhas, 150 m, 33°04'8.47"N, -16°19'14.57"E, yellow and white pan trap, 20.03.2012; Depository: Biology Centre of the Upper Austrian Provincial Museum Linz. Paratypes: (identity number, sex, locality, altitude above sea level, UTM coordinates, flower-visiting behaviour, date of collection): Females: PS12/47: 1♀, Porto Santo, Pedregal de Dentro, 220 m, 33°05'38.62"N, -16°19'34.07"E, yellow pan trap, 20.03.2012; PS12/75: 1♀, Porto Santo, north of Serra de Dentro, 60 m, 33°05'15.36"N, -16°18'33.15"E, yellow pan trap, 19.03.2012; PS12/110, PS12/111: 2♀♀, Porto Santo, Capela da Craça, above Vila Baleira, 160 m, 33°04'24.85"N, -16°19'25.57"E, yellow pan trap, 20.03.2012; PS12/116: 1♀, Porto Santo, near restaurant "Panorama" above Casinhas,

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150 m, 33°04'8.47"N, -16°19'14.57"E, yellow and white pan trap, 20.03.2012; PS12/118, PS12/118: 2♀♀, Porto Santo, near Pico da Cabrita, 230 m, 33°05'42.18"N, -16°19'04.49"E, white pan trap, 20.03.2012; PS12/137: 1♀, Porto Santo, north of Morenos, 90 m, 33°02'26.38"N, -16°23'16.39"E, *Leontodon taraxacoides* (VILL.) MERAT, 20.03.2012; PS12/152: 1♀, Porto Santo, Campo de Baixo, near tennis court, 20 m, 33°02'50.07"N, -16°21'23.35"E, *Sinapis arvensis* L., 20.03.2012; PS12/156: 1♀, Porto Santo, Capela de S. Pedro, 50 m, 33°02'44.85"N, -16°21'43.82E, *Rapistrum rugosum* (L.) ALL., 20.03.2012. Males: PS12/43: 1♂, Porto Santo, southwest of Serra de Fora, 85 m, 33° 04'14.74"N, -16°18'53.61"E, yellow pan trap, 18.03.2012; PS12/81: 1♂, Porto Santo, Vereda do Pico Branco, 310 m, 33°05'31.84"N, -16°18'17.16", *Calendula arvensis* L., 19.02.2012; PS12/112, PS12/113: 2♂♂, Porto Santo, Capela da Craça, above Vila Baleira, 160 m, 33°04'24.85"N, -16°19'25.57"E, yellow pan trap, 20.03.2012.

Distribution and habitat characteristics

Individuals of *A. dourada* were detected on half of all investigated localities (10 from 21 localities, distributed all over the island); Fig. 13-16. So we can assume that *A. dourada* is widely distributed on Porto Santo. The range of altitudes reaches from sea level up to 310 m a.s.l. (highest point is Pico do Facho; 517 m a.s.l). Individuals of *A. dourada* were found primarily in the inframediterranean and lower thermomediterranean thermotypes; terminology according (CAPELO et al. 2004).

Flight time

There are not enough data available.

Flower visiting

So far, flower visits by females and males have been detected by A. Kratochwil and A. Schwabe on individuals of four plant taxa belonging to two plant families: *Calendula arvensis* L. (Asteraceae), *Leontodon taraxacoides* (VILL.) MERAT (Asteraceae), *Rapistrum rugosum* (L.) ALL. (Brassicaceae), *Sinapis arvensis* L. (Brassicaceae). Additionally there is one observation made by COCKERELL (1922): *Euphorbia* spec. (Euphorbiaceae).

Differential diagnosis

1. Female *A. dourada*

Concerning average body length, females of *A. wollastoni* are larger than those of *A. dourada* (Fig. 17a), the same is true concerning wing length (Fig. 17b).

C o l o u r . No difference between *A. wollastoni* and *A. dourada.*

P u b e s c e n c e . Head: In the paraocular area there are yellowish-white hairs from the malar area and overtop, in contrast to *A. wollastoni* the line of the subantennal socket; near fovea only some few brownish hairs (in the case of *A. wollastoni* area with brownish hairs larger), Fig. 1, 6; Mesosoma: tibial scopa with yellowish-white hairs; in contrast to *A. wollastoni* with fewer dorsoventral brown hair tips or basal fewer brownish hairs (in the case of *A. wollastoni* more than the half of the scopa and the basal area with totally brownish hairs).

S t r u c t u r e . Head: no differences in HL/HW and FL1:FL2:FL3; minor differences

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in HW:MsW:MtW (*A. dourada*: 1.1:1.1:1.0; *A. wollastoni*: 1.0:1.0:1.0), OOD:POD:OCD (*A. dourada*: 4.3:3.8:1.0; *A. wollastoni*: 4.8:4.0:1.0), FVL/FVW-Index (Fig. 17c) and in clypeus length (Fig. 17d); labrum process in the rule liguliform (not emarginated rarely trapezoid-liguliform) in contrast to *A. wollastoni* (in the rule trapezoid, partly emarginated, slightly emarginated or not emarginated, rarely trapezoid-liguliform or at the end of the process left and right side thickened); PSl and PBAl smaller than in *A. wollastoni* (Fig. 17e,f); propodeum sculpture more homogeneous than in *A. wollastoni*.

2. Male *A. dourada*

Like females, male *A. wollastoni* have a larger average body length than those of *A. dourada* (Fig. 18a); the same trend becomes evident concerning wing length (Fig. 18b), but there is a high variation due to small specimen numbers.

C o l o u r . No differences.

P u b e s c e n c e . Head: with dominantly white hairs in contrast to white-yellowish hairs of *A. wollastoni*; near facial fovea long yellowish-white hairs, only some brownish hairs in contrast to *A. wollastoni* near facial fovea with long brownish hairs; scapus and antennal socket with long yellowish-white hairs (*A. wollastoni* with long brownish and yellowish hairs), vertex with yellowish-white hairs (*A. wollastoni* with yellowish-white and brownish hairs); Fig. 3, 10. Mesosoma: mesoscutum with lateral long and dense yellowish hairs (*A. wollastoni*: some brownish hairs could be intermingled); mesepisternum with long yellowish-white hairs (*A. wollastoni* only white hairs).

S t r u c t u r e . Head: no differences in HL/HW; HW: (MsW:MtW and FL1:FL2:FL3; minor differences in OOD:POD:OCD (*A. dourada*: 4.5:3.8:1.0; *A. wollastoni*: 3.8:3.0:1.0); clypeus of *A. wollastoni* longer than in *A. dourada* (Fig. 18c); no difference in labrum process morphology but in the width of labrum process (Fig. 18d). Mesosoma: difference in PSl but not in PBAl (Fig. 18e); propodeum structure see females.

Morphological similarity to *A. tiaretta* WARNCKE 1974

A. dourada shares a remarkable morphological similarity with *A. tiaretta* WARNCKE 1974 distributed in southern Spain, North Africa, Israel and Syria (see map 473 in GUSENLEITNER & SCHWARZ 2002). Especially in male genital morphology, but also in female fovea facialis structure, *A. dourada* and *A. tiaretta* show a close morphological relation. All other potentially related species do not correspond in these features.

In dorsal view the male genitalia of *A. dourada* and *A. tiaretta* do not differ in detail; only in side view, the penis base of *A. tiaretta* seems slightly vesicular swollen. Characteristic features are the sharp pointed penis valvae and the elongated top of the gonostylus. If in potentially related species the penis valvae show similarities, then differences in gonostylus morphology or in the sculpture of the body surface occur. The same phenomena concern the fovea facialis of females. If females of related species resemble one another in the morphology of the fovea facialis, they differ in the sculpture of the body surface.

Concerning the sculpture of the body surface *A. dourada* and *A. wollastoni* show in both sexes close similarity to *A. tiaretta*. *A. tiaretta* seems more roughly shagreened and with stronger and denser puncturing. Another congruent feature of all these three species is the form of the labrum process (narrow, triangular), but in *A. tiaretta* truncate, in *A.*

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dourada and *A. wollastoni* rounded. The depression zone of the tergites is in all three species not well developed. The propodeal triangle is characterised by fine structures without obvious rugulae, lamina or sutures. In the case of *A. tiaretta* (similar to most of all species of *Micrandrena*) confused structured basal lamina and basal sutures exist. In apical direction the surface of the propodeal triangle change in a mostly homogeneously grainy and shagreened structure. *A. dourada* and *A. wollastoni* are over the whole area of the propodeum triangle more intensively grained and shagreened, but in basal position only with weakly developed sutural structures.

A. tiaretta is assigned to the subgenus *Micrandrena*, but the existence of longitudinal grooved structures in the frons and in the supraclypeal and paraocular areas, the below narrowed facial foveae, and the propodeal triangle finely structured without intensively developed rugulae, lamina or sutures demonstrate connecting morphological features with the subgenus *Distandrena*.

Lacking molecular genetic analysis we leave *A. wollastoni* and *A. dourada* in the subgenus *Micrandrena*, although morphological features of the subgenus *Distandrena* occur.

Evolutionary and biogeographical aspects

According to GELDMACHER et al. (2000) and GALOPIM DE CARVALHO & BRANDÃO (1991) the age of the Madeiran Archipelago ranges from 3.6 to 14 million years. Geologically, Porto Santo is the oldest island (14 million years). Much younger are Madeira (4.6 million years) and Desertas Islands (3.6 million years). During the last glacial period (18,000 years BP) a landbridge probably connected Madeira with the Desertas Islands (BREHM et al. 2003) (today depth of ocean about 90 m). During the past millions of years the distance to the continent was influenced by continental drift, sea-level variations and geological processes of forming and erosion of landbridge islands. In most cases sea-level variations represented the most important influencing factor. Reconstructions of the glacial coastline during the last glacial optimum (18.000 years BC) show a sea level which was 120 m deeper than today. Furthermore, many islands covered a larger area than today and many of them which today are below the sea surface in former times were above sea-level (GARCIA-TALAVERA 1999). MOORE et al. (2002) thus infer a minimal distance of 200 km from Europe in former times.

Concerning the geological age of the different islands of the Madeiran Archipelago we hypothesize, that the oldest one, Porto Santo, was colonized before the existence of Madeira. In former times Porto Santo had a much more expanded size and relief energy, but erosion processes diminished the island area and reduced the relief.

According to several morphological features *A. dourada* shows a close relation to *A. tiaretta* which is distributed in the South Palaearctic. The probability is high, that a continental ancestor of *A. tiaretta* colonized first Porto Santo (or stepping-stone islands which today are under sea-level) and developed to the endemic *A. dourada*. Then Madeira was colonized by *A. dourada*, which developed to Madeira's own endemic species, *A. wollastoni*.

Analogously is likely that *A. portosanctana* is an early colonizer and became an old endemic species, long before the existence of Madeira. Furthermore we hypothesize that *A. portosanctana* was the ancestor of *Andrena maderensis* COCKERELL 1922.

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Of interest is the third example: *Osmia madeirensis* is a well characterised endemic species of Madeira Island. This species developed from an ancestor of *Osmia latreillei* (information by letter; A.W. Ebmer). The distribution area of *Osmia latreillei* extends from the Canary Islands to Jordania. On Porto Santo Island only *Osmia latreillei iberoafricana* (PETERS 1975) occurs, missing on Madeira Island. The relationship to *Osmia latreillei iberoafricana* (PETERS 1975) has to be investigated. Parallel to the findings above, we draw the conclusion that primarily the continental *O. latreillei iberoafricana* (PETERS 1975) colonized Porto Santo (or one of the former landbridge islands). The colonization of Madeira Island led to the endemic *Osmia madeirensis* van der ZANDEN 1991.

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Zusammenfassung

Eine neue *Andrena*-Art (*A. dourada* nov.sp.) von Porto Santo (Madeira-Archipel, Portugal) wird beschrieben und eine Differentialdiagnose mit der nahverwandten *A. wollastoni* COCKERELL 1922, vorgenommen. Unterschiede zwischen den beiden Arten konnten u.a. in der Körper- und Flügellänge, im "Facial-Fovea-Index" sowie in der Clypeus-, Stigma- und Propodeumlänge festgestellt werden. *A. wollastoni* und *A. dourada* zeigen in mehreren Merkmalen ein hohes Maß an morphologischer Ähnlichkeit zu *A. tiaretta* WARNCKE 1974, die in Südspanien, Nordafrika, Israel und Syrien vorkommt. Diese Ähnlichkeit ist besonders in der Morphologie des männlichen Genitalapparates auffällig. *A. wollastoni* und *A. dourada* zeigen auch morphologische Merkmale von Arten der Untergattung *Distandrena.* Wir belassen derzeit *A. wollastoni* und *A. dourada* in der Untergattung *Micrandrena.* Angaben zur Verbreitung, zum Lebensraum, zur Flugzeit und zum Blütenbesuchsverhalten von *A. dourada* werden angefügt sowie evolutionsbiologische und biogeographische Aspekte diskutiert.

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Anschriften der Verfasser: Prof. Dr. Anselm KRATOCHWIL
Department of Biology/Chemistry, Ecology Section,
University of Osnabrück
Barbarastr. 13
D-49069 Osnabrück, Germany
E-Mail: anselm.kratochwil@biologie.uni-osnabrueck.de

Erwin SCHEUCHL
Kastanienweg 19
D-84030 Ergolding, Germany
E-Mail: erwin.scheuchl@t-online.de

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Fig. 1-6: *Andrena wollastoni* (**1**) portrait of head, female; (**2**) mesonotum, scutellum, propodeum, female; (**3**) head, male; (**4**) male of *Andrena wollastoni*, collected by Becker 1904 and label "*Andrena* ♀ sp.nov."; Biology Centre of the Upper Austrian Provincial Museum Linz (Collection of Warncke); *Andrena dourada* nov.sp. (**5**) dorsal view, female; (**6**) head, female.

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Fig. 7-12: *Andrena dourada* nov.sp. (**7**) mesonotum, female; (**8**) labrum, female; (**9**); propodeum, female; (**10**) portrait of head, male; (**11**) mesonotum, scutellum, male; (**12**) male genital capsule.

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Fig. 13-16: (**13**) South coast of Porto Santo with the stripe of the "golden" sand beach and the capital Vila Baleira. Three localities where *A. dourada* was detected: (**14**) ruderal site near Capela da Craça; (**15**) abandoned fields near Pedregal de Dentro; (**16**) dry rocky grassland at the base of Pico da Cabrita. Photos: A. Schwabe.

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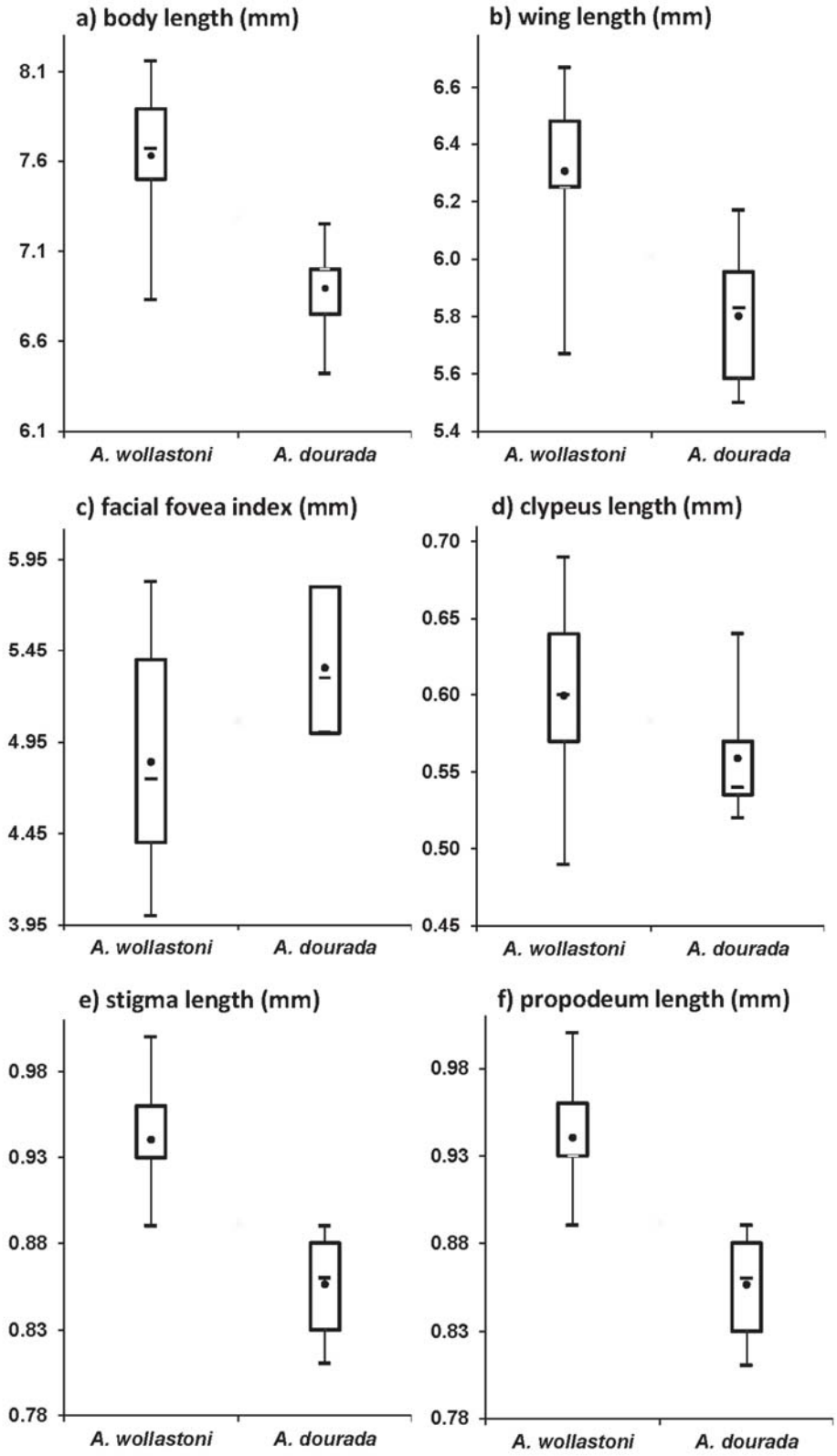

Fig. 17: Morphological differences between females of *A. wollastoni* and *A. dourada*: (**a**) body length; (**b**) wing length; (**c**) facial fovea index; (**d**) clypeus length; (**e**) stigma length; (**f**) propodeum length.

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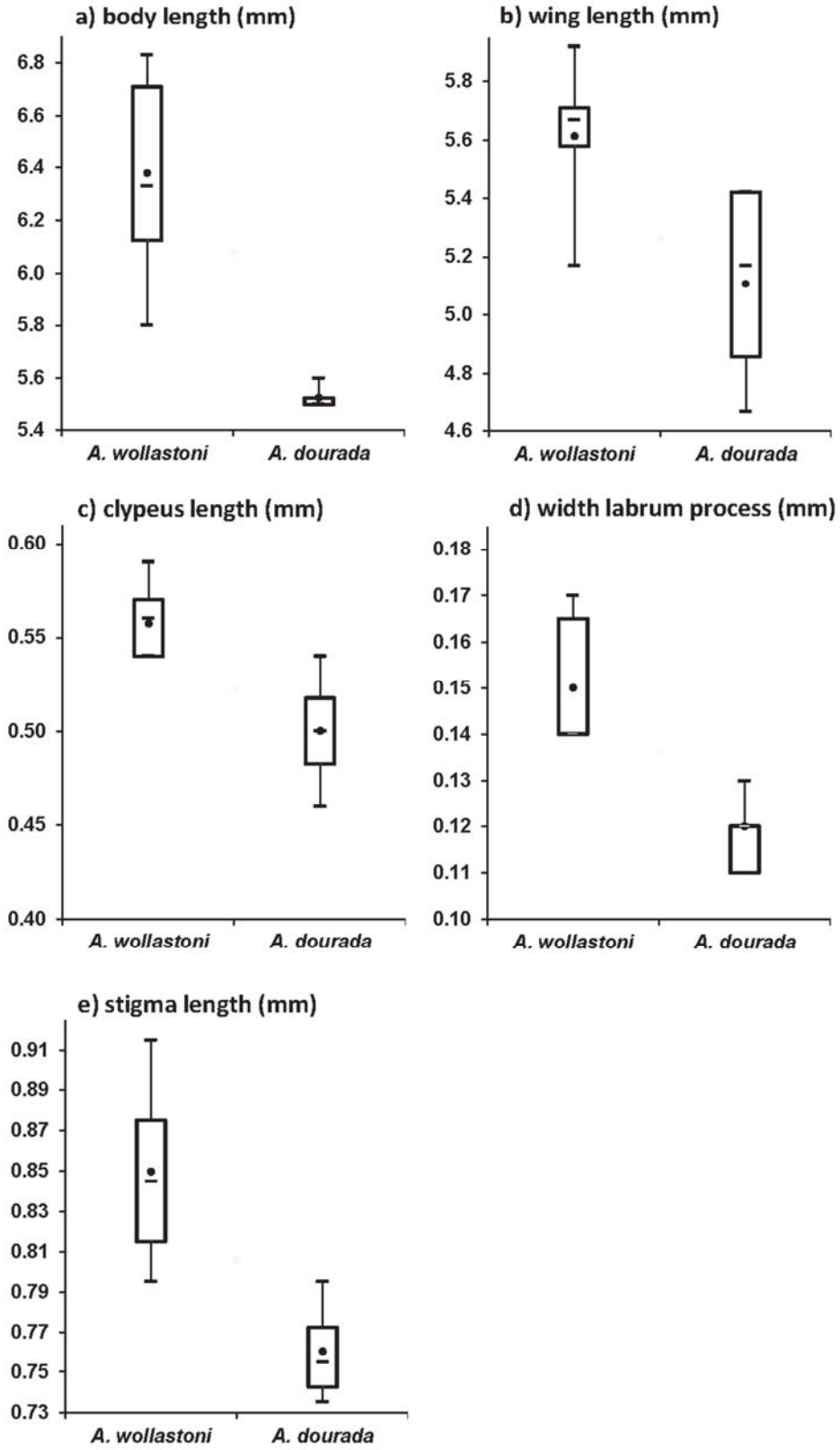

Fig. 18: Morphological differences between males of *A. wollastoni* and *A. dourada*: (**a**) body length; (**b**) wing length; (**c**) clypeus length; (**d**) width of labrum process; (**e**) stigma length.

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Autor(en)/Author(s): Kratochwil Anselm, Scheuchl Erwin

Artikel/Article: Andrena (Micrandrena) dourada nov.sp. from Porto Santo, Madeira Archipelago, Portugal 755-774