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Intra-island distribution of the wild bee species of Madeira Island, habitat preferences and flower-visiting behaviour (Hymenoptera, Apoidea, Anthophila)

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With 64 figures and 28 tables

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ABSTRACT: The aim of this study was to analyse the intra-island distribution pattern, the habitat preferences, and the flower-visiting behaviour of the wild bee species of Madeira Island. The total dataset from Madeira Island includes 2,226 data from 491 localities (1,029 with flower visits on 112 plant taxa belonging to 39 plant families). We sampled a total of 1,595 data from 1989 to 2022. Additionally, 392 data came from collections of institutions and museums checked by the authors, supplemented by 227 data from the literature, eight data from private collections, and five from further reliable observations.

In all, we detected 18 wild bee species, which reflect the complete species pool of permanently established species as well as single observations. *Anthidium manicatum* and *Xylocopa violacea* are here included as new species for Madeira Island. In some cases, new taxonomic findings have been added to the checklist published by KRATOCHWIL *et al.* (2018). These are listed under 'status'. The distribution of the wild bee species was documented on a base of square-grid cells (1 km x 1 km) based on the military map of the Madeira Archipelago (2004). We were able to analyse data from wild bee specimens on 251 representative square-grid cells (30% of the whole area with 826 square-grid cells), which reflect the proportion of the occurring thermo-, hygro- and vegetation series.

Among the frequently occurring species, *Bombus terrestris lusitanicus*, *Andrena wollastoni*, and *Lasioglossum wollastoni* show the largest distribution areas, whereas most of the populations of *Amegilla quadrifasciata maderae*, *Bombus r. ruderatus*, *Andrena maderensis*, *Osmia madeirensis*, and *O. niveata* colonise the warmer zones. Species-specific habitat preferences were characterised according to the bioclimatic vegetation-series system of RIVAS-MARTÍNEZ (1996, 2009). Flower-visiting preferences were documented on the plant-species level.

Six of the identified wild bee species and one subspecies can be classified as endemic to Madeira Island or Madeira Archipelago, eight species as introduced or probably introduced, and three species as native or probably native. The endemic wild bee species make up large numbers of individuals. This is also true for *Bombus terrestris lusitanicus* (native, the most frequently recorded species) and *Lasioglossum v. villosulum* (probably native, the third most frequently recorded species).

Key words: endemism, distribution pattern, habitat analyses, flower-visiting behaviour, introduced species, island biogeography, Hymenoptera, Apoidea, Anthophila, Madeira Archipelago, native species, vegetation series.

RESUMO: O objetivo deste estudo foi analisar o padrão de distribuição intra-ilha, as preferências de habitat e o comportamento de visita floral das espécies de abelhas selvagens da Ilha da Madeira. O conjunto de dados total da Ilha da Madeira inclui 2,226 dados de 491 localidades (1,029 com visitas florais em 112 táxons de plantas pertencentes a 39 famílias). 1,595 dados foram amostrados de 1989 a 2022 pelos autores. Além disso, 392 dados vieram de coleções de instituições e museus verificados pelos autores, complementados por 227 dados da literatura, oito dados de coleções particulares e mais cinco observações confiáveis.

Detetámos todas as 18 espécies de abelhas selvagens que constituem o conjunto completo de espécies de abelhas selvagens permanentemente estabelecidas, bem como observações únicas. *Anthidium manicatum* e *Xylocopa violacea* são adicionadas como espécies novas para a Ilha da Madeira.

Em alguns casos, novos achados taxonómicos foram adicionados em comparação com a lista de verificação publicada por KRATOCHWIL *et al.* (2018). Estes estão listados em 'status'. A distribuição das espécies de abelhas selvagens foi documentada na matriz de células de malha quadrada (1 km x 1 km), com base no mapa militar do Arquipélago da Madeira (2004). Conseguimos analisar dados de espécimes de abelhas selvagens em 251 células representativas de grade quadrada (30% de toda a área com 826 células de grade quadrada), que refletem com grande aproximação a proporção de ocorrência de termo, higro e séries de vegetação.

Entre as espécies de ocorrência frequente, *Bombus terrestris lusitanicus*, *Andrena wollastoni* e *Lasioglossum wollastoni* apresentam as maiores áreas de distribuição, enquanto a maioria das populações de *Amegilla quadrfasciata maderae*, *Bombus r. ruderatus*, *Andrena maderensis*, *Osmia madeirensis* e *O. niveata* colonizam as zonas mais quentes. As preferências de habitats específicos das espécies foram caracterizadas com base no sistema bioclimático de séries de vegetação de RIVAS-MARTÍNEZ (1996, 2009). As preferências de visitação de flores foram documentadas ao nível da espécie de planta.

Sete das espécies de abelhas selvagens identificadas e uma subespécie podem ser classificadas como endémicas da Ilha da Madeira ou do Arquipélago da Madeira, oito como espécies introduzidas ou provavelmente introduzidas e três como espécies nativas ou provavelmente nativas. As espécies endémicas de abelhas silvestres compõem um elevado número de indivíduos. Isto também é verdade para *Bombus terrestris lusitanicus* (nativa, a espécie mais frequentemente registada) e *Lasioglossum v. villosulum* (provavelmente nativa, a terceira espécie mais registada).

Palavras-chave: endemismo, padrão de distribuição, análises de habitat, comportamento de visitação de flores, espécies introduzidas, biogeografia insular, Hymenoptera, Apoidea, Anthophila, Arquipélago da Madeira, espécies nativas, séries de vegetação.

Abbreviations:

abbr. = abbreviation(s); agg. = aggregate; appr. = approximately; *a.s.l.* = above sea level; cf. = compare; co. = checked observation(s); E = east, ind. = individual(s); K/S = Kratochwil / Schwabe; leg. = collected; loc. = locality; n = number(s); N = north; *pers. comm.* = personal communication; resp. = respective; S = south; W = west.

Status of bee taxa: endMI = endemic to Madeira Island; endMID = endemic to Madeira Island and Desertas; endMA = endemic to Madeira Archipelago; intr = introduced; intr? = probably introduced; nat = native; nat? = probably native.

Status of plant taxa: cult = cultivated; end = endemic to Madeira Archipelago; intr = introduced; intr? = probably introduced; mac = Macaronesian; nat = native; nat? = probably native.

Plant families: Aca = Acanthaceae, Aiz = Aizoaceae, Api = Apiaceae, Ast = Asteraceae, Big = Bignoniaceae, Bor = Boraginaceae, Bra = Brassicaceae, Cac = Cactaceae, Cae = Caesalpiniaceae, Cle = Clethraceae, Con = Convolvulaceae, Cra = Crassulaceae, Cuc = Cucurbitaceae, Eri = Ericaceae, Eup = Euphorbiaceae, Fab = Fabaceae, Ger = Geraniaceae, Hyd = Hydrangeaceae, Hyp = Hypericaceae, Lam = Lamiaceae, Lil = Liliaceae, Mal = Malvaceae, Nyc = Nyctaginaceae, Ona = Onagraceae, Oxa = Oxalidaceae, Pap = Papaveraceae, Pas = Passifloraceae, Pla = Plantaginaceae, Poa = Poaceae, Pro = Proteaceae, Res = Resedaceae, Ros = Rosaceae, Sax = Saxifragaceae, Scr = Scrophulariaceae, Sol = Solanaceae, Str = Strelitziaceae, Tro = Tropaeolaceae, Val = Valerianaceae, Ver = Verbenaceae.

Collections: HEC = Hope Entomological Collections, Oxford University, England; ICLAM = Laboratório Agrícola da Madeira, Camacha, Portugal; MZHF = Finnish Museum of Natural History, Helsinki, Finland; OLML = Biology Centre of the Upper Austrian Provincial Museum Linz, Austria; SDEI = Senckenberg German Entomological Institute, Müncheberg; UMB = Überseemuseum Bremen, Germany; cAK = collection A. Kratochwil, Germany; cJS = collection J. Smit, The Netherlands.

Symbols: ♀ = female, queen; ♂ = male; ♀ = worker; in the case of *Bombus*: ♀ = queen.

INTRODUCTION

The wild bee faunas of the different archipelagos of the Macaronesian Islands show great differences in species numbers, in numbers of endemic, native and introduced species, and in the biogeographic affiliations of the species (KRATOCHWIL & SCHWABE, 2018a). Low species numbers exist in the Azores (n = 17; only one species endemic, 16 species introduced), the Madeira Archipelago (n = 21; nine endemic, four native or probably native, eight introduced or probably introduced), and Cape Verde (n = 17; nine endemic, four native, one introduced), whereas high species numbers are found in the Canary Islands (127 species; 88 endemic, 56 native, seven introduced); KRATOCHWIL & SCHWABE (2018a). Knowledge of the bee fauna of Cape Verde is still insufficient.

On Madeira Island, 18 wild bee species were detected (six species and one subspecies endemic; four of them restricted to Madeira Island, with one also found on the Desertas Islands). There were six introduced/ two probably introduced species, and two native/one probably native species.

If wild bee species are compared to the group of Syrphidae (Diptera) with high flight activity, Madeira Island has 25 species, with four endemic ones (REGO *et al.*, 2022).

The analysis of the biogeographic spectra of the native wild bee species of the different archipelagos

(excluding the Azores, where there are nearly only introduced species) shows that the Madeira Archipelago is characterised by species from the Western Palaearctic-Mediterranean region and the Canary Islands by species from the Western Palaearctic-Mediterranean region complemented by Holomediterranean and mainly Saharan-Arabian elements. Cape Verde is dominated by Ethiopian and Sahelo-Sudanese elements (KRATOCHWIL & SCHWABE, 2018a).

The reasons for all these differences (*e.g.* species numbers, endemisms, introductions, biogeographic affiliations) are manifold. They include the evolutionary history and geology of the islands and archipelagos, the number of islands, their climatic conditions, the diversity of the orography of the islands and their habitats, the age of the islands, and the respective distances to sources of settlement (neighbouring islands and mainland); see KRATOCHWIL & SCHWABE (2018a); KRATOCHWIL *et al.* (2021).

Different publications on the wild bee fauna of the Madeira Archipelago are available. The first checklist by FELLENDORF *et al.* (1999) was supplemented and edited by KRATOCHWIL *et al.* (2008, 2018). It was necessary to clarify many taxonomic questions (KRATOCHWIL & SCHEUCHL, 2013; KRATOCHWIL *et al.*, 2014; KRATOCHWIL, 2018; KRATOCHWIL, 2020; KRATOCHWIL *et al.*, 2021). The wild bees of Porto Santo

were analysed in more detail, and grid-based, species-specific distribution maps were worked out (KRATOCHWIL & SCHWABE, 2018b). The bee-plant networks of wild bee species on both Porto Santo and Madeira Island could be analysed and compared (KRATOCHWIL *et al.*, 2019). More detailed studies were also compiled, including one with a molecular biological approach focused on the species of the *Andrena wollastoni* group, studied on the Canary Islands and the Madeira Archipelago (KRATOCHWIL & SCHWABE, 2020; KRATOCHWIL *et al.*, 2021).

Analysing the distribution pattern of wild bee species on an island, their habitat preferences, and their flower-visiting behaviour is advantageous if the studied island has a wide range of different habitat types with a large diversity of entomophilous plant species (KRATOCHWIL *et al.*, 2019). The high relief structure with pronounced fluvial erosion and steep slopes (altitudes from the sea level to mountain regions more than 1,800 m *a.s.l.*), precipitation and temperature gradients between north and south (partly influenced by the trade-wind system), and the high plant-resource diversity for wild bees (BORGES *et al.*, 2008) favour Madeira Island as a model object for entomofaunistic studies.

In the following, the wild bee species will be characterised according to their intra-island distribution pattern, their habitat preferences and their flower-visiting behaviour. The checklist by KRATOCHWIL *et al.* (2018) is a reference for further information on the wild bee species of Madeira Island. In some cases, new taxonomic findings were added in the present study.

Here, the following questions are analysed in detail:

- Which wild bee species show the largest distribution pattern on Madeira Island, and which species have a limited distribution?
- What are the preferred habitats of the different species?
- Are there different species groups with the same habitat preferences?
- What differences in flower-visiting behaviour can be observed between the wild bee species, and which plant species and plant families play a key role?

Physico-geographical factors

Overview

Madeira Island has a size of about 740 km² and an age of about 4.6 Ma, and is of volcanic origin. The distance between the Madeira Archipelago and mainland Portugal is about 800 km, and that between it and the

western coast of Africa about 600 km (GALOPIM DE CARVALHO & BRANDÃO, 1991; GELDMACHER *et al.*, 2000; BORGES *et al.*, 2008). The sea level during the last glacial optimum was 120 m lower than it is today (GARCIA-TALAVERA, 1999). The highest elevation is the Pico Ruivo de Santana (1,862 m *a.s.l.*). About 90% of the surface lies above 500 m *a.s.l.*, while appr. one third of the surface has an elevation of more than 1,000 m *a.s.l.* The island has a diverse orography with high relief energy, especially in the north, and is rich in 'ribeiras' (ravines with steep slopes). Coastlines are mostly steep with rocky habitats, and are often rich in endemic plant species (CAPELO *et al.*, 2005). The climate is oceanic and influenced mainly above 800-1,000 m/ res. 300 m *a.s.l.* (southern / northern side) by the trade-wind system (blowing from the NE). The windward sides of the island are characterised by high annual precipitation of more than 1,500 mm/a; the leeward sides show about 500 to 800 mm/a of precipitation in the lower zones (DE LIMA & DE LIMA, 2009). The driest zones are the southern and eastern coastlines, which have Mediterranean characteristics. Climatic gradients are strong and additionally modified by the steep slopes, most of more than 30% (MESQUITA *et al.*, 2022), with different types of sun exposure and hygric conditions.

Biogeographic characteristics and potential natural vegetation

Concerning the flora and the wild bee fauna (and many other faunal taxa too), there are mainly strong biogeographical relationships between the Madeira Archipelago and the Canary Islands. The affinities to the Azores and Cape Verde depend on the taxon (*e.g.* the Madeira Archipelago and Azores show high similarities in bryophytes). The flora and different faunal taxa also show connections with the Mediterranean area (AGUIN-POMBO & PINHEIRO DE CARVALHO, 2009; KRATOCHWIL & SCHWABE, 2018a). Nearly all taxa (species level) of flora, fauna and fungi are rich in endemic species (BORGES *et al.*, 2008).

Especially in the lower zones of Madeira Island, the primary vegetation has been replaced since the 15th century by secondary vegetation (the latter mostly rich in introduced plant species) and by settlements as well as agricultural fields (*e.g.*, SJÖGREN, 1972; OBERDORFER, 1975; CAPELO *et al.*, 1999, 2005; COSTA *et al.*, 2012). The Laurisilva forest is still present, with considerable extension, and protected as a 'UNESCO Natural World Heritage Site'. All potential natural vegetation series are excellent indicators of the combined thermo- and ombrotype conditions

according to RIVAS-MARTÍNEZ (1996, 2009), even if they are actually dominated by secondary vegetation types. The system of such vegetation series was also used by CAPELO *et al.* (2004, 2005), MESQUITA *et al.* (2004, 2022), and COSTA *et al.* (2004, 2012) to describe the biogeographic characteristics of Madeira Island.

The types were distinguished according to COSTA *et al.* (2004, 2012). In Table 1 we do not use a specific sigmasyntaxonomical nomenclature (*e.g.* Clethro arboreae – Ocoteo foetentis sigmetum), but we regard the specific plant association as a target community for the series (*e.g.* the Clethro arboreae – Ocoteetum foetentis series).

Table 1 – Vegetation series of Madeira Island, used for the habitat characterisation of wild bee species (modified according to CAPELO *et al.*, 2004, 2005; MESQUITA *et al.*, 2004; COSTA *et al.*, 2004, 2012).

a) Mediterranean macrobioclimate, inframediterranean dry series (abbr. May-Ol); Figs. 1 and 2.

The **Mayteno umbellatae – Oleetum maderensis series** (xerophytic microforest) potentially covers the south coast of Madeira up to altitudes of 200 m *a.s.l.* Further plant communities are, *e.g.*, Euphorbietum piscatoriae (*e.g.* *Euphorbia piscatoria*, *Globularia salicina*, *Echium nervosum*), Artemisio argenteae – Genistetum tenerae (*e.g.* *Genista tenera*, *Carlina salicifolia*) and Sedo nudi – Aeonietum glutinosi.

b) Mediterranean macrobioclimate, inframediterranean lower subhumid series (abbr. Hel-Si); Figs. 3 and 4.

The **Helichryso melaleuci – Sideroxyletum marmulanae series** (meso-xerophytic microforest of *S. mirmulans* = *S. marmulano*) reflects subhumid conditions, influenced by fog and humid winds (altitudes: eastern coast up to 50 m / 80 m *a.s.l.*; southern coast: scattered above type a, between 200 and 300 m *a.s.l.*). Meanwhile, very rare stands of *Juniperus turbinata* subsp. *canariensis* occur. As a secondary plant community, there is a substitution stage of *Helichrysum melaleucum* and *Globularia salicina*. Rock habitats are characterised by the *Sinapidendro gymnocalicis* – *Sedetum brissemoretii* with *Aeonium glandulosum*.

c) Mediterranean macrobioclimate, upper inframediterranean-thermomediterranean series, upper subhumid type (abbr. Sem-Ap 1).

This type (1) of the **Semele androgynae – Apollonietum barbujanae series** (subhumid forest of *A. barbujana*, *Laurus novocanariensis* and others including lianas, *e.g.* *S. androgyna*, *Smilax*-species) characterises south-facing altitudes of 300 to 600 m *a.s.l.* Characteristic forest fringes are marked by the *Myrto communis* – *Hypericum canariensis*. It is the main area for viticulture and fruit trees.

d) Mediterranean macrobioclimate, thermomediterranean series, lower humid type (abbr. Sem-Ap 2); Figs. 5 and 6.

This type (2) of the **Semele androgynae – Apollonietum barbujanae series** characterises south-facing (600 to 800 m *a.s.l.*) and north-facing slopes (50-300 / 450 m *a.s.l.*), growing in complex with (tree-)heath communities (*Erica platycodon* subsp. *maderincola*, *Erica arborea*, *Myrica faya*) but still thermophytic elements, *e.g.*, *Globularia salicina*.

e) Temperate macrobioclimate, infra- to mesotemperate series, humid and lower hyperhumid type (abbr. Cle-Oc); Figs. 7 and 8.

The **Clethro arboreae – Ocoteetum foetentis series** represents the humid Laurisilva forest complex in the trade-wind zone from altitudes of 800 to 1,450 m *a.s.l.* (south exposed) and 300 to 1,400 m *a.s.l.* (north exposed). The tree stratum is about 30 m tall (*e.g.* *Ocotea foetens*, *Laurus novocanariensis*, *Clethro arborea*, *Persea indica*); lianas are present, and the forests are rich in different strata. Ferns and bryophytes play an important role, partly as epiphytes. In the vegetation complex, there are also tall-herb / shrub communities, *e.g.* the *Pericallido auritae* – *Geranietum palmatae*. A substitution community is characterised by *Vaccinium padifolium* and *Erica arborea*; the *Vaccinio padifolii* – *Ericetum maderincolae* also characterises wind-exposed rock cliffs and forms a probably natural community there.

f) Temperate macrobioclimate, upper mesotemperate series, upper hyperhumid and ultrahyperhumid type (abbr.: Pol-Er); Figs. 9 and 10.

From appr. 1,400 to 1,650 *a.s.l.* the **Polysticho falcinelli – Ericetum arboreae series** (high altitude tree-heath series) occurs. A substitution plant community (clearings) is, *e.g.*, the *Teucrio francoi* – *Origanetum virentis*. Large areas are actually characterised by monotonous pastures with the invader *Ulex europaeus*.

g) Temperate macrobioclimate, supratemperate series, ultrahyperhumid type (abbr.: Arm-Pa).

The **Armerio maderensis – Parafestucetum albidae series** (high-altitude rock vegetation complex) characterises the highest peak areas on rocky substrates (> 1,650 m *a.s.l.*). Characteristic species are, *e.g.*, *Koeleria loweana* (= *Parafestuca albida*) and *Deschampsia maderensis*. Further plant communities are, *e.g.*, the *Sinapidendro frutescentis* – *Aeonietum glandulosi* and the *Thymetum micantis*.



Fig. 1 – Vegetation series a) with Mediterranean dry macrobioclimate (*Mayteno umbellatae* – *Oleetum maderensis*). The endemic plant species *Echium nervosum* (Bor) is a key species for flower-visiting wild bee species. Ribeira Brava, Miradouro da Cruz, 01.04.2022; Table 1. Photo A. Schwabe.



Fig. 2 – Vegetation series a) with *Sinapidendron angustifolium* (end, Bra), an important resource for pollen and nectar (same site and date as Fig. 1). Photo A. Schwabe.



Fig. 3 – Vegetation series b) with Mediterranean subhumid macrobioclimate (*Helichryso melaleuci* – *Sideroxyletum marmulanae*). *Argyranthemum pinnatifidum* subsp. *succulentum* (end, Ast) is regularly visited by *Andrena wollastoni* (end). Ponta de São Lourenço, 26.03.2005; Table 1. Photo A. Schwabe.



Fig. 4 – Close-up of *Argyranthemum pinnatifidum* subsp. *succulentum* (same site and date as Fig. 3). Photo A. Schwabe.



Fig. 5 – Vegetation series d) (transition type between the Mediterranean and temperate zone: *Semele androgynae* – *Apollo-nietum barbujanae* 2). The type occurs on the northern slopes even at low altitudes. The coastal rocky sites are characterised, e.g., by *Andryala glandulosa* subsp. *glandulosa* (end, Ast). Near Seixal, 03.04.2022; Table 1. Photo A. Schwabe.



Fig. 6 – Vegetation series d) is rich in traditional cultural landscapes with ruderal vegetation, vegetable gardens, and therefore large quantities of pollen and nectar resources. Arco de São Jorge, 02.04.2022; Table 1. Photo A. Schwabe.



Fig. 7 – Vegetation series e) (Laurisilva, *Clethra arborea* – *Ocoteetum foetentis*) is still characterised by considerable areas of Laurel forest and tree-heath substitution stages. In gaps in the Laurisilva zone, the endemic plant species *Melanoselinum decipiens* (Api) offers pollen and nectar (shown: *Bombus terrestris lusitanicus*). 990 m *a.s.l.*, Encumeada, 01.04.2022; Table 1. Photo A. Schwabe.



Fig. 8 – We only got wild bee data for one tree species of the Laurisilva forest [vegetation series e)] (*Clethra arborea*: huge tree in the foreground and flowering / fruiting stage on the inset picture). *Andrena wollastoni* was detected as flower visitor. 1,100 m *a.s.l.*, Ribeiro Frio, 15.03.2012; Table 1. Photo A. Schwabe.



Fig. 9 – Vegetation series f) (*Polysticho falcinelli* – *Ericetum arboreae*). Large areas are grazed mainly by cattle and have been partly invaded by the introduced species *Ulex europaeus* (Fab). 1,450 m *a.s.l.*, Paúl da Serra, 01.04.2022; Table 1. Photo: A. Schwabe.



Fig. 10 – Some remnants of the endemic tree-heath stands (here with *Vaccinium padifolium*, Eri) are left in vegetation series f) (with inset picture of flowers). 1,550 m *a.s.l.*, 01.04.2022; Table 1. Photo A. Schwabe.

METHODS

Transfer of data in a base map

We used the UTM map of Madeira Island, and prepared maps for different data (e.g. vegetation series) and for the wild bee data on this basis. The map is divided into 826 square-grid cells, each measuring 1 km x 1 km. In case of the marginal coastal square-grid cells, the land cover is often small. Each of these square-grid cells was designated to one type of the vegetation series [a)-g); see above], transferred from the map by CAPELO *et al.* (2004). In the case of transitions of two series in one square-grid cell, we used the dominant one. The map with the transferred data of the vegetation series (Fig. 11) shows the following distribution data of all square-grid cells (Table 2A) and the square-grid cells with bee data (Table 2B), differentiated into types a)-g).

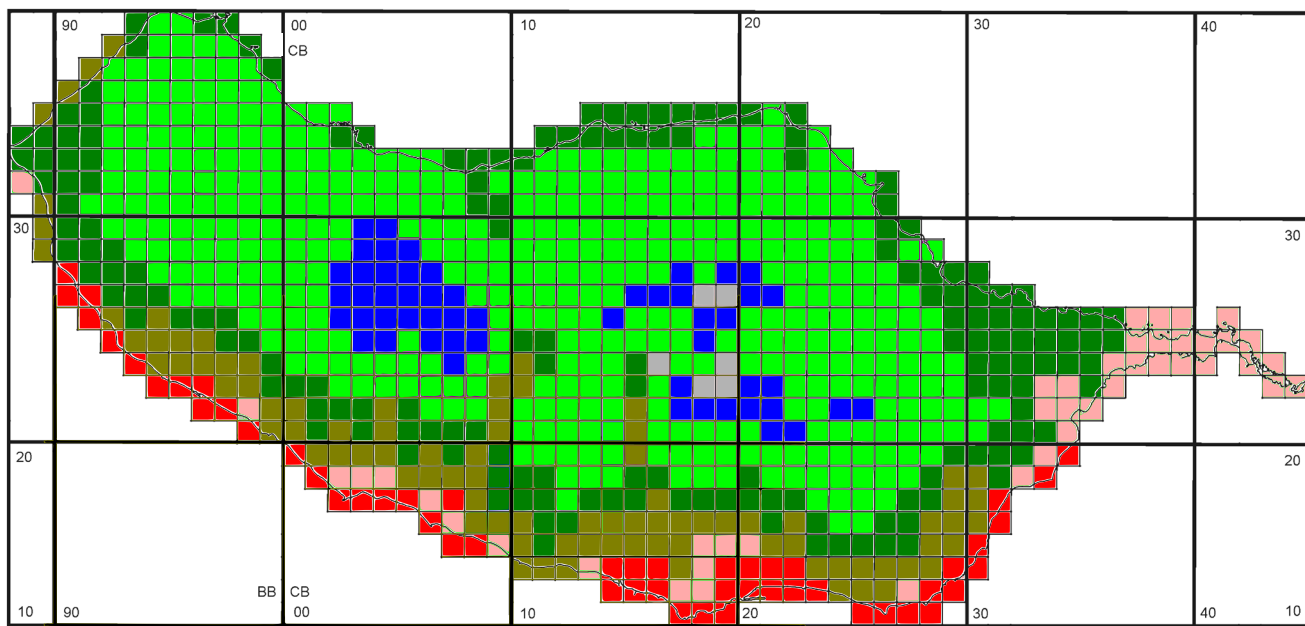


Fig. 11 – Vegetation-series distribution of Madeira Island, reflecting the thermo-hygic and biogeographical conditions (adapted and modified from CAPELO *et al.*, 2004, 2005; MESQUITA *et al.*, 2004; COSTA *et al.*, 2004, 2012; MESQUITA., 2022); for abbr., see Table 1.

Red: a) = Mediterranean macrobioclimate, inframediterranean dry series (May-OI) ‘Madeiran oleaster microforest’.

Pink: b) = Mediterranean macrobioclimate, inframediterranean lower subhumid series (Hel-Si) ‘Marmulano-tree microforest’.

Olive ochre: c) = Mediterranean macrobioclimate, upper inframediterranean-thermomediterranean series, upper subhumid type (Sem-Ap 1) ‘Barbusano-tree dry forest’.

Green: d) = Mediterranean macrobioclimate, thermomediterranean series, lower humid type (Sem-Ap 2) ‘Barbusano-tree mesic forest’.

Light green: e) = Temperate macrobioclimate, infra- to mesotemperate series, humid and lower hyperhumid type (Cle-Oc) ‘Stink-laurel forest’.

Blue: f) = Temperate macrobioclimate, upper mesotemperate series, upper hyperhumid and ultrahyperhumid type (Pol-Er) ‘Tree-heath community’.

Grey: g) = Temperate macrobioclimate, supratemperate series, ultrahyperhumid type (Arm-Pa) ‘High-altitude rock vegetation complexes’.

Table 2 – Square-grid cell numbers (total and with bee data) and percentages of the different vegetation series [a-g]): for abbr., see Table 1. Percentages refer to the sum of square-grid cells that occur (A) or that have been sampled for wild bee data (B). ‘B’ closely reflects the proportion of occurring vegetation series.

vegetation series	total grid numbers	percentages	
		A	B
a	53	6	8
b	44	5	7
c	90	11	12
d	170	21	24
e	410	50	42
f	53	6	6
g	6	1	1
sum	826		251

Sampling of wild bee data

Sampling procedure

The total dataset from Madeira Island includes 2,226 data from 491 localities belonging to 18 wild bee species (1,029 specimens with flower visits on 112 plant taxa belonging to 39 plant families). In the period from 1989 to 2022, we sampled 1,595 wild bee data in Madeira Island (1,160 collected specimens, 435 observations). A total of 940 specimens (61%) were collected or observed during flower-visiting, 43 (3%) on nesting sites. In some cases, Moericke traps (yellow, white, and blue pan traps, 7% of collected specimens, $n = 104$) and Malaise traps (1%, $n = 15$) were applied. Additionally, we used 392 data from checked museum specimens (ICLAM, MZHF, SDEI, OLML, UMB). Included were 289 reliable literature data, eight data from private collections (M. Andrade, Madeira; M. Boeiro, Azores; R. Santos, Azores; I. Silva, Madeira), and five data with reliable observations (T. Dellinger, Madeira; G. Matzke-Hajek, Germany; F. Rocha, Madeira; H. Schaefer, Germany; P. Wirtz, Madeira). All in all, the data base included 2,226 wild bee specimens belonging to 18 species. The 491 localities could be assigned to 251 of 826 square-grid cells (30%) of the UTM map (grid cell = 1 km x 1 km) (Fig. 12, Table 2).

In the 'Wild Bee Species Characterisation' section, we differentiate the localities for each wild bee species according to altitudes (m *a.s.l.*). It should be noted that in this specific approach, there is no differentiation, *e.g.*, into northern or southern coastal areas or slopes. The areas of the northern coast often show biogeographic characteristics of the Laurisilva biogeographical series [e, Fig. 11].

The wild bee species were classified into the categories 'endemic to the Madeira Archipelago' (endMA), to Madeira Island (endMI), and to Madeira Island and Desertas (MID); 'introduced' (intr), and 'probably introduced' (intr?); 'native' (nat), and 'probably native' (nat?).

Approach to map the single bee taxa

The data were sampled in 251 square grids (whole set: 826 square-grid cells); Fig. 12. We tried to stratify the whole set of square-grid cells according to the vegetation series (which also reflect combined thermo-/ ombrotypes) and sampled the 251 square-grid cells in a (near) similar proportion to the vegetation series comparable to the whole 826 square-grid set (Table 2).

Approach to analysing flower-visiting behaviour and possible habitat preferences

We already elaborated a network study of wild bee and flower-visiting interactions on Madeira Island based on 637 observations, and compared the results with Porto Santo Island, where there were 300 bee-plant interactions (KRATOCHWIL & SCHWABE, 2018b; KRATOCHWIL *et al.*, 2019). In our study (KRATOCHWIL & SCHWABE, 2018b), we differentiated flower-visiting data observed in the Mediterranean zones (Porto Santo and zones a-d) on Madeira Island) from the temperate zones e-g) (which only occur on Madeira Island). Using this approach, we were able to compare both islands.

In this study, we enlarged the data of flower visits. Here, we present summary tables for the single bee species

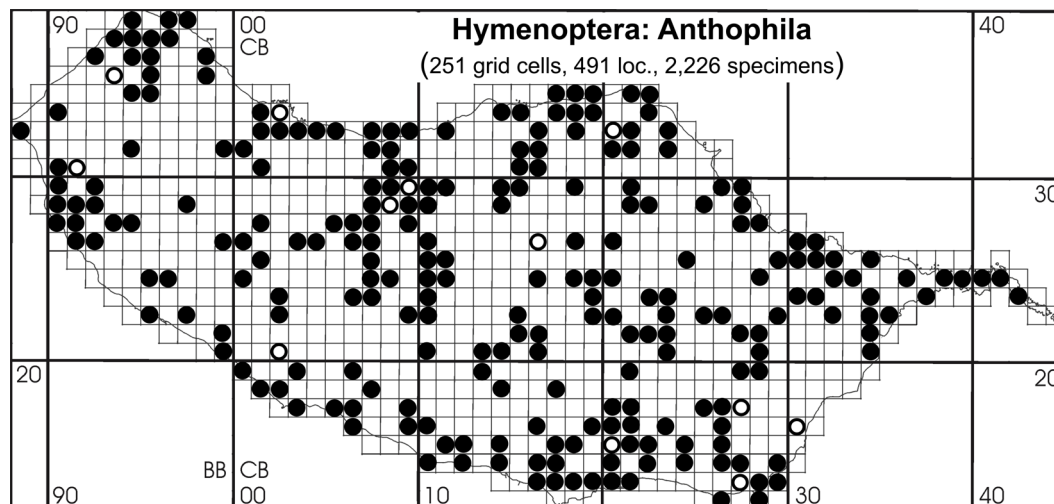


Fig. 12 – Studied square-grid cells on Madeira Island (black dots: authors' data, checked specimens of collections, and checked observations; circles: literature data).

(1,029 flower visits on 115 plant taxa) and overviews of the interactions of the females of the 10 most frequently occurring bee species. We also provide a presence table of all bee species based on the observations in square-grid cells in defined vegetation series. Flower visits of single bee species and preferences of biogeographic zones together will elucidate the habitat preferences.

The nomenclature of plant species follows JARDIM & MENEZES DE SEQUEIRA (2008), with the exception of *Taraxacum*, which refers to MUER *et al.* (2020). The names of plant communities follow CAPELO *et al.* (2004). Additionally, we checked PRESS & SHORT (1994) and MUER *et al.* (2020) for further information concerning vascular plant species.

Data recording and deposition of the specimens in collections

Voucher specimens are in the private collections of A. Kratochwil (n = 625), A. Aguiar (n = 57), J. Smit (n = 478), C. Praz (Neuchâtel, Switzerland; n = 1), or in the collections of the ICLAM (n = 144), UMB (n = 125); OLML (n = 31), MZHF (n = 90), or SDEI (n = 2). Included were 227 reliable literature data, eight data from private collections (M. Andrade, Madeira, n = 1; M. Boieiro, Azores, n = 4; R. Santos, Azores, n = 2; I. Silva, Madeira, n = 1), two unpublished data with photo documentation (T. Dellinger, Madeira, n = 1; H. Schaefer, Germany, n = 1) and two data without photo documentation (F. Rocha, Madeira, n = 1, P. Wirtz, Madeira, n = 1). Four hundred and thirty-five data are observations by the authors.

The following colleagues contributed additional data: Barkemeyer, W. (Museum of Natural History, Flensburg, Germany; n = 1); Brazão, C. (ICLAM, Camacha; n = 17); Cravo, D. (ICLAM, Camacha; n = 9); Erber, D. (Gießen, Germany; n = 1; cFA); Evenhuis, H. H. (Bennekom, The Netherlands; n = 3; cJS); Freitas, N. (Universidade da Madeira, Funchal; n = 4; ICLAM); Jesus, J. (ICLAM, Camacha; n = 29, in cooperation with A. Aguiar n = 95), Smit, J. T., (Leiden, The Netherlands; n = 299).

Literature data were also used, but there are only a few publications that provide accurate data on wild bee species and their localities. In some cases, the locality data are insufficient to integrate the findings into our grid-cell system. Due to the methods used in COSTA (2019) (high proportions of observations on *Echium candicans*), extraordinarily high numbers of interactions (not always different individuals) were recorded, so that a transfer of all these interactions into our data set was not appropriate. Therefore, we only used qualitative data of species with

such high interaction numbers as a valuable addition. FELLENDORF *et al.* (1999) did not always exactly indicate in their descriptions whether flower-visiting observations were made on Madeira Island or on Porto Santo (KRATOCHWIL *et al.*, 2019); these cases had to be excluded if they referred to wild bee or plant species that occur on both islands. In all cases where exact numbers of observations of individuals at each locality or of flower visits were not available, the observation was counted as one individual.

RESULTS AND DISCUSSION

Actualised taxonomic list of the occurring wild bee species of Madeira Island

Eighteen different wild bee species were detected on Madeira Island (Table 3). These wild bee species represent the families Colletidae, Andrenidae, Halictidae, Megachilidae, Anthophoridae and Apidae. The semi-domesticated honeybee *Apis mellifera* Linnaeus, 1758, was not considered. Sixteen species are listed in KRATOCHWIL *et al.* (2019); a new species, *Anthidium manicatum*, identified by MATZKE-HAJEK (2021), was included, documented by excellent photos. A *Xylocopa* species was observed in several localities in the Funchal area since 1994 and even photographed. Only recently, in 2020, a voucher specimen was collected. We were able to study this specimen, a female of *Xylocopa violacea*, which is deposited in a private collection (I. Silva, Madeira).

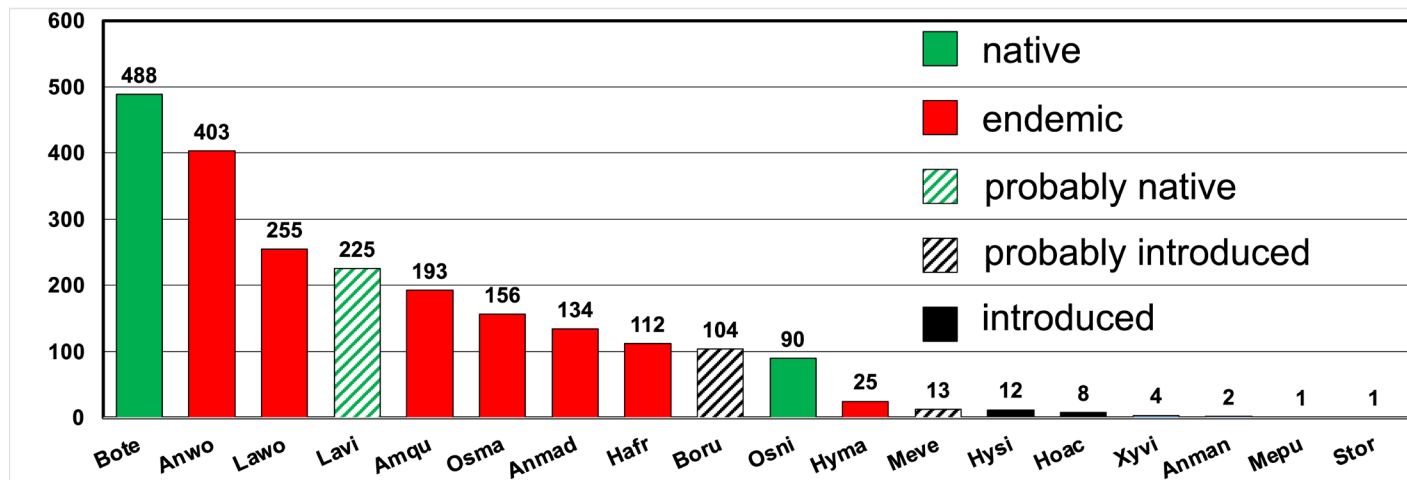
For the nomenclature of wild bee species, we updated the checklist from KRATOCHWIL *et al.* (2018).

Wild bee species frequency in all investigated square-grid cells and status

Figure 13 shows the pooled frequency of the species in all square-grid cells with the status of the wild bee species. High and relatively high abundances are indicated for the endemic species (*Andrena wollastoni*, *Lasioglossum wollastoni*, *Osmia maderensis*, *Amegilla quadrifasciata maderae*, *Andrena maderensis*, *Halictus frontalis*). An exception is *Hylaeus maderensis*, which is generally a rare species. The native species *Bombus terrestris lusitanicus* and the probably native species *Lasioglossum v. villosulum* also reach high frequencies. Most of the introduced or probably introduced species (*Megachile versicolor*, *Hylaeus s. signatus*, *Hoplitis acuticornis*, *Anthidium manicatum*, *Megachile pusilla*, *Stelis ornatula*, and *Xylocopa violacea*) have low numbers of individuals; an exception is *Bombus r. ruderatus*.

Table 3 – Wild bee species (Hymenoptera: Anthophila) of Madeira Island (n = number of wild bee data, * = subspecies).

Species	Abbr.	Status	n
COLLETIDAE			
1 <i>Hylaeus (Paraprosopis) maderensis</i> (Cockerell, 1921)	Hyma	endMA	25
2 <i>Hylaeus (Prosopis) s. signatus</i> (Panzer, 1798)	Hysi	intr	12
ANDRENIDAE			
3 <i>Andrena (Suandrena) maderensis</i> Cockerell, 1922	Anmad	endMID	134
4 <i>Andrena (Micrandrena) wollastoni</i> (Cockerell, 1922)	Anwo	endMI	403
HALICTIDAE			
5 <i>Halictus (Halictus) frontalis</i> Smith, 1853	Hafr	endMI	112
6 <i>Lasioglossum (Evylaeus) v. villosulum</i> (Kirby, 1802)	Lavi	nat?	225
7 <i>Lasioglossum (Dialictus) wollastoni</i> (Cockerell, 1922)	Lawo	endMA	255
MEGACHILIDAE			
8 <i>Anthidium manicatum</i> (Linnaeus, 1758)	Anman	intr	2
9 <i>Hoplitis (Alcidamea) acuticornis</i> (Dufour & Peris, 1840)	Hoac	intr	8
10 <i>Megachile (Eutricharea) pusilla</i> Pérez, 1844	Mepu	intr	1
11 <i>Megachile (Megachile) versicolor</i> Smith, 1844	Meve	intr?	13
12 <i>Osmia (Helicosmia) madeirensis</i> Van der Zanden, 1991	Osma	endMI	156
13 <i>Osmia (Helicosmia) niveata</i> (Panzer, 1798)	Osni	nat	90
14 <i>Stelis (Stelis) ornata</i> (Klug, 1807)	Stor	intr	1
ANTHOPHORIDAE			
15 <i>Amegilla quadrifasciata maderae</i> (Sichel, 1868)	Amqu	endMA*	193
APIDAE			
16 <i>Bombus (Megabombus) r. ruderatus</i> (Fabricius, 1775)	Boru	intr?	104
17 <i>Bombus (Bombus) terrestris lusitanicus</i> Krüger, 1956	Bote	nat	488
18 <i>Xylocopa violacea</i> (Linnaeus, 1758)	Xyvi	intr	4

**Fig. 13** – Frequency of the collected or observed wild bee specimens of Madeira Island; abbr., see Table 3. Red: endemic (for differentiation, see Table 3); green: native or probably native; diagonally striped: introduced or probably introduced. Xyvi, Anman, Mepu, Stor = introduced.

Wild bee species characterisation

Colletidae

Hylaeus (Paraprosopis) maderensis (Cockerell, 1921)

- **Status:** Endemic to Madeira Archipelago (Fig. 14). H. Dathe (*pers. comm.*) has studied the type specimen of *H. maderensis* (HEC) and compared it with the type specimen of *H. azorae* (Warncke, 1992), endemic to the Azores (deposited at OLML). A high degree of morphological similarity is evident between the two species, which, as shown by morphological analysis, occupy an isolated position compared to all other Palaearctic species. A Neartic origin can be excluded (H. Dathe, *pers. comm.*). Unfortunately, only one male of *H. azorae* has been detected so far; the female is unknown.

- **Literature:** SAUNDERS (1903), COCKERELL (1921), ERLANDSSON (1983), KRATOCHWIL (2018), KRATOCHWIL *et al.* (2018, 2019).

- **Specimens analysed:** 1♀, 19♂♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 15 and 16, Tables 4 and 5): There is no clear concentration of *H. maderensis* in specific vegetation series (Table 4). We detected this endemic species locally on coastal rocks (*e.g.* visiting the endemic plant species *Aeonium glutinosum*, see below), and on ruderal sites, but it also occurred at higher altitudes: NW Paúl da Serra at 1,350 m *a.s.l.* (FELLENDORF *et al.*, 1999), Rabaçal at 1,080 m *a.s.l.* (ALFKEN, 1940); area of Pico do Areeiro 1,500 m *a.s.l.*, and 1,800 *a.s.l.* (COSTA, 2019).

Hylaeus maderensis was observed on seven plant families (Table 5) and showed a broader polylectic behaviour. This is in accordance with other *Hylaeus* species, *e.g.*, from the Canary Islands: *Hylaeus ater* Saunders, 1903, was detected on Boraginaceae, Brassicaceae, Crassulaceae, Euphorbiaceae, and Rubiaceae; *H. canariensis* Erlandsson, 1983, on Brassicaceae, Fabaceae; and *H. hohmanni* Dathe, 1993, on Asteraceae, Boraginaceae, Brassicaceae, Euphorbiaceae, Fabaceae, and Rubiaceae (HOHMANN *et al.*, 1993). On Madeira Island, the endemic species *Aeonium glutinosum* has importance as a source of pollen and nectar, as do *Echium candicans* and *Sinapidendron angustifolium*. Introduced plant species, *e.g.* *Ageratina adenophora*, are also visited.

- **Flight time:** At lower altitudes, the species was detected from April to June, and at higher altitudes (> 1,080 m *a.s.l.*) from July to August; the first observation was 8th April and the latest observation was 4th September).



Fig. 14 – *Hylaeus maderensis*, frontal view of the endemic bee species with the characteristic mask of the males. This specimen (cAK) visited the endemic plant species *Sinapidendron angustifolium* (Fig. 2) on coastal rocks in Madalena do Mar (SW coast, 08.04.1995; vegetation series c). Photo A. Kratochwil.

- **Data from the authors** (15♂♂): cAK (1♂): 1♂, Madalena do Mar, 45 m *a.s.l.*, 32° 42' 12.03" N, 17° 08' 13.77" W, 08.04.1995, leg. K/S. cJS (14♂♂): 11♂♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 07.06.1998, leg. J. T. Smit; 3♂♂, Reis Magos, Caniço, 24 m *a.s.l.*, 32° 38' 52.23" N, 16° 49' 27.46" W, 09.06.1998, leg. P. Wirtz.

- **Data from collections** (4♂♂): ICLAM (2♂♂): 1♂, Levada do Norte, Ginjas, 1.8 km NE Estanquinhos, 1,065 m *a.s.l.*, 32° 46' 17.14" N, 17° 03' 14.27" W, 04.09.2008, leg. C. Brazão; 1♂, Machico, 0.3 km NW Pico do Facho, 283 m *a.s.l.*, 32° 43' 26.97" N, 16° 45' 31.49" W, 05.06.2008, leg. C. Brazão. SDEI (2♂♂): 2♂♂, NW Paúl da Serra, 1,350m *a.s.l.*, 32° 44' 0.54" N, 17° 3' 11.98" W, leg. R. Hentscholek, collection of A. W. Ebmer.

- **Data from literature** (3♀♀, 2♂♂, 1 ind.): ALFKEN (1940): 1♂, Rabaçal, 1,080 m *a.s.l.*, 17.07.1935-04.08.1935, leg. O. Lundblad; FELLENDORF *et al.* (1999): 2♀♀, Ponta do Garajau and Ponta dos Reis Magos, S Caniço, 50 m *a.s.l.*, mid-May until July; 1♂, Lombada dos Marinheiros, 700 m *a.s.l.*, August; COSTA (2019): 1♀, 25.07.2018 (checked by A. Kratochwil), and another specimen from area of Pico do Areeiro (1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W; 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W).

Hylaeus (Prosopis) s. signatus (Panzer, 1798)

- **Status:** Introduced. H. Dathe (SDEI) identified the specimens as subsp. *signatus*.

- **Literature:** SMIT & SMIT (2003), DATHE (1980), SCHEUCHL & WILLNER (2016), KRATOCHWIL *et al.* (2018, 2019).

- **Specimens analysed:** 6♀♀, 6♂♂.

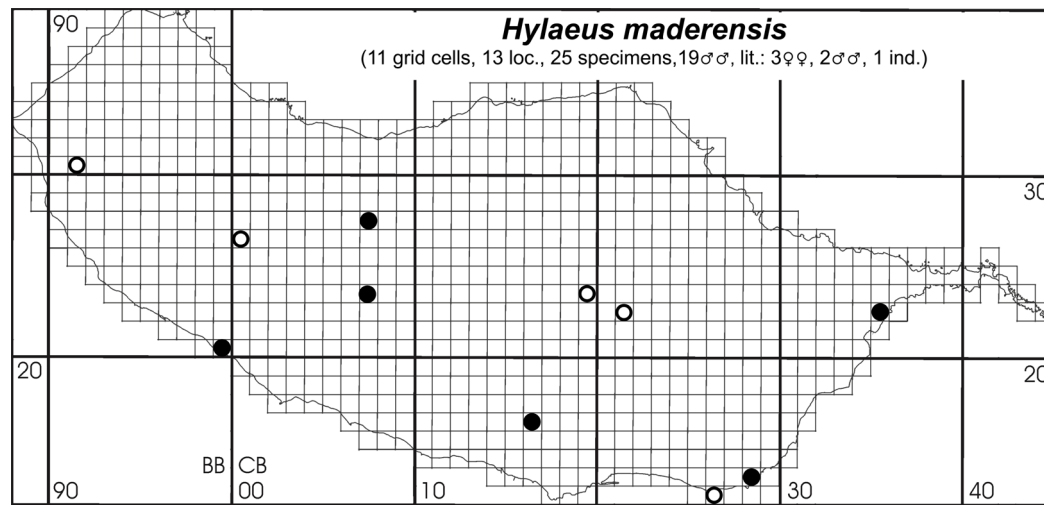


Fig. 15 – Detections of *Hylaesus maderensis* (black dots: authors' data and checked specimens of collections; circles: literature data).

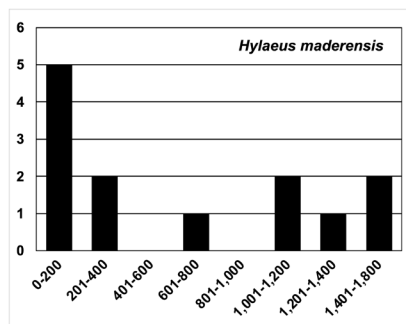


Fig. 16 – Number of localities with *Hylaesus maderensis* detections per altitude level (m a.s.l.).

Table 4 – Presence of *Hylaesus maderensis* in square-grid cells of different vegetation series ¹.

Vegetation series	Presence %	absolute
May-Ol	a	10%
Hel-Si	b	-
Sem-Ap 1	c	7%
Sem-Ap 2	d	2%
Cle-Oc	e	3%
Pol-Er	f	13%
Arm-Pa	g	1

¹ The synoptic table (Table 28) of all bee species will be presented in the "Major occurrences of wild bee species in vegetation series on Madeira Island" section.

Table 5 – Plant-species spectrum visited by *Hylaesus maderensis*.

Plant species, plant families	Status	n
<i>Petroselinum crispum</i>	Api intr	1♂
<i>Torilis arvensis</i> subsp. <i>neglecta</i>	Api nat	2♂♂
<i>Ageratina adenophora</i>	Ast intr	4♂♂
<i>Echium candicans</i>	Bor end	1♀, 1♂
<i>Sinapidendron angustifolium</i>	Bra end	1♂
<i>Aeonium glutinosum</i>	Cra end	2♀♀, 7♂♂
<i>Hydrangea macrophylla</i>	Hyd intr	1♂
<i>Rubus fruticosus</i> agg.	Ros -	1♂
<i>Rubus ulmifolius</i>	Ros nat	1♂

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Fig. 17): *Hylaesus s. signatus* was found in one raster grid and one locality (6♀♀, 6♂♂, Socorridos valley, W Funchal between Câmara de Lobos and S. Martinho at an altitude of 250-300 m a.s.l., leg. J. Smit, J. T. Smit). The locality where *Hylaesus s. signatus* was found corresponds to zone c (Table 1). It is not possible to predict whether this species will continue to spread on Madeira Island. However, the example of the Azores shows that *H. s. signatus* has a great dispersal potential if the specific food plant (*Reseda*) is available (WEISSMANN *et al.*, 2017).

Hylaesus s. signatus is oligolectic all over the distribution area on *Reseda* species (KOSTER, 1981; SCHEUCHL & WILLNER, 2016). SMIT & SMIT (2003) detected *H. s. signatus* on *R. luteola* (females and males). *R. luteola* occurs on Madeira Island at altitudes up to 1,000 m a.s.l. (PRESS & SHORT, 1994).

- **Flight time**: All detections are from 07.06.1998. In mainland Europe, the species occurs in the first generation in April and May and sometimes in a second generation from August to September (SCHEUCHL & WILLNER, 2016).

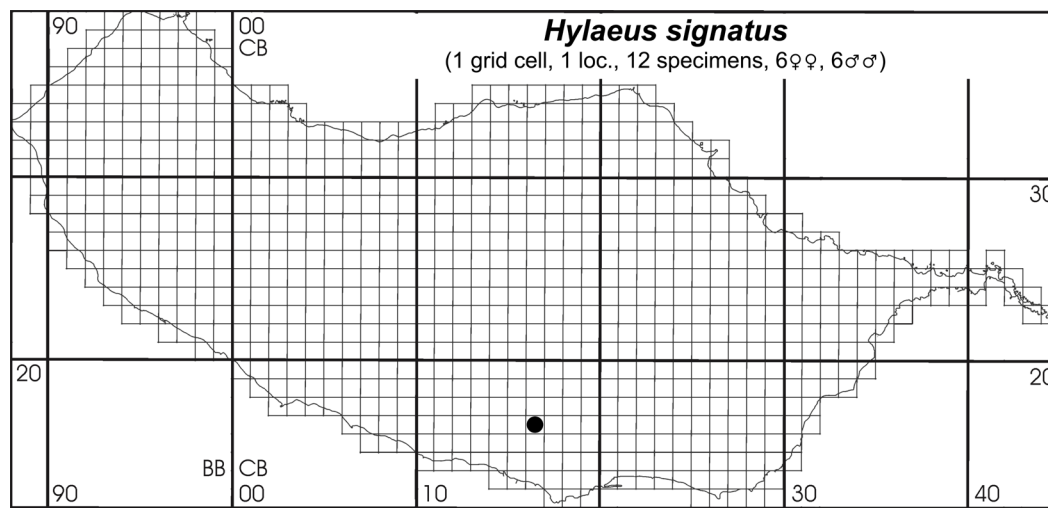


Fig. 17 – Detection of *Hylaeus s. signatus* in one square-grid cell (black dot: data of J. and J. T. Smit).

- **Data from the authors:** 6♀♀, 6♂♂, Socorridos valley, W Funchal, 250-300 m *a.s.l.*, 28.05.1995, 07.06.1995, leg. J. Smit and J. T. Smit (SMIT & SMIT, 2003).

Andrenidae

Andrena (Suandrena) maderensis Cockerell, 1922

- **Status:** Endemic to Madeira Island (Figs. 18 and 19).
 - **Literature:** COCKERELL (1922), WARNCKE (1968), FELLENDORF *et al.* (1999), GUSENLEITNER & SCHWARZ (2002), KRATOCHWIL *et al.* (2014, 2018, 2019), KRATOCHWIL (2021).
 - **Specimens analysed:** 98♀♀, 29♂♂.
 - **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 20 and 21, Tables 6 and 7): *Andrena maderensis* shows main occurrences in the Mediterranean macroclimate [vegetation series a), mainly b), further c), d)], but there have also been detections at altitudes about 1400 m *a.s.l.* (Dellinger, *pers. comm.*). Coastal rocks with endemic vegetation [vegetation series a), b)] are frequently used as habitat. The range of altitudes reaches from sea level up to about 1,000 m *a.s.l.* (1,400 m *a.s.l.*); but most of the observations concentrated at lower altitudes (47% of detections are between 0 and 200 m *a.s.l.*).

Sixty-six flower visits were recorded (four plant families). Brassicaceae were the most important resources for the females. These observations support the hypothesis that the species of the subgenus *Suandrena* prefer Brassicaceae (DYLEWSKA, 1983; KRATOCHWIL, 1991). Brassicaceae are essential for the females of this oligolectic species, especially the endemic species *Sinapidendron angustifolium* in the coastal-rocky areas and the

Macaronesian species *Erysimum maderense* in other rocky areas. In the cultural landscape (including road sites), ruderal species such as *Raphanus r. subsp. raphanistrum* or *Rapistrum rugosum* s.l. are used. This flower-visiting spectrum corresponds partly to that of *A. portosanctana* on Porto Santo (KRATOCHWIL *et al.*, 2014). *A. portosanctana* mainly visits the flowers of *Cakile maritima* subsp. *maritima* (lacking on Madeira Island); or, e.g., *Sinapis arvensis* and *Rapistrum rugosum* s.l. (all Brassicaceae).

- **Flight time and nesting sites:** The flight activity ranges from February (first observation 17th February) to May (latest observation 13th June). The highest frequencies of males and females are reached in April. All *Andrena* species nest in the ground. We found a nesting site on Ponta de São Lourenço (weakly consolidated bare ground).



Fig. 18 – The endemic bee species with preferences for Brassicaceae *Andrena maderensis* (female) was detected in Porto da Cruz (N coast) in ruderal vegetation. The bee collected pollen on *Raphanus r. subsp. raphanistrum*. 02.04.2022, vegetation series d). Photo A. Kratochwil.



Fig. 19 – The endemic bee species *Andrena maderensis* (male) in a coastal rock habitat of the N coast (São Cristovão; two males used the nectar in the inflorescences of the native *Crepis vesicaria*, 31.03.2022, vegetation series d). Like other species of the subgenus *Suandrena*, the tergites show a green-metallic sheen. Photo A. Kratochwil.

Table 6 – Presence of *Andrena maderensis* in square-grid cells of different vegetation series.

Vegetation series	Presence %
May-Ol a	29%
Hel-Si b	35%
Sem-Ap 1 c	18%
Sem-Ap 2 d	17%
Cle-Oc e	13%
Pol-Er f	-
Arm-Pa g	-

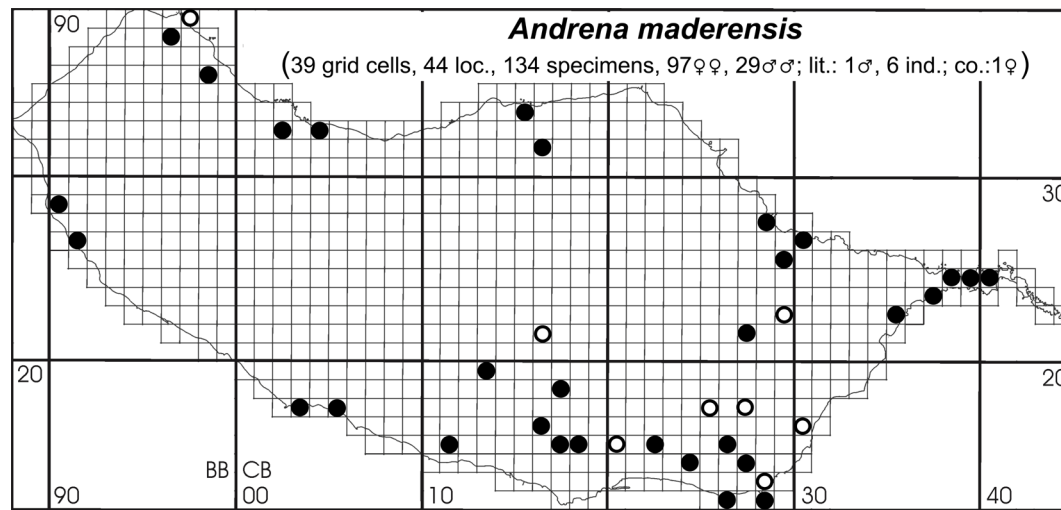


Fig. 20 – Detections of *Andrena maderensis* (black dots: authors' data, checked specimens of collections, one checked observation; circles: literature data).

Table 7 – Plant-species spectrum visited by *Andrena maderensis*.

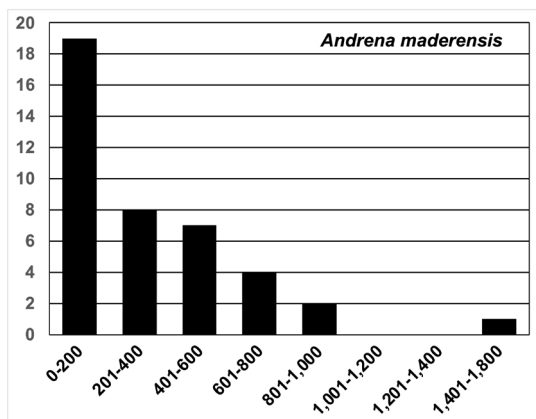


Fig. 21 – Number of localities with *Andrena maderensis* detections per altitude level (m a.s.l.).

Plant species, plant families	Status	n
<i>Argyranthemum p. subsp. pinnatifidum</i>	Ast end	1♂
<i>Crepis vesicaria</i>	Ast nat	4♀♀, 4♂♂
<i>Leontodon taraxacoides subsp. longirostris</i>	Ast nat	1♂
<i>Sonchus asper</i>	Ast nat?	1♀
<i>Sonchus oleraceus</i>	Ast nat?	1♀
<i>Brassica oleracea</i>	Bra cul	4♀♀
<i>Erysimum bicolor</i>	Bra end	1♀
<i>Erysimum maderense</i>	Bra end	1♀
<i>Raphanus r. subsp. raphanistrum</i>	Bra nat	17♀♀, 5♂♂
<i>Rapistrum rugosum s.l.</i>	Bra nat	2♀♀
<i>Sinapidendron angustifolium</i>	Bra end	19♀♀
<i>Sinapis arvensis</i>	Bra nat	2♀
<i>Geranium maderense</i>	Ger end	1♀
<i>Oxalis pes-caprae</i>	Oxa intr	1♂

- **Data from the authors** (80♀♀, 26♂♂): **cAK** (55♀♀, 13♂♂): 1♀, Cabo do Castelo, S Camacha, 488 m *a.s.l.*, 32° 39' 51.20" N, 16° 50' 46.06" W, 09.04.1995, leg. K/S; 3♂♂, Ponta de São Lourenço, above Ponta do Buraco, 71 m *a.s.l.*, 32° 44' 35.16" N, 16° 42' 01.06" W, 10.04.1995, leg. K/S; 1♂, Ponta de São Lourenço, 57 m *a.s.l.*, 32° 44' 39.19" N, 16° 43' 05.43" W, 26.03.2005, leg. K/S; 1♀, 1♂, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 26.03.2005, leg. K/S; 1♂, Ponta de São Lourenço, 101 m *a.s.l.*, 32° 44' 44.01" N, 16° 43' 20.74" W, 26.03.2005, leg. K/S; 1♀, Ponta de São Lourenço, 93 m *a.s.l.*, 32° 44' 44.34" N, 16° 43' 16.19" W, 26.03.2005, leg. K/S; 1♀, W Ponta do Garajau, S Caniço, 82 m *a.s.l.*, 32° 38' 23.20" N, 16° 51' 13.01" W, 29.03.2005, leg. K/S; 12♀♀, Larano, E Porto da Cruz, 274 m *a.s.l.*, 32° 45' 45.14" N, 16° 48' 29.69" W, 29.03.2005, leg. K/S; 4♀♀, W Ponta do Garajau, S Caniço, 82 m *a.s.l.*, 32° 38' 23.20" N, 16° 51' 13.01" W, 30.03.2005, leg. K/S; 1♀, 1♂, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 02.04.2005, leg. K/S; 10♀♀, W Ribeira Brava, Ribeiro da Caldeira, 37 m *a.s.l.*, 32° 40' 25.21" N, 17° 04' 09.99" W, 02.04.2005, leg. K/S; 2♀♀, W Ribeira Brava, Ribeiro da Corujeira – Ribeiro da Caldeira, 26 m *a.s.l.*, 32° 40' 34.34" N, 17° 04' 27.05" W, 02.04.2005, leg. K/S; 4♀♀, above Paúl do Mar, 43 m *a.s.l.*, 32° 45' 28.83" N, 17° 13' 41.69" W, 03.04.2005, leg. K/S; 1♂, above Porto Moniz, 407 m *a.s.l.*, 32° 51' 35.12" N, 17° 10' 26.56" W, 03.04.2005, leg. K/S; 13♀♀, 2♂♂, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 04.04.2005, leg. K/S; 1♀, 1♂, Referta, S Porta da Cruz, 192 m *a.s.l.*, 32° 45' 18.77" N, 16° 49' 7.14" W, 06.04.2005, leg. K/S; 1♀, Fajã do Penedo, near Boaventura, 238 m *a.s.l.*, 32° 48' 17.8" N, 16° 57' 49.2" W, 25.03.2022, leg. K/S; 1♀, Funchal, Jardim Botânico, 281 m *a.s.l.*, 32° 39' 45.9" N, 16° 53' 47.2" W, 29.03.2022, leg. K/S; 2♂♂, São Cristovão, 104 m *a.s.l.*, 32° 49' 39.3" N, 16° 58' 41.2" W, 31.03.2022, leg. K/S; 1♀, Ponta de São Lourenço, 66 m *a.s.l.*, 32° 44' 38.0" N, 16° 43' 32.6" W, 02.04.2022, leg. K/S; 1♀, Santa Cruz, 39 m *a.s.l.*, 32° 46' 15.8" N, 16° 49' 45.2" W, 02.04.2022, leg. K/S. **cFA**: 1♀, Cabo Girão, 597 m *a.s.l.*, 32° 39' 26.98" N, 17° 00' 18.19" W, 11.04.2002, leg. Aguiar / Jesus. **cJS**: (24♀♀, 13♂♂): 1♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 11.02.1998, leg. J. T. Smit; 1♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 15.02.1998, leg. J. T. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 16.02.1998, leg. J. T. Smit; 2♀♀, Barreira, NW Funchal, 743 m *a.s.l.*, 32° 41' 11.43" N, 16° 56' 47.90" W, 19.02.1998, leg. J. T. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 24.02.1998, leg. J. T. Smit; 4♀♀, 5♂♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 27.02.1998, leg. J. T. Smit; 1♂, Ribeira Brava, 125 m *a.s.l.*, 32° 40' 32.04" N, 17° 03' 55.92" W, 03.03.1998, leg. J. T. Smit; 1♀, Fajã da Nogueira, N Caniço, 222 m *a.s.l.*, 32° 39' 09.89" N, 16° 50' 07.79" W, 10.03.1998, leg. J. T. Smit; 3♀♀, 1♂, Ponta de São Lourenço,

77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 23.03.1998, leg. J. T. Smit; 2♀♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 01.04.1998, leg. J. T. Smit; 1♀, 2♂♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 03.04.1998, leg. J. T. Smit; 2♂♂, Serra da Eira da Laje, NE Jardim da Serra, 963 m *a.s.l.*, 32° 41' 29.49" N, 16° 59' 03.80" W, 05.04.1998, leg. J. T. Smit; 1♀, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 17.04.1998, leg. J. T. Smit; 4♀♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 22.04.1998, leg. J. T. Smit; 1♀, Palheiro Ferreiro, NW São Gonçalo, 505 m *a.s.l.*, 32° 39' 15.75" N, 16° 52' 17.22" W, 06.05.1998, leg. J. T. Smit; 3♀♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 23.05.1998, leg. J. T. Smit.

- **Data from collections** (17♀♀, 3♂♂): **ICLAM**: 1♀, Pico do Facho, Machico, 260 m *a.s.l.*, 32° 43' 26.12" N, 16° 45' 29.00" W, 14.04.2003, leg. Aguiar / Jesus. **UMB** (16♀♀, 3♂♂): 4♀♀, Fajã da Ovelha, 34 km NWN Funchal, 483 m *a.s.l.*, 32° 46' 27.43" N, 17° 14' 2.88" W, 02.04.1994, leg. H. Hohmann; 1♀, Ribeira da Janela, 639 m *a.s.l.*, 32° 50' 16.37" N, 17° 9' 21.13" W, 03.04.1994, leg. H. Hohmann; 4♀♀, 2♂♂, Seixal, 260 m *a.s.l.*, 32° 48' 52.33" N, 17° 5' 31.96" W, 11.04.1994, leg. H. Hohmann; 1♀, João Frino, 856 m *a.s.l.*, 32° 42' 51.07" N, 16° 50' 21.47" W, 13.04.1994, leg. H. Hohmann; 6♀♀, 1♂, Caniçal, 35 m *a.s.l.*, 32° 44' 21.44" N, 16° 44' 17.38" W, 31.03.1994, leg. H. Hohmann.

- **Data from literature** (17♀♀, 3♂♂): **WARNCKE** (1968): 1♂, Vale Paraíso, W Camacha, 13.06.1957, leg. H. Lindberg; **FELLENDORF et al.** (1999): 20♀♀, 6♂♂; 16.03.1997: Gaula, 200 m *a.s.l.*; females, March to June: Funchal, 200 m *a.s.l.*; Reis Magos, about 50 m *a.s.l.*; Camacha, about 600 m *a.s.l.*; Santo António da Serra, about 650 m *a.s.l.*; Porto Moniz, about 50 m *a.s.l.* Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 6 ind.).

- **Checked observation**: T. Dellinger (University of Madeira) found the species (1♀) at Miradouro do Paredão, Santo António, 1,433 m *a.s.l.*, 17.02.2022, on *Erysimum bicolor*. A document photo was checked by A. Kratochwil.

***Andrena (Micrandrena) wollastoni* (Cockerell, 1922)**

- **Status**: Endemic to Madeira Island (Figs. 22-24).

- **Literature**: ALFKEN (1940), WARNCKE (1968), COCKERELL (1922), FELLENDORF et al. (1999), GUSENLEITNER & SCHWARZ (2002), KRATOCHWIL et al. (2018, 2019, 2021), COSTA (2019), KRATOCHWIL (2020), KRATOCHWIL & SCHWABE (2020).

- **Specimens analysed**: 250♀♀, 134♂♂, 2 ind.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 25 and 26, Tables 8 and 9): *Andrena wollastoni* is widely distributed in all vegetation series (Fig.

25). Detections reach from sea level up to 1,800 m *a.s.l.*, but most of the observations are concentrated up to 800 m *a.s.l.* (Fig. 26). The very hot and dry sites [vegetation series a)] are obviously sparsely populated (Table 8). This is in line with other taxa of the *A. wollastoni* group (e.g., *A. acuta*, Tenerife; *A. catula*, Gran Canaria; KRATOCHWIL & SCHWABE, 2020). Ruderal sites such as fallows, slopes, fringe structures are used, especially in the cultural landscapes of the subhumid vegetation series c). In the Mediterranean vegetation series b), coastal rocks, amongst other habitats, are populated. Coastal rocks with more subhumid conditions and gaps in microforests and Laurisilva belong with high probability to the natural habitats before human impact.

In our observations, this polylectic species used 12 different plant families (Table 9). E.g. the flowers of the endemic Laurisilva tree *Clethra arborea* [vegetation series e)] as well as the endemic *Echium candicans* [vegetation series f), punctually also g)] were resources.

- **Flight time and nesting sites:** The flight activity ranges from February (first observation 11th February) to August (latest observation 4th August). *Andrena wollastoni* occurs in higher individual numbers in May and April at lower altitudes. At higher altitudes (> 1000 m *a.s.l.*), the activity starts in April, with the highest individual numbers in July. On the coastal slopes east of Porto da Cruz [vegetation series d) with *Erica arborea*], we found a nesting site on quasi-consolidated loamy substrate in a flattened micro patch, criss-crossed with biological crusts between *Erica arborea* tree heath (micro area of 35 x 35 cm with about 90 nests); Fig. 24. Other nesting sites were found W Boca do Risco (29.03.2006).



Fig 22 – The endemic bee species *Andrena wollastoni* (female), collecting pollen on the native plant species *Rapistrum rugosum* s.l. (Ponta de São Lourenço, roadside, 02.04.2022; [vegetation series b)]. Photo A. Schwabe.



Fig. 23 – *Andrena wollastoni* (male, endemic), visiting the native *Crepis vesicaria* (Urzal, northern slope, 460 m *a.s.l.*; [vegetation series e]). Photo A. Schwabe.



Fig 24 – Nesting site of *Andrena wollastoni* E Porto da Cruz (Cova das Pedras) on a flattened micro patch; N coast [vegetation series d)]. The area with nest holes was 35 x 35 cm, with about 90 holes; see text. 29.03.2005. Photo A. Schwabe.

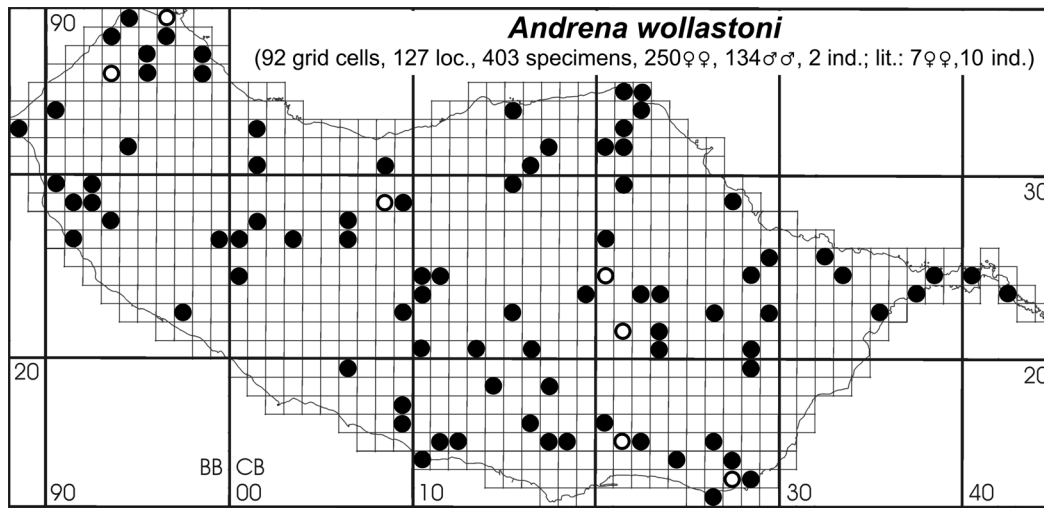


Fig. 25 – Detections of *Andrena wollastoni* (black dots: authors' data, checked specimens of collections; circles: literature data).

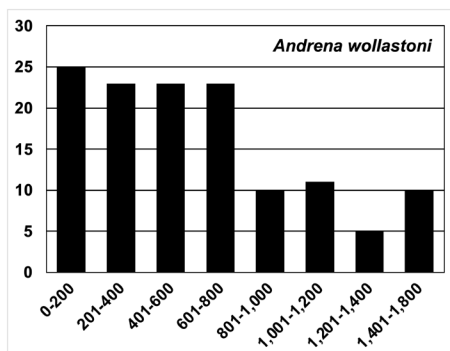


Fig. 26 – Number of localities with *Andrena wollastoni* detections per altitude level (m a.s.l.).

Table 8 – Presence of *Andrena wollastoni* in square-grid cells of different vegetation series.

Vegetation series	Presence %	absolute
May-Ol a	14%	
Hel-Si b	35%	
Sem-Ap 1 c	54%	
Sem-Ap 2 d	37%	
Cle-Oc e	38%	
Pol-Er f	38%	
Arm-Pa g	1	

- Data from the authors (180♀♀, 101♂♂, 2 ind.): **cAK** (77♀♀, 36♂♂): 12♀♀, Cabo do Castelo, S Camacha, 488 m a.s.l., 32° 39' 51.20" N, 16° 50' 46.06" W, 09.04.1995, leg. K/S; 1♀, 1♂, Pico do Facho, Machico, 266 m a.s.l., 32° 43' 22.49" N, 16° 45' 30.60" W, 10.04.1995, leg. K/S; 2♀♀, Ponta de São Lourenço, above Ponta do Buraco, 71 m a.s.l., 32° 44' 35.16" N, 16° 42' 01.06" W, 10.04.1995, leg. K/S; 1♀, Ponta de São Lourenço, above Rochinha, 78 m a.s.l., 32° 44' 40.19" N, 16° 43' 22.21" W, 26.03.2005, leg. K/S; 5♀♀, 6♂♂, Ponta de São Lourenço, 72 m a.s.l., 32° 44'

Table 9 – Plant-species spectrum visited by *Andrena wollastoni*.

Plant species, plant families	Status	n
<i>Melanoselinum decipiens</i>	Api end	1♀
<i>Ageratina adenophora</i>	Ast intr	2♀♀
<i>Argyranthemum pinnatifidum</i> s.l.	Ast end	2♀♀, 3♂♂
<i>Argyranthemum pinnatifidum</i> subsp. <i>succulentum</i>	Ast end	5♀♀, 7♂♂
Asteraceae yellow	Ast -	2♀♀, 1♂
<i>Calendula arvensis</i>	Ast nat	1♀
<i>Chrysanthemum segetum</i>	Ast intr	1♀
<i>Crepis vesicaria</i>	Ast nat	19♀♀, 10♂♂
<i>Erigeron karwinskianus</i>	Ast intr	1♂
<i>Galactites tomentosa</i>	Ast nat	3♂♂
<i>Hypochoeris radicata</i>	Ast intr	1♀, 1♂
<i>Leontodon taraxacoides</i> subsp. <i>longirostris</i>	Ast nat	6♀♀, 4♂♂
<i>Sonchus asper</i>	Ast nat?	5♀♀, 7♂♂
<i>Sonchus oleraceus</i>	Ast nat?	5♀♀
<i>Echium candicans</i>	Bor end	1♀♀, 2 ind.
<i>Brassica napus</i> subsp. <i>rapifera</i>	Bra cult	1♀, 5♂♂
<i>Brassica oleracea</i>	Bra cult	1♀, 1 ind.
<i>Crambe fruticosa</i>	Bra end	3♀♀
<i>Erysimum bicolor</i>	Bra mac	1♀
<i>Erysimum maderense</i>	Bra end	1♀
<i>Raphanus r.</i> subsp. <i>raphanistrum</i>	Bra nat	3♀♀, 2♂♂
<i>Rapistrum rugosum</i> s.l.	Bra nat	7♀♀
<i>Sinapis arvensis</i>	Bra nat	2♀
<i>Sisymbrium officinale</i>	Bra nat	4♀♀
<i>Clethra arborea</i>	Cle end	2♂♂
<i>Aeonium glandulosum</i>	Cra end	1♀, 5♂♂
<i>Aichryson villosum</i>	Cra end	3♀
<i>Vaccinium padifolium</i>	Eri end	1♂
<i>Cytisus scoparius</i>	Fab intr	1♀, 1 ind.
<i>Geranium maderense</i>	Ger end	4♀♀
Poaceae	Poa -	2♀♀, 3♂♂
<i>Digitalis purpurea</i>	Scr nat	3♂♂
<i>Centranthus calcitrapae</i>	Val nat	1♂

42.29" N, 16° 43' 07.48" W, 26.03.2005, leg. K/S; 4♀♀, 1♂, Ponta de São Lourenço 100 m a.s.l., 32° 44' 44.01" N, 16° 43' 20.74" W, 26.03.2005, leg. K/S; 8♀♀, Serra de Água, lookout point, 465 m a.s.l., 32° 43' 50.79" N, 17° 01' 26.59" W, 27.03.2005, leg. K/S; 1♀, Eirinha, above Serra de Água, 506 m a.s.l., 32° 43' 54.22" N, 17° 01' 30.19" W, 27.03.2005, leg. K/S; 3♀♀, 1♂, Câmara do Bispo, S Quinta Grande, 316 m a.s.l., 32° 39' 17.50" N, 17° 01' 02.02" W, 28.03.2005, leg. K/S; 1♀, Fajã dos Padres, W Quinta Grande, 325 m a.s.l., 32° 39' 21.12" N, 17° 01' 04.44" W, 28.03.2005, leg. K/S; 1♀,

- 5♂♂, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, leg. K/S; 5♂♂, Referta, S Porto da Cruz, 192 m *a.s.l.*, 32° 45' 18.77" N, 16° 49' 7.14" W, 29.03.2005, leg. K/S; 5♂♂, W Boca do Risco, 708 m *a.s.l.*, 32° 45' 23.76" N, 16° 47' 26.45" W, 29.03.2005, leg. K/S; 1♀, W Ponta do Garajau, S Caniço, 82 m *a.s.l.*, 32° 38' 23.20" N, 16° 51' 13.01" W, 30.03.2005, leg. K/S; 1♀, Funchal, in front of Jardim Botânico, 277 m *a.s.l.*, 32° 39' 41.27" N, 16° 53' 41.25" W, 30.03.2005, leg. K/S; 1♂, Cova do Negro, W Rabaçal, 1,130 m *a.s.l.*, 32° 48' 23.66" N, 17° 11' 50.04" W, 02.04.2005, leg. K/S; 1♀, above Paúl do Mar, ER 213, 50 m *a.s.l.*, 32° 45' 29.52" N, 17° 13' 41.76" W, 03.04.2005, leg. K/S; 1♂, above Porto Moniz, 407 m *a.s.l.*, 32° 51' 35.12" N, 17° 10' 26.56" W, 03.04.2005, leg. K/S; 1♀, Pico do Facho, Machico, 266 m *a.s.l.*, 32° 43' 22.49" N, 16° 45' 30.60" W, 06.04.2005, leg. K/S; 1♀, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 06.04.2005, leg. K/S; 3♀♀, Referta, S Porto da Cruz, 192 m *a.s.l.*, 32° 45' 18.77" N, 16° 49' 7.14" W, 06.04.2005, leg. K/S; 7♀♀, S S. Jorge, ER 101, 110 m *a.s.l.*, 32° 49' 31.59" N, 16° 53' 56.82" W, 06.04.2005, leg. K/S; 4♂♂, S. Jorge, 256 m *a.s.l.*, 32° 50' 03.66" N, 16° 54' 21.61" W, 06.04.2005, K/S; 1♂, Lombo do Urzal, near Boaventura, 456 m *a.s.l.*, 32° 47' 04.4" N, 16° 58' 37.4" W, 25.03.2022, leg. K/S; 2♀♀, 2♂♂, Fajã do Penedo near Boaventura, 264 m *a.s.l.*, 32° 47' 53.6" N, 16° 58' 05.5" W, 25.03.2022, leg. K/S; 4♀♀, Fajã do Penedo, near Boaventura, 238 m *a.s.l.*, 32° 48' 17.8" N, 16° 57' 49.2" W, 25.03.2022, leg. K/S; 1♀, W P. Moniz, 417 m *a.s.l.*, 32° 51' 38.2" N, 17° 12' 04.1" W, 26.03.2022, leg. K/S; 1♀, leftside valley of S. Vicente, 200 m *a.s.l.*, 32° 47' 47.1" N, 17° 02' 44.5" W, 27.03.2022, leg. K/S; 1♀, above P. Moniz, 618 m *a.s.l.*, 32° 51' 04.3" N, 17° 11' 22.5" W, 28.03.2022, leg. K/S; 4♀♀, Jardim Botânico, Funchal, 281 618 m *a.s.l.*, 32° 39' 45.9" N, 16° 53' 47.2" W, 29.03.2022, leg. K/S; 6♀♀, 3♂♂, São Cristovão, coastal rock, 104 m *a.s.l.*, 32° 49' 39.3" N, 16° 58' 41.2" W, 31.03.2022, leg. K/S; 4♀♀, Ponta de São Lourenço, 66 m *a.s.l.*, 32° 44' 38.0" N, 16° 43' 32.6" W, 02.04.2022, leg. K/S. *cFA* (15♀♀, 10♂♂): 3♂♂, Ponta de São Lourenço, Casa do Sardinha, 41 m *a.s.l.*, 32° 44' 32.59" N, 16° 41' 03.09" W, 02.04.1989, leg. F. Aguiar; 1♂, Levada do Risco, before reaching the waterfall, 1,054 m *a.s.l.*, 32° 45' 40.21" N, 17° 07' 40.46" W, 01.06.1996, leg. F. Aguiar; 1♂, Achada da Cruz, Santana, 256 m *a.s.l.*, 32° 49' 21.05" N, 16° 53' 37.98" W, 22.04.1997, leg. F. Aguiar; 1♂, Curral das Freiras, land belonging to Comissão de levadas, 525 m *a.s.l.*, 32° 43' 33.47" N, 16° 58' 05.17" W, 07.05.1998, leg. Aguiar / Jesus; 1♀, Boca da Corrida, above forest services post, 1,216 m *a.s.l.*, 32° 42' 36.75" N, 16° 59' 13.65" W, 27.05.1999, leg. Aguiar / Jesus; 1♀, 1♂, Queimadas, near the pig breeding, 877 m *a.s.l.*, 32° 47' 10.52" N, 16° 54' 23.26" W, 22.05.2003, leg. Aguiar / Jesus; 1♂, Fajã das Éguas, Serra de Água, 718 m *a.s.l.*, 32° 44' 34.03" N, 17° 01' 29.98" W, 04.05.2006, leg. F. Aguiar *et al.*; 1♂, Caminho de São Lourenço, Calheta, 707 m *a.s.l.*, 32° 46' 42.02" N, 17° 13' 17.94" W, 08.06.2018, leg. A. Aguiar; 1♀, Caminho de São Lourenço, Calheta, 816 m *a.s.l.*, 32° 47' 02.94" N, 17° 13' 04.58" W, 08.06.2018, leg. A. Aguiar; 1♀, Caminho de São Lourenço, Calheta, 828 m *a.s.l.*, 32° 47' 04.27" N, 17° 12' 59.40" W, 08.06.2018, leg. A. Aguiar; 1♀, Achada do Teixeira, Santana, 1,564 m *a.s.l.*, 32° 45' 49.64" N, 16° 55' 12.11" W, 22.06.2018, leg. A. Aguiar; 1♀, Achada do Teixeira, Santana, 1,573 m *a.s.l.*, 32° 45' 49.90" N, 16° 55' 13.55" W, 22.06.2018, leg. A. Aguiar; 1♂, Achada do Teixeira, Santana, 1,572 m *a.s.l.*, 32° 45' 53.21" N, 16° 55' 20.71" W, 22.06.2018, leg. A. Aguiar; 1♀, Achada do Teixeira, Santana, 1,573 m *a.s.l.*, 32° 45' 53.35" N, 16° 55' 22.80" W, 22.06.2018, leg. A. Aguiar; 4♀♀, Vereda Calheta – Rabaçal, Calheta, 968 m *a.s.l.*, 32° 45' 19.33" N, 17° 08' 37.68" W, 02.07.2018, leg. A. Aguiar; 3♀♀, Vereda Calheta – Rabaçal, Calheta, 970 m *a.s.l.*, 32° 45' 19.51" N, 17° 08' 37.36" W, 02.07.2018, A. Aguiar; 1♀, Vereda Calheta – Rabaçal, Calheta, 983 m *a.s.l.*, 32° 45' 20.48" N, 17° 08' 35.09" W, 02.07.2018, leg. A. Aguiar. *cJS* (85♀♀, 50♂♂): 1♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 22.04.1997, leg. J. T. Smit; 1♀, Lombada dos Marinheiros, 578 m *a.s.l.*, 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 2♀♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 1♀, João Frino, 698 m *a.s.l.*, 32° 42' 01.48" N, 16° 50' 05.85" W, 19.07.1997, leg. J. Smit; 2♀♀, Portela, 640 m *a.s.l.*, 32° 48' 29.79" N, 16° 51' 56.77" W, 19.07.1997, leg. J. Smit; 4♂♂, Achada do Poiso, 1,374 m *a.s.l.*, 32° 42' 44.84" N, 16° 53' 13.54" W, 20.07.1997, leg. J. Smit; 18♀♀, Rabaçal, 1,064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 20.07.1997, leg. J. Smit; 1♀, Paúl da Serra, 1,579 m *a.s.l.*, 32° 45' 43.56" N, 17° 03' 54.28" W, 20.07.1997, leg. J. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 11.02.1998, leg. J. T. Smit; 3♂♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 15.02.1998, leg. J. T. Smit; 1♀, Barreira, NW Funchal, 743 m *a.s.l.*, 32° 41' 11.43" N, 16° 56' 47.90" W, 19.02.1998, leg. J. T. Smit; 3♀♀, 3♂♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 24.02.1998, leg. J. T. Smit; 2♀♀, 1♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 27.02.1998, leg. J. T. Smit; 2♀♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 01.03.1998, leg. J. T. Smit; 7♀♀, 10♂♂, Fajã da Nogueira, N Caniço, 222 m *a.s.l.*, 32° 39' 09.89" N, 16° 50' 07.79" W, 10.03.1998, leg. J. T. Smit; 12♀♀, 3♂♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 25.03.1998, leg. J. T. Smit; 3♀♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 25.03.1998, J. T. Smit; 3♀♀, 3♂♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 03.04.1998, leg. J. T. Smit; 1♂, Serra da Eira da Laje, NW Jardim da Serra, 963 m *a.s.l.*, 32° 41' 29.49" N, 16° 59' 03.80" W, 05.04.1998, leg. J. T. Smit; 12♀♀, 1♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 17.04.1998, leg. J. T. Smit; 2♀♀, 3♂♂, São Jorge, 297 m *a.s.l.*, 32° 49' 08.85" N, 16° 54' 17.92" W, 04.05.1998, leg. J. T. Smit; 1♂, Lombada do

Loreto, NE Arco da Calheta, 358 m *a.s.l.*, 32° 43' 12.71" N, 17° 09' 35.85" W, 05.05.1998, leg. J. Smit; 3♀♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 2♂♂, Boa Morte, 483 m *a.s.l.*, 32° 49' 08.83" N, 17° 14' 13.73" W, 05.05.1998, leg. J. Smit; 1♀, 2♂♂, Palheiro Ferreiro, NW São Gonçalves, 505 m *a.s.l.*, 32° 39' 15.75" N, 16° 52' 17.22" W, 06.05.1998, leg. J. Smit; 3♀♀, 3♂♂, Pico do Areeiro, 1,730 m *a.s.l.*, 32° 44' 07.57" N, 16° 55' 50.37" W, 16.05.1998, leg. J. T. Smit; 1♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 19.05.1998, leg. J. T. Smit; 1♀, 10♂♂, Rabaçal, 1,064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 21.05.1998, leg. J. T. Smit; 1♀, Funchal, Jardim Botânico, 264 m *a.s.l.*, 32° 39' 43.23" N, 16° 53' 48.10" W, 22.05.1998, leg. J. T. Smit; 1♀, Ribeira da Corujeira, SE Monte, 332 m *a.s.l.*, 32° 40' 17.84" N, 16° 54' 56.80" W, 24.05.1998, leg. J. T. Smit. **oFA** (3♀♀, 5♂♂, 2 ind.): 1 ind., Boca da Corrida, below miradouro, 1,152 m *a.s.l.*, 27.05.1999, 32° 42' 39.43" N, 16° 59' 07.37" W, obs. F. Aguiar; 1 ind. Pinheiro, 1 km SW Serra de Água church, 379 m *a.s.l.*, 22.02.2007, 32° 43' 17.28" N, 17° 02' 02.72" W, obs. F. Aguiar; 2♂♂, Ilha, dirt road above habitational zone, 541 m *a.s.l.*, 31.05.2007, 32° 48' 09.98" N, 16° 54' 36.35" W, obs. F. Aguiar; 1♀, Achadas da Cruz to Fajã Nova, Porto Moniz, 424 m *a.s.l.*, 05.07.2007, 32° 51' 11.06" N, 17° 12' 30.19" W, obs. F. Aguiar; 1♂, Farol to Cais de S. Jorge, 126 m *a.s.l.*, 13.03.2008, 32° 49' 59.89" N, 16° 54' 06.16" W, obs. F. Aguiar; 1♂, Santana, Achada do Teixeira, 1,570 m *a.s.l.*, 01.06.2010, 32° 45' 55.52" N, 16° 55' 07.44" W, obs. F. Aguiar; 1♀, Santana, Achada do Teixeira, 1,575 m *a.s.l.*, 01.06.2010, 32° 45' 51.94" N, 16° 55' 10.58" W, obs. F. Aguiar; 1♀, São Jorge to the sea, Caminho da Saúde, 133 m *a.s.l.*, 24.03.2011, 32° 49' 44.51" N, 16° 54' 03.84" W, obs. F. Aguiar; 1♂, Caminho de São Lourenço, Fajã da Ovelha, dirt road, 733 m *a.s.l.*, 19.05.2011, 32° 46' 51.15" N, 17° 13' 09.11" W, obs. F. Aguiar.

- **Data from collections** (70♀♀, 33♂♂): **ICLAM** (16♀♀, 18♂♂): 1♂ Boca da Corrida, below miradouro, 1,152 m *a.s.l.*, 32° 42' 39.43" N, 16° 59' 07.37" W, 27.5.1999, leg. Aguiar / Jesus; 1♀, Pico do Facho, Machico, 266 m *a.s.l.*, 32° 43' 22.49" N, 16° 45' 30.60" W, 24.02.2000, leg. Aguiar / Jesus; 1♀, Estrada para o Fanal, 2 km from Paúl da Serra crossing, 1,359 m *a.s.l.*, 32° 46' 10.41" N, 17° 06' 59.10" W, 28.06.2000, leg. Aguiar / Jesus; 1♀, Boca da Corrida, above forest services post, 1,216 m *a.s.l.*, 32° 42' 36.75" N, 16° 59' 13.65" W, 07.06.2001, leg. Aguiar / Jesus; 1♂, Chão da Ribeira, behind trout nursery, 617 m *a.s.l.*, 32° 47' 32.99" N, 17° 06' 53.91" W, 13.06.2002, leg. Aguiar / Jesus; 1♂, Levada Rabaçal to Risco, 300m before the waterfall, 1,299 m *a.s.l.*, 32° 45' 30.18" N, 17° 07' 35.79" W, 27.06.2002, leg. Aguiar / Jesus; 1♂, Levada do Norte, near Boa Morte, 421 m *a.s.l.*, 32° 40' 34.66" N, 17° 01' 56.09" W, 27.02.2003, leg. Aguiar / Jesus; 1♀, 2♂♂, Ilha, dirt road, 547 m *a.s.l.*, 32° 48' 16.64" N, 16° 55' 13.25" W, 22.04.2003, leg. Aguiar / Jesus; 1♀, Eira do Serrado, Pico do Serrado, 955 m *a.s.l.*, 32° 42' 25.14" N, 16° 57' 35.72" W, 17.06.2004, leg. Aguiar

/ Jesus; 3♂♂, Levada Nova, Tabúa to Ponta do Sol, 705 m *a.s.l.*, 32° 41' 51.22" N, 17° 03' 35.50" N, 10.03.2005, leg. F. Aguiar *et al.*; 1♀, Farol to Cais de S. Jorge, 125 m *a.s.l.*, 32° 50' 04.67" N, 16° 54' 12.45" W, 12.05.2005, leg. Aguiar / Jesus; 2♂♂, Fajã das Éguas, Serra de Água, 452 m *a.s.l.*, 32° 44' 11.36" N, 17° 01' 19.73" W, 04.05.2006, leg. F. Aguiar *et al.*; 1♀, Caniçal, Prainha, Ponta de São Lourenço, 71 m *a.s.l.*, 32° 44' 42.83" N, 16° 43' 08.52" W, 26.04.2007, leg. Aguiar / Jesus; 1♀, Vereda Chão das Feiteiras, Ribeiro Frio, 1,167 m *a.s.l.*, 32° 43' 50.68" N, 16° 52' 58.83" W, 17.05.2007, leg. Aguiar / Jesus; 1♂, Lombo Grande, Ilha, dirt road above habitational zone, 542 m *a.s.l.*, 32° 48' 18.33" N, 16° 54' 49.95" W, 31.05.2007, leg. J. Jesus; 1♀, Lombo Grande, Ilha, dirt road above habitational zone, 537 m *a.s.l.*, 32° 48' 19.24" N, 16° 54' 49.97" W, 31.05.2007, leg. F. Aguiar; 2♀♀, Lombo Grande, Ilha, dirt road above habitational zone, 480 m *a.s.l.*, 32° 48' 19.85" N, 16° 54' 41.99" W, 31.05.2007, leg. C. Brazão; 1♀, Vereda Achadas da Cruz to Fajã Nova, beginning of descent, 427 m *a.s.l.*, 32° 51' 09.31" N, 17° 12' 29.58" W, 05.07.2007, leg. J. Jesus; 1♂, Vereda Santo da Serra to Lamaceiros, 1.4 km SW Pico do Suna, 1,060 m *a.s.l.*, 32° 43' 21.94" N, 16° 51' 21.09" W, 07.05.2009, leg. D. Cravo; 1♂, Vereda Santo da Serra to Lamaceiros, 0.6 km SW Forest Guard house, 888 m *a.s.l.*, 32° 44' 00.68" N, 16° 50' 37.37" W, 20.05.2010, leg. D. Cravo; 1♂, Vereda Paúl da Serra to Fanal, 1.7 km SE Fanal Guard house, 1,052 m *a.s.l.*, 32° 47' 37.40" N, 17° 07' 32.51" W, 14.04.2011, leg. J. Jesus; 1♂, Roseira, Porto Moniz, 0.34 km N reservoir 631 m *a.s.l.*, 32° 50' 05.65" N, 17° 11' 00.61" W, 05.05.2011, leg. D. Cravo; 2♂♂, Roseira, Porto Moniz, 0.34 km N reservoir, 638 m *a.s.l.*, 32° 50' 06.51" N, 17° 11' 01.56" W, 05.05.2011, leg. D. Cravo; 1♀, Caminho de São Lourenço, 1.6 km NE Fajã da Ovelha church, 756 m *a.s.l.*, 32° 46' 38.02" N, 17° 12' 54.35" W, 19.05.2011, leg. F. Aguiar; 1♀, Levada do Norte, Serra de Água, near the power station, 676 m *a.s.l.*, 32° 44' 22.17" N, 17° 00' 50.79" W, 28.06.2011, leg. J. Jesus; 1♀, Encumeada, Serra de Água, 0.35 km SW Estalagem, 622 m *a.s.l.*, 32° 44' 35.75" N, 17° 01' 18.30" W, 28.06.2011, leg. J. Jesus; 1♀, Serralhal, 1.5 km NW Caniço, 484 m *a.s.l.*, 32° 39' 51.28" N, 16° 50' 46.77" W, leg. Aguiar / Jesus. **oFA**: 1 ind., Boca da Corrida, below miradouro, 1,152 m *a.s.l.*, 32° 42' 39.43" N, 16° 59' 07.37" W, 27.05.1999, obs. F. Aguiar; 1 ind., Pinheiro, 1 km SW Serra de Água church, 379 m *a.s.l.*, 32° 43' 17.28" N, 17° 02' 02.72" W, 22.02.2007, obs. F. Aguiar; 2♂♂, Ilha, dirt road above habitational zone, 541 m *a.s.l.*, 32° 48' 09.98" N, 16° 54' 36.35" W, 31.05.2007, obs. F. Aguiar; 1♀, Achadas da Cruz to Fajã Nova, Porto Moniz, 424 m *a.s.l.*, 32° 51' 11.06" N, 17° 12' 30.19" W, 05.07.2007, obs. F. Aguiar; 1♂, Farol to Cais de S. Jorge, 126 m *a.s.l.*, 32° 49' 59.89" N, 16° 54' 06.16" W, 13.03.2008, obs. F. Aguiar; 1♀, Santana, Achada do Teixeira, 1,575 m *a.s.l.*, 32° 45' 51.94" N, 16° 55' 10.58" W, 01.06.2010, obs. F. Aguiar; 1♂, Santana, Achada do Teixeira, 1,570 m *a.s.l.*, 32° 45' 55.52" N, 16° 55' 07.44" W, 01.06.2010, obs. F. Aguiar; 1♀,

São Jorge, Caminho da Saúde, 133 m *a.s.l.*, 32° 49' 44.51" N, 16° 54' 03.84" W, 24.03.2011, obs. F. Aguiar; 1♂, Caminho de São Lourenço, Fajã da Ovelha, dirt road, 733 m *a.s.l.*, 32° 46' 51.15" N, 17° 13' 09.11" W, 19.05.2011, obs. F. Aguiar. **MZHF** (4♀♀, 5♂♂): 1♀, 1♂, Boa Morte – Quinta Grande, 343 m *a.s.l.*, 32° 40' 20.60" N, 17° 01' 53.64" W, 21.04.1995, leg. M. Koponen; 2♂♂, Porto da Cruz, 16 m *a.s.l.*, 32° 46' 19.20" N, 16° 49' 40.80" W; 20.04.1990, leg. M. Koponen; 2♀♀, Funchal, Jardim Botânico, 293 m *a.s.l.*, 32° 39' 43.20" N, 16° 53' 42.00" W, 16.04.1990; 2♂♂, Estreito de Câmara de Lobos – Caldeira, 550 m *a.s.l.*, 32° 39' 34.04" N, 17° 00' 10.99" W, leg. M. Koponen; 1♀, Garajau, 44 m *a.s.l.*, 32° 38' 13.20" N, 17° 00' 00.00" W, leg. H. Lindberg. **OLML** (6♀♀, 5♂♂): 2♀♀, Santo da Serra, 5.V. leg. Frey; 1♀, Caramujo, leg. J. Mateu; 3♀♀, 5♂♂, Ribeira da Janela, 650 m *a.s.l.*, 12.-16.05.2007, leg. R. Hentscholek, det. A. W. Ebmer. **UMB** (44♀♀, 5♂♂): 10♀♀, Jardim do Mar, 50 m *a.s.l.*, 32° 44' 18.64" N, 17° 12' 40.44" W, 02.04.1994, leg. Hohmann; 2♀♀, Maloeira, 635 m *a.s.l.*, 32° 45' 55.93" N, 17° 12' 32.23" W, 02.04.1994, leg. Hohmann; 1♀, Ribeira da Janela, 637 m *a.s.l.*, 32° 50' 16.58" N, 17° 9' 21.20" W, 03.04.1994, leg. H. Hohmann; 6♀♀, Rosário, 302 m *a.s.l.*, 32° 46' 36.57" N, 17° 1' 53.54" W, 03.04.1994, leg. H. Hohmann; 3♂♂, Achada do Cedro Gordo, 700 m *a.s.l.*, 32° 44' 57.72" N, 16° 52' 22.20" W, 04.04.1994, leg. H. Hohmann; 4♀♀, Paúl da Serra, 1,423 m *a.s.l.*, 32° 45' 26.99" N, 17° 05' 49.83" W, 10.04.1994, leg. H. Hohmann; 2♂♂, João Frino, 766 m *a.s.l.*, 32° 42' 30.19" N, 16° 49' 54.50" W, 13.04.1994, leg. H. Hohmann; 1♀, Reis Magos, 18 m *a.s.l.*, 32° 38' 50.38" N, 16° 49' 27.93" W, 13.04.1994, leg. Hohmann; 20♀♀, Caniçal, 33 m *a.s.l.*, 32° 44' 20.68" N, 16° 44' 17.61" W, 31.03.1994, leg. H. Hohmann.

- **Data from literature** (7♀♀, 5♂♂): ALFKEN (1940): 4♀♀. Rabaçal, 1,080 m *a.s.l.*, 01.07.-04.08.1935; 2♀♀, Caramujo, 1,250 m *a.s.l.*, 06.-14.08.1935, leg. Lundblad. WARNCKE (1968): 1♀, Santo António da Serra, 780 m *a.s.l.*, July 1924, leg. Liebe. 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.*; Paúl da Serra, about 1,400 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.*. Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 8 ind.). COSTA (2019) from area of Pico do Areeiro (1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W; 1,800 m *a.s.l.*, 32° 44' 00" N, 16° 55' 47" W; n = 2 ind.).

Halictidae

Halictus (Halictus) frontalis Smith, 1853

- **Status:** Endemic to Madeira Island (Fig. 27).
- **Literature:** SMITH (1853), BLÜTHGEN (1940), EBMER (1988),

FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018, 2019), COSTA (2019).

- **Specimens analysed:** 74♀♀, 15♂♂, 1 ind.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 28 and 29, Tables 10 and 11): *Halictus frontalis* is a characteristic species of the more humid zones (Fig. 28). Detections reach from sea level up to 1,800 m *a.s.l.* Occurrences from 0 to 400 m *a.s.l.* are, however, generally limited to the northern parts of the island (Fig. 29). Apart from this, the range of *H. frontalis* is concentrated in higher altitudes. In our observations, it was especially found in vegetation series f), where potential tree-heath series occur, and to a lesser extent in zones c) to e) (Table 10). The species visited six different plant families. The main pollen resources for the females are endemic or native Asteraceae (Table 11). Areas of series f) are often heavily devastated by intensive cattle impact and enrichment of the invading introduced species *Ulex europaeus*. There are only a few data of flower visits from series f); the most remarkable is the tiny, introduced *Taraxacum hamatum*, with inflorescences pressed to the ground in grazed areas. In lower humid areas [series c), e)] the endemic species *Andryala glandulosa* and the native species *Crepis vesicaria* play a role.

- **Flight time and nesting sites:** The flight activity lasts from March (first observation 10th March) to September (latest observation 17th September). High abundances are reached in the lower altitudes in March, April, and May, and in the higher altitudes in July. Nesting sites in the soil have been found by A. Aguiar (nesting holes sheltered by rocks, Paúl da Serra, 1,584 m *a.s.l.*, dirt road from Estanquinhos to Ginjas; July 2007), and C. Brazão and J. Jesus (Paúl da Serra, 1,586 m *a.s.l.*, 1,588 m *a.s.l.*; August 2007).



Fig. 27 – *Halictus frontalis* (female), collecting pollen on the introduced *Taraxacum hamatum* [vegetation series f)] in the heavily grazed pastures of the potential tree-heath zone. Paúl da Serra, 1,550 m *a.s.l.*, 01.04.2022. Photo A. Kratochwil.

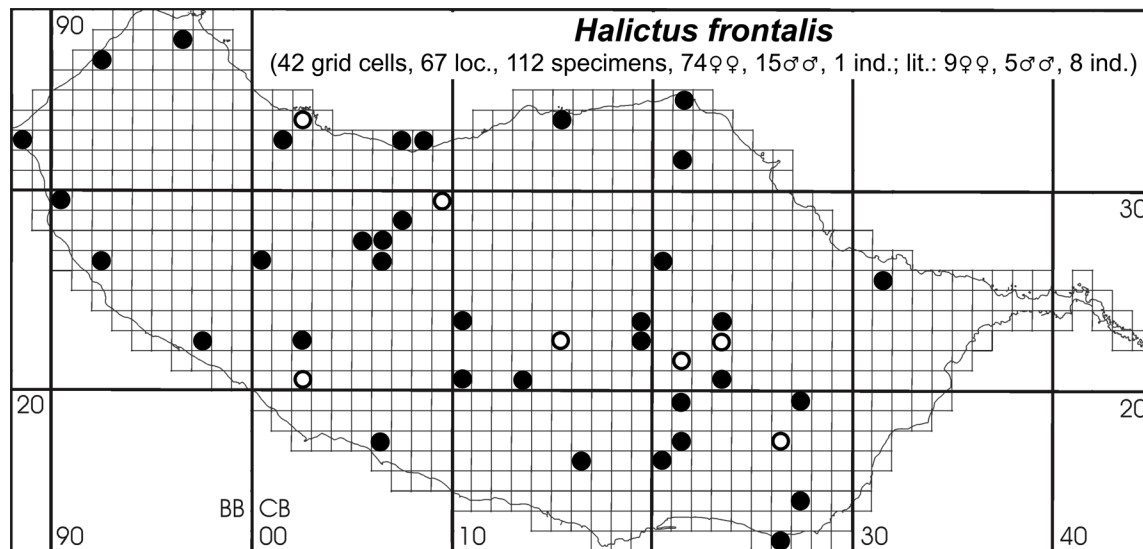


Fig. 28 – Detections of *Halictus frontalis* (black dots: authors' data, checked specimens of collections; circles: literature data).

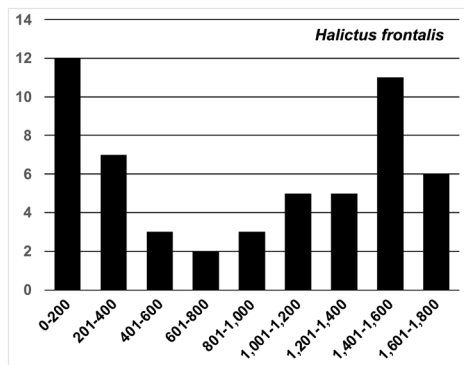


Fig. 29 – Number of localities with *Halictus frontalis* detections per altitude level (m a.s.l.).

Table 10 – Presence of *Halictus frontalis* in square-grid cells of different vegetation series.

Vegetation series	Presence %	absolute
May-Ol	a	5%
Hel-Si	b	6%
Sem-Ap 1	c	21%
Sem-Ap 2	d	18%
Cle-Oc	e	15%
Pol-Er	f	31%
Arm-Pa	g	2

- Data from the authors (66♀♀, 7♂♂, 1 ind.): **cAK** (16♀♀): 8♀♀, Serra de Água, lookout point, 465 m a.s.l., 32° 43' 50.79" N, 17° 01' 26.59" W, 27.03.2005, leg. K/S; 1♀, Eirinha above Serra de Água, 506 m a.s.l., 32° 43' 54.22" N, 17° 01' 30.19" W, 27.03.2005, leg. K/S; 1♀, W S. Vicente, old road between Ribeiro do Inferno

– Ribeiro dos Caimbos, 10 m a.s.l., 32° 48' 33.51" N, 17° 03' 24.31" W, 03.04.2005, leg. K/S; 1♀, above Porto Moniz, 407 m a.s.l., 32° 51' 35.12" N, 17° 10' 26.56" W, 03.04.2005, leg. K/S; 3♀, Ponta do Garajau, S Caniço, 112 m a.s.l., 32° 38' 18.33" N, 16° 51' 02.84" W, 04.04.2005, leg. K/S; 1♀, E S. Vicente near Fajã da Areia, 22 m a.s.l., 32° 48' 40.3" N, 17° 02' 34.4" W, 28.03.2022, leg. K/S; 1♀, Paúl da Serra, 1,578 m a.s.l., 32° 45' 44.3" N, 17° 04' 12.8" W, 01.04.2022, leg. K/S. **cFA** (1♀, 1♂): 1♀, Voltas, above Ginjas, S. Vicente, 1,005 m a.s.l., 32° 46' 23.97" N, 17° 03' 15.20" W, 10.04.2003, leg. Aguiar / Jesus; 1♂, Boca da Corrida, gravel road above the house, 1,226 m a.s.l., 32° 42' 35.04" N, 16° 59' 15.72" W, 02.09.2003, leg. Aguiar / Jesus. **cJS** (27♀♀): 3♀♀, Parque Ecológico, near Poço da Neve, 1,633 m a.s.l., 32° 43' 32.87" N, 16° 55' 29.69" W, 11.07.1997, leg. J. Smit; 1♀, Lombada dos Marinheiros, 578 m a.s.l., 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 4♀♀, Fontes, 1,124 m a.s.l., 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 1♀, João Frino, 698 m a.s.l., 32° 42' 01.48" N, 16° 50' 05.85" W, 19.07.1997, leg. J. Smit; 1♀, Achada do Poiso, 1,374 m a.s.l., 32° 42' 44.84" N, 16° 53' 13.54" W, 20.07.1997, leg. J. Smit; 1♀, Rabaçal, 1,064 m a.s.l., 32° 45' 43.45" N, 17° 08' 03.01" W, 20.07.1997, leg. J. Smit; 2♀♀, Fajã da Nogueira, N Caniço, 222 m a.s.l., 32° 39' 09.89" N, 16° 50' 07.79" W, 10.03.1998, leg. J. T. Smit; 1♀, Ribeira Brava, 125 m a.s.l., 32° 40' 32.04" N, 17° 03' 55.92" W, 01.05.1998, leg. J. Smit; 1♀, Lombada do Loreto, NE Arco da Calheta, 358 m a.s.l., 32° 43' 12.71" N, 17° 09' 35.85" W, 05.05.1998, leg. J. Smit; 3♀♀, Ponta do Pargo, 322 m a.s.l., 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♀, Terreiro da Luta, N Monte, 886 m a.s.l., 32° 41' 05.47" N, 16° 53' 56.59" W, 06.05.1998, leg. J. Smit; 1♀, Montado do Barreiro, 1,167 m a.s.l., 32° 42' 08.08" N, 16° 54' 11.43" W, 15.05.1998, leg. J. T. Smit; 2♀♀, Pico do Areiro, 1,730 m a.s.l., 32° 44' 07.57" N, 16° 55' 50.37" W, 16.05.1998, leg. J. T.

Smit; 2♀♀, Chão da Ribeira, Seixal, 433 m a.s.l., 32° 48' 33.25" N, 17° 06' 55.52" W, 23.05.1998, leg. J. T. Smit; 2♀♀, Ribeira da Corujeira, SE Monte, 332 m a.s.l., 32° 40' 17.84" N, 16° 54' 56.80" W, 24.05.1998; leg. J. T. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m a.s.l., 32° 40' 27.17" N, 16° 57' 22.11" W, 07.06.1998, leg. J. T. Smit. **oFA** (22♀♀, 6♂♂): 2♀♀, Fajã da Quebrada Nova, below Achadas da Cruz, 45 m a.s.l., 32° 50' 58.50" N, 17° 13' 09.83" W, 18.05.2003, obs. F. Aguiar; 1♀, Canhas to Paúl da Serra, gravel road left side, 967 m a.s.l., 32° 43' 29.28" N, 17° 06' 20.80" W, 29.06.2004, obs. F. Aguiar; 1♀, Vereda da Entrosa, Boaventura to Arco de S. Jorge, 122 m a.s.l., 32° 49' 33.40" N, 16° 58' 06.99" W, 31.03.2005, obs. F. Aguiar; 2♀♀, Ilha, dirt road above habitational zone, 532 m a.s.l., 32° 48' 10.65" N, 16° 54' 37.29" W, 31.05.2007 obs. F. Aguiar; 1♀, Farol to Cais de S. Jorge, 146 m a.s.l., 32° 50' 02.81" N, 16° 54' 10.50" W, 21.06.2007, obs. F. Aguiar; 1♀, Farol to Cais de S. Jorge, 76 m a.s.l., 32° 50' 05.64" N, 16° 54' 11.59" W, 21.06.2007, obs. F. Aguiar; 1 ind., Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,585 m a.s.l., 32° 46' 11.91" N, 17° 04' 27.59" W, 05.07.2007, obs. F. Aguiar; 1♀,1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,584 m a.s.l., 32° 46' 12.10" N, 17° 04' 27.13" W, 05.07.2007, obs. F. Aguiar; 3♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,584 m a.s.l., 32° 46' 12.10" N, 17° 04' 27.20" W, 05.07.2007, obs. F. Aguiar; 2♀♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,584 m a.s.l., 32° 46' 12.17" N, 17° 04' 27.11" W, 05.07.2007, obs. F. Aguiar; 2♀♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,518 m a.s.l., 32° 46' 14.51" N, 17° 04' 09.47" W, 05.07.2007, obs. F. Aguiar; 1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,518 m a.s.l., 32° 46' 14.51" N, 17° 04' 09.47" W, 05.07.2007 obs. F. Aguiar; 1♂, Poço da Neve, road to Pico do Areeiro, 1,588 m a.s.l., 32° 43' 27.82" N, 16° 55' 25.92" W, 31.07.2008, obs. F. Aguiar; 1♂, Poço da Neve, road to Pico do Areeiro, 1,625 m a.s.l., 32° 43' 31.76" N, 16° 55' 28.44" W, 31.07.2008, obs. F. Aguiar; 1♀, Poiso, vereda from Poiso to Chão das Feiteiras, 914 m a.s.l., 32° 44' 02.63" N, 16° 53' 10.59" W, 23.04.2009, obs. F. Aguiar; 1♀, Estanquinhos, Paúl da Serra, 1,582 m a.s.l., 32° 46' 08.71" N, 17° 04' 27.69" W, 14.05.2009, obs. F. Aguiar; 1♂, Prazeres to Paúl do Mar, vereda near Jardim Atlantico Hotel, 424 m a.s.l., 32° 45' 15.70" N, 17° 13' 05.40" W, 17.09.2009, obs. F. Aguiar; 1♀, Santana, Achada do Teixeira, 1,562 m a.s.l., 32° 45' 49.71" N, 16° 55' 12.67" W, 01.06.2010, obs. F. Aguiar; 1♂, Farol to Cais de S. Jorge, 149 m a.s.l., 32° 49' 59.13" N, 16° 54' 06.93" W, 17.06.2010, obs. F. Aguiar; 1♀, Farol to Cais de S. Jorge, 103 m a.s.l., 32° 50' 05.28" N, 16° 54' 12.30" W, 17.06.2010, obs. F. Aguiar; 1♀, Prazeres to Paúl do Mar, vereda near Jardim Atlantico Hotel, 495 m a.s.l., 32° 45' 10.34" N, 17° 13' 04.38" W, 28.04.2011, obs. F. Aguiar; 1♀, Boca da Corrida, near the Forest Service house, 1,218 m a.s.l., 32° 42' 39.94" N, 16° 59' 12.63" W, 01.03.2012, obs. F. Aguiar.

Table 11 – Plant-species spectrum visited by *Halictus frontalis*.

Plant species, plant families	Status	n
<i>Andryala glandulosa</i> s.l.	Ast end	2♀♀
<i>Andryala g. subsp. glandulosa</i>	Ast end	2♀♀
<i>Argyranthemum pinnatifidum</i> s.l.	Ast end	2♀♀
Asteraceae yellow	Ast -	4♀♀, 4♂♂
<i>Carlina salicifolia</i>	Ast mac	2♂
<i>Crepis vesicaria</i>	Ast nat	7♀♀
<i>Galactites tomentosa</i>	Ast nat	4♀♀
<i>Sonchus oleraceus</i>	Ast nat?	1♀
<i>Taraxacum hamatum</i>	Ast intr	1♀
<i>Echium candicans</i>	Bor end	2 ind.
<i>Erysimum bicolor</i>	Bra mac	1♀
<i>Erica platycodon</i> subsp. <i>maderincola</i>	Eri end	1♂
<i>Cytisus scoparius</i>	Fab intr	1♂
<i>Oxalis pes-caprae</i>	Oxa intr	1♀

- **Data from collections** (8♀♀, 8♂♂): **ICLAM**: 1♀, Serra de Água, N Terra Grande, 484 m a.s.l., 32° 43' 52.88" N, 17° 01' 26.21" W, 31.07.1998, leg. Aguiar / Jesus; 1♀, Serra das Funduras, near coast, 534 m a.s.l., 32° 45' 11.96" N, 16° 47' 58.38" W, 12.06.2003, leg. Aguiar / Jesus; 1♀, Parque Ecológico, near Poço da Neve, 1,633 m a.s.l., 32° 43' 32.87" N, 16° 55' 29.69" W, 24.06.2004, leg. Aguiar / Jesus; 1♀, Canhas to Paúl da Serra, gravel road left side, 967 m a.s.l., 32° 43' 29.28" N, 17° 06' 20.80" W, 29.06.2004, leg. Aguiar / Jesus; 1♀, Farol to Cais de S. Jorge, halfway down to sea, 125 m a.s.l., 32° 50' 04.67" N, 16° 54' 12.45" W, 12.05.2005, leg. Aguiar / Jesus; 2♀♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,586 m a.s.l., 32° 46' 09.88" N, 17° 04' 26.17" W, 30.08.2007, leg. C. Brazão; 1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,588 m a.s.l., 32° 46' 10.99" N, 17° 04' 25.93" W, 30.08.2007, leg. J. Jesus; 1♀, 1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,531 m a.s.l., 32° 46' 12.40" N, 17° 04' 09.05" W 30.08.2007, leg. J. Jesus; 1♂, Poço da Neve, S Pico do Areeiro, 1,566 m a.s.l., 32° 43' 23.43" N, 16° 55' 20.96" W, 31.07.2008; 1♂, Poço da Neve, S Pico do Areeiro, 1,600 m a.s.l., 32° 43' 29.98" N, 16° 55' 28.12" W, 31.07.2008; 1♂, Poço da Neve, S Pico do Areeiro, 1,611 m a.s.l., 32° 43' 31.37" N, 16° 55' 29.92" W, 18.09.2008, leg. J. Jesus; 1♂, Poço da Neve, S Pico do Areeiro, 1,620 m a.s.l., 32° 43' 31.65" N, 16° 55' 29.16" W, 18.09.2008, leg. J. Jesus; 1♂, Poço da Neve, S Pico do Areeiro, 1,620 m a.s.l., 32° 43' 32.56" N, 16° 55' 30.46" W, 18.09.2008, J. Jesus; 1♂, Vereda Prazeres to Paúl do Mar, Calheta Municipality, 463 m a.s.l., 32° 45' 14.54" N, 17° 13' 04.06" W, 17.09.2009.

- **Data from literature** (9♀♀, 5♂♂, 8 ind.): BLÜTHGEN (1940): 1♀, Feiteiras, S S. Vicente, about 200 m a.s.l., 15.08.1935; 7♀♀, 5♂♂: Rabaçal, about 1,080 m a.s.l., 17.07.-04.08.1935; FELLENDORF et al. (1999): 13♀♀, 6♂♂; in May: Camacha, about. 600 m a.s.l.; Seixal, about 50 m a.s.l.; in August: Cural das Freiras, 1,000 m

a.s.l.; 2 km south of Ribeiro Frio, 1,100 m *a.s.l.*; Poiso, 1,400 m *a.s.l.*; in September: Camacha, about 600 m *a.s.l.* Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality ($n = 6$ ind.); 1♀, beginning of April, Lombo de S. João, 4.5 km NW Funchal, about 500 m *a.s.l.* COSTA (2019): 2 ind. from area of Pico do Areeiro (1,500m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W; 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W).

Lasioglossum (Evylaeus) v. villosulum (Kirby, 1802)

- **Status:** Probably native (Fig. 30).

- **Literature:** GRIBODO (1883), SAUNDERS (1903), BLÜTHGEN (1940), FELLENDORF *et al.* (1999), SCHEUCHL & WILLNER (2016), KRATOCHWIL *et al.* (2018, 2019).

- **Specimens analysed:** 189♀♀, 21♂♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 31 and 32, Tables 12 and 13): *Lasioglossum v. villosulum* shows high presence mainly in the Mediterranean vegetation series a), c), and d) (from dry to lower humid types). But it has also, albeit rarely, been found in the pastures of Paúl da Serra (see below). Coastal rocks, and in the more humid series c) and d) ruderal sites, pastures and gardens are its main habitat types.

Lasioglossum v. villosulum shows a preference in flower-visiting behaviour (pollen collecting) on Asteraceae in its whole Trans-Palaeartic distribution area, but has no strict habitat preferences (SCHEUCHL & WILLNER, 2016). In our observations on Madeira Island, the species visited Asteraceae nearly exclusively. The females were

mainly found on Asteraceae-Cichorioideae (exceptions: *Galactites tomentosa*, *Helichrysum foetidum*). The endemic species *Andryala glandulosa* subsp. *glandulosa* and *Crepis andryaloides*, the native species *Crepis vesicaria*, *Leontodon taraxacoides* subsp. *longirostris*, and the probably native species *Urospermum picroides* play a role as resources. In the heavily grazed area Paúl da Serra [vegetation series f)], the tiny, introduced *Taraxacum hamatum* is used (compare *Halictus frontalis*). HOHMANN *et al.* (1993) also reported mainly flower visits on Asteraceae in the Canary Islands.



Fig. 30 – The probably native species *Lasioglossum v. villosulum* (female), collecting pollen on the frequently occurring native plant species *Leontodon taraxacoides* subsp. *longirostris*. São Cristóvão, coastal rocky site, 31.03.2022; vegetation series d). Photo A. Kratochwil.

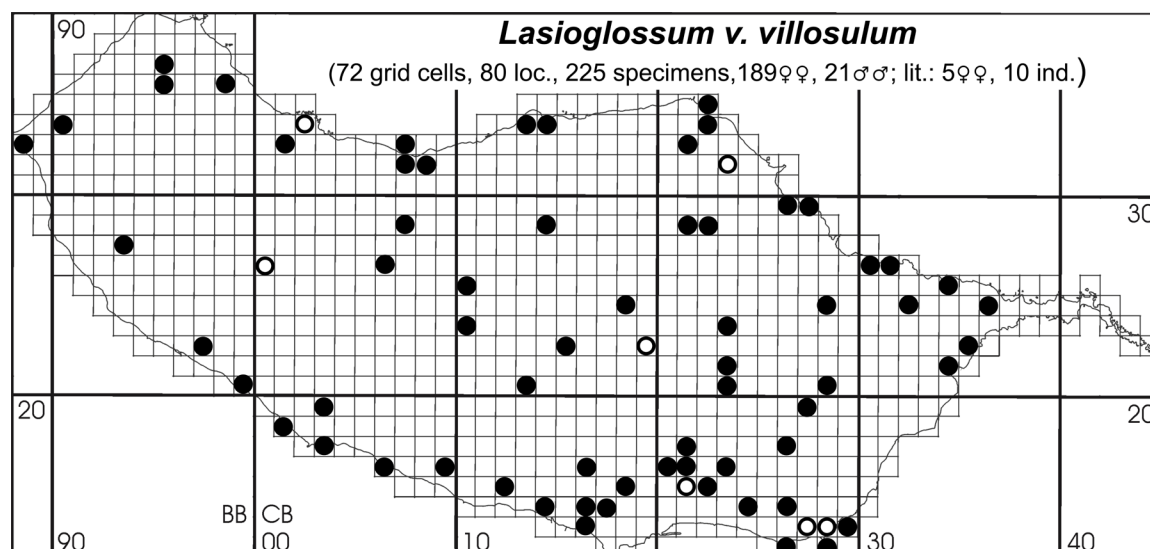


Fig. 31 – Detections of *Lasioglossum v. villosulum* (black dots: authors' data, checked specimens of collections; circles: literature data).

- **Flight time:** Flight-activity data exist from February (first observation 8th February) to December (latest observation 10th December). According to HOHMANN *et al.* (1993), the flight activity of *L. villosulum* on Tenerife is year-round. On Madeira Island, *L. villosulum* reaches its highest abundances at lower altitudes in April and May. In large parts of Europe, *L. villosulum* is bivoltine (SCHEUCHL & WILLNER, 2016). The data from Madeira Island indicate bivoltinism at lower altitudes.

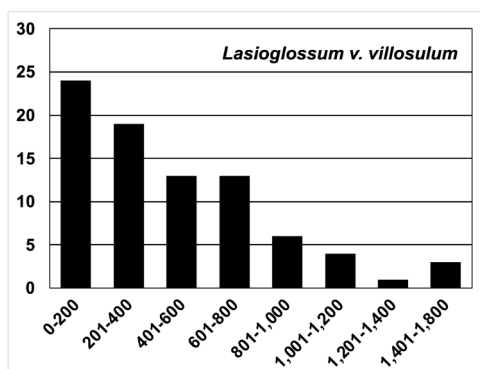


Fig. 32 – Number of localities with *Lasioglossum v. villosulum* detections per altitude level (m a.s.l.).

Table 12 – Presence of *Lasioglossum v. villosulum* in square-grid cells of different vegetation series.

Vegetation series	Presence %	absolute
May-Ol	a	52%
Hel-Si	b	18%
Sem-Ap 1	c	46%
Sem-Ap 2	d	35%
Cle-Oc	e	21%
Pol-Er	f	13%
Arm-Pa	g	1

Table 13 – Plant-species spectrum visited by *Lasioglossum v. villosulum*.

Plant species, plant families	Status	n
<i>Andryala glandulosa</i> subsp. <i>glandulosa</i>	Ast end	1 ♀, 1 ♂
Asteraceae yellow	Ast -	5 ♀♀
<i>Crepis andryaloides</i>	Ast end	1 ♀
<i>Crepis vesicaria</i>	Ast nat	8 ♀♀
<i>Galactites tomentosa</i>	Ast nat	1 ♀
<i>Helichrysum foetidum</i>	Ast intr	2 ♀♀
<i>Hypochoeris radicata</i>	Ast intr	1 ♀
<i>Leontodon taraxacoides</i> subsp. <i>longirostris</i>	Ast nat	18 ♀♀
<i>Sonchus asper</i>	Ast nat?	1 ♀
<i>Sonchus oleraceus</i>	Ast nat?	1 ♀
<i>Taraxacum hamatum</i>	Ast intr	5 ♀♀
<i>Urospermum picroides</i>	Ast nat?	14 ♀♀
<i>Aeonium glutinosum</i>	Cra end	1 ♂

- **Data from the authors** (112♀♀, 14♂♂): **cAK** (51♀♀): 4♀♀, Pico do Facho, Machico, 266 m a.s.l., 32° 43' 22.49" N, 16° 45' 30.60" W, 10.04.1995, leg. K/S; 21♀♀, Ponta da Oliveira, Caniço de Baixo, 22 m a.s.l., 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 1♀, Serra de Água, lookout point, 465 m a.s.l., 32° 43' 50.79" N, 17° 01' 26.59" W, 27.03.2005, leg. K/S; 3♀♀, Boca do Risco, 356 m a.s.l., 32° 45' 18.75" N, 16° 46' 13.12" W, 29.03.2005, leg. K/S; 1♀, Larano, E Porto da Cruz, 275 m a.s.l., 32° 45' 45.14" N, 16° 48' 29.69" W, 29.03.2005, leg. K/S; 1♀, W Ponta do Garajau, S Caniço, 82 m a.s.l., 32° 38' 23.20" N, 16° 51' 13.01" W, 30.03.2005, leg. K/S; 5♀♀, W S. Vicente, ER 101, Fajã do Rente, 75 m a.s.l., 32° 48' 29.57" N, 17° 03' 05.00" W, 03.04.2005, leg. K/S; 1♀, W S. Vicente, old road between Ribeiro do Inferno – Ribeiro dos Caimbos, 10 m a.s.l., 32° 48' 33.51" N, 17° 03' 24.31" W, 03.04.2005, leg. K/S; 1♀, Ponta dos Reis Magos, SE Caniço, 14 m a.s.l., 32° 38' 55.50" N, 16° 49' 22.06" W, 04.04.2005, leg. K/S; 4♀♀, Penha d'Águia de Baixo above Faial, 92 m a.s.l., 32° 47' 7.44" N, 16° 50' 56.38" W, 06.04.2005, leg. K/S; 1♀, Lombo do Urzal near Boaventura, 472 m a.s.l., 32° 46' 55.6" N, 16° 58' 42.3" W, 25.03.2022, leg. K/S; 1♀, W Achada, Fonte Vermelha, 813 m a.s.l., 32° 50' 10.7" N, 17° 11' 19.0" W, 26.03.2022, leg. K/S; 1♀, above P. Moniz, 618 m a.s.l., 32° 51' 04.3" N, 17° 11' 22.5" W, 28.03.2022, leg. K/S; 2♀♀, São Cristovão, coastal rock, 104 m a.s.l., 32° 49' 39.3" N, 16° 58' 41.2" W, 31.03.2022, leg. K/S; 4♀♀, Paúl da Serra, 1,578 m a.s.l., 32° 45' 44.3" N, 17° 04' 12.8" W, 01.04.2022, leg. K/S. **cFA** (3♀♀, 1♂): 1♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m a.s.l., 32° 40' 09.25" N, 17° 03' 46.32" W, 30.04.1989, leg. F. Aguiar; 1♀, Areeiro, São Martinho, 159 m a.s.l., 32° 38' 47.11" N, 16° 57' 26.71" W, 06.03.1992, leg. F. Aguiar; 1♀, Curral das Freiras, land belonging to Comissão de levadas, 525 m a.s.l., 32° 43' 33.47" N, 16° 58' 05.17" W, 15.04.1999, leg. Aguiar / Jesus; 1♂, Farol, Ponta do Pargo, 248 m a.s.l., 32° 48' 39.26" N, 17° 15' 34.01" W, 23.09.1999, leg. Aguiar / Jesus. **cJS** (56♀♀, 13♂♂): 2♂♂, Funchal, Pico dos Barcelos, 338 m a.s.l., 32° 39' 31.00" N, 16° 56' 22.00" W, 09.07.1997, leg. J. Smit; 1♀, Funchal, Jardim Botânico, 264 m a.s.l., 32° 39' 43.23" N, 16° 53' 48.10" W, 09.07.1997, leg. J. Smit; 1♂, Funchal, Ribeira dos Socorridos, 315 m a.s.l., 32° 40' 27.17" N, 16° 57' 22.11" W, 10.07.1997, leg. J. Smit; 1♀, Madalena do Mar, 31 m a.s.l., 32° 42' 06.79" N, 17° 08' 01.31" W, 15.07.1997, leg. J. Smit; 1♂, Palheiro Ferreiro, northwest of São Gonçalo, 505 m a.s.l., 32° 39' 15.75" N, 16° 52' 17.22" W, 19.07.1997, leg. J. Smit; 3♀♀, Palheiro Ferreiro, NW São Gonçalo, 505 m a.s.l., 32° 39' 15.75" N, 16° 52' 17.22" W, 19.07.1997, leg. J. Smit; 2♀♀, João Frino, 698 m a.s.l., 32° 42' 01.48" N, 16° 50' 05.85" W, 19.07.1997, leg. J. Smit; 1♂, Machico, 10 m a.s.l., 32° 43' 05.58" N, 16° 45' 48.59" W, 19.07.1997; leg. J. Smit; 1♂, Achada do Poiso, 1,374 m a.s.l., 32° 42' 44.84" N, 16° 53' 13.54" W, 20.07.1997; leg. J. Smit; 8♀♀, Funchal, Ribeira dos Socorridos, 315 m a.s.l., 32° 40' 27.17" N, 16° 57' 22.11" W, 11.02.1998, leg. J. T. Smit; 1♀, Canhas, NW Ponta do Sol, 57 m

a.s.l., 32° 41' 19.37" N, 17° 07' 03.64" W, 10.04.1998, leg. J. T. Smit; 4♀♀, Ribeira Brava, 125 m *a.s.l.*, 32° 40' 32.04" N, 17° 03' 55.92" W, 01.05.1998, leg. J. Smit; 2♀♀, Lombada do Loreto, NE Arco da Calheta, 358 m *a.s.l.*, 32° 43' 12.71" N, 17° 09' 35.85" W, 01.05.1998, leg. J. Smit; 1♀, Caniçal, 86 m *a.s.l.*, 32° 44' 31.98" N, 16° 44' 39.84" W, 02.05.1998, leg. J. Smit; 1♀, São Jorge, 297 m *a.s.l.*, 32° 49' 08.85" N, 16° 54' 17.92" W, 04.05.1998, leg. J. Smit; 1♀, Boa Morte, 483 m *a.s.l.*, 32° 49' 08.83" N, 17° 14' 13.73" W, 05.05.1998, leg. J. Smit; 4♀♀, Terreiro da Luta, N Monte, 886 m *a.s.l.*, 32° 41' 05.47" N, 16° 53' 56.59" W, 06.05.1998, leg. J. Smit; 7♀♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 18.05.1998, leg. J. T. Smit; 1♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 19.05.1998, leg. J. T. Smit; 2♂♂, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 19.05.1998, leg. J. T. Smit; 5♂♂, Funchal, Jardim Botânico, 264 m *a.s.l.*, 32° 39' 43.23" N, 16° 53' 48.10" W, 22.05.1998, leg. J. T. Smit; 18♀♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 23.05.1998, leg. J. T. Smit; 1♀, Ribeira da Corujeira, SE Monte, 332 m *a.s.l.*, 32° 40' 17.84" N, 16° 54' 56.80" W, 24.05.1998, leg. J. T. Smit. **oFA** (2♀♀): 1♀, Achada do Gramacho, Santana, vereda to Ribeira de São Jorge, 45 m *a.s.l.*, 32° 49' 44.78" N, 16° 53' 47.40" W, 16.04.2009, obs. F. Aguiar, 1♀, Caminho do Cabo de Larano, Porto da Cruz, 340 m *a.s.l.*, 32° 45' 39.32" N, 16° 48' 04.49" W, 23.02.2012, obs. F. Aguiar.

- **Data from collections** (76♀♀, 7♂♂): **ICLAM** (17♀♀, 2♂♂): 1♂, Queimadas, Santana, 885 m *a.s.l.*, 32° 46' 58.80" N, 16° 54' 08.29" W, 26.11.1998, leg. Aguiar / Jesus; 2♀♀, Precas, Agricultural Station, Câmara de Lobos, 124 m *a.s.l.*, 32° 39' 20.53" N, 16° 58' 35.57" W, 20.05.1999, leg. Aguiar / Jesus; 1♀, Farol, Ponta do Pargo, 248 m *a.s.l.*, 32° 48' 39.26" N, 17° 15' 34.01" W, 23.09.1999, leg. Aguiar / Jesus; 2♀♀, Pico do Facho, Machico, 252 m *a.s.l.*, 32° 43' 25.89" N, 16° 45' 27.83" W, 26.03.2002, leg. Aguiar / Jesus; 1♀, Guindaste, Faial, 29 m *a.s.l.*, 32° 47' 25.46" N, 16° 50' 48.67" W, 14.04.2003, leg. Aguiar / Jesus, 2♀♀, Vereda da Entrosa, Boaventura to Arco de S. Jorge, 122 m *a.s.l.*, 32° 49' 33.40" N, 16° 58' 06.99" W, 15.05.2003, leg. Aguiar / Jesus; 1♀, Ribeira da Janela, road to Fanal, 680 m *a.s.l.*, 32° 50' 04.02" N, 17° 09' 17.27" W, 08.07.2004, leg. Aguiar / Jesus; 1♀, Pico do Areeiro to Pico Ruivo, 1,649 m *a.s.l.*, 32° 45' 03.16" N, 16° 56' 18.47" W, 02.06.2005, leg. Aguiar / Jesus; 1♀, Levada do Norte, Serra de Água, 1,150 m *a.s.l.*, 32° 43' 22.14" N, 17° 00' 08.50" W, 12.10.2006, leg. Aguiar / Jesus; 1♀, Levada da Fajã do Rodrigues, S. Vicente, 902 m *a.s.l.*, 32° 46' 32.22" N, 17° 03' 14.75" W, 15.02.2007, leg. Aguiar / Jesus; 2♀♀, Boaventura, S. Vicente, 371 m *a.s.l.*, 32° 49' 13.85" N, 16° 58' 56.22" W, 19.04.2007, leg. Aguiar / Jesus; 1♀, Ribeiro Frio, near the bar, 1,166 m *a.s.l.*, 32° 43' 52.96" N, 16° 52' 57.74" W, 17.05.2007, leg. Aguiar / Jesus; 2♀♀, Serra das Funduras, 0.7 km NE Natural Park house, 299 m *a.s.l.*, 32° 44'

49.65" N, 16° 47' 00.63" W, 21.02.2008, leg. C. Brazão; 1♂, Farol to Cais de S. Jorge, 25 m *a.s.l.*, 32° 49' 45.81" N, 16° 53' 52.85" W, 17.06.2010, leg. F. Aguiar. **MZHF** (14♀♀): 1♀, S. Vicente, 27 m *a.s.l.*, 01.7.-02.07.1957, 32° 48' 28.80" N, 17° 02' 49.20" W, leg. H. Lindberg; 2♀♀, Queimadas, 882 m *a.s.l.*, 24.6.-26.06.1957, 32° 47' 00.72" N, 16° 54' 21.65" W, leg. H. Lindberg; 1♀, Boca da Corrida, 1185 m *a.s.l.*, 10.12.1991, 32° 42' 39.60" N, 16° 59' 09.60" W, leg. M. Koponen; 1♀, João Frino to Águas Mansas, 720 m *a.s.l.*, 19.12.1994, 32° 41' 34.80" N, 16° 50' 13.20" W, leg. M. Koponen; 1♀, Boa Morte – Quinta Grande, 416 m *a.s.l.*, 21.04.1995, 32° 40' 20.60" N, 17° 01' 53.64" W, leg. M. Koponen; 1♀, Monte, 559 m *a.s.l.*, 17.04.1995, 32° 40' 30.46" N, 16° 54' 4.94" W, leg. M. Koponen; 3♀♀, Palheiro Ferreiro – Babosas, 550-800 m *a.s.l.*, 17.04.1990, 32° 39' 36.00" N, 16° 52' 33.60" W, leg. M. Koponen; 1♀, Estreito de Câmara de Lobos – Caldeira, 608 m *a.s.l.*, 18.04.1995, 32° 39' 34.04" N, 17° 00' 10.99" W, leg. M. Koponen; 3♀♀, Funchal, Santo Amaro – Fajã, 300 m *a.s.l.*, 19.04.1995, 32° 39' 25.20" N, 16° 56' 38.40" W, leg. M. Koponen. **OLML** (8♀♀, 3♂♂): 8♀♀, Camacha, 730 m *a.s.l.*, 32° 40' 47.47" N, 16° 51' 1.04" W, 09.08.1992, leg. P. Wirtz; 3♂♂, Quinta do Palheiro Ferreiro, 569 m *a.s.l.*, 32° 39' 45.23" N, 16° 52' 06.72" W, 08.08.1966, leg. E. W. Classey. **UMB** (37♀♀, 2♂♂): 2♀♀, Achada do Cedro Gordo, 700 m *a.s.l.*, 32° 44' 57.72" N, 16° 52' 22.20" W, 04.04.1994, leg. H. Hohmann; 2♂♂, João Frino, 766 m *a.s.l.*, 32° 42' 30.19" N, 16° 49' 54.50" W, 13.04.1994, leg. H. Hohmann; 28♀♀, Lombo de São João, 537 m *a.s.l.*, 32° 42' 10.40" N, 17° 06' 9.09" W, 03.04.1994, leg. H. Hohmann; 1♀, Maloeira, 635 m *a.s.l.*, 32° 45' 55.93" N, 17° 12' 32.23" W, 02.04.1994, leg. H. Hohmann; 1♀, Ribeira Brava, Miradouro, 59 m *a.s.l.*, 32° 40' 10.85" N, 17° 03' 45.66" W, 10.04.1994, leg. H. Hohmann; 5♀♀, Ribeira de Janela, 639 m *a.s.l.*, 32° 50' 16.37" N, 17° 09' 21.13" W, 03.04.1994, leg. H. Hohmann.

- **Data from literature** (5♀♀, 10 ind.): SAUNDERS (1903): 1♀, Monte (Funchal), about 570 m *a.s.l.*, 27.02.1902, leg. A. E. Eaton; 2♀♀, Monte (Funchal), about 570 m *a.s.l.*, 15.03.1902, leg. A. E. Eaton. BLÜTHGEN (1940): 2♀♀ females, 17.07.-04.08.1935, Rabaçal, about 1000 m *a.s.l.* FELLENDORF *et al.* (1999): 45♀♀, 4♂♂, collected in March, April, May, August and September; Caniço, about 300 m *a.s.l.*; Reis Magos, about 50 m *a.s.l.*; Camacha, about 600 m *a.s.l.*; Poiso, 1,400 m *a.s.l.*; Portela, about 660 m *a.s.l.*; Santana, about 400 m *a.s.l.*, João da Ribeira, about 700 m *a.s.l.*; Encumeada, about 1,000 m *a.s.l.*; Funchal, about 300 m *a.s.l.* Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 9 ind.). COSTA (2019): 1 ind. from Pico do Areeiro, 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W).

- **Further checked data** (checked by A. Kratochwil): Boieiro, M., 1♀, Portela, 640 m *a.s.l.*, 32° 48' 29.79" N, 16° 51' 56.77" W, June 2017, leg. M. Boieiro.

***Lasioglossum (Evyllaes) wollastoni* (Cockerell, 1922)**

- **Status:** Endemic to Madeira Island (Fig. 33).

- **Literature:** SAUNDERS (1903), COCKERELL (1922), BLÜTHGEN (1940), WARNCKE (1975), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018, 2019).

- **Specimens analysed:** 199♀♀, 36♂♂.



Fig. 33 – *Lasioglossum wollastoni* (female), collecting pollen on the native plant species *Rapistrum rugosum* s.l. (Ponta de São Lourenço, roadside, 02.04.2022; vegetation series b). Photo A. Kratochwil.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 34 and 35, Tables 14 and 15): *Lasioglossum wollastoni* shows the highest presence in the grid cells of the subhumid to humid Mediterranean zones [vegetation series b), c), d)]. Coastal rocks, other rocky places and ruderal sites are important habitat types. This polylectic species visits eight different plant families and feeds on the flower resources of endemic plant species, e.g. *Echium nervosum*, *Andryala glandulosa* s.l., *Argyranthemum pinnatifidum* s.l., *Sinapidendron angustifolium*, *Aeonium glutinosum*. Ruderal species such as *Rapistrum rugosum* s.l., *Sonchus oleraceus*, and vegetables in gardens (*Brassica oleracea*) are also used. Some introduced species play a role as well (e.g. *Bidens pilosa*, *Chrysanthemum segetum*, *Helichrysum foetidum*).

- **Flight time and nesting sites:** Flight-activity data exist from February (first observation 15th February) to September (latest observation 20th September). According to the data *L. wollastoni* is active from March to the beginning of August at lower altitudes (with high abundances in March and April). At higher altitudes (from 1,000 to 1,600 m *a.s.l.*), the activity starts later (in July). We did not find nesting sites on Madeira Island, but on Porto Santo there was breeding activity at the end of March 2017 in sandy, weakly consolidated substrate (see photo documentation in KRATOCHWIL & SCHWABE, 2018b, Fig. 12c). According to PAULY & MICHEZ (2013), ‘nests are constructed in loose aggregations in bare ground’.

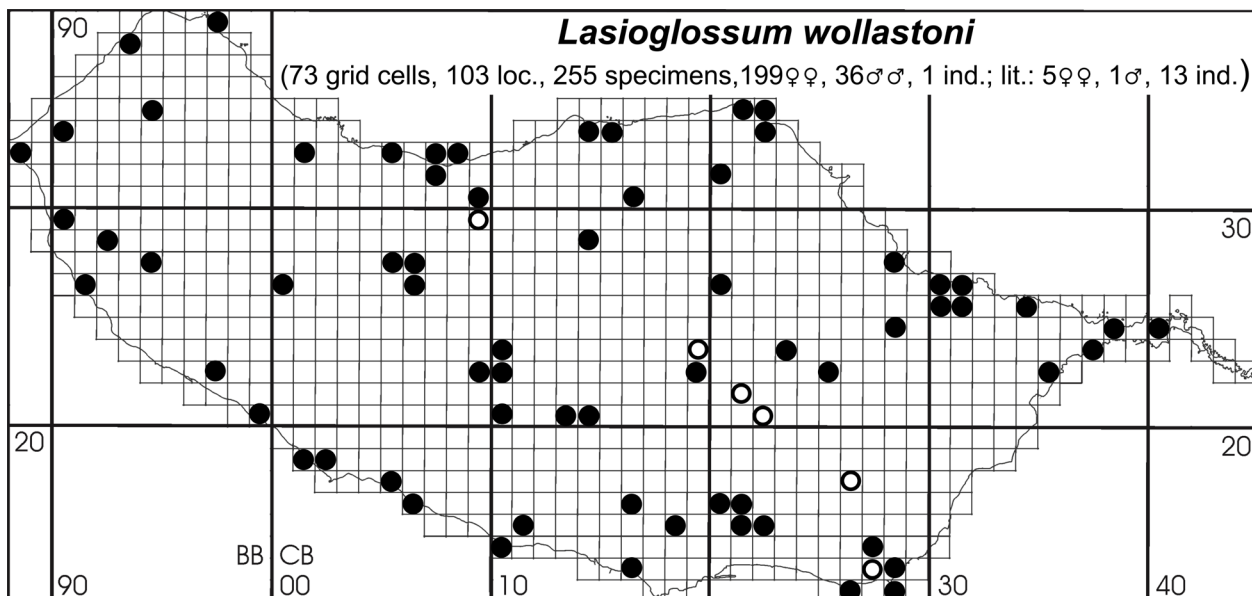


Fig. 34 – Detections of *Lasioglossum wollastoni* (black dots: authors' data, checked specimens of collections; circles: literature data).

W, 03.04.2005, leg. K/S; 3♀♀, E Seixal, old road between Ilhéu das Ceroulas – Ribeira de João Delgado, 51 m *a.s.l.*, 32° 48' 37.15" N, 17° 03' 37.41" W, 03.04.2005, leg. K/S; 1♀, Ponta do Pargo, near lighthouse, 345 m *a.s.l.*, 32° 48' 50.16" N, 17° 15' 30.24" W, 03.04.2005, leg. K/S; 1♀, E Ribeira da Janela, old road between Ribeira da Janela – Ribeiro Escuro, 17 m *a.s.l.*, 32° 48' 59.01" N, 17° 05' 4.72" W, 03.04.2005, leg. K/S; 1♀, Ponta do Garajau, S Caniço, 112 m *a.s.l.*, 32° 38' 18.33" N, 16° 51' 02.84" W, 04.04.2005, leg. K/S; 1♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 04.04.2005, leg. K/S; 4♀♀, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 04.04.2005, leg. K/S; 10♀♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 05.04.2005, leg. K/S; 1♀, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 06.04.2005, leg. K/S; 3♀♀, Porto da Cruz, peninsula with ruins; 15 m *a.s.l.*, 32° 46' 28.63" N, 16° 49' 38.98" W, 06.04.2005, leg. K/S; 3♀♀, Lombo do Urzal, near Boaventura, 472 m *a.s.l.*, 32° 46' 54.3" N, 16° 58' 45.5" W, 25.03.2022, leg. K/S; 1♀, Fajã do Penedo, near Boaventura, 323 m *a.s.l.*, 32° 47' 59.8" N, 16° 57' 46.3" W, 25.03.2022, leg. K/S; 30♀♀, E S. Vicente, near Fajã Areia, 22 m *a.s.l.*, 32° 48' 40.3" N, 17° 02' 34.4" W, 28.03.2022, leg. K/S; 1♀, 29.03.2022, Funchal, Jardim Botânico, 281 m *a.s.l.*, 32° 39' 45.9" N, 16° 53' 47.2" W, leg. K/S; 2♀♀, E Ponta Delgada, old road, 95 m *a.s.l.*, 32° 49' 37.92" N, 16° 58' 49.67" W, 31.03.2022, leg. K/S; 2♀♀, São Cristovão, coastal rock, 104 m *a.s.l.*, 32° 49' 39.3" N, 16° 58' 41.2" W, 31.03.2022, leg. K/S; 3♀♀, São Lourenço, 54 m *a.s.l.*, 32° 44' 36.5" N, 16° 43' 21.8" W, 02.04.2022, leg. K/S; 1♀, São Cristovão, old coastal road, 104 m *a.s.l.*, 32° 49' 39.3" N, 16° 58' 41.2" W, 03.04.2022, leg. K/S. **cFA** (2♀♀, 1♂): 1♀, Areeiro, São Martinho, 159 m *a.s.l.*, 32° 38' 47.11" N, 16° 57' 26.71" W, 23.03.1992, leg. F. Aguiar; 1♂, Boca da Corrida, below Miradouro, 1,152 m *a.s.l.*, 32° 42' 39.43" N, 16° 59' 07.37" W, 02.09.2004, leg. Aguiar / Jesus; 1♀, Pinheiro, Ribeira Brava, 394 m *a.s.l.*, 32° 43' 19.37" N, 17° 02' 03.95" W, 04.05.2006, leg. F. Aguiar *et al.* **cJS** (28♀♀, 4♂♂): 1♀, 1♂, Lombada dos Marinheiros, 578 m *a.s.l.*, 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 1♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 1♂, Ribeiro Frio, 893 m *a.s.l.*, 32° 44' 05.11" N, 16° 53' 11.73" W, 17.07.1997, leg. J. Smit; 1♀, Portela, 640 m *a.s.l.*, 32° 48' 29.79" N, 16° 51' 56.77" W, 19.07.1997, leg. J. Smit; 2♀♀, Paúl da Serra, 1,579 m *a.s.l.*, 32° 45' 43.56" N, 17° 03' 54.28" W, 20.07.1997, leg. J. Smit; 1♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 15.02.1998, leg. J. T. Smit; 1♀, Fajã da Nogueira, N Caniço, 222 m *a.s.l.*, 32° 39' 09.89" N, 16° 50' 07.79" W, 10.03.1998, leg. J. T. Smit; 1♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 21.03.1998, leg. J. T. Smit; 1♀, Calheta, Lombo do Atouguia, 306 m *a.s.l.*, 32° 43' 26.85" N, 17° 09' 55.18" W, 07.04.1998, leg. J. T. Smit; 1♀, Rabaçal, 1,064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 07.04.1998, leg. J. T. Smit;

2♀♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 14.04.1998, leg. J. T. Smit; 1♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 25.04.1998, leg. J. T. Smit; 4♀♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♀, Boa Morte, 483 m *a.s.l.*, 32° 49' 08.83" N, 17° 14' 13.73" W, 05.05.1998, leg. J. Smit; 1♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 12.05.1998, leg. J. T. Smit; 1♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 19.05.1998, leg. J. T. Smit; 1♀, Rabaçal, 1,064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 21.05.1998, leg. J. T. Smit; 3♀♀, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 23.05.1998, leg. J. T. Smit; 1♀, Ribeira da Corujeira, SE Monte, 332 m *a.s.l.*, 32° 40' 17.84" N, 16° 54' 56.80" W, 24.05.1998, leg. J. T. Smit; 2♀♀, Reis Magos, Caniço, 11 m *a.s.l.*, 32° 38' 45.15" N, 16° 49' 30.22" W, 06.06.1998, leg. J. T. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 07.06.1998, leg. J. T. Smit; 2♂♂, Reis Magos, Caniço, 11 m *a.s.l.*, 32° 38' 45.15" N, 16° 49' 30.22" W, 09.06.1998, leg. P. Wirtz. **oFA** (5♀♀, 7♂♂, 1 ind.): 1♀, Farol to Cais de S. Jorge, 33 m *a.s.l.*, 32° 50' 00.47" N, 16° 54' 01.68" W, 21.06.2007, obs. F. Aguiar; 1♀, Farol to Cais de S. Jorge, 147 m *a.s.l.*, 32° 50' 04.18" N, 16° 54' 11.00" W, 21.06.2007, obs. F. Aguiar; 1♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,585 m *a.s.l.*, 32° 46' 11.96" N, 17° 04' 27.15" W, 05.07.2007, obs. F. Aguiar; 1♂, Achadas da Cruz to Fajã Nova, Porto Moniz, 423 m *a.s.l.*, 32° 51' 10.97" N, 17° 12' 30.23" W, 05.07.2007, obs. F. Aguiar; 1♂, Achadas da Cruz to Fajã Nova, Porto Moniz, 424 m *a.s.l.*, 32° 51' 11.06" N, 17° 12' 30.19" W, 05.07.2007, obs. F. Aguiar; 1♂, Achadas da Cruz to Fajã Nova, Porto Moniz, 423 m *a.s.l.*, 32° 51' 11.27" N, 17° 12' 30.40" W, 05.07.2007, obs. F. Aguiar; 1 ind., Achadas da Cruz to Fajã Nova, Porto Moniz, 423 m *a.s.l.*, 32° 51' 11.98" N, 17° 12' 31.11" W, 05.07.2007, obs. F. Aguiar; 3♂♂, Santo da Serra, dirt road to Pico do Suna, 1,181 m *a.s.l.*, 32° 43' 24.13" N, 16° 51' 42.47" W, 20.09.2007, obs. F. Aguiar; 1♀, Portela, dirt road from Portela to Ribeira de Machico, 569 m *a.s.l.*, 32° 45' 24.14" N, 16° 48' 29.13" W, 21.02.2008, obs. F. Aguiar; 1♀, Achada do Gramacho, Santana, Vereda to Ribeira de São Jorge, 240 m *a.s.l.*, 32° 49' 35.60" N, 16° 53' 34.63" W, 19.08.2008, obs. F. Aguiar; 1♂, Caminho do Cabo de Larano, Porto da Cruz, 320 m *a.s.l.*, 32° 45' 42.53" N, 16° 48' 10.47" W, 04.06.2009, obs. F. Aguiar.

- **Data from collections** (18♀♀, 24♂♂): **ICLAM** (9♀♀, 20♂♂): 1♂, Boca da Corrida, above Jardim da Serra, 807 m *a.s.l.*, 32° 42' 28.73" N, 16° 58' 54.19" W, 27.08.1998, leg. Aguiar / Jesus; 1♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 19.06.2000, leg. Aguiar / Jesus; 1♂, Boca da Corrida, above Jardim da Serra, 859 m *a.s.l.*, 32° 42' 28.19" N, 16° 58' 56.31" W, 13.07.2000, leg. Aguiar / Jesus; 1♀, Poço da Neve, near Pico do Areeiro, 1,567 m *a.s.l.*, 32° 43' 24.87" N, 16° 55' 28.70" W, 11.07.2002, leg. Aguiar / Jesus; 1♂, Pico do

Facho, Machico, 266 m *a.s.l.*, 32° 43' 14.80" N, 16° 45' 22.82" W, 12.06.2003, leg. Aguiar / Jesus; 1♂, Boca da Corrida, above Jardim da Serra, 859 m *a.s.l.*, 32° 42' 28.19" N, 16° 58' 56.31" W, 09.08.2004, leg. Aguiar / Jesus; 1♂, Farol to Cais de S. Jorge, 28 m *a.s.l.*, 32° 49' 52.45" N, 16° 53' 56.75" W, 12.05.2005, leg. J. Jesus; 1♂, near Eirinha, Serra de Água, 351 m *a.s.l.*, 32° 43' 40.95" N, 17° 01' 30.88" W, 30.08.2005, leg. Aguiar / Jesus; 1♂, Farol to Cais de S. Jorge, 159 m *a.s.l.*, 32° 49' 56.97" N, 16° 54' 06.85" W, 21.06.2007, leg. J. Jesus; 1♂, Farol to Cais de S. Jorge, 159 m *a.s.l.*, 32° 49' 56.98" N, 16° 54' 06.77" W, 21.06.2007, leg. J. Jesus; 1♂, Farol to Cais de S. Jorge, 159 m *a.s.l.*, 32° 49' 57.07" N, 16° 54' 06.92" W, 21.06.2007, leg. C. Brazão; 1♂, Farol to Cais de S. Jorge, 147 m *a.s.l.*, 32° 49' 57.34" N, 16° 54' 06.47" W, 21.06.2007, leg. C. Brazão; 2♂♂, Farol to Cais de S. Jorge, 160 m *a.s.l.*, 32° 50' 03.28" N, 16° 54' 10.90" W, 21.06.2007, leg. F. Aguiar; 1♀, Vereda Achadas da Cruz to Fajã Nova, 441 m *a.s.l.*, 32° 51' 09.78" N, 17° 12' 30.44" W, 05.07.07, leg. C. Brazão; 1♂, Vereda Achadas da Cruz to Fajã Nova, 454 m *a.s.l.*, 32° 51' 10.53" N, 17° 12' 31.96" W, 05.07.2007, leg. J. Jesus; 1♂, Caldeira, Câmara de Lobos, 630 m *a.s.l.*, 32° 39' 34.31" N, 17° 00' 15.05" W, 06.08.2007, leg. C. Brazão; 1♀, Pico Senhora de Fátima, stairs leading to little church, 183 m *a.s.l.*, 32° 47' 34.20" N, 17° 01' 55.47" W, 23.08.2007, leg. C. Brazão; 1♀, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,582 m *a.s.l.*, 32° 46' 11.61" N, 17° 04' 21.68" W, 30.08.2007, leg. J. Jesus; 1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,578 m *a.s.l.*, 32° 46' 12.33" N, 17° 04' 15.28" W, 30.08.2007, leg. C. Brazão; 1♀, Ilha, dirt road above habitational zone, 580 m *a.s.l.*, 32° 48' 10.15" N, 16° 55' 14.75" W, 28.02.2008, leg. C. Brazão; 1♂, Fonte da Pedra, 1.53 km SE Achadas da Cruz, 983 m *a.s.l.*, 32° 49' 36.87" N, 17° 11' 42.71" W, 07.08.2008, leg. C. Brazão; 1♂, Fonte da Pedra, 1.53 km SE Achadas da Cruz, 985 m *a.s.l.*, 32° 49' 37.46" N, 17° 11' 48.03" W, 07.08.2008, leg. J. Jesus; 1♂, Vereda do Larano, 2.7 km SE Porto da Cruz, 495 m *a.s.l.*, 32° 45' 28.91" N, 16° 47' 57.39" W, 04.05.2009, leg. D. Cravo; 1♀, S. Vicente, 0.2 km E Pico Senhora de Fátima, 201 m *a.s.l.*, 32° 47' 34.48" N, 17° 01' 51.72" W, 18.06.2009, leg. D. Cravo; 1♀, Achada do Teixeira, 130 m S car parking, 1,214 m *a.s.l.*, 32° 45' 36.88" N, 16° 54' 58.56" W, 01.06.2010, leg. D. Cravo; 1♀, road from Paúl da Serra to Prazeres, 782 m *a.s.l.*, 32° 45' 50.12" N, 17° 11' 29.91" W, 24.06.2010, leg. D. Cravo; 1♂, Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,587 m *a.s.l.*, 32° 46' 00.16" N, 17° 04' 08.99" W, 19.08.2010, leg. J. Jesus; 1♀, Caminho de São Lourenço, 1.85 km NE Fajã da Ovelha church, 753 m *a.s.l.*, 32° 46' 45.90" N, 17° 12' 47.71" W, 19.05.2011, leg. D. Cravo. **MZHF** (8♀♀, 1♂): 5♀♀, 1♂, Porto Moniz, 27 m *a.s.l.*, 32° 52' 01.20" N, 17° 10' 04.80" W, 04.07.1957, leg. H. Lindberg, 1♀, Garajau, 52 m *a.s.l.*, 32° 38' 13.20" N, 16° 51' 00.00" W, 19.04.1959, leg. H. Lindberg; 1♀, Caniçal, 15 m *a.s.l.*, 32° 44' 25.68" N, 16° 43' 47.31" W, 29.04.1959, leg. H. Lindberg; 1♀, Ribeiro Frio, 926 m *a.s.l.*, 32° 44' 17.88" N, 16° 53' 02.63" W, 14.05.1959, leg. S.

Panelius. **OLML** (1♀, 3♂♂): 3♂♂, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 17.07.1968, leg. S. Erlandson; 1♀, Monte, 559 m *a.s.l.*, 32° 40' 30.46" N, 16° 54' 4.94" W, 19.03.1989, leg. J. A. W. Lucas.

- **Data from literature** (5♀♀, 1♂, 13 ind.): SAUNDERS (1903): 1♀ (Monte, Funchal), *Sonchus oleraceus*, 27.02.1902, leg. A. E. Eaton. BLÜTHGEN (1940): 2♀♀, leg. O. Lundblad, 17.07.-04.08.1935, Rabaçal (about 1,000 m *a.s.l.*). 1♀ is deposited in the Biology Centre of the Upper Austrian Provincial Museum Linz (Collection of Warncke); 1♂, 06.-14.08.1935, Caramujo (1,250 m *a.s.l.*); 1♂, 15.08.1935, Feiteiras S. S. Vicente (about 200 m *a.s.l.*). In the Biology Centre of the Upper Austrian Provincial Museum Linz (Collection of Warncke) there are 3♂♂ collected by S. Erlandsson (1♂, 17.07.1968; 2♂♂, 19.07.1968), Funchal. In the Biology Centre of the Upper Austrian Provincial Museum Linz (Collection of Warncke) there is a female collected by J. A. W. Lucas, 19.03.1989, Monte, 500-600 m *a.s.l.* FELLENDORF *et al.* (1999): 15♀♀, 21♂♂: in January, February, May, July, August and September, Caniço (about 300 m *a.s.l.*), Reis Magos (about 50 m *a.s.l.*), Camacha (about 600 m *a.s.l.*), Pico do Facho (about 300 m *a.s.l.*), Poiso (1,000 m *a.s.l.*), Santo António da Serra (about 650 m *a.s.l.*), João da Ribeira (about 700 m *a.s.l.*), Porto Moniz (about 50 m *a.s.l.*), Ponta S. Lourenço (about 100 m *a.s.l.*), Pico do Areeiro (about 1,800 m *a.s.l.*). Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 11 ind.). 1♀ (MMF 26626) 1♂ (MMF 26625): Madeira; 7♀♀, Camacha, 09.08.1992, leg. P. Wirtz, det. A. W. Ebmer (OLML). COSTA (2019): 2 ind. from area of Pico do Areeiro (1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W; 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W).

Megachilidae

***Anthidium manicatum* (Linnaeus, 1758)**

- **Status:** Introduced.

- **Literature:** MATZKE-HAJEK (2021).

- **Specimens analysed:** Specimens were identified by MATZKE-HAJEK (2021) and documented with photos. Based on photo analysis, no assignment to either *Anthidium manicatum manicatum* (common in Europe) or *Anthidium m. barbarum* (common in North Africa) is possible. Both taxa differ in the colour pattern and molecular structure (M. Kasperek, *pers. comm.*).

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Fig. 36): MATZKE-HAJEK (2021) observed several individuals of *A. manicatum* on the introduced *Salvia leucantha* (Lamiaceae) in the 'Parque de Santa

Catarina' (near the harbour of Funchal), on 29.09.2021 and 01.10.2021. The site corresponds to the Mediterranean macrobioclimate, inframediterranean dry series (May-OI). The species prefers to visit zygomorphic flowers (SCHEUCHL & WILLNER, 2016), as in the case of *Salvia* (see above) and other Lamiaceae and further plant families.

Anthidium manicatum shows a Transpalaeartic distribution, and has been introduced in many places by humans in different regions (the USA, Brazil, Argentina, and Uruguay), as noted by STRANGE *et al.* (2011). In Central Europe, the species can mainly be found in gardens and parks in urban areas (SCHEUCHL & WILLNER, 2016).

In the Macaronesian Islands, the species was introduced to the Azores (first record: 1857, DROUËT, 1861; see also WEISSMANN *et al.*, 2017) and the Canary Islands (LIEFTINCK, 1958). *Anthidium manicatum* is now common on Tenerife, Gran Canaria, and La Palma (<https://www.biodiversidadcanarias.es/biota/especie/A00810?lang=de>).

The close distance to the port of Funchal suggests a human introduction by shipping. Such an introduction can occur through specimens nesting in stems. Nevertheless, the obviously late introduction to Madeira Island is surprising. It is uncertain whether this species can survive on Madeira Island and spread further.

***Hoplitis (Alcidamea) acuticornis* (Dufour & Perris, 1840)**

- **Status:** Introduced.

- **Literature:** ALFKEN (1940), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).

- **Specimens analysed:** 3♀, 1♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 37 and 38, Table 16): The rare *Hoplitis acuticornis* occurred nearly exclusively in the temperate macrobioclimate. Only three flower-visiting data could be obtained (high-altitude pasture, visiting *Echium candicans*; COSTA, 2019). According to SCHEUCHL & WILLNER (2016), the species has a strong preference for Fabaceae in Central Europe.

- **Further comments:** J. Smit collected *Stelis ornatula* (KLUG, 1807), which is a brood parasite specialised on *Hoplitis*, in the same locality (Fontes) and at the same time (15.07.1997). According to AMIET *et al.* (2004) and SCHEUCHL & WILLNER (2016), a host species is *H. acuticornis* (DUFOUR & PERRIS, 1840). Therefore, we assume that on Madeira Island the host of *S. ornatula* is *H. acuticornis*.

- **Flight time:** The species was observed in June and July.

- **Data from the authors** (1♀, 1♂): **cJS:** 1♂, Lombada dos Marinheiros, 578 m *a.s.l.*, 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 1♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit.

- **Further checked data** (2♀♀; checked by A. Kratochwil): Boieiro, M.; 1♀, Lombo do Mouro, 1,243 m *a.s.l.*, 32° 44' 45.06" N, 17° 2' 28.05" W, 27.06.2017, leg. M. Boieiro; Santos, R.: 1♀, Paúl da Serra, 1,423 m *a.s.l.*, 32° 45' 26.99" N, 17° 5' 49.83" W, 27.06.2017 leg. R. Santos.

- **Data from literature** (3♀♀, 1♂): ALFKEN (1940): 1♀, 1♂, Rabaçal, 1,066 m *a.s.l.*, 32° 45' 39.71" N, 17° 08' 4.78" W, 17.07.-04.08.1935, leg. O. Lundblad; COSTA (2019): 1♀, Pico do Areeiro, 1,800 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa; 1♀, Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa.

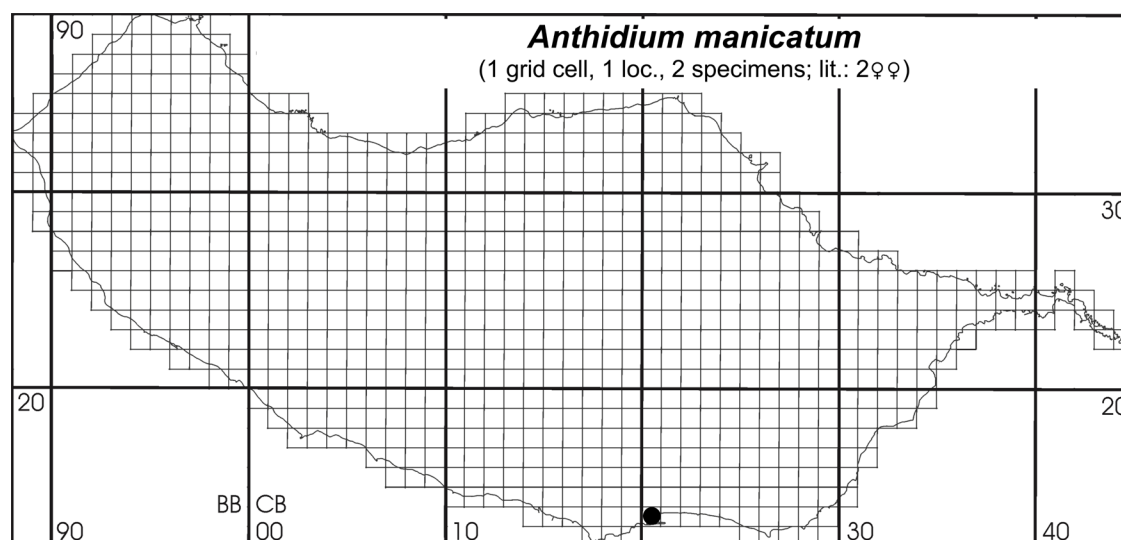


Fig. 36 – Detection of *Anthidium manicatum* (black dot: data of MATZKE-HAJEK 2021, photos checked by A. Kratochwil).

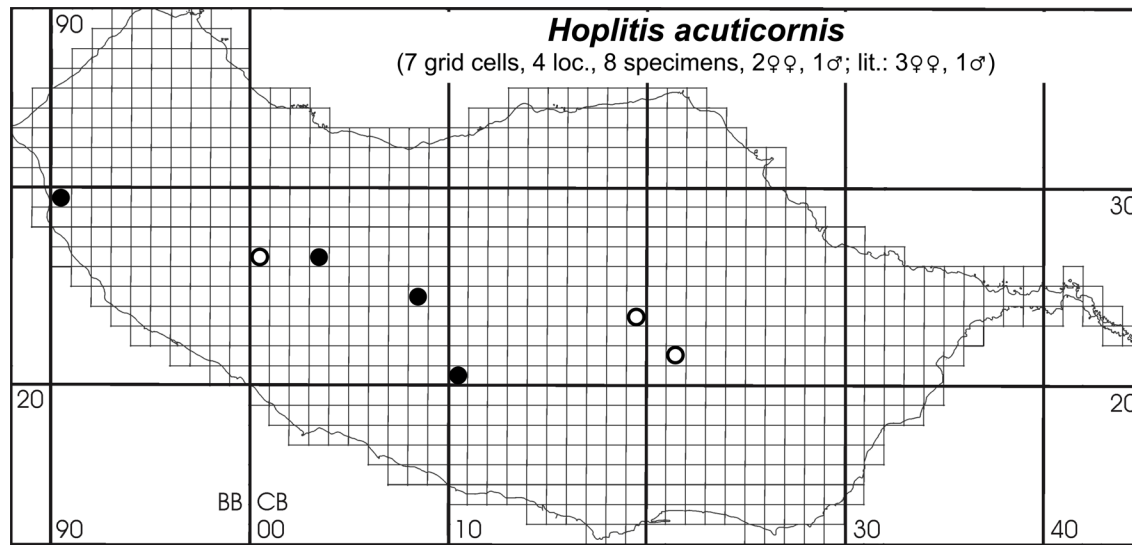


Fig. 37 – Detections of *Hoplitis acuticornis* (black dots: authors' data and checked specimens of collections; circles: literature data).

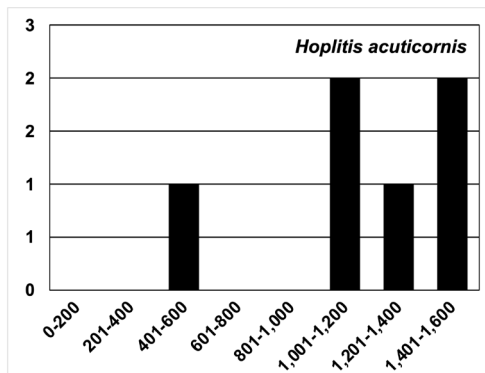


Fig. 38 – Number of localities with *Hoplitis acuticornis* detections per altitude level (m a.s.l.).

Table 16 – Presence of *Hoplitis acuticornis* in square-grid cells of different vegetation series.

Vegetation series	Presence %	absolute
May-Ol	a	-
Hel-Si	b	-
Sem-Ap 1	c	-
Sem-Ap 2	d	2%
Cle-Oc	e	2%
Pol-Er	f	13%
Arm-Pa	g	2

Megachile (Eutricharea) pusilla Pérez, 1844

- **Status:** Introduced.
- **Literature:** KRATOCHWIL *et al.* (2018).
- **Specimens analysed:** 1♂.
- **Distribution, habitat characteristics, and flower-visiting behaviour** (Fig. 39): M. Andrade collected 1♂

on flowers of the cultivated *Chamaesyce hypericifolia* (Euphorbiaceae, 11.09.2017, central municipal gardens Funchal, 32° 38' 52.05" N, 16° 54' 40.07" W, 28 m a.s.l.). The locality corresponds to the Mediterranean macrobioclimate, inframediterranean dry series (May-Ol). There is no indication that this wild bee species established populations on Madeira Island.

Megachile (Megachile) versicolor Smith, 1844

- **Status:** Introduced?.
- **Literature:** ALFKEN (1940), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).
- **Specimens analysed:** 3♀♀, 4♂♂.
- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 40 and 41, Table 17): There are only observations of flower visits of 2♂♂: *Oenanthe divaricata* (Apiaceae), *Echium candicans* (Boraginaceae). According to SCHEUCHL & WILLNER (2016), the species is polylectic in Central Europe.
- **Flight time:** The species was observed in July and August.

- **Data from the authors** (3♀♀, 2♂♂): *cJS*: 2♂♂, Parque Ecológico, near Poço da Neve, 1,634 m a.s.l., 32° 43' 32.87" N, 16° 55' 29.69" W, 11.07.1997, leg. J. Smit; 3♀♀, Parque Ecológico, near Poço da Neve, 1,634 m a.s.l., 32° 43' 32.87" N, 16° 55' 29.69" W, 11.07.1997, leg. J. Smit.

- **Further checked data** (2♂♂): Boieiro, M.: 1♂, Folhadal, 948 m a.s.l., 32° 45' 32.56" N, 17° 01' 23.81" W, July 2017, leg. M. Boieiro; 1♂, Pico do Areeiro, 1,800 m a.s.l., 32° 43' 8" N, 16° 54' 31" W, July 2017, leg. M. Boieiro.

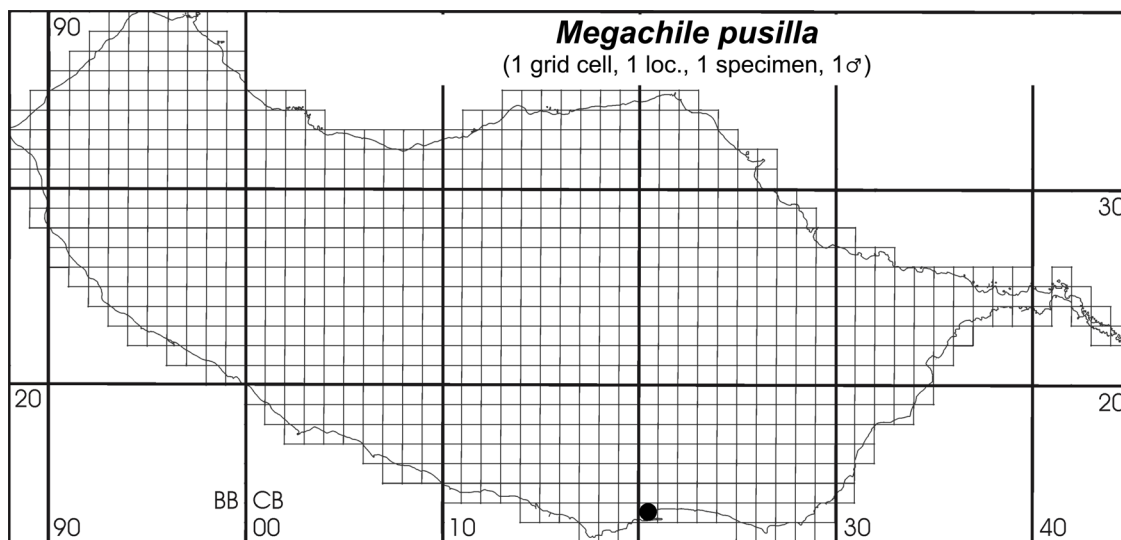


Fig. 39 – Detection of *Megachile pusilla* (black dot: data of M. Andrade, checked by C. Praz).

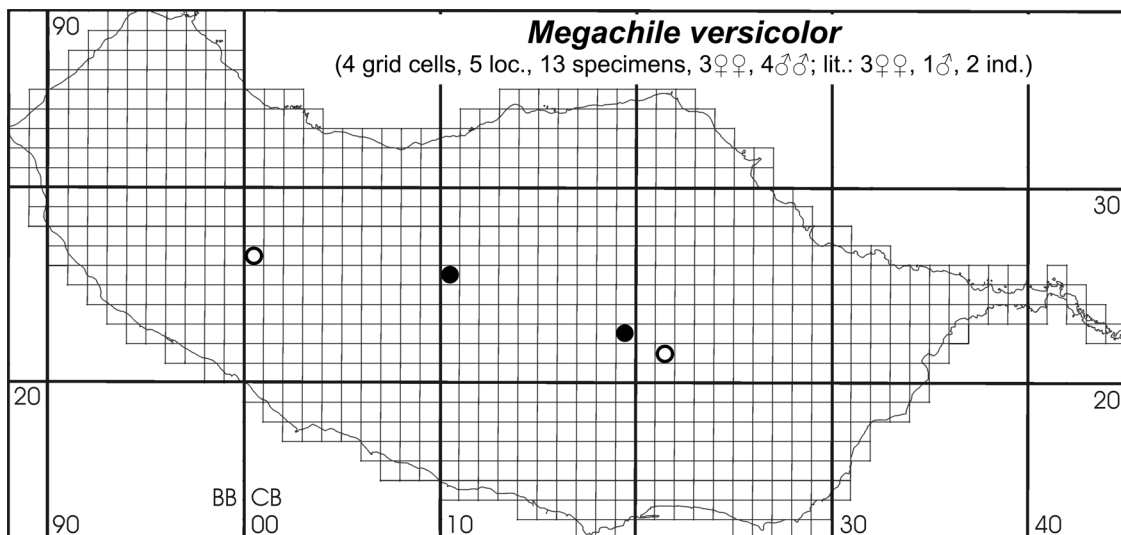


Fig. 40 – Detections of *Megachile versicolor* (black dots: authors' data and checked specimens; circles: literature data).

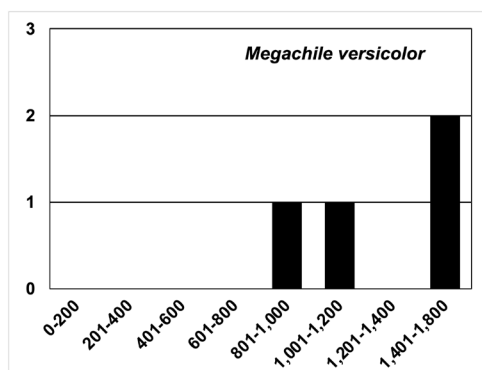


Fig. 41 – Number of localities with *Megachile versicolor* detections per altitude level (m a.s.l.).

Table 17 – Presence of *Megachile versicolor* in square-grid cells of different vegetation series.

Vegetation series	Presence % absolute
May-Ol	a -
Hel-Si	b -
Sem-Ap 1	c -
Sem-Ap 2	d -
Cle-Oc	e 1%
Pol-Er	f 6%
Arm-Pa	g 2

- **Data from literature** (3♀, 1♂, 2 ind.): ALFKEN (1940): 3♀, 1♂, Rabaçal, 1,066 m *a.s.l.*, 32° 45' 39.71" N, 17° 08' 4.78" W, 17.07.-04.08.1935, leg. O. Lundblad; COSTA (2019): 1 ind., Pico do Areeiro, 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W, leg. R. Costa; 1 ind., Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa.

Osmia (Helicosmia) madeirensis Van der Zanden, 1991

- **Status:** Endemic to Madeira Island (Figs. 42 and 43).
 - **Literature:** VAN DER ZANDEN (1983), VAN DER ZANDEN (1991), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).
 - **Specimens analysed:** 87♀, 57♂.
 - **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 44 and 45, Tables 18 and 19): *Osmia madeirensis* shows an especially high presence in the lower subhumid vegetation series b). It is mainly the Mediterranean series [a) to d)] that is populated. Coastal rocks and ruderal sites, including fallows and road margins, are the main habitats. *Osmia madeirensis* shows a preference for Asteraceae (five plant families were recorded overall, but nearly only Asteraceae for females). Endemic (*Andryala glandulosa* subsp. *glandulosa*) and native plant species (e.g., *Crepis vesicaria*, *Leontodon taraxacoides* subsp. *longirostris*) play an important role as pollen and nectar resources in the coastal-rock sites. Further species such as *Galactites tomentosa*, *Sonchus asper*, and *S. oleraceus* are used in ruderal sites.

- **Flight time:** Flight-activity data exist from February (first observation 5th February) to July (latest observation 16th July), with high abundances in May and April.



Fig. 42 – *Osmia madeirensis* (female), collecting pollen on the introduced plant species *Hypochoeris radicata* (above Porto Moniz, 28.03.2022; [vegetation series e]). Photo A. Kratochwil.



Fig. 43 – *Osmia madeirensis* (female, sideview) with antlerlike structures on the broad plate of the insect's head ('clypeus'); same site and date as Fig. 42. Photo A. Kratochwil.

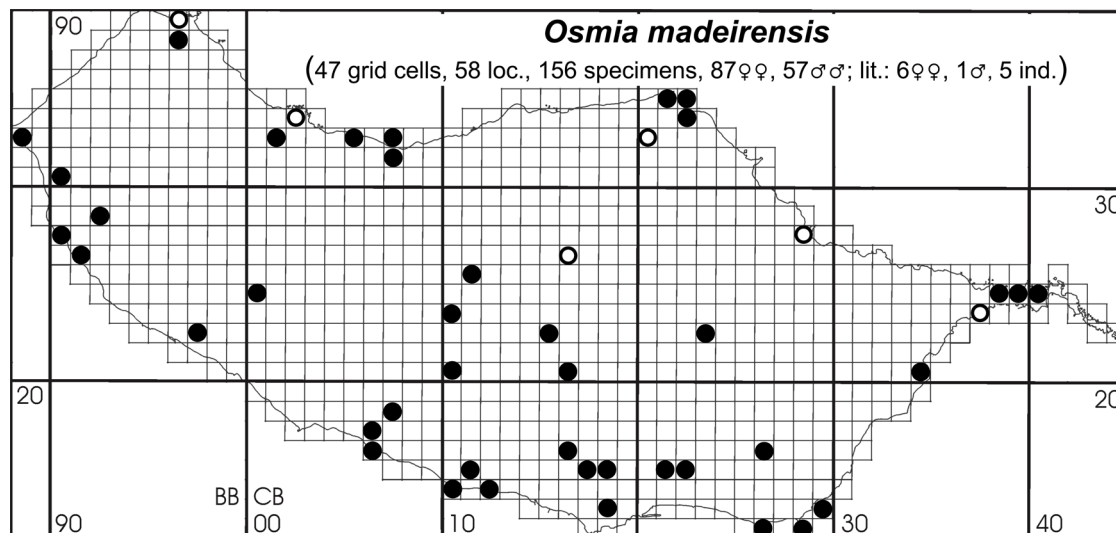


Fig. 44 – Detections of *Osmia madeirensis* (black dots: authors' data, checked specimens of collections; circles: literature data).

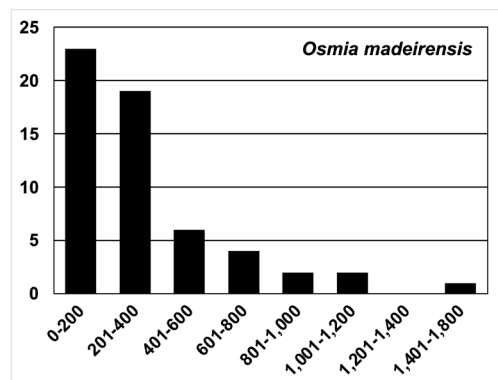


Fig. 45 – Number of localities with *Osmia madeirensis* detections per altitude level (m a.s.l.).

Table 18 – Presence of *Osmia madeirensis* in square-grid cells of different vegetation series.

Vegetation series	Presence %
May-Ol a	29%
Hel-Si b	53%
Sem-Ap 1 c	32%
Sem-Ap 2 d	20%
Cle-Oc e	10%
Pol-Er f	6%
Arm-Pa g	-

Table 19 – Plant-species spectrum visited by *Osmia madeirensis*.

Plant species, plant families	Status	n
<i>Andryala glandulosa</i> subsp. <i>glandulosa</i>	Ast end	8♀♀, 1♂
<i>Argyranthemum pinnatifidum</i> s.l.	Ast end	1♂
<i>Calendula arvensis</i>	Ast nat	1♂
<i>Calendula maderensis</i>	Ast end	1♂
<i>Calendula officinalis</i>	Ast intr	1♀
<i>Crepis andryaloides</i>	Ast end	1♂
<i>Crepis vesicaria</i>	Ast nat	6♀♀, 4♂♂
<i>Galactites tomentosa</i>	Ast nat	11♀♀, 6♂♂
<i>Gazzania</i> sp.	Ast intr	1♂
<i>Helichrysum foetidum</i>	Ast intr	1♀
<i>Helminthotheca echioides</i>	Ast nat?	2♀♀
<i>Hypochoeris radicata</i>	Ast intr	1♀
<i>Leontodon taraxacoides</i> subsp. <i>longirostris</i>	Ast nat	14♀♀, 10♂♂
<i>Sonchus asper</i>	Ast nat?	1♀
<i>Sonchus oleraceus</i>	Ast nat?	4♀♀, 2♂♂
<i>Sonchus</i> sp.	Ast -	1♂
<i>Urospermum picroides</i>	Ast nat?	3♀♀
<i>Echium plantagineum</i>	Bor nat	1♂
<i>Raphanus r.</i> subsp. <i>raphanistrum</i>	Bra nat	1♂
<i>Bituminaria bituminosa</i>	Fab nat	1♀,♂
<i>Rubus ulmifolius</i>	Ros nat	1♂

- **Data from the authors** (74♀♀, 47♂♂): **cAK** (46♀♀, 32♂♂): 1♀, 1♂, Ponta de São Lourenço, above Ponta do Buraco, 71 m a.s.l., 32° 44' 35.16" N, 16° 42' 01.06" W, 10.04.1995, leg. K/S; 3♀♀, Ponta da Oliveira, Caniço de Baixo, 22 m a.s.l., 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 1♀, Ponta da Oliveira, Caniço de Baixo, 22 m a.s.l., 32° 38' 28.16" N, 16° 49' 53.02" W, 24.03.2005, leg. K/S; 1♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m a.s.l., 32° 40' 09.25" N, 17° 03' 46.32" W, 25.03.2005, leg. K/S; 1♂, Ponta da Oliveira, Caniço de Baixo, 22 m a.s.l., 32° 38' 28.16" N, 16° 49' 53.02" W, 26.03.2005, leg. K/S; 1♀, 3♂♂, Serra de Água, lookout point, 465 m a.s.l., 32° 43' 50.79" N, 17° 01' 26.59" W, 27.03.2005, leg. K/S; 1♂, Eirinha above Serra de Água, 506 m a.s.l., 32° 43' 54.22" N, 17° 01' 30.19" W, 27.03.2005, leg. K/S; 3♂♂, Cabo Girão, S Quinta Grande, 603 m a.s.l., 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, leg. K/S; 1♂, Fajã dos Padres, W Quinta Grande, 325 m a.s.l., 32° 39' 21.12" N, 17° 01' 04.44" W, 28.03.2005, leg. K/S; 1♀, 1♂, Câmara do Bispo, S Quinta Grande, 316 m a.s.l., 32° 39' 17.50" N, 17° 01' 02.02" W, 28.03.2005, leg. K/S; 1♀, Fajã dos Padres, W Quinta Grande, 325 m a.s.l., 32° 39' 21.12" N, 17° 01' 04.44" W, 28.03.2005, leg. K/S; 1♂, Ponta da Garajau, S Caniço, 112 m a.s.l., 32° 38' 18.33" N, 16° 51' 02.84" W, 29.03.2005, leg. K/S; 1♂, W Ponta do Garajau, S Caniço, 82 m a.s.l., 32° 38' 23.20" N, 16° 51' 13.01" W, 30.03.2005, leg. K/S; 1♂, Ponta da Garajau, S Caniço, 112 m a.s.l., 32° 38' 18.33" N, 16° 51' 02.84" W, 01.04.2005, leg. K/S; 11♀♀, 3♂♂, Ribeira Brava in front of tunnel entrance, 44 m a.s.l., 32° 40' 29.71" N, 17° 03' 51.75" W, 02.04.2005, leg. K/S; 2♂♂, Ponta do Pargo, near lighthouse, 345 m a.s.l., 32° 48' 50.16" N, 17° 15' 30.24" W, 03.04.2005, leg. K/S; 2♀♀; E Ribeira da Janela, old road between Ribeira da Janela – Ribeiro Escuro, 17 m a.s.l., 32° 48' 59.01" N, 17° 05' 4.72" W, 03.04.2005, leg. K/S; 1♂, W S. Vicente, old road between Ribeiro do Inferno – Ribeiro dos Caimbos, 10 m a.s.l., 32° 48' 33.51" N, 17° 03' 24.31" W, 03.04.2005, leg. K/S; 1♂, E Seixal, old road between Ilhéu das Ceroulas – Ribeira de João Delgado, 51 m a.s.l., 32° 48' 37.15" N, 17° 03' 37.41" W, 03.04.2005, leg. K/S; 9♂♂, W S. Vicente, ER 101, Fajã do Rente, 75 m a.s.l., 32° 48' 29.57" N, 17° 03' 05.00" W, 03.04.2005, leg. K/S; 1♀, Ponta da Oliveira, Caniço de Baixo, 22 m a.s.l., 32° 38' 28.16" N, 16° 49' 53.02" W, 03.04.2005, leg. K/S; 15♀♀, Ponta de São Lourenço, 101 m a.s.l., 32° 44' 44.01" N, 16°43'20.74"W, 04.04.2005, leg. K/S; 7♀♀, Ponta dos Reis Magos, SE Caniço, 14 m a.s.l., 32° 38' 55.50" N, 16° 49' 22.06" W, 04.04.2005, leg. K/S; 1♂, Ponta S. Jorge, viewpoint above Barranco, 295 m a.s.l., 32° 50' 03.02" N, 16° 54' 41.05" W, 06.04.2005, leg. K/S; 1♀, above P. Moniz, 379 m a.s.l., 32° 51' 40.5" N, 17° 10' 32.2" W, 28.03.2022, leg. K/S; 1♀, Funchal, Jardim Botânico, 281 m a.s.l., 32° 39' 45.9" N, 16° 53' 47.2" W, 29.03.2022, leg. K/S. **cFA** (3♀♀, 1♂): 2♀♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m a.s.l., 32° 40' 09.25" N, 17° 03' 46.32" W, 30.04.1989, leg. F. Aguiar; 1♂, Ribeira das Galinhas, Paúl do Mar, 50 m a.s.l., 32° 45' 58.86" N, 17° 14' 09.35" W, 01.04.2004, leg. Aguiar / Jesus;

1♀, Farol, Ponta do Pargo, 248 m *a.s.l.*, 32° 48' 39.26" N, 17° 15' 34.01" W, 08.06.2004, leg. Aguiar / Jesus. **cJS** (21♀♀, 14♂♂): 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 10.07.1997, leg. J. Smit; 1♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 1♀, 1♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 01.04.1998, leg. J. T. Smit; 2♂♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 03.04.1998, leg. J. T. Smit; 1♀, 1♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 17.04.1998, leg. J. T. Smit; 2♀♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 25.04.1998, leg. J. T. Smit; 2♀♀, Água de Pena, 57 m *a.s.l.*, 32° 42' 33.48" N, 16° 45' 44.40" W, 03.05.1998, leg. J. Smit; 4♀♀, 3♂♂, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♂, Lombada do Loreto, NE Arco de Calheta, 358 m *a.s.l.*, 32° 43' 12.71" N, 17° 09' 35.85" W, 05.05.1998, leg. J. T. Smit; 1♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 12.05.1998, leg. J. T. Smit; 4♂♂, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 19.05.1998, leg. J. T. Smit; 1♂, Chão da Ribeira, Seixal, 433 m *a.s.l.*, 32° 48' 33.25" N, 17° 06' 55.52" W, 19.05.1998, leg. J. T. Smit; 5♀♀, Ribeira Brava, 125 m *a.s.l.*, 32° 40' 32.04" N, 17° 03' 55.92" W, 21.05.1998, leg. J. T. Smit; 3♀♀, Santa Quitéria, W São Martinho, 195 m *a.s.l.*, 32° 38' 45.89" N, 16° 56' 24.79" W, 31.05.1998, leg. J. T. Smit; 1♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 07.06.1998, leg. J. T. Smit. **oFA** (4♀♀): 1♀, Lombada dos Marinheiros, gravel road, 683 m *a.s.l.*, 32° 47' 28.88" N, 17° 13' 57.09" W, 08.06.2004, obs. F. Aguiar; 1♀, Ponta de São Lourenço, 500 m NW Prainha beach, 71 m *a.s.l.*, 32° 44' 42.83" N, 16° 43' 08.52" W, 19.04.2007, obs. F. Aguiar; 2♀♀, Farol to Cais de S. Jorge, 80 m *a.s.l.*, 32° 50' 00.03" N, 16° 54' 03.87" W, 21.06.2007, obs. F. Aguiar.

- **Data from collections** (13♀♀, 10♂♂): **ICLAM** (7♀♀, 4♂♂): 1♂, Ribeira das Galinhas, Paúl do Mar, 50 m *a.s.l.*, 32° 45' 58.86" N, 17° 14' 09.35" W, 01.04.2004, leg. J. Jesus; 2♀♀, Farol, Ponta do Pargo, 248 m *a.s.l.*, 32° 48' 39.26" N, 17° 15' 34.01" W, 08.06.2004, leg. Aguiar / Jesus; 1♀, Eira do Serrado, Pico do Serrado, 955 m *a.s.l.*, 32° 42' 25.14" N, 16° 57' 35.72" W, 17.06.2004, leg. Aguiar / Jesus; 1♀, Ribeirinha, Camacha, 649 m *a.s.l.*, 32° 40' 20.95" N, 16° 50' 50.97" W, 05.05.2005, leg. Aguiar / Jesus; 1♀, Prainha, Ponta de São Lourenço, Caniçal, 71 m *a.s.l.*, 32° 44' 42.83" N, 16° 43' 08.52" W, 26.04.2007, leg. Aguiar / Jesus; 1♂, Ribeiro Frio, garden, 1,166 m *a.s.l.*, 32° 43' 47.70" N, 16° 53' 01.23" W, 17.05.2007, leg. Aguiar / Jesus; 2♀♀, Farol to Cais de S. Jorge, 30 m *a.s.l.*, 32° 49' 49.90" N, 16° 53' 56.05" W, 21.06.2007, leg. J. Jesus; 1♂, Cabo Girão, 526 m *a.s.l.*, 32° 39' 24.19" N, 17° 0' 10.58" W, 16.04.2008, leg. C. Brazão; 1♂, Caminho de São Lourenço, 1.85 km NE Fajã da Ovelha church, 773 m *a.s.l.*, 32° 46' 47.02" N, 17° 12' 45.08" W, 19.05.2011, leg. F. Aguiar. **OLML** (3♀♀, 2♂♂): 1♀,

Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 02.05.??, leg. R. Storå; 2♀♀, 1♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 15.03.1989, leg. J. A. W. Lucas; 1♂, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 13.03.1989, leg. J. A. W. Lucas. **UMB** (2♀♀, 4♂♂): 1♂, Boca da Encumeada – Boca dos Corgos, 993 m *a.s.l.*, 32° 45' 15.52" N, 17° 01' 7.80" W, 30.05.1987, leg. W. Barkemeyer; 1♀, 2♂♂, Jardim do Mar, 50 m *a.s.l.*, 32° 44' 18.64" N, 17° 12' 40.44" W, 02.04.1994, leg. H. Hohmann; 1♂, Curral das Freiras, 600 m *a.s.l.*, 32° 43' 11.82" N, 16° 58' 0.66" W, 13.04.1994, leg. H. Hohmann; 2♀♀, Ribeira Brava, 50 m *a.s.l.*, 32° 41' 6.29" N, 17° 3' 5.38" W, 11.04.1994, leg. H. Hohmann.

- **Data from literature** (6♀♀, 1♂, 5 ind.): VAN DER ZANDEN (1983): 1♀, 1♂, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 10.04.1970, leg. G. van der Zanden; VAN DER ZANDEN (1991): 4♀♀, Caniçal, 33 m *a.s.l.*, 32° 44' 20.68" N, 16° 44' 17.61" W, 28.05.1989, leg. H. G. Teunissen; 1♀, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 10.04.1970, leg. W. Hoogenes; FELLENDORF *et al.* (1999), 1 ind., Port Moniz, 40 m *a.s.l.*, 32° 52' 0.06" N, 17° 10' 14.19" W, leg. Fellendorf *et al.*; 1 ind., Seixal, 115 m *a.s.l.*, 32° 49' 26.41" N, 17° 6' 33.53" W, leg. Fellendorf *et al.*; 1 ind., Caniço, 164 m *a.s.l.*, 32° 38' 53.92" N, 16° 50' 8.73" W, leg. Fellendorf *et al.*; 1 ind., Porto da Cruz, 147 m *a.s.l.*, 32° 45' 51.09" N, 16° 49' 41.74" W, leg. Fellendorf *et al.*; 1 ind., João Frino, 1,589 m *a.s.l.*, 32° 45' 38.56" N, 16° 57' 34.09" W, leg. Fellendorf *et al.* Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 5 ind.).

***Osmia (Helicosmia) niveata* (Fabricius, 1804)**

- **Status:** Native (Fig. 46).

- **Literature:** FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).



Fig. 46 – *Osmia niveata* (male), taking nectar from the native plant species *Centranthus calcitrapae* (coast E S. Vicente near Fajã da Areia, 27.03.2022); vegetation series d). Photo A. Kratochwil.

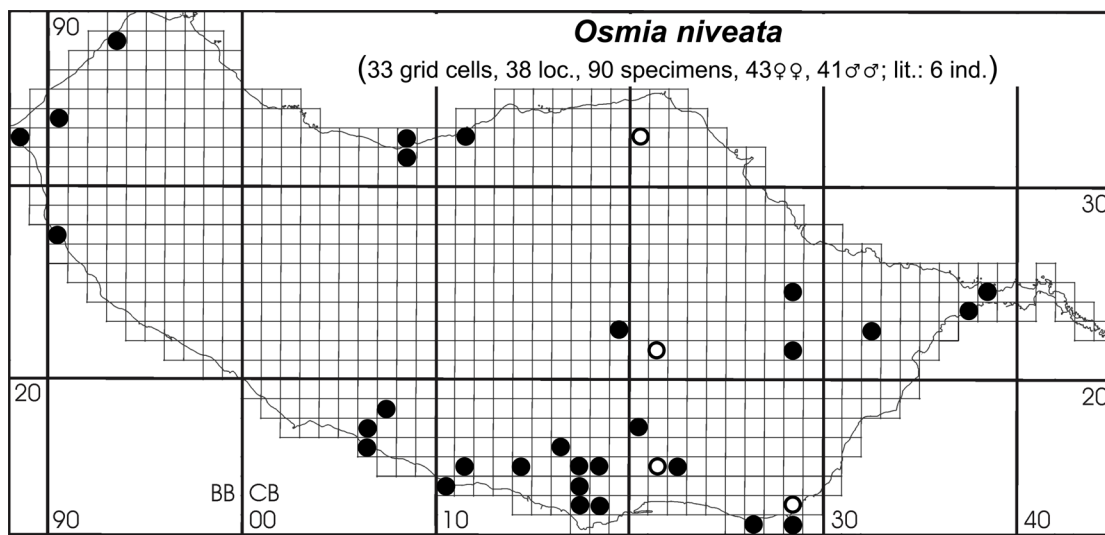


Fig. 47 – Detections of *Osmia niveata* (black dots: authors' data, checked specimens of collections; circles: literature data).

- **Specimens analysed:** 43♀♀, 41♂♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 47 and 48, Tables 20 and 21): *Osmia niveata* occurs mainly in the dry to subhumid vegetation series a), b), c). Ruderal sites are especially characteristic, as are, locally, coastal rocks. The flower resources are nearly exclusively Asteraceae, especially ruderal plant species (e.g., *Galactites tomentosa*). We observed 11 females and 12 males (Table 21). Oligolectic behaviour has been documented in Central Europe (SCHEUCHL & WILLNER, 2016), especially for *Carduoideae* s.l.

- **Flight time:** Flight-activity data exist from February (first observation 7th February) to July (latest observation 9th July), with high abundances in March and April.

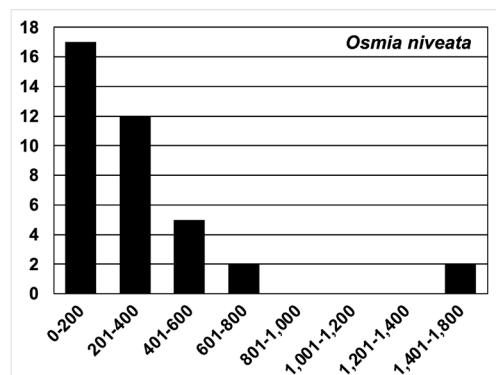


Fig. 48 – Number of localities with *Osmia niveata* detections per altitude level (m a.s.l.).

Table 20 – Presence of *Osmia niveata* in square-grid cells of different vegetation series.

Vegetation series	Presence %, absolute
May-Ol	a 24%
Hel-Si	b 41%
Sem-Ap 1	c 32%
Sem-Ap 2	d 13%
Cle-Oc	e 2%
Pol-Er	f 6%
Arm-Pa	g 1

Table 21 – Plant-species spectrum visited by *Osmia niveata*.

Plant species, plant families	Status	n
<i>Andryala</i> sp.	Ast -	1♂
<i>Bidens pilosa</i>	Ast intr	1♂
<i>Calendula officinalis</i>	Ast intr	1♂
<i>Crepis andryaloides</i>	Ast end	1♂
<i>Crepis vesicaria</i>	Ast nat	2♂♂
<i>Galactites tomentosa</i>	Ast nat	9♀♀, 1♂
<i>Leontodon taraxacoides</i> subsp. <i>longirostris</i>	Ast nat	2♀♀
<i>Sonchus asper</i>	Ast nat?	2♂♂
<i>Echium nervosum</i>	Bor end	2♂♂
<i>Centhrantus calcitrapae</i>	Val nat	1♂

- **Data from the authors** (30♀♀, 31♂♂): **cAK** (11♀♀, 16♂♂): 2♀♀, Arco da Calheta, ER 101, 333 m *a.s.l.*, 32° 42' 22.13" N, 17° 08' 22.47" W, 08.04.1995, leg. K/S; 2♀♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 1♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 25.03.2005, leg. K/S; 2♂♂, Ponta de São Lourenço, 101 m *a.s.l.*, 32° 44' 44.01" N, 16° 43' 20.74" W, 26.03.2005, leg. K/S; 2♂♂, Ribeira Brava in front of tunnel entrance, 44 m *a.s.l.*, 32° 40' 29.71" N, 17° 03' 51.75" W, 27.03.2005, leg. K/S; 2♀♀, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, leg. K/S; 1♀, Câmara do Bispo, S Quinta Grande, 316 m *a.s.l.*, 32° 39' 17.50" N, 17° 01' 02.02" W, 28.03.2005, leg. K/S; 4♀♀, Funchal, in front of Jardim Botânico, 277 m *a.s.l.*, 32° 39' 41.27" N, 16° 53' 41.25" W, 30.03.2005, leg. K/S; 1♂, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 30.03.2005, leg. K/S; 1♂, Ponta do Garajau, S Caniço, 112 m *a.s.l.*, 32° 38' 18.33" N, 16° 51' 02.84" W, 02.04.2005, leg. K/S; 1♂, Archadas da Cruz, Miradouro Vereda do Calhau, 470 m *a.s.l.*, 32° 51' 07.88" N, 17° 12' 36.20" W, 03.04.2005, leg. K/S; 4♂♂, E S. Vicente, near Fajã da Areia, 21 m *a.s.l.*, 32° 48' 40.3" N, 17° 02' 34.4" W, 27.03.2022, leg. K/S; 1♂, below leftside valley of S. Vicente, 54 m *a.s.l.*, 32° 48' 16.4" N, 17° 02' 51.4" W, 27.03.2022, leg. K/S; 1♂, E S. Vicente, near Fajã da Areia, 22 m *a.s.l.*, 32° 48' 40.3" N, 17° 02' 34.4" W, 28.03.2022, leg. K/S; 1♂, Funchal, Jardim Botânico, 281 m *a.s.l.*, 32° 39' 45.9" N, 16° 53' 47.2" W, 29.03.2022, leg. K/S; 1♂, W Miradouro Quebradas, 33 m *a.s.l.*, 32° 49' 02.1" N, 17° 00' 45.3" W, 31.03.2022, leg. K/S. **cFA**: 1♀, Preces, Câmara de Lobos, 179 m *a.s.l.*, 32° 39' 37.11" N, 16° 58' 49.56" W, 09.03.2000, leg. Aguiar / Jesus. **cJS** (18♀♀, 15♂♂): 2♀♀, Funchal, Jardim Botânico, 264 m *a.s.l.*, 32° 39' 43.23" N, 16° 53' 48.10" W, 09.07.1997, leg. J. Smit; 5♂♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 07.02.1998, leg. J. T. Smit; 2♀♀, 1♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 16.02.1998, leg. J. T. Smit; 1♀, 1♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 21.02.1998, leg. J. T. Smit; 1♀, 1♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 24.02.1998, leg. J. T. Smit; 3♀♀, 2♂♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 01.03.1998, leg. J. T. Smit; 1♀, 1♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 07.03.1998, leg. J. T. Smit; 1♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 01.04.1998, leg. J. T. Smit; 4♀♀, 1♂, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 03.04.1998, leg. J. T. Smit; 1♂, Boa Morte, 483 m *a.s.l.*, 32° 49' 08.83" N, 17° 14' 13.73" W, 05.05.1998, leg. J. Smit; 1♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♀, 2♂♂, Paúl do Mar, 150 m *a.s.l.*, 32° 45' 59.16" N, 17° 13' 59.29" W, 05.05.1998, leg. J. Smit; 1♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 19.05.1998, leg. J. T. Smit.

- **Data from collections** (13♀♀, 9♂♂): **ICLAM**: 1♀, Cabo Girão, above car parking, 587 m *a.s.l.*, 32° 39' 24.92" N, 17° 00' 23.10" W, 09.05.2002, leg. Aguiar / Jesus. **MZHF** (9♀♀, 7♂♂): 1♂, Funchal, Santo Amaro – Fajã, 300 m *a.s.l.*, 32° 39' 25.20" N, 16° 56' 38.40" W, 19.04.1995, leg. M. Koponen; 1♂, São Martinho, 184 m *a.s.l.*, 32° 38' 39.78" N, 16° 56' 29.68" W, 12.03.1980, leg. M. Koponen; 9♀♀, 5♂♂, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 31.20" N, 16° 56' 16.80" W, 22.03.1980, leg. M. Koponen. **UMB** (3♀♀, 1♂): 1♀, 1♂, Corujeira, 550 m *a.s.l.*, 32° 40' 36.74" N, 16° 54' 38.12" W, 14.03.1989, leg. J. A. W. Lucas; 1♀, Machico, 230 m *a.s.l.*, 32° 43' 54.41" N, 16° 47' 28.76" W, 14.05.1989, leg. J. A. W. Lucas; 1♀, Ribeira Brava, Miradouro, 59 m *a.s.l.*, 32° 40' 10.85" N, 17° 03' 45.66" W, 10.04.1994, leg. H. Hohmann; 1♂, Ribeira Brava, 115 m *a.s.l.*, 32° 41' 31.56" N, 17° 02' 54.60" W, 31.03.1994, leg. H. Hohmann.

- **Data from literature** (6 ind.): COSTA (2019): 1 ind., Pico do Areeiro, 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W, leg. R. Costa; 1 ind., Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W; FELLENDORF *et al.* (1999): 1 ind., Caniço, 164 m *a.s.l.*, 32° 38' 53.92" N, 16° 50' 8.73" W, leg. Fellendorf *et al.*; 1 ind. Caniçal, 33 m *a.s.l.*, 32° 44' 20.68" N, 16° 44' 17.61" W, leg. Fellendorf *et al.*; 1 ind., Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, leg. Fellendorf *et al.*, 1 ind., Reis Magos, 20 m *a.s.l.*, 32° 38' 50.17" N, 16° 49' 29.19" W. leg. Fellendorf *et al.* Due to the lack of differentiation (number of individuals per locality, characterisation 'female, male'), only one individual is counted per locality (n = 4 ind.).

- **Further checked data**: Santos, R.: 1♂, Portela, 640 m *a.s.l.*, 32° 48' 29.79" N, 16° 51' 56.77" W, 03.07.2017, leg. R. Santos.

***Stelis (Stelis) ornatula* (Klug, 1807)**

- **Status**: Introduced.

- **Literature**: FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).

- **Specimens analysed**: 1♀.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Fig. 49): *Stelis ornatula* has so far been found only in one grid cell (1♀, Fontes, 1,200 m *a.s.l.*, 16.07.1997, leg. J. Smit); see comments on *Hoplites acuticornis*.

Anthophoridae

***Amegilla (Amegilla) quadrifasciata maderae* (Sichel 1868)**

- **Status**: Subspecies endemic to the Madeira Archipelago. A differentiation as a subspecies seems

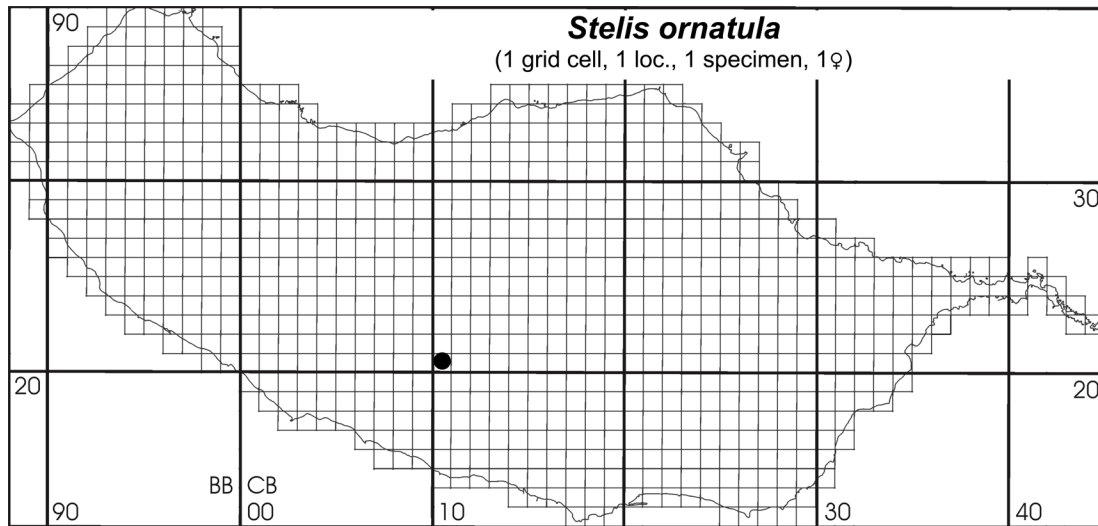


Fig. 49 – Detection of *Stelis ornatula* (black dot: data of J. Smit).

justified due to the characteristic morphological features; molecular investigations are in progress (Kratochwil, *in prep.*). Figs. 50-52.

- **Literature:** SICHEL (1867), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).

- **Specimens analysed:** 102♀♀, 67♂♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 53 and 54, Tables 22 and 23): *Amegilla q. maderae* is a typical bee species mainly of the dry, lower subhumid vegetation series [a), b)]. Some observations were also made at higher altitudes. Intensive flower visits were observed on the two *Echium* species: *E. plantagineum* and especially *E. nervosum*. Coastal rocky sites with *E. nervosum* are very typical habitats. The same is true for *E. nervosum* planted in gardens or near roads. The endemic *E. nervosum* is an extraordinary important pollen and nectar resource for this polylectic species. On Porto Santo, *E. nervosum* is also a key species for *A. q. maderae*. In the higher mountains, the species has been detected visiting the endemic *E. candicans* (restoration site with microclimatic favourable conditions, COSTA, 2019). All in all, the polylectic species visited flowers of nine plant families. HERRERA (1990) found a flower visitation rate of 29.6 flowers per minute for *A. quadrifasciata* (*Lavandula latifolia* in southern Spain). The species' fast flight, regular approach to single flowering plants within a collecting home range, and its hovering in front of the flowers (Fig. 50) are remarkable. The males patrol the flowers and nesting sites in search of females.

In Central Europe (SCHEUCHL & WILLNER, 2016) as well as on the Canary Islands, *A. quadrifasciata* s.l. is a polylectic species. In the Canary Islands, HOHMANN *et al.* (1993); BECERRA

(1992); GARCÍA (2000) found 18 plant families visited by this wild bee species.

- **Flight time and nesting sites:** *A. q. maderae* flies year-round. We have detections from all months except October and November. These exceptions are probably due to a lack of collecting activity. Often, the endogamic colonies of *A. q. maderae* are found close to *E. nervosum* stands in the cliff areas. Near Ribeira Brava, particularly high flight activity was observed by the authors at nesting sites (05.04.1995, 29.12.2006). It was also observed in May and September (FELLENDORF *et al.*, 1999). Numerous nests were found on eroded paths (Fig. 52).

There is one observation of a sleeping aggregation (males) in Madeira Island (publication in preparation).

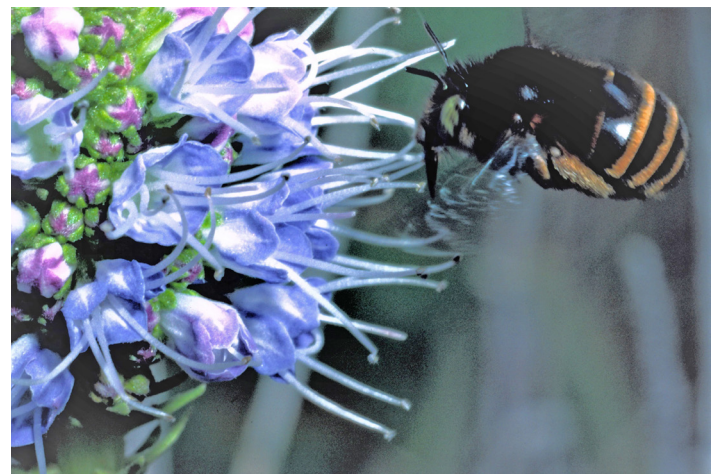


Fig. 50 – *Amegilla quadrifasciata maderae* (female), with a humming bird-like approach to *Echium nervosum* flowers. Ribeira Brava, Miradouro do Pico da Cruz, 25.03.2005; vegetation series a). Photo A. Kratochwil.



Fig. 51 – *Amegilla quadrifasciata maderae* (female): flower visit to *Echium nervosum*. Ponta de São Lourenço, coastal rocky site, 02.04.2022; vegetation series b). Photo A. Kratochwil.

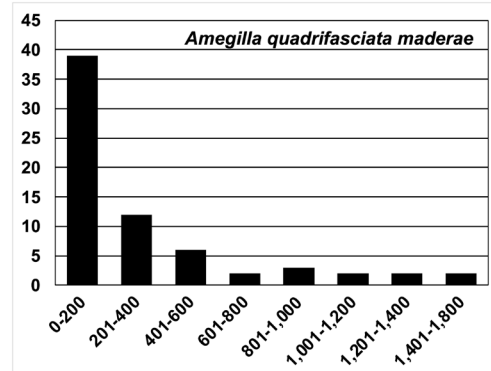


Fig. 54 – Number of localities with *Amegilla quadrifasciata maderae* detections per altitude level (m a.s.l.).



Fig. 52 – Nesting site of *Amegilla quadrifasciata maderae* in December. Overlook (the line marks the micro area of nesting holes) and inset picture of one hole. Ribeira Brava, Miradouro do Pico da Cruz, 29.12.2006; vegetation series a). Photo: A. Schwabe.

Table 22 – Presence of *Amegilla quadrifasciata maderae* in square-grid cells of different vegetation series.

Vegetation series	Presence %	Presence, absolute
May-Ol	a	71%
Hel-Si	b	59%
Sem-Ap 1	c	21%
Sem-Ap 2	d	30%
Cle-Oc	e	8%
Pol-Er	f	13%
Arm-Pa	g	1

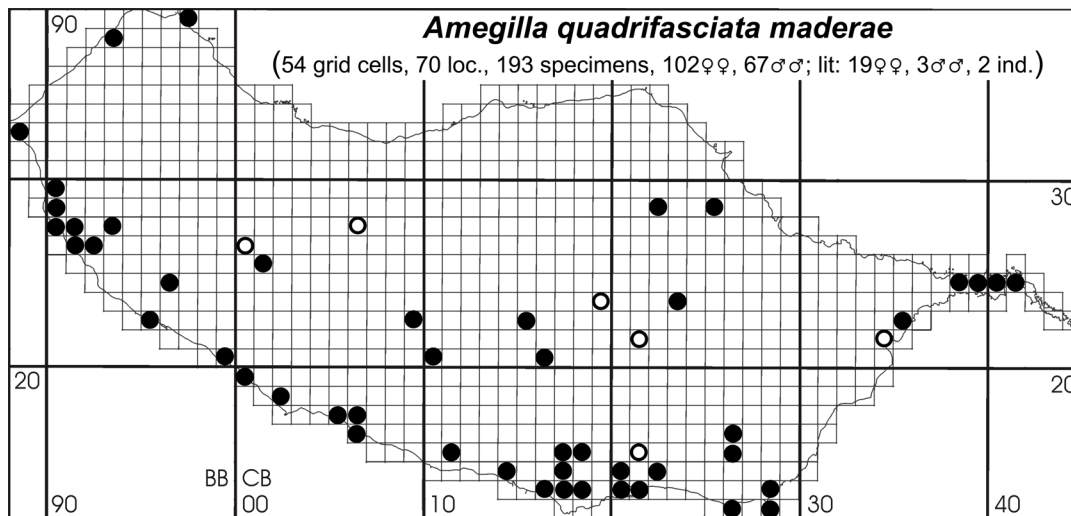


Fig. 53 – Detections of *Amegilla quadrifasciata maderae* (black dots: authors' data, checked specimens of collections; circles: literature data).

Table 23 – Plant-species spectrum visited by *Amegilla quadrifasciata maderae*.

Plant species, plant families	Status	n
<i>Aptenia cordifolia</i>	Aiz nat	1 ♀
<i>Carlina salicifolia</i>	Ast mac	1 ♀
<i>Galactites tomentosa</i>	Ast nat	2 ♀♀, 7 ♂♂
<i>Leontodon taraxacoides</i> subsp. <i>longirostris</i>	Ast nat	1 ♂
<i>Tagetes</i> sp.	Ast intr	1 ♂
<i>Echium candicans</i>	Bor end	3 ♂♂, 2 ind.
<i>Echium nervosum</i>	Bor end	31 ♀♀, 5 ♂♂
<i>Echium plantagineum</i>	Bor nat	6 ♀♀, 1 ♂
<i>Rapistrum rugosum</i> s.l.	Bra nat	2 ♀♀
<i>Sinapidendron angustifolium</i>	Bra end	2 ♀♀
<i>Sechium edule</i>	Cuc int	2 ♀♀
<i>Bituminaria bituminosa</i>	Fab nat	3 ♀♀, 1 ♂
<i>Stachys ocymastrum</i>	Lam nat	4 ♀♀, 4 ♂♂
<i>Misopates orontium</i>	Scr nat	1 ♀
<i>Lantana camara</i>	Ver intr	1 ♂
<i>Verbena bonariensis</i>	Ver intr	1 ♀, 4 ♂♂

- **Data from the authors** (87 ♀♀, 49 ♂♂): **cAK** (39 ♀♀, 17 ♂♂): 1 ♀, 1 ♂, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 02.04.1995, leg. K/S; 1 ♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 05.04.1995, leg. K/S; 1 ♀, 2 ♂♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 05.04.1995, leg. K/S; 1 ♀, Ponta do Garajau, S Caniço, 112 m *a.s.l.*, 32° 38' 18.33" N, 16° 51' 02.84" W, 07.04.1995, K/S; 2 ♂♂, Arco da Calheta, ER 101, 333 m *a.s.l.*, 32° 42' 22.13" N, 17° 08' 22.47" W, 08.04.1995, leg. K/S; 1 ♂, Pico do Facho, Machico, 266 m *a.s.l.*, 32° 43' 22.49" N, 16° 45' 30.60" W, 10.04.1995, leg. K/S; 2 ♂♂, Ponta de São Lourenço, above Ponta do Buraco, 71 m *a.s.l.*, 32° 44' 35.16" N, 16° 42' 01.06" W, 10.04.1995, leg. K/S; 2 ♀♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 11.04.1995, K/S; 1 ♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 1 ♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 25.03.2005, leg. K/S; 3 ♀♀, Cais, E Madalena do Mar, ER 213, 11 m *a.s.l.*, 32° 41' 34.43" N, 17° 07' 29.24" W, 25.03.2005, leg. K/S; 1 ♂, Cais, E Madalena do Mar, ER 213, 11 m *a.s.l.*, 32° 41' 34.43" N, 17° 07' 29.24" W, 25.03.2005, leg. K/S; 2 ♂♂, Câmara do Bispo, S Quinta Grande, 316 m *a.s.l.*, 32° 39' 17.50" N, 17° 01' 02.02" W, 28.03.2005, leg. K/S; 1 ♂, Fajã dos Padres, W Quinta Grande, 325 m *a.s.l.*, 32° 39' 21.12" N, 17° 01' 04.44" W, 28.03.2005, leg. K/S; 1 ♂, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, leg. K/S; 2 ♀♀, W Ponta do Garajau, S Caniço, 82 m *a.s.l.*, 32° 38' 23.20" N, 16° 51' 13.01" W, 30.03.2005, leg. K/S; 1 ♀, W Ribeira Brava, Ribeira da Caldeira, E 213, 37 m *a.s.l.*, 32° 40' 25.21" N, 17° 04' 09.99" W, 02.04.2005, leg. K/S; 2 ♀♀, Reservatório do Paúl do Mar, above

Paúl do Mar, ER 212, 107 m *a.s.l.*, 32° 45' 51.92" N, 17° 13' 50.32" W, 28.12.2006, leg. K/S; 3 ♀♀, petrol station, E Ponta da Sol, 27 m *a.s.l.*, 32° 40' 35.91" N, 17° 04' 36.98" W, 29.12.2006, leg. K/S; 3 ♀♀, Calheta, 38 m *a.s.l.*, 32° 43' 18.43" N, 17° 10' 43.70" W, 03.01.2007, leg. K/S; 1 ♀, E Calheta, above Paúl do Mar, ER 212, 411 m *a.s.l.*, 32° 44' 15.10" N, 17° 10' 15.91" W, 03.01.2007, leg. K/S; 1 ♀, Ribeira das Galinhas, Paúl do Mar, 50 m *a.s.l.*, 32° 45' 58.86" N, 17° 14' 09.35" W, 03.01.2007, leg. K/S; 1 ♀, P. Moniz, 20 m *a.s.l.*, 32° 52' 00.3" N, 17° 09' 58.7" W, 28.03.2022, leg. K/S; 1 ♀, 4 ♂♂, Ribeira Brava, 60 m *a.s.l.*, 32° 40' 11.8" N, 17° 03' 45.5" W, 29.03.2022, leg. K/S; 3 ♀♀, Ribeira Brava, 60 m *a.s.l.*, 32° 40' 11.8" N, 17° 03' 45.5" W, 01.04.2022, leg. K/S; 10 ♀♀, São Lourenço, 54 m *a.s.l.*, 32° 44' 36.5" N, 16° 43' 21.8" W, 02.04.2022, leg. K/S. **cFA** (5 ♀♀, 4 ♂♂): 1 ♂, Pico das Pedras, garden of main house, 924 m *a.s.l.*, 32° 46' 38.50" N, 16° 53' 48.97" W, 14.08.1985, leg. F. Aguiar; 1 ♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 30.04.1989, leg. F. Aguiar; 1 ♀, Achadas da Cruz, Porto Moniz, 514 m *a.s.l.*, 32° 51' 03.74" N, 17° 12' 33.69" W, 19.09.1989, leg. F. Aguiar; 1 ♂, Areiro, São Martinho, 159 m *a.s.l.*, 32° 38' 47.11" N, 16° 57' 26.71" W, 30.03.1992, leg. F. Aguiar; 1 ♀, Areiro, São Martinho, 159 m *a.s.l.*, 32° 38' 47.11" N, 16° 57' 26.71" W, 04.05.1992, leg. F. Aguiar; 1 ♀, Pico da Urze, Paúl da Serra, 1,334 m *a.s.l.*, 32° 44' 57.40" N, 17° 07' 16.04" W, 23.08.1997, leg. F. Aguiar; 1 ♂, Funchal, Lombo da Boa Vista, 176 m *a.s.l.*, 32° 39' 18.97" N, 16° 53' 38.56" W, 15.05.1999, leg. F. Aguiar; 1 ♂, Quebrada, Paúl do Mar, 50 m *a.s.l.*, 32° 45' 11.85" N, 17° 13' 28.74" W, 09.01.2000, leg. Aguiar / Jesus; 1 ♀, Amparo, Funchal, 162 m *a.s.l.*, 32° 38' 44.74" N, 16° 56' 37.06" W, 25.05.2004, leg. J. Jesus; **cJS** (16 ♀♀, 22 ♂♂): 1 ♂, Funchal, 24 m *a.s.l.*, 32° 38' 42.72" N, 16° 54' 49.93" W, 23.02.1995, leg. H. H. Evenhuis; 1 ♀, 1 ♂, Funchal, 24 m *a.s.l.*, 32° 38' 42.72" N, 16° 54' 49.93" W, 05.03.1995, leg. H. H. Evenhuis; 2 ♀♀, 5 ♂♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 07.07.1997, leg. J. Smit; 1 ♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 09.07.1997, leg. J. Smit; 1 ♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 13.07.1997, leg. J. Smit; 1 ♀, 1 ♂, Lombada dos Marinheiros, 578 m *a.s.l.*, 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 1 ♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 1 ♀, 3 ♂♂, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 27.02.1998, leg. J. T. Smit; 3 ♀♀, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 23.03.1998, leg. J. T. Smit; 1 ♀, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 23.04.1998, leg. J. T. Smit; 1 ♀, Ribeira Brava, 125 m *a.s.l.*, 32° 40' 32.04" N, 17° 03' 55.92" W, 01.05.1998, leg. J. Smit; 1 ♀, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 02.05.1998, leg. J. Smit; 1 ♂, Câmara de Lobos, 174 m *a.s.l.*, 32° 39' 6.75" N, 16° 58' 22.17" W, 03.05.1998, leg. J. Smit; 1 ♀, 1 ♂, Faial, 191 m *a.s.l.*, 32° 46' 58.10" N, 16° 51' 35.00"

W, 04.05.1998, leg. J. Smit; 1♀, 1♂, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♀, 7♂♂, S Zimbreiros, SE Caniço, 105 m *a.s.l.*, 32° 38' 58.26" N; 16° 49' 55.10" W, 15.06.1998, leg. J. T. Smit. **oFA** (3♀♀, 6♂♂): 1♂, Preces, Agricultural Station, Câmara de Lobos, 124 m *a.s.l.*, 32° 39' 20.53" N, 16° 58' 35.57" W, 16.06.1998, obs. F. Aguiar; 1♂, Ponta de São Lourenço, track between Baia d'Abra and Casa do Sardinha, 54 m *a.s.l.*, 32° 44' 45.29" N, 16° 41' 15.48" W, 30.5.1999, obs. F. Aguiar; 1♂, Ponta do Pargo, Miradouro do Fio, Terra Chã, 362 m *a.s.l.*, 32° 48' 34.76" N, 17° 15' 24.19" W, 08.06.2004, obs. F. Aguiar; 1♀, Ponta de São Lourenço, 500 m NW of Prainha beach, 72 m *a.s.l.*, 32° 44' 43.40" N, 16° 43' 09.07" W, 19.04.2007, obs. F. Aguiar; 1♀, 1♂, Funchal, Rua Lombo da Boa Vista, 175 m *a.s.l.*, 32° 39' 19.25" N, 16° 53' 38.04" W, 02.08.2008, obs. F. Aguiar; 1♂, Funchal, Rua Lombo da Boa Vista, 175 m *a.s.l.*, 32° 39' 19.25" N, 16° 53' 38.04" W, 30.08.2008, obs. F. Aguiar; 1♂, Funchal, Rua Lombo da Boa Vista, 175 m *a.s.l.*, 32° 39' 19.25" N, 16° 53' 37.92" W, 11.10.2008, obs. F. Aguiar; 1♀, Prazeres to Paúl do Mar, vereda near Jardim Atlântico Hotel, 427 m *a.s.l.*, 32° 45' 15.70" N, 17° 13' 05.29" W, 17.09.2009, obs. F. Aguiar. **oKS** (24♀♀): 1♀, W Ponta do Sol, between Livramento and Anjos, 38 m *a.s.l.*, 32° 40' 56.30" N, 17° 06' 31.87" W, 25.03.2005, obs. K/S; 1♀, Ponta de São Lourenço, 101 m *a.s.l.*, 32° 44' 44.01" N, 16° 43' 20.74" W, 26.03.2005, obs. K/S; 1♀, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, obs. K/S; 3♀♀, W Ribeira Brava, Ribeira da Caldeira, E 213, 37 m *a.s.l.*, 32° 40' 25.21" N, 17° 04' 09.99" W, 02.04.2005, obs. K/S; 12♀♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 29.12.2006, obs. K/S; 1♀, Restaurante 'O Precipício', Fajã da Ovelha, 375 m *a.s.l.*, 32° 46' 13.89" N, 17° 14' 05.42" W, 28.12.2006, obs. K/S; 4♀♀, petrol station, E Ponta da Sol, 27 m *a.s.l.*, 32° 40' 35.91" N, 17° 04' 36.98" W, 29.12.2006, obs. K/S; 1♀, Ponta de São Lourenço, 56 m *a.s.l.*, 32° 44' 36.74" N, 16° 43' 22.04" W, 31.12.2006, obs. K/S.

- **Data from collections** (15♀♀, 18♂♂): **ICLAM** (3♀♀, 7♂♂): 1♂, Curral das Freiras, land belonging to Comissão de levadas, 525 m *a.s.l.*, 32° 43' 33.47" N, 16° 58' 05.17" W, 27.05.1999, leg. Aguiar / Jesus; 1♀, Ribeirinha, Camacha, 649 m *a.s.l.*, 32° 40' 20.95" N, 16° 50' 50.97" W, 21.06.1999, leg. Aguiar / Jesus; 2♀♀, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 10.02.2000, leg. Aguiar / Jesus; 1♂, Ribeira das Galinhas, Paúl do Mar, 50 m *a.s.l.*, 32° 45' 58.86" N, 17° 14' 09.35" W, 01.04.2004, leg. J. Jesus; 3♂♂, Eira do Serrado, Pico do Serrado, 955 m *a.s.l.*, 32° 42' 25.14" N, 16° 57' 35.72" W, 17.06.2004, leg. Aguiar / Jesus; 2♂♂, lighthouse (Farol), Ponta do Pargo, 185 m *a.s.l.*, 32° 48' 37.34" N, 17° 15' 33.43" W, 10.07.2008, leg. C. Brazão. **MZHF** (12♀♀, 11♂♂): 2♀♀, 1♂, Serra d'Água, 325 m *a.s.l.*, 32° 43' 33.60" N, 17° 01' 37.20" W, 16.07.-19.07.1957, leg. H. Lindberg; 1♀, 1♂, Terrenos de Santa Luzia, 61 m *a.s.l.*, 32° 39'

13.36' N, 16° 54' 42.34" W, 21.07.1957, leg. H. Lindberg; 1♂, Ribeiro Frio, 926 m *a.s.l.*, 32° 44' 02.40" N, 16° 53' 09.60" W, 14.05.1959, leg. H. Lindberg; 2♀♀, 1♂, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 16.71" N, 16° 55' 50.85" W, 18.03.1980, leg. M. Koponen; 1♀, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 16.71" N, 16° 55' 50.85" W, 20.03.1980, leg. M. Koponen; 1♂, Funchal, 10 m *a.s.l.*, 32° 38' 31.20" N, 16° 56' 16.80" W, 15.04.1990, leg. M. Koponen; 1♂, Ribeira Brava, 30 m *a.s.l.*, 32° 40' 12.00" N, 17° 03' 50.40" W, 19.04.1990, leg. M. Koponen; 1♀, Funchal, Lido, 17 m *a.s.l.*, 32° 38' 9.49" N, 16° 55' 58.77" W, 18.12.1994, M. Koponen; 4♀♀, 4♂♂, Funchal, Amparo – Quebradas, 150 m *a.s.l.*, 32° 38' 45.78" N, 16° 56' 58.13" W, 16.04.1995, leg. M. Koponen; 1♀, 1♂, Funchal, Santo Amaro – Fajã, 300 m *a.s.l.*, 32° 39' 35.20" N, 16° 56' 38.40" W, 19.04.1995, leg. M. Koponen.

- **Data from literature** (19♀♀, 3♂♂, 2 ind.): ALFKEN (1940): 1♀, 2♂♂, Machico, 10 m *a.s.l.*, 32° 43' 05.58" N, 16° 45' 48.59" W, 12.07.1935, leg. O. Lundblad; 1♀, Caramujo, 1,273 m *a.s.l.*, 32° 46' 20.49" N, 17° 03' 46.44" W, 06.-14.08.1935, leg. O. Lundblad; 8♀♀, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 11.07.-15.07.1935, leg. O. Lundblad; 9♀♀, 1♂, Rabaçal, 1,069 m *a.s.l.*, 32° 45' 39.71" N, 17° 08' 4.78" W, 17.07.-04.08.1935, leg. O. Lundblad; COSTA (2019): 1 ind. Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa; 1 ind., area Pico do Areeiro, 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W, leg. R. Costa.

Apidae

Bombus (Megabombus) r. ruderatus (Fabricius, 1775)

- **Status:** Introduced?, Fig. 55.

- **Literature:** FABRICIUS (1775), FELLENDORF *et al.* (1999), KRATOCHWIL *et al.* (2018).



Fig. 55 – *Bombus r. ruderatus* (queen), visiting the native *Bituminaria bituminosa* in ruderal vegetation. Ponta de São Lourenço, roadside, 02.04.2022; vegetation series b). Photo. A. Kratochwil.

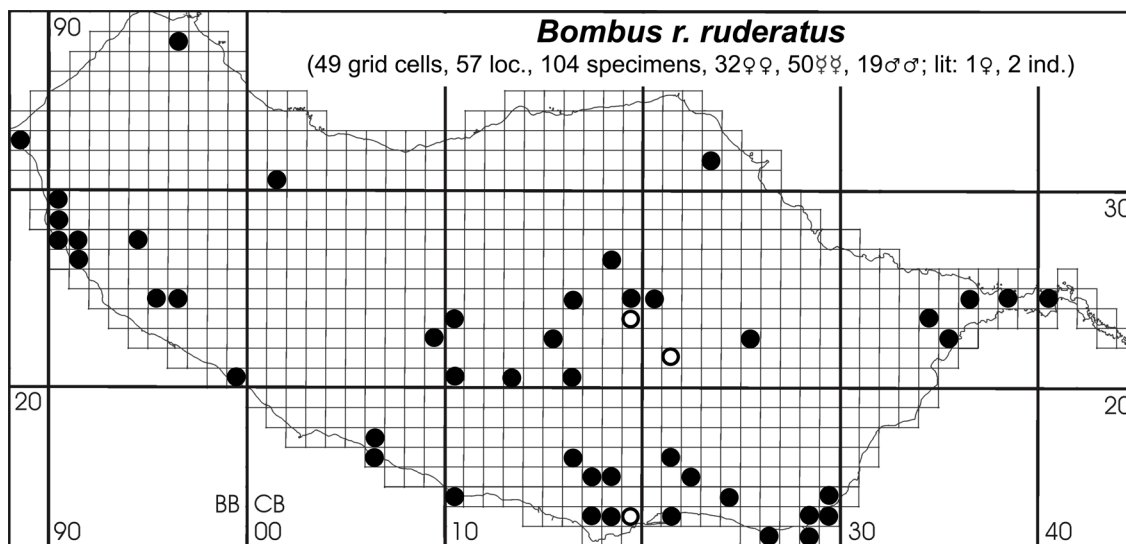


Fig. 56 – Detections of *Bombus r. ruderatus* (black dots: authors' data, checked specimens of collections; circles: literature data).

- **Specimens analysed:** 32♀♀, 50♂♂, 19♂♂.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 56 and 57, Tables 24 and 25): *Bombus r. ruderatus* shows main occurrences in the Mediterranean dry to subhumid vegetation series a), b), c). *Bombus r. ruderatus* was detected in half of all grid cells in series a). Coastal rocks, ruderal sites, and gardens are among the habitat types. The polylectic species (detection of 14 plant families) with a long proboscis was observed on many different plant species, as well as on ornamental species in gardens with deep flower tubes (e.g. 'Azalea' *Rhododendron* sp.).

- **Flight time:** *Bombus r. ruderatus* flies year-around. We have detections from all months with the exceptions of February, October, and November.

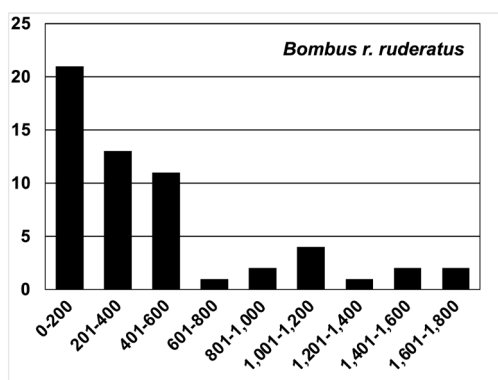


Fig. 57 – Number of localities with *Bombus r. ruderatus* detections per altitude level.

Table 24 – Presence of *Bombus r. ruderatus* in square-grid cells of different vegetation series.

Vegetation series	Presence %, absolute
May-Ol a	48%
Hel-Si b	35%
Sem-Ap 1 c	38%
Sem-Ap 2 d	15%
Cle-Oc e	10%
Pol-Er f	6%
Arm-Pa g	2

Table 25 – Plant-species spectrum visited by *Bombus r. ruderatus*.

Plant species, plant families	Status	n
<i>Arctium minus</i>	Ast nat	1 ind.
<i>Galactites tomentosa</i>	Ast nat	1♀, 1♂
<i>Borago officinalis</i>	Bor intr	1 ind.
<i>Echium candicans</i>	Bor end	2 ind.
<i>Echium nervosum</i>	Bor end	1♀, 4♂♂, 2♂♂
<i>Echium plantagineum</i>	Bor nat	1♀, 2♂♂
<i>Opuntia tuna</i>	Cac intr	1♀
<i>Cucurbita pepo</i>	Cuc cult	1♂
<i>Ipomoea purpurea</i>	Cuc intr	1♀, 1♂
<i>Rhododendron</i> sp. ('Azalea')	Eri cult	1♀
<i>Bituminaria bituminosa</i>	Fab nat	5♀♀, 8♂♂
<i>Lathyrus clymenum</i>	Fab nat	1♀
<i>Trifolium</i> sp.	Fab -	1 ind.
<i>Vicia benghalensis</i>	Fab nat	1♂
<i>Vicia lutea</i>	Fab nat	1♀
<i>Stachys ocymastrum</i>	Lam nat	1♀, 1♂
<i>Agapanthus praecox</i>	Lil cult	1 ind.
<i>Hibiscus</i> sp.	Mal cult	6♀♀
<i>Bougainvillea majus</i>	Nyc cult	1 ind.
<i>Papaver rhoeas</i>	Pap nat	2♂♂
<i>Rubus ulmifolius</i>	Ros nat	1♂, 1♂
<i>Tropaeolum majus</i>	Tro intr	1 ind.
<i>Digitalis purpurea</i>	Scr nat	2♀♀

- **Data from the authors** (26♀♀, 39♂♂, 12♂♂): **cAK** (18♀♀, 9♂♂, 1♂♂): 1♀, Arco da Calheta, ER 101, 333 m *a.s.l.*, 32° 42' 22.13" N, 17° 08' 22.47" W, 08.04.1995, leg. K/S; 1♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 11.04.1995, leg. K/S; 1♀, 2♂♂, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 1♀, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 24.03.2005, leg. K/S; 1♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 25.03.2005, leg. K/S; 1♂, Ponta de São Lourenço, above Rochinha, 78 m *a.s.l.*, 32° 44' 40.19" N, 16° 43' 22.21" W, 26.03.2005, leg. K/S; 1♀, Ponta de São Lourenço, 101 m *a.s.l.*, 32° 44' 44.01" N, 16° 43' 20.74" W, 26.03.2005, leg. K/S; 1♀, Fajã dos Padres, W. Quinta Grande, 325 m *a.s.l.*, 32° 39' 21.12" N, 17° 01' 04.44" W, 28.03.2005, leg. K/S; 1♂, Funchal, in front of Jardim Botânico, 277 m *a.s.l.*, 32° 39' 41.27" N, 16° 53' 41.25" W, 30.03.2005, leg. K/S; 1♀, Ribeira Brava, in front of tunnel entrance, 44 m *a.s.l.*, 32° 40' 29.71" N, 17° 03' 51.75" W, 02.04.2005, leg. K/S; 2♀♀, Serra de Água, lookout point, 465 m *a.s.l.*, 32° 43' 50.79" N, 17° 01' 26.59" W, 02.04.2005, leg. K/S; 2♂♂, Ponta dos Reis Magos, SE Caniço, 14 m *a.s.l.*, 32° 38' 55.50" N, 16° 49' 22.06" W, 04.04.2005, leg. K/S; 1♀, Restaurante 'O Precipício', Fajã da Ovelha, 375 m *a.s.l.*, 32° 46' 13.89" N, 17° 14' 05.42" W, 28.12.2006, leg. K/S; 1♀, above Paúl do Mar, ER 212, Reservatório do Paúl do Mar, 67 m *a.s.l.*, 32° 45' 49.96" N, 17° 13' 51.95" W, 31.12.2006, leg. K/S; 3♀♀, Paúl do Mar, near Aparthotel, 35 m *a.s.l.*, 32° 45' 57.20" N, 17° 14' 8.47" W, 01.01.2007, leg. K/S; 2♂♂, Este de Calheta, above Paúl do Mar, ER 212, 411 m *a.s.l.*, 32° 44' 15.10" N, 17° 10' 15.91" W, 03.01.2007, leg. K/S; 3♀♀, Paúl do Mar, near Aparthotel, 35 m *a.s.l.*, 32° 45' 57.20" N, 17° 14' 8.47" W, 03.01.2007, leg. K/S; 1♂, Ribeira Brava, near the river mouth, 60 m *a.s.l.*, 32° 40' 11.8" N, 17° 03' 45.5" W, 29.03.2022, leg. K/S; 1♀, São Lourenço, 66 m *a.s.l.*, 32° 44' 38.0" N, 16° 43' 32.6" W, 02.04.2022, leg. K/S. **cFA** (1♀, 3♂♂): 1♂, Posto Agrário do Pico, Santana, 419 m *a.s.l.*, 32° 48' 27.67" N, 16° 53' 11.23" W, 20.07.1998, leg. F. Aguiar; 1♂, Jardim da Serra, 500 m before Boca da Corrida, 1,079 m *a.s.l.*, 32° 42' 17.68" N, 16° 59' 12.68" W, 10.09.1998, leg. Aguiar / Jesus; 1♂, Fajã dos Cardos, Curral das Freiras, 762 m *a.s.l.*, 32° 44' 36.72" N, 16° 57' 49.62" W, 07.9.2001, leg. Aguiar / Jesus; 1♀, Boca da Corrida, above forest services post, 1,216 m *a.s.l.*, 32° 42' 36.75" N, 16° 59' 13.65" W, 17.09.2001, leg. D. Erber. **cJS** (2♀♀, 18♂♂, 6♂♂): 2♂♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 07.07.1997, leg. J. Smit; 1♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 09.07.1997, leg. J. Smit; 1♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 13.07.1997, leg. J. Smit; 1♂, Lombada dos Marinheiros, 578 m *a.s.l.*, 32° 47' 16.13" N, 17° 14' 18.83" W, 15.07.1997, leg. J. Smit; 1♀, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 2♂♂, Funchal, Pico das Romeiras, 423 m

a.s.l., 32° 39' 47.94" N, 16° 56' 47.61" W, 01.03.1998, leg. J. T. Smit; 1♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 28.03.1998, leg. J. T. Smit; 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 03.04.1998, leg. J. T. Smit; 1♂, Funchal, Pico das Romeiras, 423 m *a.s.l.*, 32° 39' 47.94" N, 16° 56' 47.61" W, 22.04.1998, leg. J. T. Smit; 1♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 25.04.1998, leg. J. T. Smit; 1♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 30.04.1998, leg. J. T. Smit; 2♂♂, Caniçal, 86 m *a.s.l.*, 32° 44' 31.98" N, 16° 44' 39.84" W, 02.05.1998, leg. J. Smit; 1♂, Palheiro Ferreiro, NW São Gonçalo, 505 m *a.s.l.*, 32° 39' 15.75" N, 16° 52' 17.22" W, 06.05.1998, leg. J. Smit; 2♂♂, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32° 39' 31.00" N, 16° 56' 22.00" W, 12.05.1998, leg. J. T. Smit; 7♂♂, 1♂, S Zimbreiros, SE Caniço, 105 m *a.s.l.*, 32° 38' 58.26" N, 16° 49' 55.10" W, 15.06.1998, leg. J. T. Smit. **oFA** (5♀♀, 2♂♂, 2 ind.): 1 ind., Chão da Ribeira, Seixal, 517 m *a.s.l.*, 32° 47' 44.24" N, 17° 06' 52.97" W, 20.06.1996, obs. F. Aguiar; 1 ind., Curral das Freiras, land belonging to Comissão de levadas, 525 m *a.s.l.*, 32° 43' 33.47" N, 16° 58' 05.17" W, 16.04.1998, obs. F. Aguiar; 1♀, Pico do Facho, Machico, 266 m *a.s.l.*, 32° 43' 22.49" N, 16° 45' 30.60" W, 12.06.2003, obs. F. Aguiar; 1♀, Caniço, near Pico da Atalaia, 17 m *a.s.l.*, 32° 39' 02.76" N, 16° 49' 04.85" W, 29.05.2005, obs. F. Aguiar; 1♂, Reis Magos, near Atalaia peak, 31 m *a.s.l.*, 32° 39' 04.50" N, 16° 49' 03.06" W, 29.05.2005, obs. F. Aguiar; 1♀, Santo da Serra, dirt road to Pico do Suna, 1,118 m *a.s.l.*, 32° 43' 44.51" N, 16° 51' 25.34" W, 20.09.2007, obs. F. Aguiar; 1♂, Caniçal, 135 m *a.s.l.*, 32° 44' 55.44" N, 16° 42' 24.15" W, 05.6.2008, obs. F. Aguiar; 1♀, road from Paúl da Serra to Prazeres, 860 m *a.s.l.*, 32° 46' 04.08" N, 17° 11' 24.81" W, 24.06.2010, obs. F. Aguiar; 1♀, Caniçal, dirt road, 390 m *a.s.l.*, 32° 44' 25.01" N, 16° 45' 43.11" W, 12.01.2012, obs. F. Aguiar. **oKS** (12♂♂): 1♂, Ponta do Garajau, S Caniço, 112 m *a.s.l.*, 32° 38' 18.33" N, 16° 51' 02.84" W, 28.03.2005, obs. K/S; 2♂♂, Ponta do Pargo, near lighthouse, 345 m *a.s.l.*, 32° 48' 50.16" N, 17° 15' 30.24" W, 03.04.2005, obs. K/S; 1♂, above Porto Moniz, 407 m *a.s.l.*, 32° 51' 35.12" N, 17° 10' 26.56" W, 03.04.2005, obs. K/S; 8♂♂, Ponta dos Reis Magos, SE Caniço, 14 m *a.s.l.*, 32° 38' 55.50" N, 16° 49' 22.06" W, 04.04.2005, obs. K/S.

- **Data from collections** (6♀♀, 11♂♂, 7♂♂): **ICLAM** (2♀♀, 1♂, 1♂): 1♂, Jardim da Serra, 500 m before Boca da Corrida, 1,079 m *a.s.l.*, 32° 42' 17.68" N, 16° 59' 12.68" W, 27.08.1998, leg. Aguiar / Jesus; 1♀, Montado do Sabugal, above Fajã da Nogueira, 825 m *a.s.l.*, 32° 44' 47.39" N, 16° 54' 43.99" W, 17.07.2003, leg. Aguiar / Jesus; 1♂, Boca da Corrida, below miradouro, 1,152 m *a.s.l.*, 32° 42' 39.43" N, 16° 59' 07.37" W, 16.08.2004, leg. Aguiar / Jesus; 1♀, Vereda Pico do Areeiro to Pico Ruivo, 1,568 m *a.s.l.*, 32° 44' 44.69" N, 16° 56' 01.80" W, 02.06.2005, leg. Aguiar / Jesus. **MZHF** (3♀♀, 8♂♂, 5♂♂): 1♂, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 31.20" N, 16° 56' 16.80" W, 10.03.1980, leg. M. Koponen; 1♂,

Monte, 559 m *a.s.l.*, 32° 40' 30.46" N, 16° 54' 04.94" W, 12.06.1957, leg. H. Lindberg; 1♂, Funchal, 10 m *a.s.l.*, 32° 38' 49.90" N, 16° 54' 18.00" W, 15.04.1990, leg. M. Koponen; 1♀, Funchal, Amparo – Quebradas, 150 m *a.s.l.*, 32° 38' 45.78" N, 16° 56' 58.13" W, 16.04.1995, leg. M. Koponen; 1♀, 4♂♂, Serra d'Água, 325 m *a.s.l.*, 32° 43' 33.60" W, 17° 01' 37.20" N, 16.07.-19.07.1957, leg. H. Lindberg; 1♀, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 21.20" N, 16° 56' 16.80" W, 18.03.1980, leg. M. Koponen; 1♀, Ribeira Brava, 30 m *a.s.l.*, 32° 40' 12.00" N, 17° 03' 50.40" W, 19.04.1990, leg. M. Koponen; 1♀, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 31.20" N, 16° 56' 16.80" W, 20.03.1980, leg. M. Koponen; 1♀, Pico Ruivo, 1,797 m *a.s.l.*, 32° 45' 41.60" N, 16° 56' 17.58" W, 27.6.-29.06.1957, leg. H. Lindberg; 1♀, 1♀, Funchal, Pico da Cruz, 224 m *a.s.l.*, 32° 38' 45.06" N, 16° 56' 10.03" W, 08.03.1980, leg. M. Koponen; 1♀, Funchal, 10 m *a.s.l.*, 32° 38' 49.20" N, 16° 56' 16.80" W, 9.6.-10.06.1957, leg. H. Lindberg. **UMB** (1♀, 2♀♀, 1♂): 1♀, Fajã de Ovelha, 483 m *a.s.l.*, 32° 46' 27.43" N 17° 14' 2.88" W, 02.04.1994, leg. H. Hohmann; 1♀, Paúl do Mar, 15 m *a.s.l.*, 32° 45' 32.65" N, 17° 13' 49.58" W, 02.04.1994, leg. H. Hohmann; 1♀, 1♂, Calheta, 374 m *a.s.l.*, 32° 44' 16.83" N, 17° 10' 51.57" W, 10.04.1994, leg. H. Hohmann.

- **Data from literature** (1♀, 2 ind.): COSTA (2019): 1 ind., Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa; 1 ind., area Pico do Areeiro 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W, leg. R. Costa; SAUNDERS (1903): 1♀, Funchal, 54 m *a.s.l.*, 32° 38' 26.00" N, 16° 55' 26.66" W, leg. A. E. Eaton.

***Bombus (Bombus) terrestris lusitanicus* Krüger, 1956**

- **Status:** Native (Figs. 58-60).



Fig. 58 – *Bombus terrestris lusitanicus* (worker), collecting pollen on the endemic plant species *Echium nervosum*. Coast E S. Vicente near Fajã da Areia, 27.03.2022; vegetation series d). Photo A. Schwabe.



Fig. 59 – *Bombus terrestris lusitanicus* (worker) with subspecies-characteristic red hairs on the third (hind) metatarsus (Corbiculae) and on the second metatarsus, visiting *Vicia faba* in a traditional garden of the northern slopes. Because of the short proboscis, nectar is gained by biting holes ('nectar robbing'). Ribeira Funda near São Jorge, 30.03.2022; vegetation series e). Photo A. Schwabe.



Fig. 60 – *Bombus terrestris lusitanicus* (male), visiting the native species *Galactites tomentosa*; many wild bee species visit this species frequently. Arco de S. Jorge, ruderal habitat near the coast, 04.04.2022; vegetation series d). Photo A. Schwabe.

- **Literature:** BISCHOFF (1937), ERLANDSSON (1979), WIDMER *et al.* (1998), FELLENDORF *et al.* (1999), RASMONT *et al.* (2008), KRATOCHWIL *et al.* (2018).

- **Specimens analysed:** 36♀♀, 352♀♀; 13♂♂, 1 ind.

- **Distribution, habitat characteristics, and flower-visiting behaviour** (Figs. 61 and 62, Tables 26 and 27): *Bombus terrestris lusitanicus* has an especially high presence in the vegetation series of the temperate climate [e), f)] and the transition zone d). The species is a typical element of the cultural landscape, with small vegetable gardens and different types of anthropogenic vegetation on the northern slopes. Gardens with ornamental plants are frequently visited in many areas. Further coastal rocks, fallows, and the pasture landscapes in the potential tree-heath series f) are populated.

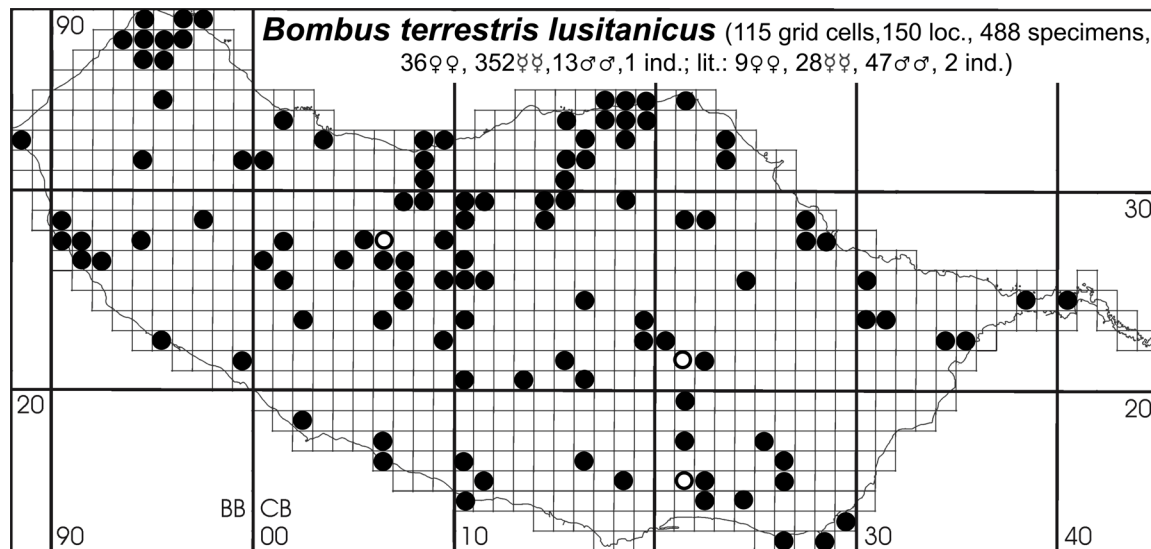


Fig. 61 – Detections of *Bombus terrestris lusitanicus* (black dots: authors' data, checked specimens of collections; circles: literature data).

In near-natural sites on Madeira Island, the endemic *Echium nervosum* on coastal rocks plays a role as a pollen and nectar resource. In the case of stormy weather, *B. t. lusitanicus* forages there 'by feet' from flower to flower. Ruderal plants such as *Bituminaria bituminosa* and *Galactites tomentosa* and many others play a role. In the small vegetable gardens especially in the northern part of Madeira, flowering *Brassica oleracea* and *Tropaeolum majus* are regularly visited. In the intensively grazed hyperhumid vegetation series f), there is often only the introduced *Ulex europaeus* left as a pollen and nectar resource, which is intensively used by *B. t. lusitanicus*. All in all, in our observations, 30 plant families were visited by this polylectic species. In the case of *Rhododendron* sp. ('Azalea') and *Vicia faba*, *Bombus t. lusitanicus* was only able to get nectar by biting holes ('nectar robbing').

- **Flight time:** *Bombus t. lusitanicus* flies year-around. We have detections from all months.

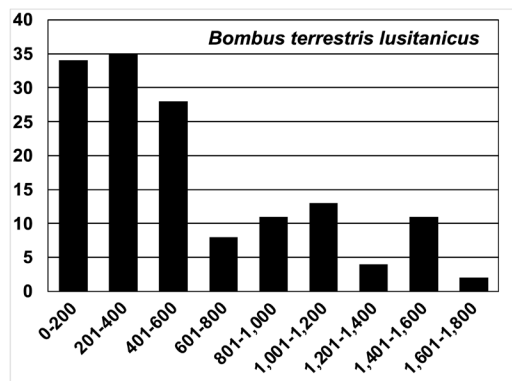


Fig. 62 – Number of localities with *Bombus terrestris lusitanicus* detections per altitude level.

Table 26 – Presence of *Bombus terrestris lusitanicus* in square-grid cells of different vegetation series.

Vegetation series	Presence %, absolute
May-Ol a	38%
Hel-Si b	35%
Sem-Ap 1 c	36%
Sem-Ap 2 d	43%
Cle-Oc e	54%
Pol-Er f	56%
Arm-Pa g	2

- **Data of the authors** (27♀♀, 345♂♂, 7♂♂, 1 ind.): **cAK** (2♀♀, 39♂♂): 2♂♂, Ponta do Garajau, S Caniço; 112 m *a.s.l.*, 32° 38' 18.33" N, 16° 51' 02.84" W, 07.04.1995, leg. K/S; 2♂♂, Poiso, 1,175 m *a.s.l.*, 32° 43' 13.28" N, 16° 53' 27.21" W, 07.04.1995, leg. K/S; 1♀, Cabo do Castelo, S Camacha, 488 m *a.s.l.*, 32° 39' 51.20" N, 16° 50' 46.06" W, 09.04.1995, leg. K/S; 1♂, Ponta da Oliveira, Caniço de Baixo, 22 m *a.s.l.*, 32° 38' 28.16" N, 16° 49' 53.02" W, 13.04.1995, leg. K/S; 3♂♂, E Arco da Calheta, ER 101, 322 m *a.s.l.*, 32° 42' 31.99" N, 17° 08' 14.93" W, 25.03.2005, leg. K/S; 1♂, Ribeira Brava, in front of tunnel entrance, 44 m *a.s.l.*, 32° 40' 29.71" N, 17° 03' 51.75" W, 27.03.2005, leg. K/S; 1♂, Serra de Água, lookout point, 465 m *a.s.l.*, 32° 43' 50.79" N, 17° 01' 26.59" W, 27.03.2005, leg. K/S; 4♂♂, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, leg. K/S; 1♂, Funchal, in front of Jardim Botânico, 277 m *a.s.l.*, 32° 39' 41.27" N, 16° 53' 41.25" W, 30.03.2005, leg. K/S; 1♂, Ribeira Brava, in front of tunnel entrance, 44 m *a.s.l.*, 32° 40' 29.71" N, 17° 03' 51.75" W, 02.04.2005, leg. K/S; 1♂, Cova do Negro, W Rabaçal, 1,130 m *a.s.l.*, 32° 48' 23.66" N, 17° 11' 50.04" W, 02.04.2005, leg. K/S; 1♂, Ponta dos Reis Magos, SE

Table 27 – Plant-species spectrum visited by *Bombus terrestris lusitanicus*. * = ‘nectar robbing’.

Plant species, plant families	Status	n
<i>Justitia adhatoda</i>	Aca	cult 2♀♀
<i>Carpobrotus edulis</i>	Aiz	intr 1 ind.
<i>Melanoselinum decipiens</i>	Api	end 2♀♀
Asteraceae yellow	Ast	- 1♀
<i>Bidens pilosa</i>	Ast	intr 12♀♀, 3♂♂, 1 ind.
<i>Calendula officinalis</i>	Ast	intr 1♀
<i>Carlina salicifolia</i>	Ast	mac 1♀
<i>Cirsium vulgare</i>	Ast	intr 1♀
<i>Crepis capillaris</i>	Ast	intr 2♀♀
<i>Crepis vesicaria</i>	Ast	nat 2♀♀
<i>Galactites tomentosa</i>	Ast	nat 3♀♀, 18♀♀
<i>Sonchus asper</i>	Ast	nat? 4♀♀
<i>Taraxacum hamatum</i>	Ast	intr 2♀♀
<i>Tacoma capensis</i>	Big	intr 2♀♀
<i>Echium candicans</i>	Bor	end 4 ind.
<i>Echium nervosum</i>	Bor	end 1♀, 37♀♀
<i>Echium plantagineum</i>	Bor	nat 2♀♀
<i>Brassica oleracea</i>	Bra	cult 2♀♀, 52♀♀
<i>Erysimum bicolor</i>	Bra	mac 1♀
<i>Raphanus r. subsp. raphanistrum</i>	Bra	nat 1♀
<i>Sinapidendron angustifolium</i>	Bra	end 2♀♀
<i>Cercis siliquastrum</i>	Cae	cult 1 ind.
<i>Ipomoea purpurea</i>	Con	intr 1♀
<i>Crassula ovata</i>	Cra	intr 1♀
<i>Sechium edule</i>	Cuc	intr 1♀
<i>Rhododendron sp. ('Azalea')*</i>	Eri	cult 6♀♀
<i>Vaccinium padifolium</i>	Eri	end 1♀
<i>Euphorbia pulcherrima</i>	Eup	cult 1♀
<i>Bituminaria bituminosa</i>	Fab	nat 15♀♀
<i>Cytisus scoparius</i>	Fab	intr 1♀
<i>Trifolium pratense</i>	Fab	intr 1♀
<i>Trifolium repens</i>	Fab	nat 4♀♀
<i>Ulex europaeus</i>	Fab	intr 4♀♀, 46♀♀
<i>Vicia angustifolia</i>	Fab	nat 3♀♀
<i>Vicia faba*</i>	Fab	cult 3♀♀
<i>Wisteria sinensis</i>	Fab	cult 17♀♀
<i>Geranium maderense</i>	Ger	end 3♀♀
<i>Geranium robertianum</i>	Ger	nat 7♀♀
<i>Pelargonium sp.</i>	Ger	intr 3♀♀
<i>Rosmarinum officinale</i>	Lam	cult 6♀♀
<i>Salvia leucantha</i>	Lam	intr 1♀
<i>Teucrium betonicum</i>	Lam	end 2♀♀
<i>Agapanthus praecox</i>	Lil	intr 1♀
<i>Allium triquetrum</i>	Lil	intr? 2♀♀
<i>Lilium sp.</i>	Lil	cult 1♀
<i>Bougainvillea spectabilis</i>	Nyc	cult 1 ind.
<i>Callianthe picta (Abutilon pictum)</i>	Mal	intr 4♀♀
<i>Fuchsia magellanica</i>	Ona	intr 1♀, 9♀♀
<i>Oxalis pes-caprae</i>	Oxa	intr 14♀♀
<i>Fumana muralis</i>	Pap	nat 3♀♀
<i>Passiflora caerulea</i>	Pas	intr 4♀♀
<i>Plantago sp.</i>	Pla	- 1♀
<i>Hakea sericea</i>	Pro	intr 1♀
<i>Rubus ulmifolius</i>	Ros	nat 1♀
<i>Bergenia crassifolia (= cordifolia)</i>	Sax	cult 3♀♀
<i>Salpichroa organifolia</i>	Sol	intr 1♀, 2♀♀
<i>Strelitzia reginae</i>	Str	cult 2♀♀
<i>Tropaeolum majus</i>	Tro	intr 19♀♀

Canico, 14 m *a.s.l.*, 32° 38' 55.50" N, 16° 49' 22.06" W, 04.04.2005, leg. K/S; 1♀, N Fonte da Pedra, 874 m *a.s.l.*, 32° 49' 54.26" N, 17° 11' 16.03" W, 28.12.2006, leg. K/S; 1♀, 1♀, above Paúl do Mar, ER 212, Reservatório do Paúl do Mar, 67 m *a.s.l.*, 32° 45' 49.96" N, 17° 13' 51.95" W, 29.12.2006, leg. K/S; 1♀, Falca de Cima, near Boaventura, 396 m *a.s.l.*, 32° 47' 27.0" N, 16° 58' 29.4" W, 25.03.2022, leg. K/S; 3♀♀, Fajã do Penedo, near Boaventura, 238 m *a.s.l.*, 32° 48' 17.8" N, 16° 57' 49.2" W, 25.03.2022, leg. K/S; 4♀♀, Arco de S. Jorge, 109 m *a.s.l.*, 32° 49' 36.1" N, 16° 56' 52.8" W, 25.03.2022, leg. K/S; 1♀, Fanal, above Ribeira Janela, 1,134 m *a.s.l.*, 32° 48' 27.2" N, 17° 08' 30.0" W, 26.03.2022, leg. K/S; 1♀, W P. Moniz, 417 m *a.s.l.*, 32° 51' 38.2" N, 17° 12' 04.1" W, 26.03.2022, leg. K/S; 1♀, P. Moniz, 20 m *a.s.l.*, 32° 52' 00.3" N, 17° 09' 58.7" W, 28.03.2022, leg. K/S; 1♀; road Encumeada to Paúl da Serra, 1,220 m *a.s.l.*, 32° 44' 55.3" N, 17° 02' 04.2" W, 01.04.2022, leg. K/S; 1♀, Encumeada Pass, 996 m *a.s.l.*, 32° 45' 16.5" N, 17° 01' 10.6" W, 01.04.2022, leg. K/S; 1♀, above Rosário, S. Vicente, 707 m *a.s.l.*, 32° 45' 48.5" N, 17° 01' 19.6" W, 01.04.2022, leg. K/S; 5♀♀, Arco São Jorge, 109 m *a.s.l.*, 32° 49' 36.1" N, 16° 56' 52.8" W, 01.04.2022, leg. K/S. **cFA** (2♀♀, 1♀, 1♂): 1♀, Funchal, Lombo da Boa Vista, 174 m *a.s.l.*, 32° 39' 18.68" N, 16° 53' 38.36" W, 18.10.89, leg. F. Aguiar; 1♀, Ribeirinha, Camacha, 649 m *a.s.l.*, 32° 40' 20.95" N, 16° 50' 50.97" W, 26.02.1999, leg. Aguiar / Jesus; 1♂, Eira do Serrado, between miradouro and peak, 1,025 m *a.s.l.*, 32° 42' 37.29" N, 16° 57' 55.05" W, 17.06.2004, leg. Aguiar / Jesus; 1♀, Fajã dos Cardos, Curral das Freiras, 762 m *a.s.l.*, 32° 44' 36.72" N, 16° 57' 49.62" W, 07.09.2004, leg. Aguiar / Jesus. **cJS** (3♀♀, 6♀♀, 3♂♂): 1♀, Funchal, Ribeira dos Socorridos, 315 m *a.s.l.*, 32° 40' 27.17" N, 16° 57' 22.11" W, 10.07.1997, leg. J. Smit; 1♂, Parque Ecológico, near Poço da Neve, 1,633 m *a.s.l.*, 32° 43' 32.87" N, 16° 55' 29.69" W, 11.07.1997, leg. J. Smit; 1♀, 1♂, Fontes, 1,124 m *a.s.l.*, 32° 42' 33.11" N, 17° 00' 57.13" W, 16.07.1997, leg. J. Smit; 2♀♀, Rabaçal, 1064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 20.07.1997, leg. J. Smit; 1♀, Ponta de São Lourenço, 77 m *a.s.l.*, 32° 44' 36.05" N, 16° 42' 01.91" W, 27.02.98, leg. J. T. Smit; 1♀, Rabaçal, 1,064 m *a.s.l.*, 32° 45' 43.45" N, 17° 08' 03.01" W, 03.03.1998, leg. J. T. Smit; 1♀, Funchal, Pico dos Barcelos, 338 m *a.s.l.*, 32°39'31.00"N, 16° 56' 22.00" W, 08.03.1998, leg. J. T. Smit; 1♀, Ponta do Pargo, 322 m *a.s.l.*, 32° 48' 44.56" N, 17° 15' 38.36" W, 05.05.1998, leg. J. Smit; 1♀, Palheiro Ferreiro, NW São Gonçalo, 505 m *a.s.l.*, 32° 39' 15.75" N, 16° 52' 17.22" W, 06.05.1998, leg. J. Smit; 1♂, Terreiro da Luta, N Monte, 886 m *a.s.l.*, 32° 41' 05.47" N, 16° 53'56.59" W, 06.05.1998, leg. J. Smit. **oFA** (13♀♀, 6♀♀, 3♂♂, 1 ind.): 1♀, Encumeada, road to S. Vicente, 989 m *a.s.l.*, 32° 45' 15.42" N, 17° 01' 01.27" W, 12.09.1996, obs. F. Aguiar; 1♀, Tranqual, Campanário, 570 m *a.s.l.*, 32° 39' 56.73" N, 17° 01' 07.18" W, 30.03.2000, obs. F. Aguiar; 1♀, Paúl da Serra, 2 km SW Estanquinhos, 1,458 m *a.s.l.*, 32° 45' 20.26" N, 17° 05' 21.70" W, 16.04.2003, obs. F. Aguiar; 1 ind., Pinheiro, Serra de Água, 381 m *a.s.l.*, 32° 43' 19.20" N, 17° 02' 02.28" W, 11.01.2007,

obs. F. Aguiar; 3♂♂, Pinheiro, Serra de Água, 1 km SW Serra de Água church, 373 m *a.s.l.*, 32° 43' 17.42" N, 17° 02' 01.88" W, 11.01.2007, obs. F. Aguiar; 1♀, Pinheiro, 1 km SW Serra de Água church, 379 m *a.s.l.*, 32° 43' 17.28" N, 17° 02' 02.72" W, 22.02.2007, obs. F. Aguiar; 1♀, Pinheiro, 1 km SW Serra de Água church, 379 m *a.s.l.*, 32° 43' 17.28" N, 17° 02' 02.72" W, 22.02.2007, obs. F. Aguiar; 6♀♀, Levada da Fajã do Rodrigues, Rosário, S. Vicente, 605 m *a.s.l.*, 32° 46' 00.08" N, 17° 02' 09.61" W, 15.03.2007, obs. F. Aguiar; 1♀; Paúl da Serra, dirt road from Estanquinhos to Ginjas, 1,585 m *a.s.l.*, 32° 46' 11.84" N, 17° 04' 28.12" W, 05.07.2007, obs. F. Aguiar; 1♀, Portela, dirt road from Portela to Ribeira de Machico, 573 m *a.s.l.*, 32° 45' 23.69" N, 16° 48' 28.42" W, 08.05.2008, obs. F. Aguiar; 1♀, near Poço da Neve, road to Pico do Areeiro, 1,566 m *a.s.l.*, 32° 43' 36.71" N, 16° 55' 09.78" W, 18.09.2008, obs. F. Aguiar; 1♀, Poiso, vereda from Poiso to Chão das Feiteiras, 1,199 m *a.s.l.*, 32° 41' 59.16" N, 16° 53' 58.70" W, 23.04.2009, obs. F. Aguiar; 1♀, Canhas to Paúl da Serra, dirt road, 1,162 m *a.s.l.*, 32° 44' 06.76" N, 17° 06' 23.10" W, 29.04.2010, obs. F. Aguiar; 1♀, road from Paúl da Serra to Prazeres, 851 m *a.s.l.*, 32° 46' 02.65" N, 17° 11' 26.96" W, 24.06.2010, F. Aguiar; 1♀, Prazeres to Paúl do Mar, vereda near Jardim Atlantico Hotel, 501 m *a.s.l.*, 32° 45' 09.24" N, 17° 13' 04.90" W, 28.04.2011, obs. F. Aguiar; 1♀, Encumeada, Serra de Água, near Forest Service house, 937 m *a.s.l.*, 32° 45' 26.71" N, 17° 01' 14.85" W, 16.06.2011, obs. F. Aguiar. **oKS** (7♀♀, 293♀♀): 1♀, W Ponta do Sol, between Livramento and Anjos, 38 m *a.s.l.*, 32° 40' 56.30" N, 17° 06' 31.87" W, 25.03.2005, obs. K/S; 2♀♀, Boca da Encumeada, 999 m *a.s.l.*, 32° 45' 16.43" N, 17° 01' 11.22" W, 27.03.2005, obs. K/S; 7♀♀, Câmara do Bispo, S Quinta Grande, 316 m *a.s.l.*, 32° 39' 17.50" N, 17° 01' 02.02" W, 28.03.2005, obs. K/S; 4♀♀, Fajã dos Padres, W Quinta Grande, 325 m *a.s.l.*, 32° 39' 21.12" N 17° 01' 04.44" W, 28.03.2005, obs. K/S; 1♀, Cabo Girão, S Quinta Grande, 603 m *a.s.l.*, 32° 39' 27.08" N, 17° 00' 23.91" W, 28.03.2005, obs. K/S; 2♀♀, Funchal, in front of Jardim Botânico, 277 m *a.s.l.*, 32° 39' 41.27" N, 16° 53' 41.25" W, 30.03.2005, obs. K/S; 5♀♀, Cova da Negro, W Rabaçal, 1,130 m *a.s.l.*, 32° 48' 23.66" N, 17° 11' 50.04" W, 02.04.2005, obs. K/S; 1♀, above Porto Moniz, 407 m *a.s.l.*, 32° 51' 35.12" N, 17° 10' 26.56" W, 03.04.2005, obs. K/S; 1♀, Casa das Queimadas, SW Santana, 896 m *a.s.l.*, 32° 47' 01.27" N, 16° 54' 23.56" W, 05.04.2005, obs. K/S; 1♀, above Paúl do Mar, ER 212, Reservatório do Paúl do Mar, 67 m *a.s.l.*, 32° 45' 49.96" N, 17° 13' 51.95" W, 28.12.2006, obs. K/S; 1♀, Restaurante 'O Precipício', Fajã da Ovelha, 375 m *a.s.l.*, 32° 46' 13.89" N, 17° 14' 05.42" W, 28.12.2006, obs. K/S; 2♀♀, N Fonte da Pedra, 874 m *a.s.l.*, 32° 49' 54.26" N, 17° 11' 16.03" W, 28.12.2006, obs. K/S; 1♀, Eirinha above Serra de Água, 506 m *a.s.l.*, 32° 43' 54.22" N, 17° 01' 30.19" W, 01.01.2007, obs. K/S; 1♀, Estanquinhos, 1,559 m *a.s.l.*, 32° 46' 12.81" N, 17° 04' 40.56" W, 01.01.2007, obs. K/S; 1♀, Pico da Fajã da Lenha, 1,331 m *a.s.l.*, 32° 46' 13.48" N, 17° 07' 05.60" W,

01.01.2007, obs. K/S; 1♀, above Calheta, 88 m *a.s.l.*, 32° 43' 23.97" N, 17° 10' 39.73" W, 03.04.2007, obs. K/S; 12♀♀, Lombo do Urzal, near Boaventura, 472 m *a.s.l.*, 32° 46' 54.3" N, 16° 58' 45.5" W, 25.03.2022, obs. K/S; 1♀, Lombo do Urzal, Boaventura, 456 m *a.s.l.*, 32° 47' 04.4" N, 16° 58' 37.4" W, 25.03.2022, obs. K/S; 2♀♀, Falca de Cima, Boaventura, 396 m *a.s.l.*, 32° 47' 27.0" N, 16° 58' 29.4" W, 25.03.2022, obs. K/S; 1♀, Fajã do Penedo, Boaventura, 264 m *a.s.l.*, 32° 47' 53.6" N, 16° 58' 05.5" W, 25.03.2022, obs. K/S; 1♀, Fajã do Penedo, Boaventura, 220 m *a.s.l.*, 32° 48' 12.1" N, 16° 57' 59.8" W, 25.03.2022, obs. K/S; 6♀♀, Fajã do Penedo, Boaventura, 238 m *a.s.l.*, 32° 48' 17.8" N, 16° 57' 49.2" W, 25.03.2022, obs. K/S; 3♀♀, Fajã do Penedo, Boaventura, 211 m *a.s.l.*, 32° 48' 20.6" N, 16° 57' 51.7" W, 25.03.2022, obs. K/S; 1♀, Arco de S. Jorge, 262 m *a.s.l.*, 32° 49' 36.9" N, 16° 56' 30.9" W, 25.03.2022, obs. K/S; 1♀, below Paúl da Serra da Lamoirinha, 1,217 m *a.s.l.*, 32° 46' 24.9" N, 17° 09' 42.5" W, 26.03.2022, obs. K/S; 1♀, Fanal, above Ribeira da Janela, 1,187 m *a.s.l.*, 32° 47' 56.9" N, 17° 07' 57.3" W, 26.03.2022; obs. K/S; 1♀, Passada Vermelha, 1,180 m *a.s.l.*, 32° 48' 19.3" N, 17° 11' 29.8" W, 26.03.22, obs. K/S; 1♀, 3♀♀, Fanal, above Ribeira Janela, 1,134 m *a.s.l.*, 32° 48' 27.2" N, 17° 08' 30.0" W, 26.03.2022, obs. K/S; 6♀♀, above P. Moniz, 644 m *a.s.l.*, 32° 50' 54.9" N, 17° 11' 42.1" W, 26.03.2022, obs. K/S; 10♀♀, Pombais, above P. Moniz, 590 m *a.s.l.*, 32° 51' 08.1" N, 17° 11' 46.0" W, 26.03.2022, obs. K/S; 4♀♀, Pombais, above P. Moniz, 427 m *a.s.l.*, 32° 51' 33.6" N, 17° 12' 06.1" W, 26.03.2022, obs. K/S; 6♀♀, Miradouro Pombais, above P. Moniz, 378 m *a.s.l.*, 32° 51' 34.6" N, 17° 12' 12.6" W, 26.03.2022, obs. K/S; 2♀♀, W P. Moniz, 417 m *a.s.l.*, 32° 51' 38.2" N, 17° 12' 04.1" W, 26.03.2022, obs. K/S; 8♀♀, S. Vicente, 364 m *a.s.l.*, 32° 47' 05.8" N, 17° 01' 13.1" W, 27.03.2022, obs. K/S; 1♀, 8♀♀, S. Vicente, 414 m *a.s.l.*, 32° 47' 18.2" N, 17° 01' 03.4" W, 27.03.2022, obs. K/S; 2♀♀, S. Vicente, 243 m *a.s.l.*, 32° 47' 19.1" N, 17° 01' 38.5" W, 27.03.2022, obs. K/S; 1♀, S. Vicente, 269 m *a.s.l.*, 32° 47' 20.6" N, 17° 03' 00.5" W, 27.03.2022, obs. K/S; 3♀♀, S. Vicente, 252 m *a.s.l.*, 32° 47' 20.9" N, 17° 01' 37.0" W, 27.03.2022, obs. K/S; 2♀♀, S. Vicente, 272 m *a.s.l.*, 32° 47' 27.6" N, 17° 03' 04.8" W, 27.03.2022, obs. K/S; 3♀♀, S. Vicente, 200 m *a.s.l.*, 32° 47' 47.1" N, 17° 02' 44.5" W, 27.03.2022, obs. K/S; 3♀♀, S. Vicente, 54 m *a.s.l.*, 32° 48' 16.4" N, 17° 02' 51.4" W, 27.03.2022, obs. K/S; 1♀, 2♀♀, E S. Vicente, near Fajã Areia, 21 m *a.s.l.*, 32° 48' 40.3" N, 17° 02' 34.4" W, 27.03.2022, obs. K/S; 2♀♀, E S. Vicente, near Fajã Areia, 19 m *a.s.l.*, 32° 48' 49.1" N, 17° 01' 52.1" W, 27.03.2022, obs. K/S; 5♀♀, above P. Moniz, 379 m *a.s.l.*, 32° 51' 40.5" N, 17° 10' 32.2" W, 28.03.2022, obs. K/S; 2♀♀, P. Moniz, 30 m *a.s.l.*, 32° 52' 0.2" N, 17° 10' 09.9" W, 28.03.2022, obs. K/S; 6♀♀, P. Moniz, 28 m *a.s.l.*, 32° 52' 00.1" W, 17° 10' 03.7" N, 28.03.2022, obs. K/S; 1♀, P. Moniz, 20 m *a.s.l.*, 32° 52' 00.3" N, 17° 09' 58.7" W, 28.03.2022, obs. K/S; 1♀, P. Moniz, 10 m *a.s.l.*, 32° 52' 01.4" N, 17° 09' 54.6" W, 28. 03. 2022, obs. K/S; 5♀♀, Fajã da Parreira, 45 m *a.s.l.*, 32° 49' 33.3" N, 17° 07' 14.5" W, 28.03.2022, obs. K/S; 2♀♀, above P. Moniz, 622 m *a.s.l.*,

32° 51' 0.76" N, 17° 11' 36.47" W, 28.03.2022, obs. K/S; 1♂, above P. Moniz, 618 m *a.s.l.*, 32° 51' 04.3" N, 17° 11' 22.5" W, 28.03.2022, obs. K/S; 1♂, above P. Moniz, 565 m *a.s.l.*, 32° 51' 07.9" N, 17° 11' 05.0" W, 28.03.2022, obs. K/S; 2♂♂, above P. Moniz, 565 m *a.s.l.*, 32° 51' 07.9" N, 17° 11' 05.0" W, 28.03.2022, obs. K/S; 8♂♂, Santa, above P. Moniz, 483 m *a.s.l.*, 32° 51' 33.0" N, 17° 11' 15.8" W, 28.03.2022, obs. K/S; 3♂♂, Funchal Botanical Garden, 281 m *a.s.l.*, 32° 39' 45.9" N, 16° 53' 47.2" W, 29.03.2022, obs. K/S; 10♂♂, Ribeira Brava, near the river mouth, 60 m *a.s.l.*, 32° 40' 11.8" N, 17° 03' 45.5" W, 29.03.2022, obs. K/S; 5♂♂, below Ribeiro Frio, 544 m *a.s.l.*, 32° 45' 20.6" N, 16° 52' 05.8" W, 30.03.2022, obs. K/S; 3♂♂, Penha D'Águia, Porto da Cruz, 83 m *a.s.l.*, 32° 46' 43.8" N, 16° 50' 48.6" W, 30.03.2022, obs. K/S; 1♂, Santana, 348 m *a.s.l.*, 32° 48' 53.6" N, 16° 53' 13.2" W, 30.03.2022, obs. K/S; 8♂♂, Ribeira Funda, near São Jorge, 585 m *a.s.l.*, 32° 49' 08.6" N, 16° 56' 25.0" W, 30.03.2022, obs. K/S; 1♂, Lapa Negra, near São Jorge, 480 m *a.s.l.*, 32° 49' 22.7" N, 16° 55' 40.6" W, 30.03.2022, obs. K/S; 9♂♂, Cabanas, near São Jorge, 492 m *a.s.l.*, 32° 49' 34.0" N, 16° 56' 18.9" W, 30.03.2022, obs. K/S; 2♂♂, Lapa Negra, near São Jorge, 409 m *a.s.l.*, 32° 49' 45.3" N, 16° 55' 26.1" W, 30.03.2022, obs. K/S; 3♂♂, Arco de S. Jorge, 40 m *a.s.l.*, 32° 49' 46.8" N, 16° 56' 58.7" W, 30.03.2022, obs. K/S; 8♂♂, Miradouro da Vigia, near São Jorge, 303 m *a.s.l.*, 32° 50' 01.9" N, 16° 54' 42.4" W, 30.03.2022, obs. K/S; 12♂♂, Farol, near São Jorge, 258 m *a.s.l.*, 32° 50' 03.5" N, 16° 54' 22.0" W, 30.03.2022, obs. K/S; 1♂, São Cristovão, 89 m *a.s.l.*, 32° 49' 37.25" N, 16° 58' 25.32" W, 31.03.2022, obs. K/S; 1♂, São Cristovão, 89 m *a.s.l.*, 32° 49' 37.25" N, 16° 58' 25.32" W, 31.03.2022, obs. K/S; 1♂, São Cristovão, 89 m *a.s.l.*, 32° 49' 37.25" N, 16° 58' 25.32" W, 31.03.2022, obs. K/S; 1♂, São Cristovão, 89 m *a.s.l.*, 32° 49' 37.25" N, 16° 58' 25.32" W, 31.03.2022, obs. K/S; 1♀, 8♂♂, São Cristovão, 89 m *a.s.l.*, 32° 49' 37.25" N, 16° 58' 25.32" W, 31.03.2022, obs. K/S; 13♂♂, Ribeira Brava, 60 m *a.s.l.*, 32° 40' 11.8" N, 17° 03' 45.5" W, 01.04.2022, obs. K/S; 1♂, Ribeira Brava, 18 m *a.s.l.*, 32° 40' 21.0" N, 17° 04' 07.7" W, 01.04.2022, obs. K/S; 5♂♂, Paúl da Serra, 1,471 m *a.s.l.*, 32° 44' 03.1" N, 17° 03' 41.3" W, 01.04.2022, obs. K/S; 1♂, road Encumeada to Paúl da Serra, 1,220 m *a.s.l.*, 32° 44' 55.3" N, 17° 02' 04.2" W, 01.04.2022, obs. K/S; 1♂, Paúl da Serra, 1,575 m *a.s.l.*, 32° 44' 57.0" N, 17° 03' 30.3" W, 01.04.2022, obs. K/S; 7♂♂, Encumeada Pass, 996 m *a.s.l.*, 32° 45' 16.5" N, 17° 01' 10.6" W, 01.04.2022, obs. K/S; 2♂, Paúl da Serra, Bica da Cana, 1,568 m *a.s.l.*, 32° 45' 25.0" N, 17° 03' 30.4" W, 01.04.2022, obs. K/S; 2♂♂, Paúl da Serra, 1,578 m *a.s.l.*, 32° 45' 44.3" N, 17° 04' 12.8" W, 01.04.2022, obs. K/S; 1♂, above Rosário, S. Vicente, 707 m *a.s.l.*, 32° 45' 48.5" N, 17° 01' 19.6" W, 01.04.2022, obs. K/S; 1♂, Rosário, above S. Vicente, 321 m *a.s.l.*, 32° 46' 37.2" N, 17° 01' 30.0" W, 01.04.2022, obs. K/S; 1♂, Pico do Facho, summit, 273 m *a.s.l.*, 32° 43' 26.1" N, 16° 45' 31.5" W, 02.04.2022, obs. K/S; 2♂♂, below Pico do Facho, 248 m *a.s.l.*,

32° 43' 41.2" N, 16° 45' 41.5" W, 02.04.2022, obs. K/S; 2♂♂, São Lourenço, 54 m *a.s.l.*, 32° 44' 36.5" N, 16° 43' 21.8" W, 02.04.2022, obs. K/S; 2♂♂, W Santa Cruz, 170 m *a.s.l.*, 32° 46' 21.7" N, 16° 50' 22.3" W, 02.04.2022, obs. K/S; 2♂♂, near Santa Cruz, 57 m *a.s.l.*, 32° 46' 28.6" N, 16° 49' 49.3" W, 02.04.2022, obs. K/S; 1♂, Arco de S. Jorge, 109 m *a.s.l.*, 32° 49' 36.1" N, 16° 56' 52.8" W, 02.04.2022, obs. K/S; 1♂, E Porto do Seixal, old coastal road, 111 m *a.s.l.*, 32° 49' 01.6" N, 17° 06' 00.0" W, 03.04.2022, obs. K/S; 1♂, below Pico do Facho, 259 m *a.s.l.*, 32° 43' 42.0" N, 16° 45' 40.8" W, 04.04.2022, obs. K/S; 2♂♂, near Maroços, 276 m *a.s.l.*, 32° 44' 05.3" N, 16° 48' 18.9" W, 04.04.2022, obs. K/S; 9♂♂, Arco de S. Jorge, 109 m *a.s.l.*, 32° 49' 36.1" N, 16° 56' 52.8" W, 04.04.2022, obs. K/S.

- **Data from collections** (9♀♀, 7♂♂, 6♂♂): **ICLAM** (8♀♀, 5♂♂, 4♂♂): 1♀, Posto Agrário do Pico, Santana, 419 m *a.s.l.*, 32° 48' 27.67" N, 16° 53' 11.23" W, 28.11.1996, leg. Aguiar / Jesus; 2♂, Ribeira Brava, Miradouro Pico da Cruz, 54 m *a.s.l.*, 32° 40' 09.25" N, 17° 03' 46.32" W, 06.05.1997, leg. J. Jesus; 1♀, Queimadas, Santana, 877 m *a.s.l.*, 32° 47' 10.52" N, 16° 54' 23.26" W, 29.07.1997, leg. Aguiar / Jesus; 1♀, Ribeira do Lageado, Paúl da Serra, 1,354 m *a.s.l.*, 32° 45' 21.32" N, 17° 06' 57.80" W, 23.08.1997, leg. Aguiar / Jesus; 1♀, Serra de Água, N Terra Grande, 484 m *a.s.l.*, 32° 43' 52.88" N, 17° 01' 26.21" W, 22.10.1998, leg. Aguiar / Jesus; 2♂♂, Ribeirinha, Camacha, 649 m *a.s.l.*, 32° 40' 20.95" N, 16° 50' 50.97" W, 26.02.1999, leg. J. Jesus; 1♀, 1♂, 2♂♂, Tranqual, Campanário, 543 m *a.s.l.*, 32° 40' 03.41" N, 17° 01' 13.41" W, 26.03.1999, leg. Aguiar / Jesus; 1♂, Boca da Corrida, below miradouro, 1,152 m *a.s.l.*, 32° 42' 39.43" N, 16° 59' 07.37" W, 27.05.1999, leg. Aguiar / Jesus; 1♀, Farol, Ponta do Pargo, 248 m *a.s.l.*, 32° 48' 39.26" N, 17° 15' 34.01" W, 28.11.2002, leg. Aguiar / Jesus; 1♀, Fajã da Ovelha, 246 m *a.s.l.*, 32° 46' 02.17" N, 17° 13' 54.68" W, 27.11.2003, leg. Aguiar / Jesus; 1♂, Eira do Serrado, Pico do Serrado, 955 m *a.s.l.*, 32° 42' 25.14" N, 16° 57' 35.72" W, 17.06.2004, leg. Aguiar / Jesus; 1♀, Canhas to Paúl da Serra, dirt road, 1,163 m *a.s.l.*, 32° 44' 01.40" N, 17° 06' 25.87" W, 29.03.2007, leg. Aguiar / Jesus. **MZHF** (1♀, 2♂♂): 2♂♂, Vale Paraíso, 775 m *a.s.l.*, 32° 40' 41.02" N, 16° 51' 41.45" W, 13.6.1957, leg. H. Lindberg; 1♀, Queimadas, 882 m *a.s.l.*, 32° 47' 00.72" N, 16° 54' 21.65" W, 24.6.-26.06.1957, leg. H. Lindberg. **UMB** (2♂♂): 1♂, Paúl do Mar, 15 m *a.s.l.*, 32° 45' 32.65" N, 17° 13' 49.58" W, 02.04.1994, leg. H. Hohmann; 1♂, Paúl do Mar, 15 m *a.s.l.*, 32° 45' 32.65" N, 17° 13' 49.58" W, 02.04.1994, leg. H. Hohmann.

- **Data from literature** (9♀♀, 28♂♂, 47♂♂, 2 ind.): COSTA (2019): 1 ind., Pico do Areeiro, 1,500 m *a.s.l.*, 32° 43' 8" N, 16° 54' 31" W, leg. R. Costa; 1 ind. area Pico do Areeiro, 1,800 m *a.s.l.*, 32° 44' N, 16° 55' 47" W, leg. R. Costa; ERLANDSON (1979): 8♀♀, 5♂♂, Funchal, 310 m *a.s.l.*, 32° 40' 0.96" N, 16° 55' 26.6" W, 03.07.72, leg. S. Erlandson; 19♂♂, 37♂♂, Rabaçal, 1,066 m *a.s.l.*, 32° 45' 39.71" N, 17° 08' 4.78" W, 01.07.-04.08.1935, leg. O. Lundblad; 1♀, 4♂♂, 10♂♂, Caramujo, 1,273 m *a.s.l.*, 32° 46' 20.49" N, 17° 03' 46.44" W, 06.-14.08.1935, leg. O. Lundblad.

Xylocopa violacea (Linnaeus, 1758)

- **Status:** Introduced (Fig. 63).

- **Distribution:** There are three observations of a *Xylocopa* species on Madeira Island without collection and one record with collection. All of them come from the Municipality of Funchal. The first observation was recorded by P. Wirtz (Quinta Magnólia, 76 m *a.s.l.*, 32° 38' 36.75" N, 16° 55' 29.88" W, June 1994). H. Schaefer documented a flower visit of *X. cf. violacea* on *Wisteria sinensis* in nine photos (Miradouro da Igreja de São Roque, 340 m *a.s.l.*, 32° 40' 06.02" N, 16° 55' 23.48" W, 03.09.2012). Another flower visit on *Wisteria sinensis* was reported by F. Rocha (Funchal, Madeira) (Travessa do Lombo da Quinta, 412 m *a.s.l.*, 32° 39' 33.87" N, 16° 52' 33.77" W, 29.03.2018). One specimen was collected by I. Silva (Jardim Bôtanico, 301 m *a.s.l.*, 32° 39' 44.58" N, 16° 53' 42.77" W, 30.06.2020). The determination by A. Aguiar revealed that it is a female of *Xylocopa violacea*. We suppose that all previous observations can also be assigned to this species. An introduction of specimens in wood or bamboo (*e.g.* via shipping) is easily possible for this species, as it nests in dead wood or culms (for dispersal and range expansion, see BANASZAK *et al.*, 2019).

Major occurrences of wild bee species in vegetation series of Madeira Island

All wild bee data in Table 28 (without and with flower-visiting data) were assigned to the grid-cell system and the specific vegetation series. In columns a to f, the percentages of qualitative occurrences in specific grid

cells are counted. These refer to the number of studied grid cells per vegetation series (= 100%). In the case of column g (only three grid cells), absolute numbers are given. The table summarises the data of the single bee species (Tables 4, 6, 8, 10, 12, 14, 16, 17, 18, 20, 22, 24, 26) in a synoptic presence table.

Table 28 shows that there is a pronounced community of bee species with main occurrence in the Mediterranean zones a), b), c). The two endemic species and one endemic subspecies (*Amegilla quadrifasciata maderae*, *Andrena maderensis*, and *Osmia madeirensis*) are characteristic of the dry to subhumid, warm environments. Further, *Bombus r. ruderatus* (intr?), *Lasioglossum v. villosulum* (nat?), and *Osmia niveata* (nat) occur mainly in this zone. The temperate humid to hyperhumid zone is generally not a very favourable habitat for wild bee species worldwide (MICHENER, 2007). Exceptions are species of the genus *Bombus*, here *B. terrestris lusitanicus*, which is also present with about 30% in zones a) to c). The occurrence of the endemic species *Halictus frontalis* (with a large body size of 11 mm), mainly in the temperate zone, is remarkable. Obviously, there are microhabitats with shelter (by rocks) for successful breeding in these very humid zones (see the 'Biogeographic Characteristics and Potential Natural Vegetation' section).

The two small endemic species *Andrena wollastoni* (7.6 mm) and *Lasioglossum wollastoni* (5.5 mm) are widely distributed, but there are only few occurrences, which are found in the very dry vegetation series a). Compared to the relatively sparse occurrences of the near relatives (KRATOCHWIL *et al.*, 2021), *e.g.* in Tenerife or Gran Canaria with a lot of other competing small wild bee species, *A. wollastoni* obviously occupies a broad spectrum of habitats.

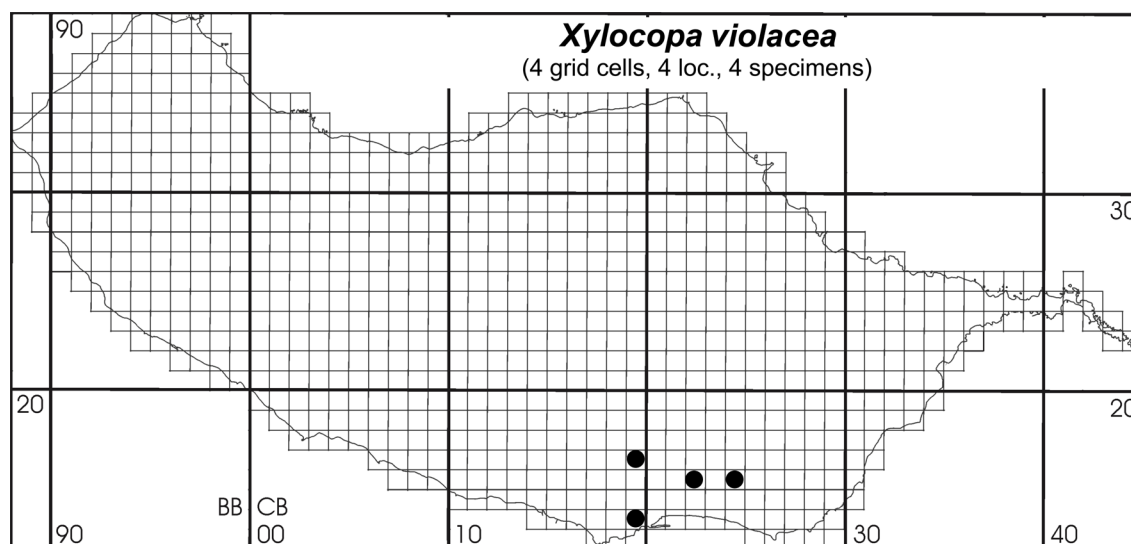


Fig. 63 – Detections of *Xylocopa violacea*.

In general, the rare species cannot be assigned to vegetation series. The endemic species *Hylaeus maderensis* has two small peaks in series a) and in series f), but it may be undersampled. All other rare species are introduced or probably introduced, and obviously have not established larger populations yet.




Flower resources for wild bee species in different vegetation series

All in all, 112 plant taxa, belonging to 39 plant families, had been recorded as pollen / nectar resources for wild bee species in our data base (816 females including in

the case of *Bombus* workers and queens; 193 males; and 29 individuals without assignment).

In the **dry Mayteno umbellatae – Oleetum maderensis vegetation series a)** (southern coast, Table 1, Figs. 1, 2, and 11), there is one endemic plant species, which plays an extraordinary role as a pollen and nectar resource for wild bee species: *Echium nervosum* (Bor). There are also occurrences of this plant species upwards to series d), including coastal areas on the northern slope, but in the a) series and the favourable microclimatic habitats of the b) series (see below), it is a key species. *Sinapidendron angustifolium* (Bra, Fig. 2) and *Aeonium glutinosum* (Cra) are also visited (all rocky coastal habitats). In ruderal sites

Table 28 – Wild bee species assigned to the grid-cell system and to the specific vegetation series (columns a) to f): the percentages of qualitative occurrences in specific grid cells per vegetation series). In column g) (three grid cells) the absolute numbers are given.

		Mediterranean dry to subhumid vegetation series			Transition zone	Temperate humid to hyper-humid vegetation series			
Dominant vegetation series/grid cell (Abbr., see Table 1)		May-OI	Hel-Si	Sem-Ap 1	Sem-Ap 2	Cle-Oc	Pol-Er	Arm-Pa	
Designation to vegetation series (Table 1)		a	b	c	d	e	f	g	
Sta- tus	number of all square grids (n = 826)	53	44	90	170	410	53	6	
	number of representative square-grid cells with bee data (n = 251)	21	17	29	61	104	16	3	
presence in square-grid cells		%	%	%	%	%	%	absolute	
Species with main occurrences in the Mediterranean veg.series:									
end	<i>Amegilla quadrifasciata maderae</i>	71	59	21	30	8	13	1	sum cells 54
intr?	<i>Bombus ruderatus</i>	48	35	38	15	10	6	2	49
nat?	<i>Lasioglossum v. villosulum</i>	52	18	46	35	21	13	1	72
end	<i>Andrena maderensis</i>	29	35	18	17	13	.	.	39
end	<i>Osmia maderensis</i>	29	53	32	20	10	6	.	47
nat	<i>Osmia niveata</i>	24	41	32	13	2	6	1	33
Species with main occurrences in transitions/temperate veg.series:									
nat	<i>Bombus terrestris lusitanicus</i>	38	35	36	43	54	56	2	115
end	<i>Halictus frontalis</i>	5	6	21	18	15	31	2	42
Species with broad amplitudes in veg.series:									
end	<i>Andrena wollastoni</i>	14	35	54	37	38	38	1	92
end	<i>Lasioglossum wollastoni</i>	15	35	38	42	15	31	2	73
Rare species, no assignment to veg.series									
end	<i>Hylaeus maderensis</i>	10	.	7	2	3	13	1	11
intr	<i>Hoplitis acuticornis</i>	.	.	.	2	2	13	2	7
intr	<i>Xylocopa cf. violacea</i>	5	.	7	2	.	.	.	4
intr?	<i>Megachile versicolor</i>	.	.	.	.	1	6	2	4
intr	<i>Anthidium manicatum</i>	5	.	.	.	.	.	.	1
intr	<i>Megachile pusilla</i>	5	.	.	.	.	.	.	1
intr	<i>Hylaeus s. signatus</i>	.	.	4	.	.	.	.	1
intr	<i>Stelis ornatula</i>	.	.	.	.	1	.	.	1
number of detected bee species/veg.series		14	10	13	13	14	12	11	
percentages			highest		2nd highest		3rd highest		

especially, the native plant species *Bituminaria bituminosa* (Fab), *Crepis vesicaria*, *Galactites tomentosa*, and *Leontodon taraxacoides* subsp. *longirostris* (all Ast) are important pollen and nectar plants.

The **lower subhumid type Helichryso melaleuci – Sideroxyetum marmulanae series b** (Table 1, Figs. 3, 4, and 11), is especially developed in the southeastern coastal parts of Madeira Island, including 'Ponta de São Lourenço'. In this vegetation series, two endemic plant species, *Echium nervosum* (Bor) as well as *Sinapidendron angustifolium* (Bra), are present as pollen and nectar resources. *Argyranthemum pinnatifidum* subsp. *succulentum* (Ast), among others, is also important. Native ruderal and other species such as *Bituminaria bituminosa* (Fab), *Crepis vesicaria*, *Galeopsis tomentosa*, *Leontodon taraxacoides* subsp. *longirostris* (all Ast), *Raphanus r.* subsp. *raphanistrum* and *Rapistrum rugosum* s.l. (both Bra) also play a role.

The **higher subhumid type Semele androgynae – Apollonietum barbujae 1 series c** (Table 1, Fig. 11), mainly found at south-facing lower altitudes (above type a), shows the importance of the two endemic plant species *Sinapidendron angustifolium* (Bra) and *Aeonium glutinosum* (Cra), and of the species *Crepis vesicaria*, *Galactites tomentosa* (both Ast), and *Reseda luteola* (Res).

The transition form from the Mediterranean to the temperate zone, the **lower humid type Semele androgynae – Apollonietum barbujae 2 series d** (Table 1, Figs. 5, 6, and 11) shows the importance of the two endemic taxa *Andryala glandulosa* subsp. *glandulosa* (Ast) and *Aeonium glandulosum* (Cra) on rocky sites as pollen and nectar resources. The native plant species *Bituminaria bituminosa* (Fab), *Crepis vesicaria* s.l. (partly the endemic *C. andryaloides*), *Galactites tomentosa*, and *Leontodon taraxacoides* subsp. *longirostris* (all Ast) are also important pollen and nectar plants.

In the **humid to lower hyperhumid type of potential Laurisilva vegetation: Clethro arborea – Ocoteetum foetentis series e** (Table 1, Figs. 7, 8, and 11) there are some elements of the Laurisilva vegetation complex that are important as pollen and nectar resources for wild bee species, especially the endemic species *Melanoselinum decipiens* (Api), *Clethra arborea* (Cle), *Echium candicans* (Bor), *Geranium maderense* (Ger), *Vaccinium padifolium* (Eri), *Andryala glandulosa* subsp. *glandulosa* (Ast), and the Macaronesian *Erysimum bicolor* (Bra). Parts of this series have been transferred in intensively grazed areas, rich in the introduced *Ulex europaeus* (Fab, see also type f), visited by *Bombus terrestris lusitanicus*. Parts of the series are also characterised by ruderal vegetation (especially *Galactites*

tomentosa and *Leontodon taraxacoides* subsp. *longirostris*; both Ast). Further, a lot of traditional vegetable gardens exist in this humid area, with flowering *Brassica oleracea* (Bra) as a very important pollen and nectar resource. Flowering cabbage plants are grown for seed production and traditional Madeiran food. *Bombus terrestris lusitanicus*, and to a lesser extent *Andrena maderensis*, are the main pollinators of *B. oleracea*, which depends on cross-pollination (KITASHIBA & NASRALLAH, 2014). The introduced *Oxalis pes-caprae* (Oxa) and *Tropaeolum majus* (Tro) are characteristic in this humid series too, they are used by *Bombus terrestris lusitanicus* especially.

There are not many data from the temperate hyperhumid vegetation series **Polysticho falcinelli – Ericetum arborea f** and **Armerio maderensis – Parafestucetum albidae g** (Table 1, Fig. 11). In both cases, there are observations on the endemic plant species *Echium candicans* (Bor, often also planted, e.g. in the case of restoration projects). The introduced and invading shrub in heavily grazed pastures *Ulex europaeus* (Fab, Fig. 9) is a pollen and nectar resource for *Bombus terrestris lusitanicus*. Tiny *Taraxacum* taxa in the grazed areas (e.g. the introduced *T. hamatum*) play a role as pollen and nectar resources for *Halictus frontalis* and *Lasioglossum v. villosulum*. Large areas show monodominant stands of *Ulex europaeus*, but there are efforts to enlarge and restore the typical high-altitude tree-heath series with the endemic *Vaccinium padifolium* (visited by *Bombus terrestris lusitanicus* and *Andrena wollastoni*) and other species of the tree-heath community (Fig. 10), e.g. in Paúl da Serra.

Remarkably, there was not a single flower visit of *Erica arborea* (Eri) which offers millions of flowers in the early year in different vegetation series [a) to f)], recorded in the whole data base.

Females of the occurring wild bee species and their plant-family spectrum

The flower-visiting and pollinating females (including in the case of *Bombus* queens and workers) are presented separately in Fig. 64 to demonstrate relationships between specific plant families and bee species. We present only bee females with higher numbers of interactions. The oligolectic behaviour or preference of certain plant families of *Andrena maderensis* (Bra), *Halictus frontalis*, *Lasioglossum v. villosulum*, *Osmia madeirensis*, and *O. niveata* (all Ast) on Madeira Island is now shown with empirical data. All other bee species are polylectic, but in the case of *Andrena wollastoni* and *Lasioglossum wollastoni*

two families (firstly Ast, secondly Bra) predominate. In the whole *Andrena wollastoni* group (six species on Madeira Island, Porto Santo, Tenerife, Gran Canaria, La Palma, La Gomera) only two species show this behaviour; all others prefer Brassicaceae (KRATOCHWIL & SCHWABE, 2020). The key species *Echium nervosum* (Bor), with simple foraging availability of large pollen and nectar quantities, is especially frequently used by the supergeneralists in the sense the term is used by VALIDO & OLESEN (2010): *Amegilla q. maderae*, *Bombus terrestris lusitanicus*, and *B. r. ruderatus*. In our study, the latter three species visited a very broad range of nine to 27 plant families (see also Tables 23, 25, and 27).

Threats to the endemic and native bee fauna of Madeira Island

Knowledge about the wild bee fauna of Madeira Island was very incomplete until yet now, as is shown, *e.g.*, by the treatment of the endemic species in the 'IUCN Red List of Threatened Species'. *E.g.*, for the endemic bee *Halictus frontalis*, only the occurrences in clearings of the Laurel Forest are named (MICHEZ *et al.*, 2013), and not the considerable populations in the tree-heath zone f). Although this study resolves some data deficits, there are still gaps in knowledge, *e.g.* those concerning *Hylaeus maderensis*, as already stated by DATHE (2013).

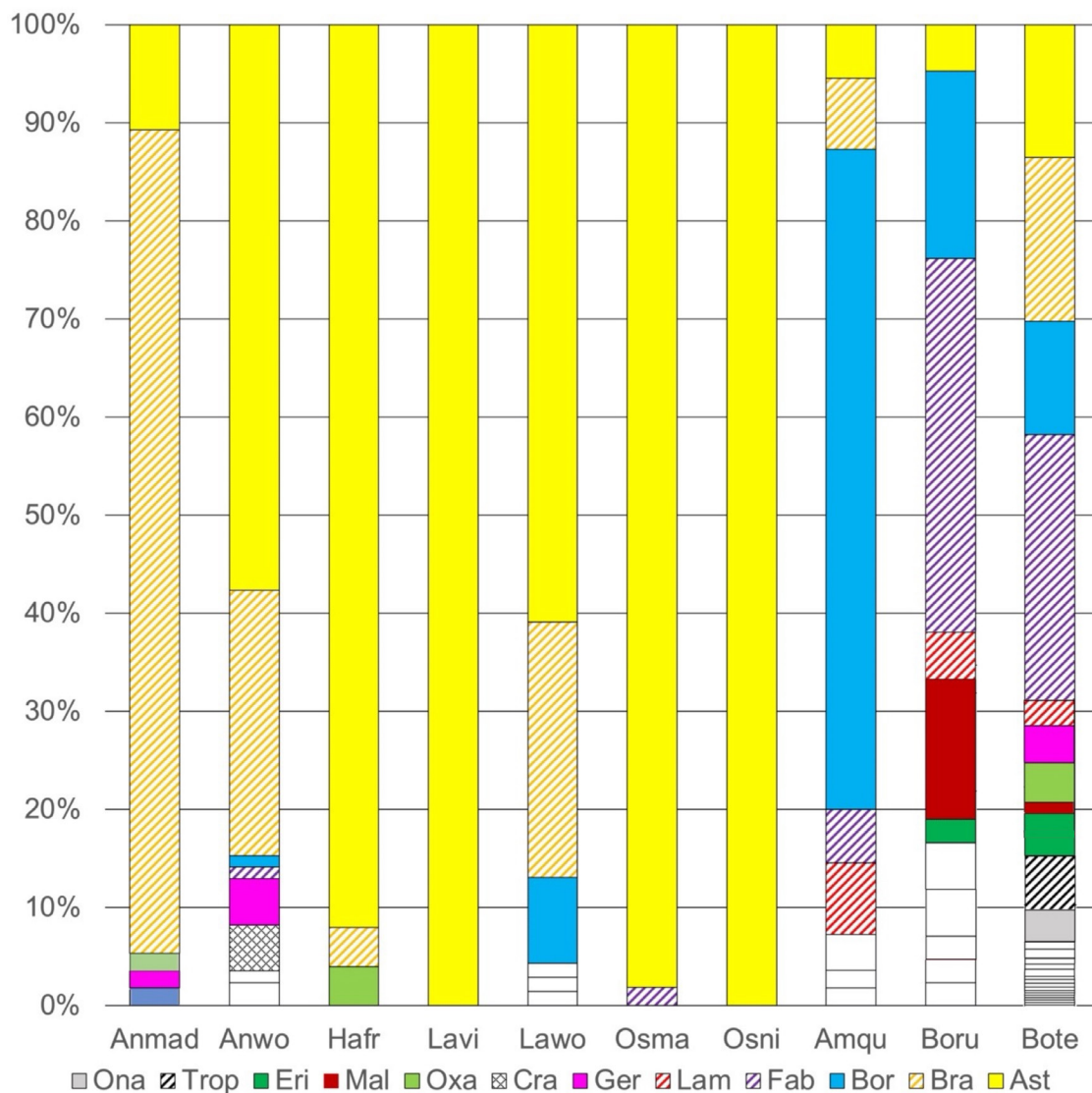


Fig. 64 – Plant-family spectrum visited by females (incl. *Bombus*: workers and queens) of the 10 most common wild bee species (n = 803 flower visits). White crossbars are not differentiated by colours (original values of interactions in brackets): Anwo = Api (1), Poa (2); Lawo = Api (1), Hyp (1), Pap (1), Scr (1); Boru = Cac (1), Co (1), Cuc (2), Pap (2), Ros (1), Scr (2); Amqu = Aiz (1), Cuc (2), Scr (1), Ver (1); Bote = Aca (2), Api (2), Big (2), Con (1), Cra (1), Cuc (1), Eup (1), Lil (4), Pap (3), Pas (4), Pla (1), Sax (3), Sol (3), Str (2).

According to the 'European Red List of Bees' (NIETO *et al.*, 2014) the major threats to bees in Europe are (1) agricultural expansion / intensification; (2) livestock farming and ranching; (3) pollution, especially from neonicotinoid pesticides; and (4) residential / commercial development. On Madeira Island, (4) is relevant mainly for the southern slopes and (2) mainly for the potential tree-heath zone f (Paúl da Serra and vicinity, northern slopes in the northwestern region, and others). Additionally, the plantations, especially of *Eucalyptus*, lead to understorey vegetation that offers no pollen and nectar resources for wild bees or to a lack of any field-layer vegetation at all because of the nearly undecomposable litter; only the flowers of *Eucalyptus* are used by honeybees.

Due to the strong relief and the construction of a large-area nature protection system there are still considerable sites of valuable coastal vegetation as well as large areas of Laurisilva forest and the typical vegetation complex. The whole island has diverse ruderal sites with rich pollen and nectar resources for wild bees, and especially on the northern slopes, where there is still traditional farming, and house gardens are rich in flowering vegetables (*e.g.* the self-incompatible *Brassica oleracea*) as well as ruderal plant species. The ornamental gardens are used by wild bee species (*e.g.* *Wisteria sinensis* by *Bombus terrestris lusitanicus*). Some of the introduced plant species, *e.g.* *Carpobrotus edulis* (Aiz), *Gazzania* sp. (Ast), *Ageratina adenophora* (Ast.) have limited or no importance as resources for wild bee species. A very important and dangerous threat is, that in the context of tomato crop cultivation in greenhouses, *Bombus* species or subspecies may be imported as pollinators and escape (DAFNI *et al.*, 2010)².

Other wild bee species may also be introduced (as had already taken place; see Table 3) and compete with the endemic and native taxa, which should be prevented by strict controls, *e.g.* of introduced plant material.

Among the endemic bee species of Madeira Island, the females of *Halictus frontalis* are not able to find plenty of pollen in the intensively grazed pasture areas of vegetation series f) (Pol-Er). This vegetation series was newly detected in this study as an important habitat type for *H. frontalis*. High nature-value (HNF) farming (CABALLERO, 2007) would enhance the necessary flower resources of Asteraceae (*e.g.* of the *Taraxacum* group as *T. hamatum*) and further restoration measures to create tree-heath stands (already in progress) that can serve as 'islands' with different flowering resources for different bee species. All other endemic and native bee species obviously have plenty of pollen and nectar resources.

Outlook

The wild bee fauna of Madeira Island is composed of a very limited number of species. These wild bee taxa are endemic or native species; a possible exception is *L. v. villosulum* (probably native). Many of them are widespread. None of the endemic species has undergone further evolutionary inter-island radiations on the island of Madeira, as was the case, *e.g.* with *Hylaeus* in Hawaii (MAGNACCA & KING, 2013), and also to a lesser extent on the subspecies level in the *Andrena acuta* – group (Tenerife, near relative to *A. wollastoni*) (KRATOCHWIL, 2020). In Tenerife, a colonisation after the connection of the former palaeo-islands is supposed. There were then 'inland islands' covered with vegetation and surrounded by lava flows (the 'kipuka scenario' presented by MACHADO, 1976, MACHADO *et al.*, 2017). 'Kipukas' are the remnants of the original habitats in the area surrounded by lava flows (VANDERGAST & GILLESPIE, 2004).

There was only a splitting of species (*Andrena dourada* versus *A. wollastoni*, *Andrena portosantana* versus *A. maderensis*) between the much older island of Porto Santo and Madeira Island (KRATOCHWIL, 2020). The origin

² PRYS-JONES *et al.* (2018) assume that *Bombus terrestris* in the Azores is a more recently introduced species related to introduction for crop pollination (*e.g.* tomatoes). They cite its low genetic differentiation (barcoding analyses by WEISSMANN *et al.*, 2017) and current presence on all nine islands of the Azores as justification for this position. The companies that manage breeding and shipping of *Bombus* individuals for crop pollination are Koppert (Straelen, Germany) and Biobest (Westerlo, Belgium). These introduced bumblebees belong to the central European subspecies *B. t. terrestris*. However, an evaluation of a larger series of bumblebees from S. Miguel (Azores), collected by A. Kratochwil and A. Schwabe in May 2022, has shown (n.p.) by morphological analysis that the populations correspond to *B. t. lusitanicus* Krüger, 1956 (RASMONT

et al., 2008). The barcoding results of WEISSMAN *et al.* (2017) cannot be used, as only few specimens were analysed and in general the subspecies level can hardly be distinguished by this method. COI sequences of specimens of H. Schaefer (Technical University, Munich, Germany) from the Azores B65-B67, acc. no. KX824773-75, were identical on the one side to a sequence of *B. terrestris* sequence from Denmark and on the other side to a sequence of *B. maderensis* Erlandsson, 1979 (= *B. terrestris lusitanicus*) from Madeira in GenBank. The queens and workers from Madeira Island can also be clearly morphologically assigned to the subspecies '*lusitanicus*'. However, introgression with the Central European populations is always possible, and it is a gradual process that ultimately dissolves the subspecies boundaries.

of these species that evolved into endemic ones was demonstrated in the case of *Andrena wollastoni* and *A. maderensis* (KRATOCHWIL, 2020, KRATOCHWIL *et al.*, 2021). Their ancestors originated from North Africa. Other species, such as *Bombus terrestris lusitanicus*, *B. r. ruderatus*, or *Amegilla quadrifasciata* s.l. originated from southern Europe. Introduced species usually have a Central European origin. Among the endemic species, *Andrena wollastoni*, which is only 7.6 mm in female body size (males 6.4 mm), plays a major role as a generalist. Considering the differences in the climatic-hygic conditions of the vegetation series, this is astonishing. The ancestors of *A. wollastoni* from the Canary Islands (KRATOCHWIL *et al.*, 2021) have much smaller niche widths (KRATOCHWIL & SCHWABE, 2020). The endemic species *Lasioglossum wollastoni* shows a similar habitat amplitude as *A. wollastoni*.

Four species with larger body sizes occur, mainly in the temperate zone of the island, as well as in zones a) to c): *B. terrestris lusitanicus* (queen: body size: 20-25 mm, worker: 12-18 mm) and the endemic *Halictus frontalis* (body size: 11 mm, preference for Asteraceae), along with *Amegilla q. maderae* (14-15 mm) and the probably introduced *B. r. ruderatus* (queen: body size 21-24 mm, worker: 11-18 mm).

The few wild bee species of Madeira Island cover a considerable number of plant species and plant family spectra in their flower-visiting behaviour, and ensure pollination for most of them. Whether the wild bee community of Madeira Island is saturated or not is difficult to answer. It appears that the introduced wild bee species currently do not have a large dispersal potential. However, long-term monitoring is absolutely necessary, as discussed in the example of introduced *Bombus terrestris* colonies (DAFNI *et al.*, 2010).

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