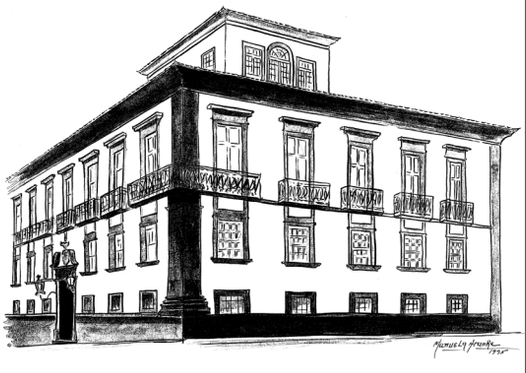

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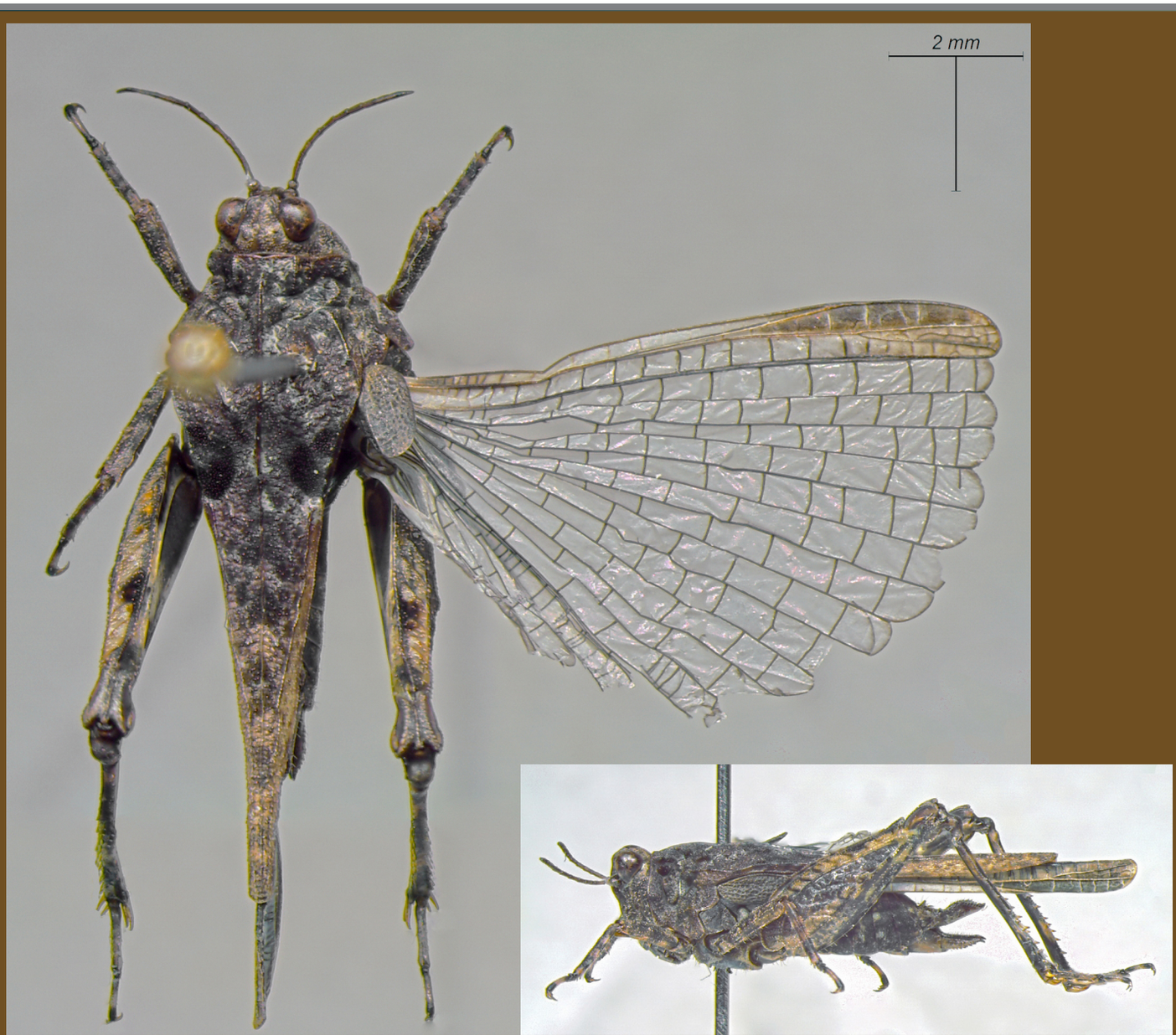

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Editor:
Manuel José Biscoito
Departamento de Ciência e de Recursos Naturais da CMF
E-mail: manuel.biscoito@cm-funchal.pt

Co-editores // Associated editors:
António Franquinho Aguiar
Laboratório de Qualidade Agrícola da Madeira
E-mail: antonio.aguiar@madeira.gov.pt
Ricardo Araújo
Museu de História Natural do Funchal
E-mail: ricardo.araujo@cm-funchal.pt
Francesca Zino
E-mail: f@zino.co.uk

Secretária editorial // Editorial board secretary:
Ivelice Gonçalves
Departamento de Ciência e de Recursos Naturais da CMF
E-mail: ivelice.goncalves@cm-funchal.pt

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Secretariado e correspondência // Address:
Museu de História Natural do Funchal
Rua da Mouraria, 31
9004-546 Funchal
Madeira – Portugal
Telefone // Phone: (+351) 291 229761
Fax: (+351) 291 225180
E-mail: mmf.pubs@cm-funchal.pt

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Comments on the butterfly fauna (Papilionoidea) of Porto Santo (Madeira Archipelago): species list, distribution patterns, and butterfly-plant network

By A. Kratochwil [1*], A. Schwabe [2] & A. M. Franquinho Aguiar [3]

With 2 figures and 3 tables

[1] *Department of Biology/Chemistry, Ecology Section, University of Osnabrück, Barbarastr. 13, D-49069 Osnabrück, Germany.*

[*] *Corresponding author: anselm.kratochwil@biologie.uni-osnabrueck.de*

[2] *Department of Biology, Technische Universität Darmstadt, Schnittspahnstr. 10, D-64287 Darmstadt, Germany.*

[3] *Entomology Lab, Laboratório de Qualidade Agrícola, Secretaria Regional de Agricultura e Pescas, Caminho Municipal dos Caboucos, 61, 9135-372 Camacha, Madeira, Portugal.*

ABSTRACT: Porto Santo (Madeira Archipelago) is a relatively old (11.1 to 14.3 Ma) and small volcanic island in the Atlantic Ocean. The main part of the island is characterised by semiarid climate and xeric vegetation, while the higher altitudes show subhumid conditions. So far, 11 butterfly species (Papilionoidea) have been detected on Porto Santo. The occurrence of *Macroglossum stellatarum* (Sphingidae) is published for the first time. The butterfly species of Porto Santo are commented and some comparisons with Madeira Island are discussed.

The distribution of butterfly species on Porto Santo was studied during March 2017 (Papilionoidea; n = 204). Some observations of previous years were added (n = 21) and *Macroglossum stellatarum* (Sphingidae; n = 3) was also included. The butterfly-plant network was sampled during March 2017 (115 flower visits).

Three species (*Colias croceus*, *Pieris rapae* and *Vanessa cardui*) show a wide occurrence on Porto Santo. As an exception, *Vanessa vulcania* prefers the subhumid regions. *Leptotes pirithous*, *Macroglossum stellatarum*, *Pararge aegeria* (which all newly colonised Porto Santo), and the migratory *Danaus plexippus* show a scattered distribution. On the whole, 115 butterfly-plant interactions could be recorded. The network shows more plant than butterfly species and is asymmetric: Seven butterfly species used 15 plant species. The butterfly and plant species were interconnected. The woody *Echium* species, *E. nervosum* (endemic to the Madeira Archipelago) and *E. portosanctensis* (endemic to Porto Santo), including hybrids, are key species as nectar resources for *Vanessa atalanta*, *V. cardui*, and *V. vulcania*. *Vanessa vulcania* could be found only within one grid in the north of the island at an altitude of 235 m *a.s.l.* *Vanessa vulcania* is probably a remnant of an earlier time period, where – due to lack of human impact – larger areas with microforests and in part *Apollonias barbujana* laurisilva existed.

Keywords: Lepidoptera, Papilionoidea, Sphingidae, island biogeography, butterfly diversity, *Vanessa vulcania*, Madeira Archipelago, Porto Santo.

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RESUMO: Porto Santo (Arquipélago da Madeira) é uma pequena ilha vulcânica relativamente antiga (11.1 a 14.3 Ma) situada no Oceano Atlântico. A parte principal da ilha é caracterizada por ter um clima semiárido e vegetação xérica, enquanto as altitudes mais altas mostram condições sub-húmidas. Até agora, 11 espécies de borboletas (Papilionoidea) foram detectadas no Porto Santo. A ocorrência de *Macroglossum stellatarum* (Sphingidae) é publicada pela primeira vez. As espécies de borboletas do Porto Santo são comentadas e algumas comparações com a ilha da Madeira são discutidas. A distribuição das espécies de borboletas no Porto Santo foi estudada durante março de 2017 (Papilionoidea; n = 204). Algumas observações de anos anteriores foram adicionadas (n = 21) e *Macroglossum stellatarum* (Sphingidae; n = 3) também foi incluído. A rede de plantas de borboletas foi amostrada durante março de 2017 (115 visitas de flores). Três espécies (*Colias croceus*, *Pieris rapae* e *Vanessa cardui*) são bastante frequentes no Porto Santo. Como exceção, *Vanessa vulcania* prefere as regiões sub-úmidas. *Leptotes pirithous*, *Macroglossum stellatarum*, *Pararge aegeria* (todas introduções recentes no Porto Santo), e a espécie migratória *Danaus plexippus* migratórias mostram uma distribuição mais dispersa. No total, foram registradas 115 interações borboleta-planta. A rede inclui mais plantas do que espécies de borboletas e é assimétrica: sete espécies de borboletas usaram 15 espécies de plantas. As espécies de borboletas e plantas estavam interligadas. As espécies lenhosas do género *Echium*, *E. nervosum* (endémica do arquipélago da Madeira) e *E. portosanctensis* (endémica do Porto Santo), incluindo os seus híbridos, são espécies-chave como recursos de néctar para *Vanessa atalanta*, *V. cardui*, e *V. vulcania*. *Vanessa vulcania* só foi encontrada dentro de uma grade no norte da ilha a uma altitude de 235 m. *Vanessa vulcania* é provavelmente um remanescente de um período de tempo anterior, em que – devido à falta de impacto humano – existiam áreas maiores com microflorestas, assim como Laurissilva do Barbusano.

Palavras-chave: Lepidoptera, Papilionoidea, Sphingidae, biogeografia de ilhas, diversidade de borboletas, *Vanessa vulcania*, Arquipélago da Madeira, Porto Santo.

INTRODUCTION

The first list of Papilionoidea of Madeira Island (seven species) was published by Felder (1862), based on specimens collected during the Novara Expedition (1857-1859), the first broad-scale scientific mission of the Austrian Imperial Navy (Basch-Ritter, 2008). The collector was the Austrian zoologist Georg von Frauenfeld (1807-1873), though he did not visit Porto Santo.

In nine expeditions, the British entomologist Thomas Vernon Wollaston (1822-1878) collected much more intensively from the Madeira Archipelago (Machado, 2006), including Madeira Island, the Desertas Islands, and Porto Santo. His main interest was the study of Madeiran Coleoptera (Wollaston, 1854), but also Hymenoptera (*e.g.*, wild bees; Kratochwil, 2018) and Lepidoptera (Karsholt, 2000). For generations, this immense material served as a base for further analyses, which resulted in numerous publications and species descriptions. Baker (1891) analysed the Papilionoidea (11 species) collected by Wollaston and commented the list (*e.g.*, abundancy, morphological features, differences to mainland forms), but without further information (*e.g.*, on which island they had been collected). As a rule, Wollaston had labelled or colour-marked the specimens according to the islands where they were collected, or (in most cases) had numbered and listed them in books (Machado, 2006). However, Baker (1891) obviously did not consider localities as important. Furthermore, most of the details had been documented by Wollaston in lists, but some of them were hard to find or lost. Baker (1891) was the first who mentioned *Macroglossum stellatarum* in relation to Madeira Island.

Rebel (1917) listed 13 Papilionoidea species for the Madeira Archipelago without further comments and without notes of the occurrences on different islands; Rebel (1940) listed 11 species (without *Pieris rapae* and *Vanessa atalanta*, mentioned in Rebel, 1917). A more detailed list by Martin (1941) refers only to Madeira Island.

The first list of the Papilionoidea of Porto Santo was published by Carvalho (1983). In 1980 and 1981, he observed four species in one locality (Achada de Baixo): *Pieris rapae*, *Colias croceus*, *Lampides boeticus*, and *Vanessa cardui*. His list also included *Vanessa indica occidentalis*, cited by Baker (1891), but the Sphingid species *Macroglossum stellatarum* was not mentioned. Owen *et al*. (1987) listed 14 species for Madeira Island.

A comprehensive overview of the butterflies of the Madeira Archipelago was given by Meyer (1993).

He distinguished the different islands of the Madeira Archipelago and found the following species numbers without vagrants: Madeira Island, 14 species; Porto Santo, five species; Deserta Grande, Bugio, Selvagem Grande, and Selvagem Pequena, one species each. Owen & Smith (1993) analysed the butterfly fauna of Macaronesia and stated the same species numbers for Madeira Island and Porto Santo as Meyer (1993).

An updated list of the butterflies of the Madeira Archipelago was presented by Aguiar & Karsholt (2006). The first distribution maps of the endemic butterflies (Papilionoidea) of Madeira Island were produced by Wakeham-Dawson *et al*. (2002a), but distribution maps of all species were not available. Wakeham-Dawson *et al*. (2002b) also provided some further notes of the butterflies of the Madeira Archipelago, and Wakeham-Dawson *et al*. (2004) presented the last published checklist of Madeira Island (13 species) and Porto Santo (10 species).

Although numerous studies have already focused on the butterflies of Porto Santo, their distribution patterns and networks with flowering plants have not been studied until now.

An overview of wild bees (Hymenoptera, Anthophila) on Porto Santo has been recently published by Kratochwil & Schwabe (2018), which proves the existence of a wide distribution of most wild-bee species – except for the bumblebee *Bombus terrestris lusitanicus*, which prefers the subhumid regions – and demonstrates the significant importance of the *Echium* species for flower-visiting bees.

The following topics will be presented in this study:

(1) a commented checklist of butterfly species of Porto Santo;

(2) a first overview of the distribution patterns of 11 butterfly species occurring on Porto Santo and their nectar resources;

(3) the structure of the butterfly-plant network in Porto Santo.

Physico-geographical factors

Porto Santo is a relatively old (11.1 to 14.3 Ma) and small volcanic island (area 42 km^2) within the Madeira Archipelago (Geldmacher *et al*., 2000), with latest volcanic activities occurring about eight million years ago (Cook, 2008). The island is separated from Madeira Island by an ocean bed more than 2000 m deep.

Geologically Porto Santo has a volcanic base, and the summits (*e.g*., Pico do Facho 517 m *a.s.l*., Pico da Gandaia 499 m *a.s.l*., Pico Branco 451 m *a.s.l*.) are characterised mainly by trachyte and basaltic structures. More than a third of the island is covered by quaternary sediments, mainly between the northeastern and southwestern mountain areas. Calcareous sand from the Pleistocene period formed eolianites, which is solidified with more than 50 m vertical thickness in part. The southern coast is dominated by a long sandy beach, while the other parts of the coast are characterised by steep cliffs. Perennial water currents are not present, but some perennial springs exist (Faust-Lichtenberger, 1988).

The bioclimate was classified as Mediterranean xeric oceanic by Rivas-Martínez (2009) with a pronounced summer aridity. Precipitation values are very low from June to August (376 mm/a), while mean temperature varies between 15.7 °C (February) and 22.8 °C (August).

There are only few habitat types, and for the last 500 years there has been a strong anthropogenic impact. There are about 446 phanerogamic plant species (nine endemic species for Porto Santo, 29 endemic species for the Madeira Archipelago, and 19 endemic species for Macaronesia). All in all, 286 plant species are (probably) native, and 103 species are (probably) introduced (Jardim & Menezes de Sequeira, 2008; Jardim & Menezes de Sequeira, 2011; Jones *et al*., 2014; Kratochwil & Schwabe, 2018).

The island was cleared to a great extent from woody vegetation (original vegetation: mainly dry microforests of Mayteno umbellatae-Oleo maderensis sigmetum). From the end of the 18th century, afforestations were made with *Pinus pinaster* and *Pinus halepensis*. Most habitats belong to the *Olea maderensis* series (Mayteno umbellatae-Oleo maderensis sigmetum); Capelo *et al*. (2004, 2005). The *Echium* species are the main nectar sources for many butterflies. The natural distribution of *E. nervosum* is concentrated in the southern part, while *E. portosanctensis* occurs naturally in the subhumid zone (Carvalho *et al*., 2010). *Echium nervosum* can also be found in plantings near the roads, while *E. portosanctensis* was planted in the northern part (hybrids exist). Small elements of the subhumidic series are still present around the main summits and on the north-facing slopes (Capelo *et al*., 2004).

Extended sand habitats occur especially in the southeastern part of the island and are relatively rich in *Lotus glaucus*. There are also drift walls with *Cakile maritima*, as well as halonitrophytic rocky and sandy sites with *Matthiola maderensis*, *Mesembryanthemum crystallinum*, and *Senecio incrassatus*. The island has a very rich ruderal flora and vegetation, now mainly characterising fallow land. Ruderal plant species such as *Asphodelus fistulosus*, *Convolvulus althaeoides*, *Rapistrum rugosum*, and *Sonchus oleraceus* play a role as nectar resources for butterflies.

METHODS

Butterfly database

We observed the butterflies of Porto Santo mainly during one visit from 19 to 31 March 2017 (A. Kratochwil and A. Schwabe). We recorded the distribution pattern of the butterflies and their interactions with plants. Qualitative observations from the dry spring of 2012 (16-20 March) preceded the 2017 study. Due to the presence of masses of flowers after the relatively wet winter in 2016/2017 (see Kratochwil & Schwabe, 2018), the time period in March 2017 was very good for butterfly monitoring.

Our approach covered the main habitat types. All in all, we monitored 45 sites in the northern and southern parts of the island – most localities with a full xeric, some localities with a subhumid mesic-xeric bioclimate. The number of observation sites reflected the proportion of the climatic types on the island. Most of these sites were identical with the wild-bee sampling sites (Kratochwil & Schwabe, 2018). We were not able to observe butterflies in the flat central part of the island (airport, golf course) because access to the area was not permitted. The GPS data of all the collected or observed butterfly species were recorded with a Garmin Oregon 700.

We recorded ten butterfly species and 204 butterfly individuals (Table 1), including 115 flower visits. Fourteen further observations by A. F. Aguiar were included in the database (six species from nine localities, and five flower visits on three plant species). Additionally, seven specimens collected on Porto Santo were found in the collections of the Museu de História Natural do Funchal (Madeira, Portugal).

Data analysis

The localities were plotted on a grid (1 km x 1 km) based on the military map of the Madeira Archipelago (2004). Interaction networks were analysed using the bipartite package (Dormann *et al*., 2008; R Core Team, 2018).

RESULTS AND DISCUSSION

Commented checklist of the butterfly species of Porto Santo

We were able to analyse the distribution pattern of 11 species (Table 2, Fig. 1), which are commented below. The Sphingid *Macroglossum stellatarum* (three observations, two flower visits observed) was included in the analysis.

We observed the following species (in alphabetical order):

Colias croceus (Geoffroy in Fourcroy, 1785)

This Palaearctic migrating species – widespread in Europe except the North (occurring in southern Scandinavia, Baltic states; see Tolman & Lewington, 1997), but common in Central and Southern Europe, and with further distribution in North Africa and Southwest Asia (Tshikolovets, 2011) – is native to the Madeira Archipelago and the Canary Islands (Tolman & Lewington, 1997).

On Madeira Island, *C. croceus* was very common on open sites (Salmon & Wakeham-Dawson, 1999), and in July and August 1998, was the most abundant butterfly on the island (Salmon & Wakeham-Dawson, 1999). The main distribution is concentrated in dry coastal areas and near human settlements (Meyer, 1993). *Colias croceus* occurs at all altitudes from sea level up to 1,800 m *a.s.l.* (Meyer & Hellers, 1990; Kudrna, 1997; Salmon & Wakeham-Dawson, 1999). Swash & Askew (1982) reported that *C. croceus* is the most abundant Madeiran butterfly at altitudes above 1,600 m *a.s.l.* *Colias croceus* was also recorded on Porto Santo (Meyer & Hellers, 1990; Aguiar & Karsholt, 2006).

It is suggested that this species (probably) breeds on Madeira Island (Vieira, 1999; Wakeham-Dawson & Aguiar, 2003; Wakeham-Dawson *et al*., 2004). The ratio between breeding and migrant individuals is unknown, but it seems that vagrants are in minority.

Salmon & Wakeham-Dawson (1999) present different varieties (forms) of *C. croceus* from the Madeira Archipelago: var. *cremonae* Verity, 1911; var. *dawsoni* Bollow, 1930; var. *geisleri* Bryk, 1923; var. *radiata* Nitsche, 1932; and var. *faillae* Stefanelli, 1900. Fuchs (1993) also described the high variability of colour forms of *C. croceus* from Faial (Azores). Such wing colour patterns, based on phenotypic plasticity, may be produced physiologically in response to environmental stress (*e.g*., temperature, general stress response) and may be genetically fixed in a population (Otaki *et al*., 2010). This is shown particularly in the genus *Vanessa* (summarised in Hijama *et al*., 2002).

Aguiar & Karsholt (2006) reported that var. *helice* (Hübner, 1879) is rather frequently seen on Porto Santo (5-10% of all populations; Tolman & Lewington, 1997).

In the Museu de História Natural do Funchal three females of the form '*helice*' are deposited, collected in May 1942 (unknown collector, determined by J. T. Smit in 1998), and also two females of the same form, collected on 30 March 1988 by F. Zino (determined by J. T. Smit in 1998).

Table 1 – List of butterfly species of Porto Santo (MA = Madeira Archipelago, CI = Canary Islands), number of observations and number of flower visits in this study.

Family	Species	Status	Number individuals	Number flower visits
	Data from the authors and Museu de História Natural do Funchal			
Pieridae	*Pieris rapae* (Linnaeus, 1758)	native/introduced?	16	2
Pieridae	*Colias croceus* (Geoffroy in Fourcroy, 1785)	native	82	23
Lycaenidae	*Leptotes pirithous* (Linnaeus, 1758)	introduced?	12	2
Lycaenidae	*Lampides boeticus* (Linnaeus, 1767)	native	4	2
Nymphalidae	*Danaus plexippus* (Linnaeus, 1758)	native/introduced?	6	1
Nymphalidae	*Vanessa atalanta* (Linnaeus, 1758)	native	19	18
Nymphalidae	*Vanessa cardui* (Linnaeus, 1758)	native	68	58
Nymphalidae	*Vanessa vulcania* (Godart, 1819)	endemic (MA, CI)	10	10
Nymphalidae	*Pararge aegeria aegeria* (Linnaeus, 1758)	introduced	5	2
Sphingidae	*Macroglossum stellatarum* (Linnaeus, 1758)	native	3	2
	Data from other observers			
Nymphalidae	*Hypolimnas misippus* (Linnaeus, 1764)	migrant	-	-
Lycaenidae	*Lycaena phlaeas phlaeoides* (Staudinger, 1901)	endemic (MA)	-	-

Table 2 – Numbers of observed individuals, localities, and grids of 11 species. * = including data from Carvalho (1983).

	Number of grids	Localities	Individuals
Colias croceus	19	38	77
Danaus plexippus	4	4	4
Hypolimnas misippus	2	2	3
Lampides boeticus	3*	4*	4
Leptotes pirithous	5	6	12
Macroglossum stellatarum	3	3	3
Pararge aegeria	4	4	5
Pieris rapae	11	13	14
Vanessa atalanta	3	3	19
Vanessa cardui	9	14	68
Vanessa vulcania	1	2	10

Table 3 – Visited plant species and number of observations in March 2017.

	Number flower visits
Echium nervosum (including hybrids)	86
Lotus glaucus	6
Asphodelus fistulosus	5
Leontodon taraxacoides	3
Cakile maritima	2
Convolvulus althaeoides	2
Matthiola maderensis	2
Brassica nigra	1
Echium portosanctensis	1
Galactites tomentosa	1
Mesembryanthemum crystallinum	1
Oxalis pes-caprae	1
Rapistrum rugosum	1
Senecio incrassatus	1
Sonchus oleraceus	1

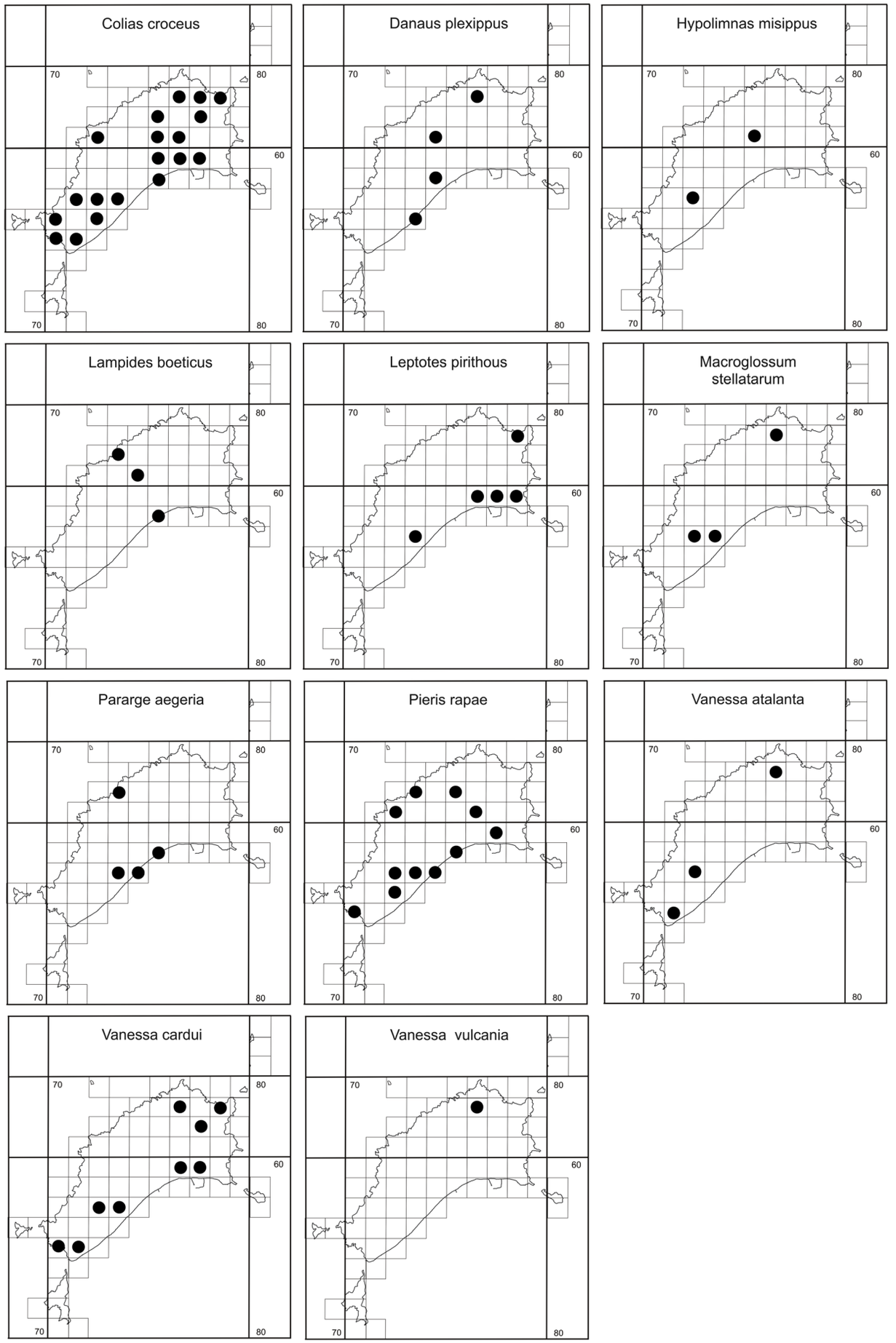

Fig. 1 – Distribution patterns of 11 butterfly species from Porto Santo.

If we use the form '*helice*' in the broader sense for all bright forms (white to yellowish wing colour; '*alba*' polymorphism), four of the specimens we observed have to be assigned to this form. So far, the literature has reported the form 'helice' only for female butterflies (Lorkovic & Herman, 1961; Limeri & Morehouse, 2016; Limeri, 2017).

Our observations demonstrate that *C. croceus* is also quite common throughout Porto Santo from sea level up to the highest mountains (19 grids, 38 localities; Fig. 1). *Colias croceus* could be detected on the flowers of ten plant species: *Asphodelus fistulosus* (Xanthorrhoeaceae) n = 5; *Brassica nigra* (Brassicaceae) n = 1; *Convolvulus althaeoides* (Convolvulaceae) n = 2; *Echium nervosum* (Boraginaceae) n = 1; *Galactites tomentosa* (Asteraceae) n = 1; *Leontodon taraxacoides* (Asteraceae) n = 3; *Lotus glaucus* (Fabaceae) n = 6; *Matthiola maderensis* (Brassicaceae) n = 2; *Mesembryanthemum crystallinum* (Aizoaceae) n = 1; and *Oxalis pes-caprae* (Oxalidaceae) n = 1.

Danaus plexippus (Linnaeus, 1758)

This species, originally native to North and Central America, nowadays has – by migration events or man-made introductions – a presence in the warmer zones (southern Portugal, southern Spain, India, Papua New Guinea, other East Indian islands, Australia, New Zealand, Hawaii, and southern Peru to Canada; Tolman & Lewington, 2008). There are migratory and non-migratory populations (Freedman *et al*., 2018). *Danaus plexippus* is classified as a migratory species in Madeira, Porto Santo, and Canary Islands (Owen & Smith, 1993). According to Aguiar & Karsholt (2006), this species has occurred periodically on Madeira Island since 1889, and was seen for the first time in Porto Santo in 1955 (Pereira, 1989). The exact date of arrival is unknown, and not recorded by Baker (1891) nor Cockerell (1923). A successful colonisation was possible because the species is able to use introduced plant species as larval food (Owen & Smith, 1989). Local populations established in the Canary Islands in 1880 or 1887 (Higgins & Riley, 1970; Leestmans, 1975; Báez, 1998), and the species was also spotted on Madeira Island (Sousa, 1986, 1991) and Porto Santo (Gardner & Classey, 1960; Vieira, 1999). The establishment on Madeira and Porto Santo is believed to have happened in August 1980 (Aguiar & Karsholt, 2006). Salmon & Wakeham-Dawson (1999) and Showler (2001) hypothesised an intended introduction. During the last two decades, *D. plexippus* has also become a resident species in the Azores (Neves *et al*., 2001).

In the Museu de História Natural do Funchal one female, collected on 14 June 1970 (unknown collector) and one male, collected in September 1957 (unknown collector), are deposited; both were determined by J. T. Smit in 1998.

One flower visit of this species was observed on *Bougainvillea* by A. F. Aguiar. On Porto Santo, *D. plexippus* was detected on four grids and in four localities (Fig. 1) flying at high speed with directed movement.

Lampides boeticus (Linnaeus, 1767)

This seasonal migratory species is widely distributed all over the world in southern regions with higher temperatures, and in subtropic and tropic zones: Southern Europe (reaching occasionally to Germany and the British Isles), North Africa, subtropical and dryer regions in South and Southeast Asia, Australia, New Zealand, and Hawaii. In Macaronesia *L. boeticus* is distributed on the Canary Islands, the Azores (Felder, 1862; Leestmans, 1974), and Madeira Island (Rebel, 1940; Meyer & Hellers, 1990; Meyer, 1993; Tolman & Lewington, 1997; Tshikolovets, 2011). On Madeira Island the species was recorded by Baker (1881), Swash & Askew (1982), and Salmon & Wakeham-Dawson (1999), and classified both as common by Owen *et al*. (1987) and as not common by Wakeham-Dawson *et al*. (2004).

Carvalho (1983) reported this species in two localities on Porto Santo (Achada de Baixo, 18 September 1980, and Farrobo, near the airport, 17 September 1980). The species was observed in two further localities (Vila Baleira, 16 July 2001; road to Fonte da Areia, 6 July 2017). *Lampides boeticus* was detected in three grids (Fig. 1) and one flower visit on *Lotus glaucus* was observed. Wakeham-Dawson & Aguiar (2003) documented egg laying on *Lotus glaucus* on Porto Santo (in July 2002).

Leptotes pirithous (Linnaeus, 1767)

The range of *L. pirithous* spans from North Africa, Southern and Central Europe, Turkey, the Middle East, Saudi Arabia, and Central Asia to India (Tolman & Lewington, 1997). The species is also present in the Canary Islands (Tshikolovets, 2011), where the first detection occurred in 1998 (Aguiar & Karsholt, 2006). Probably originating from the Canary Islands, *L. pirithous* was introduced to the Madeira Archipelago. Records of *L. pirithous* on Madeira Island and Porto Santo were reported in 2001 by Hall & Russell (2001), Wakeham-Dawson *et al*. (2002b), and Aguiar *et al*. (2002). One flower visit of this species was observed on *Rosmarinus officinalis* by A. F. Aguiar. Wakeham-Dawson *et al*. (2002b) reported observations of this species flying around *Lotus glaucus* in the sand dunes of Calheta (Porto Santo). On Porto Santo, *L. pirithous* was detected on five grids and in six localities (Fig. 1).

Macroglossum stellatarum (Linnaeus, 1758)

This migratory species has a permanent distribution in the southern Palaearctic region including North Africa, the Near East, and Pakistan, reaching eastwards to China and Japan. The northern areas are populated only in warmer months.

The first record of *M. stellatarum* was reported by Baker (1891), who characterised this species as common for Madeira Island. Further detections were reported by Rebel (1940, 1940b) and Martin (1941). *Macroglossum stellatarum* was also detected on Selvagem Grande (Aguiar & Karsholt, 2006). On Porto Santo, *M. stellatarum* was found on three grids and three localities (Fig. 1), only on flowers of *Echium nervosum* (Boraginaceae) n = 2.

Pararge aegeria aegeria (Linnaeus, 1758)

The nominal species is distributed in Maghreb, the Iberian Peninsula, the Balearic Islands, southern and southwestern France, southwestern Switzerland, Peloponnesus, Corsica, Sardinia, Sicily, southern Italy, Crete, Lesbos, Samos, Kos, Karpathos, Cyprus, southern Turkey, and the Near East (Tshikolovets, 2011). Madeira was recently colonised – the first specimen was observed by the lepidopterist Hoegh-Guldberg in 1967 on Madeira Island (Oehmig, 1983). Numerous detections of this introduced species were documented in the mid-seventies (Higgins, 1977; Oehmig, 1977, 1982; Owen *et al*., 1987; Aguiar & Karsholt, 2006). In 1981, *P. a. aegeria* was at least as common as *P. xiphia* on Madeira Island (Swash & Askew, 1981). Nowadays, *P. a. aegeria* is one of the more common butterflies on Madeira Island living in lower elevations mainly in residential areas, disturbed habitats, cultivation sites, and gardens (Lace & Jones, 1984; Owen *et al*., 1987; Shreeve & Smith, 1992; Fernández-Rubio & Garcia-Barros, 1995; Owen *et al*., 2008). It was not seen on Porto Santo in 1981 (Swash & Askew, 1982), but a single specimen was detected in 1998 (Vieira, 1999).

On Porto Santo, *P. a. aegeria* was detected on four grids and in four localities (Fig. 1) and could be observed on two plant species: *Cakile maritima* (Brassicaceae) n = 1 and *Senecio incrassatus* (Asteraceae) n = 1. Territorial and mating behaviours were noted.

Pieris rapae (Linnaeus, 1758)

This species has a trans-Palaearctic, North-African distribution including the Arabian Peninsula and subtropical Asia. It was introduced and is now resident in North America and Australia (Tshikolovets, 2011), and it is less frequent in northern Fennoscandia (Tolman & Lewington, 1997). The first indications for an occurrence on Madeira Island came from Rebel (1917), but in his checklist the taxon *P. rapae* is characterised by a question mark. In a footnote he referred to Otto Sterz, who observed *P. rapae* on Madeira Island in March 1909. A voucher specimen does not exist.

P. rapae is a recent introduction on Madeira Island and has become one of the most abundant butterfly species (Aguiar & Karsholt, 2006). According to Wolff (1975), a specimen of *P. rapae* from Madeira Island is deposited in the Museu de História Natural do Funchal, Madeira, collected on 15 December 1971. Wolff (1975) documented a single observation in 1973, but occurrence in substantial numbers started in 1974. Three years later, *P. rapae* was widespread on the island and extremely common. The altitudinal distribution of this butterfly species spans from sea level up to more than 1,500 m *a.s.l*., and it is found mainly on coastal sites and at lower altitudes (human settlements and agricultural areas).

A colonisation with established populations on Madeira Island was confirmed by, *e.g*., Oehmig (1977), Swash & Askew (1982), Lace & Jones (1984), Sousa (1986), and Meyer & Hellers (1990).

While Meyer (1993) hypothesised an introduction with vegetables from the mainland, Wolff (1975) is convinced that numerous specimens were transported from Portugal to Madeira Island during special weather periods. He pointed out a particularly favourable meteorological condition for air transport in 1974. Furthermore, Wolff (1975) stated that the specimens of Madeira must be classified as form '*metra*' (Stephens, 1824), which also occurs in Portugal.

The first record on Porto Santo was reported by Carvalho (1983) at Achada de Baixo on 17 September 1981; see also Owen & Smith (1993) and Aguiar & Karsholt (2006). Meyer & Hellers (1990) observed the species on Porto Santo, too, and it was also found on Deserta Grande (Swash & Askew, 1982).

P. rapae is quite common throughout Porto Santo (11 grids, 13 localities; Fig. 1) and could be detected on the flowers of two plant species: *Cakile maritima* (Brassicaceae) n = 1; and *Sonchus oleraceus* (Asteraceae) n = 1.

Vanessa atalanta (Linnaeus, 1758)

This migratory butterfly species is widespread throughout North America, down south to Guatemala, Cuba, Hispaniola, the Atlantic islands, North Africa, Europe, Ireland, Britain, southern Fennoscandia, the Mediterranean islands, Pakistan, Kashmir, and north of the

Himalayas to the Amur river (Field, 1971; Tolman & Lewington, 1997; Tshikolovets, 2011). The American and Old World populations were characterised as separate subspecies (Vane-Wright & Hughes, 2007).

Wollaston collected three specimens (Madeira Island, The Mount, without date), which is recorded by Baker (1891) and Rebel (1917). Swash & Askew (1982) stated that *V. atalanta* is never numerous on Madeira Island, in contrast to the observations of Wakeham-Dawson *et al*. (2004) which classified the occurrence as relatively common. The preferred habitats are human settlements with gardens (Lace & Jones, 1984; Owen *et al*., 1987; Wakeham-Dawson *et al*., 2004). *Vanessa atalanta* was also recorded on Porto Santo and Deserta Grande (Aguiar & Karsholt, 2006; see also Meyer & Hellers, 1990).

On Porto Santo, *V. atalanta* is restricted to sites with high abundancies of *Echium* flowers (3 grids, 3 localities; Fig. 1) and could be detected only on the flowers of *Echium nervosum* (Boraginaceae) n = 18.

Vanessa cardui (Linnaeus, 1758)

This cosmopolitan migratory species (except for Australia and New Zealand) is widely distributed and a permanent resident of North Africa and the Mediterranean zone (Tolman & Lewington, 2008). *Vanessa cardui* was also recorded in Venezuela (Tshikolovets, 2011). The species is resident on the Madeira Archipelago (Madeira Island, Porto Santo, Deserta Grande, Selvagem Grande and Selvagem Pequena) (Aguiar & Karsholt, 2006). On Madeira Island, the species is common from 50 to 400 m *a.s.l.* in cultivated terraces and coastal sites (Wakeham-Dawson *et al*., 2004), and, similar to *Colias croceus*, also concentrated on drier sites (abundant in Ponta de São Lourenço; Owen *et al*., 1987), and near human settlements (Meyer, 1993). *Vanessa cardui* is also quite common throughout Porto Santo from sea level up to the highest mountains (9 grids, 14 localities; Fig. 1), but not so common as *Colias croceus*.

There is evidence that this species breeds on Madeira Island but appears to be also a migrant (Owen, 1989; Salmon & Wakeham-Dawson, 1999). Breeding in winter was observed by Owen (1987).

On 18 January 1921, Cockerell (1923) collected an aberration of *V. cardui* on Porto Santo, deposited in the Oxford University Museum of Natural History (OUMNH). Such similar stress-induced colour-pattern modifications were considered as phenotypic plasticity in *V. cardui* (Otaki, 2007).

V. cardui could be detected on the flowers of three plant species, with high preference of *Echium* (Boraginaceae): *E. nervosum* n = 55; *E. portosanctensis* n = 1; and *Rapistrum rugosum* (Brassicaceae) n = 2.

Vanessa vulcania (Godart, 1819)

In the literature this species was classified as a subspecies of *V. indica* Herbst, 1797 (*e.g*., Field, 1971; Tolman & Lewington, 2008) or a species of its own (*e.g*., Bernardi, 1961; Leestmans, 1975b, 1978; Tshikolovets, 2011). Synonyms are *Pyrameis* (?) *vulcania* Godart, 1819, and *Pyrameis callirhoe* var. *occidentalis* Felder, 1862. Leestmans (1978) demonstrated the clear separation between *V. vulcania* and *V. indica*.

V. vulcania is a Macaronesian endemic species, occurring in the Madeira Archipelago and the Canary Islands (Baker, 1891; Meyer & Hellers, 1990; Tolman & Lewington, 1997; Wakeham-Dawson & Aguiar, 2003; Vane-Wright & Hughes, 2007; Tshikolovets, 2011). Within the Madeira Archipelago, *V. vulcania* was detected on Madeira Island, Porto Santo, and Deserta Grande (Meyer & Hellers, 1990; Aguiar & Karsholt, 2006).

There were also occasional detections (natural or introductions) of *V. vulcania* in Germany (Gerisch, 1975, 1978; Reinhardt & Gerisch, 1982), Western and Northern Europe (Opheim, 1960), and the Iberian Peninsula (Fernández-Vidal, 1989; Fernández-Rubio, 1991) with no establishment.

One of the first records came from Felder (1862): A male was collected during the Novara Expedition (1857-1859) by Georg von Frauenfeld on Madeira Island and described as *Pyrameis Callirhoë* Hübner, var. *occidentalis* Felder, 1862. Alfred Russel Wallace (1889) cited Wollaston (Wollaston, 1856) and noted that specimens from Porto Santo are much smaller and darker than those of Madeira (cited also in Salmon & Wakeham-Dawson, 1999). Rebel (1940) mentioned that the specimens from Madeira Island are not different from those of the Canary Islands.

V. vulcania is widely distributed on Madeira Island from sea level to altitudes up to 1,000 m *a.s.l.*, but it is not common (Wakeham-Dawson & Aguiar, 2002; Wakeham-Dawson *et al*., 2004). In contrast, Owen & Smith (1993) noted that *V. vulcania* is well established and common, more abundant than *V. atalanta*. Swash & Askew (1982) reported frequent observations, mostly at low and medium altitudes in cultivated areas (see also Owen *et al*., 1987).

Shapiro (1992a) suggests a possible introduction by Portuguese traders; however, this is not the opinion of Salmon & Wakeham-Dawson (1999). Shapiro (1992a, b) noted a habitat preference for laurisilva forests and hypothesised that *V. vulcania* could be also considered as a relict species of former broadleaved forests.

There are two different hypotheses of the origin of *V. vulcania*:

(1) Leestmans (1978) suggested that during glacial maxima, the taxon of the *V. indica* complex could have been distributed in the eremic zone of North Africa, towards the east to Somalia and the Arabian Peninsula, and from there to the Iranian Plateau, the Thar Desert and the Tien Shan, and *V. vulcania* or its ancestor reached the Canary Islands and Madeira Archipelago via southern Morocco. In this scenario *V. vulcania* and *V. indica* indica should be sister taxa (Leestmans, 1978). Wahlberg & Rubinoff (2011) note that the position of *V. vulcania* is not clear within the *V. indica* complex, but it does appear to be a separate lineage. This hypothesis is compatible with the results on mitochondrial genetic variability within the *Hyles euphorbiae* sensu lato lineage (Lepidoptera, Sphingidae, Macroglossinae) in the western Palaearctic (Hundsdoerfer *et al*., 2010). Most haplotypes of *H. tithymali* in Macaronesia, North Africa, and Yemen build a cluster of similar haplotypes.

(2) Alternatively, Vane-Wright (2007) discussed the hypothesis of a North-American taxon reaching the Atlantic islands from eastern North America, rather than North Africa, while the Asian *indica*-group species reached Asia from western North America via Beringia, a theory supported by molecular findings.

On Porto Santo, *V. vulcania* is restricted to subhumid sites with high abundancies of *Echium* flowers (1 grid, 2 localities; Fig. 1) and could be detected only on the flowers of *Echium nervosum* (Boraginaceae) n = 10.

There are additional data of other observers:

Hypolimnas misippus (Linnaeus, 1764)

The occurrence of this migrant nymphalid species was recorded in Tennent *et al*. (2013). *Hypolimnas misippus* is widespread (Africa, Asia, Australia, West Indies, and parts of Central and North America); Tolman & Lewington (2008). This species is resident on the Cape Verde Islands, occasionally reported in the Azores, the Canary Islands, and the Madeira Archipelago (Tennent *et al*., 2013). There had been three detections in Porto Santo: both sexes, Pico do Castelo, 16 November 2012; and one female at the golf club, 18 November 2012, on flowers of *Lantana camara* (2 grids, 2 localities; Fig. 1).

Lycaena phlaeas phlaeoides (Staudinger, 1901)

Lycaena phlaeas (Linnaeus, 1761) is a widespread species with 22 subspecies in the Palaearctic, oriental, and Ethiopian regions, and six subspecies in the North American region (Kohler, 2007). *Lycaena phlaeas phlaeoides* represents an endemic subspecies on the Madeira Archipelago (Rebel, 1940; Bernardi, 1961; Leestmans, 1975; Meyer & Hellers, 1990; Meyer, 1993; Tolman & Lewington, 1997; Wakeham-Dawson & Aguiar, 2003; Aguiar & Karsholt, 2006; Tshikolovets, 2011). Kohler (2007) described the subspecies as follows: 'The rich brown, somewhat mottled colour and jagged whitish postmedian band of the ventral hind wing on this subspecies are distinctive'. This subspecies is represented in the Madeira Archipelago also in different forms: form '*elea*' (Fabricus, 1798), form '*coeruleapunctata*' (Rühl, 1895), form '*obsoleta*' (Tutt, 1896), and form '*radiata*' (Tutt, 1896); see also Salmon & Wakeham-Dawson (1999). Cockerell (1923) detected a specimen without any dark colours (ordinary form '*phlaeas*'). The subspecies rank was not accepted, *e.g*., by Swash & Askew (1982). According to Meyer (1993), the Madeiran populations are native.

L. phlaeas was mentioned by Felder (1862): A male was collected during the Novara Expedition (1857-1859) by Georg von Frauenfeld on Madeira Island. The distribution of *L. p. phlaeoides* on Madeira Island was reported by Wakeham-Dawson & Aguiar (2002) and Wakeham-Dawson *et al*. (2002a) as widely spread at all altitudes up to 1,800 m *a.s.l*. The occurrence on Porto Santo is mentioned by Wakeham-Dawson *et al*. (2004).

Distribution patterns

The distribution patterns of 11 butterfly species of Porto Santo are summarised in Table 2 and Fig. 1. *Colias croceus* shows the widest distribution on the island (19 grids), followed by *Pieris rapae* and *Vanessa cardui* (11 and nine grids). All other species are characterised by a restricted distribution: *Vanessa vulcania* (one grid) and *V. atalanta* (three grids) are concentrated on sites with flowering *Echium*; *Leptotes pirithous* (five grids) and *Lampides boeticus* (three grids) prefer hot, dry, and sunny sites (Tshikolovets, 2011), in contrast to *Pararge aegeria* (four grids), which use shadow sites with trees or bushes (Tolman & Lewington, 1997). The migrant species *Danaus plexippus* and *Hypolimnas misippus* were detected on four grids and two grids respectively, while the newly detected *Macroglossum stellatarum* was found on three grids.

Flower visits and butterfly-plant network

Table 3 shows the visited plant species in March 2017, which were used as nectar resources. Butterflies could be detected on 15 plant species. The key species with the highest rates of visitation was *Echium nervosum*.

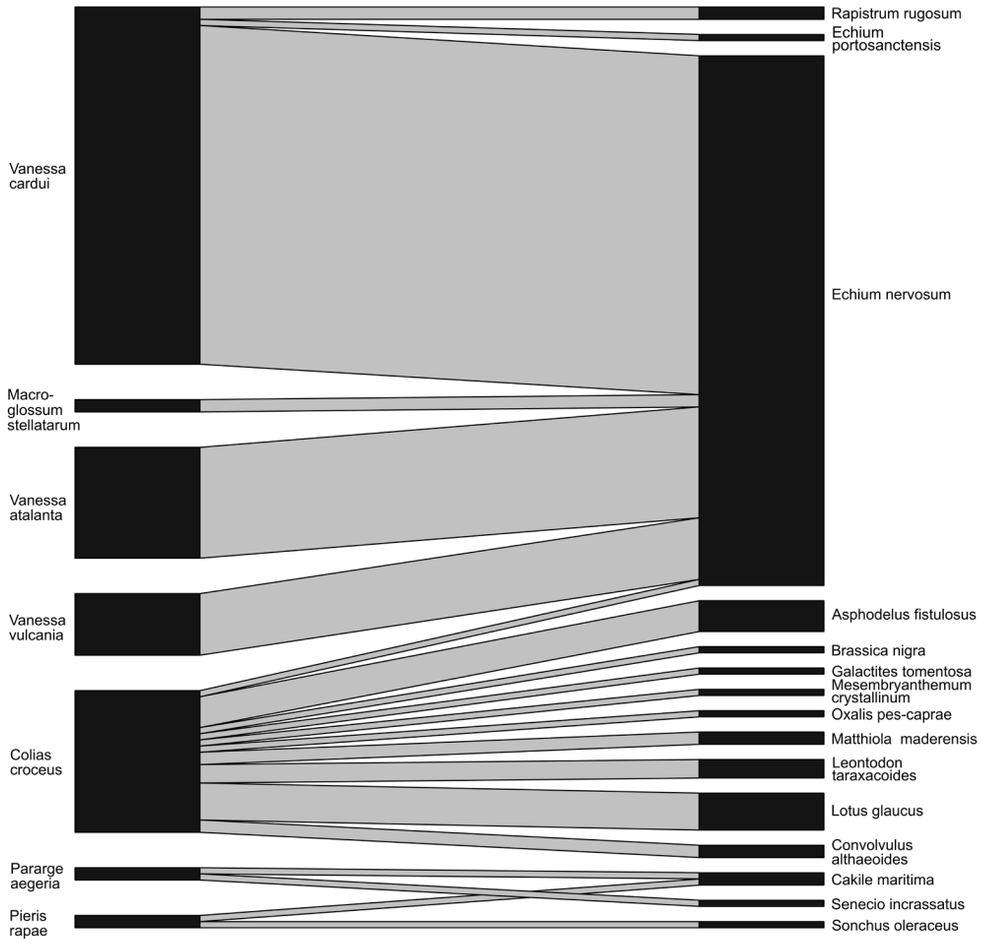

Fig. 2 – Bipartite graph of the butterfly-plant network of Porto Santo.

Most of the used plant species are endemic or native; therefore, they were already present about 500 years ago, before the beginning of the strong human impact. Most of the endemic or native plant species are common and widely distributed on Porto Santo. The plant species with the highest butterfly visitation rates is *Echium nervosum*, endemic to the Madeira Archipelago, and distributed in dry microforests, open rocky and dry habitats. *Echium nervosum* is also planted on roadsites. Also visited by butterflies is *Echium portosanctensis*, endemic to Porto Santo, growing in open rocky habitats of the subhumid zone and planted locally on roadsides in the northern part. Hybrids of these *Echium* species also exist.

A higher number of visits was observed on *Lotus glaucus* (endemic to Macaronesia) in sandy habitats and on *Cakile maritima* in driftline habitats. Butterflies were also observed on *Matthiola maderensis*, endemic to the Madeira Archipelago and growing on coastal rocks and cliffs, which are partly influenced by salt-spray.

Apart from these endemic plant species, there is a second group comprising native species with a wider distribution in the Mediterranean region or in North Africa that grow on Porto Santo, *e.g.*, on roadsides and fallows: *Asphodelus fistulosus*, *Brassica nigra*, *Convolvulus althaeoides*, *Galactites tomentosa*, *Leontodon taraxacoides*, *Rapistrum rugosum*, and *Sonchus oleraceus*.

The bipartite graph of the butterfly-plant network of Porto Santo (Fig. 2) shows the flower-visiting butterfly species on the left-hand side and the visited plant species on the right-hand side, both connected by interaction links. The butterfly-plant network is asymmetric: seven butterfly species versus 15 plant species.

The butterfly-plant network shows that the most abundant butterfly species on flowers is *Vanessa cardui* with a preference for *Echium nervosum*. *Vanessa atalanta* and the endemic *V. vulcania* also show a preference for the *Echium* species (*E. nervosum*, endemic for the Madeira Archipelago, and *Echium portosanctensis*, endemic for Porto Santo, including hybrids). In contrast, *Colias croceus* has a diversified flower-visiting behaviour (observed on ten plant species of different plant families).

CONCLUSIONS

Porto Santo, a relatively old and small volcanic island in the Atlantic Ocean, is a model area for the colonisation of islands by insect species of different areageographical origins. Regarding bee species, Porto Santo served as an important colonisation source for Madeira Island (Kratochwil & Schwabe, 2018).

Porto Santo has only two butterfly species which are endemic to archipelagos of Macaronesia or parts of it: *Vanessa vulcania*, endemic to the Madeira Archipelago and the Canary Islands, which can be considered a relict species on Porto Santo, and, at a subspecies level, *Lycaena phlaes phlaeoides* (endemic to the Madeira Archipelago). In contrast, many other butterfly species are endemic to Madeira Island: *Hipparchia maderensis* (Bethune-Baker, 1891), *Pararge xiphia* (Fabricius, 1775), *Gonepteryx maderensis* Felder, 1862, and *Pieris wollastoni* (Butler, 1886). These species do not occur on Porto Santo, because there are no habitat conditions of higher mountain zones. The endemic butterflies of Madeira Island prefer vegetation mosaics of forest sites with forest edges and forest islands (*Pararge xiphia* and *Gonepteryx maderensis*) or live generally at higher altitudes (*Hipparchia maderensis*, 800-1,800 m *a.s.l.*; *Pieris wollastoni*, 400-1,110 m *a.s.l.*). Whether these species ever existed on Porto Santo is a question that cannot be answered.

A possible exchange of butterfly individuals between Madeira Island and Porto Santo is facilitated by the small distance of 45 km between the islands (*e.g.*, in the case of *Danaus plexippus*, *Vanessa atalanta*, and *V. cardui*, but also of other butterfly species, *e.g.*, *Colias croceus*, which are migratory and good flyers).

The butterfly-plant network of Porto Santo shows asymmetry: Seven butterfly species used 15 different plant species, but not as marked as the bee-plant network with six wild-bee species and 27 different plant species (Kratochwil & Schwabe, 2018).

Like the wild-bee species, the woody *Echium* species *E. nervosum* (endemic to the Madeira Archipelago) and *E. portosanctensis* (endemic to Porto Santo), including hybrids, are key species as resources for *Vanessa atalanta*, *V. cardui* and *V. vulcania*.

V. vulcania is not common. This endemic butterfly species was found only within one grid in the north of the island at an altitude of 235 m *a.s.l.* *Vanessa vulcania* is a remnant of an earlier time period of the island, when (due to lack of human impact) areas with microforests and *Apollonias barbujana* laurisilva vegetation still existed. *Vanessa vulcania* show a similar preference for the subhumid zone as the bumblebee *Bombus terrestris lusitanicus* (Kratochwil & Schwabe, 2018).

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NOMENCLATURE

The nomenclature for plant species names follows Jardim & Sequeira (2008). One plant species was newly described in the year 2010: *Echium portosanctensis* Carvalho, Pontes, Batista-Marques & Jardim, 2010; see Carvalho *et al*., (2010).

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Paratettix meridionalis (Rambur, 1838) (Orthoptera: Tetrigidae), a grasshopper species and Family new to the Archipelago of Madeira, Portugal

By M. Matos Andrade [1 *] & A. M. Franquinho Aguiar [2]

With 1 figure

[1] *Rua das Virtudes, Barreiros Golden I, Bloco I, R/C B, 9000-645 Funchal, Madeira, Portugal.*

[*] *Corresponding author: miguelm.andrade@hotmail.com*

[2] *Entomology Lab, Laboratório de Qualidade Agrícola, Secretaria Regional de Agricultura e Pescas, Caminho Municipal dos Caboucos, 61, 9135-372 Camacha, Madeira, Portugal.*

ABSTRACT: The first record from the archipelago of Madeira of the pygmy grasshopper *Paratettix meridionalis* (Rambur, 1838) and of Family Tetrigidae is given, as well as some data from local observations.

Keywords: groundhopper, pygmy grasshopper, first record, Madeira Island, Macaronesia.

RESUMO: Publica-se a primeira referência para o arquipélago da Madeira, do gafanhoto pigmeu, *Paratettix meridionalis* (Rambur, 1838) e da respetiva Família Tetrigidae.

Palavras-chave: gafanhoto tetrigídeo, primeira referência, Ilha da Madeira, Macaronésia.

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INTRODUCTION

The family Tetrigidae counts with approximately 2026 valid species organized into 8 subfamilies and 272 genera with a worldwide distribution (Cigliano *et al*., 2018). The members of this family are characterized by their small size and elongated pronotum that extends over the length of the abdomen and covers almost the totality of the hind wings as the fore wings are reduced to a scale sclerite. In Europe 4 genera and 12 species can be found, being *Tetrix* Lattreille, 1802 the most speciose genus with 8 species (Heller, 2013). Nine of the aforementioned species can be found in Spain (Llorente & Presa, 1981) and 6 in mainland Portugal: *Paratettix meridionalis* (Rambur, 1838); *Uvarovitettix depressus* (Brisout de Barneville, 1849), *Uvarovitettix nodulosus* (Fieber, 1853), *Tetrix ceperoi* (Bolívar, 1887), *Tetrix undulata* (Sowerby, 1806) and *Tetrix subulata* (Linnaeus, 1758) (Ferreira *et al*., 2006).

This groundhopper or pygmy grasshopper, is a common Western Palaearctic species, the distribution of which is limited by the Azores Islands to the west, by France to the north, most of the Mediterranean to the south, reaching North Africa (Morocco and Lybia) and by Turkey plus several Middle Eastern countries to the east (Cigliano *et al*., 2018). In Europe, *P. meridionalis* is quite widespread throughout the Mediterranean area in humid, vegetation-rich sandy, rocky or muddy places, usually not very far from the coast. This species is already known from all the other Macaronesian Archipelagos, the Canary Islands (López & Morales, 2010), the Azores (Sousa, 2010) and the Cape Verde Islands (Hochkirch & Llorente, 2005). Any previous records of Tetrigidae were unknown from the archipelago of Madeira until April 28, 2018 when during a field trip, the author (MMA) collected a single female specimen (see Fig. 1) of *Paratettix meridionalis* (Rambur, 1838), from an agricultural field with a high abundance of grasses of the genus *Cyperus* (cf. *Cyperus esculentus* L.) located at Covas (on the way from Felpa to Rocha de Baixo), west of São Jorge, north of Madeira Island, 32° 49′ 42. 725″ N, 16° 55′ 22. 962″ W, 415 m *a.s.l*. This specimen of *P. meridionalis* is deposited in the author's private collection. It is the first recorded observation of this taxon as well as of the family Tetrigidae in the archipelago of Madeira. It is possible that this species may have been introduced from the Canary Islands or the Iberian Peninsula, through the same channels used by passengers and cargo between Madeira and those destinations. Further observations should be made to validate *P. meridionalis* establishment and to study any kind of impacts in local ecosystems.

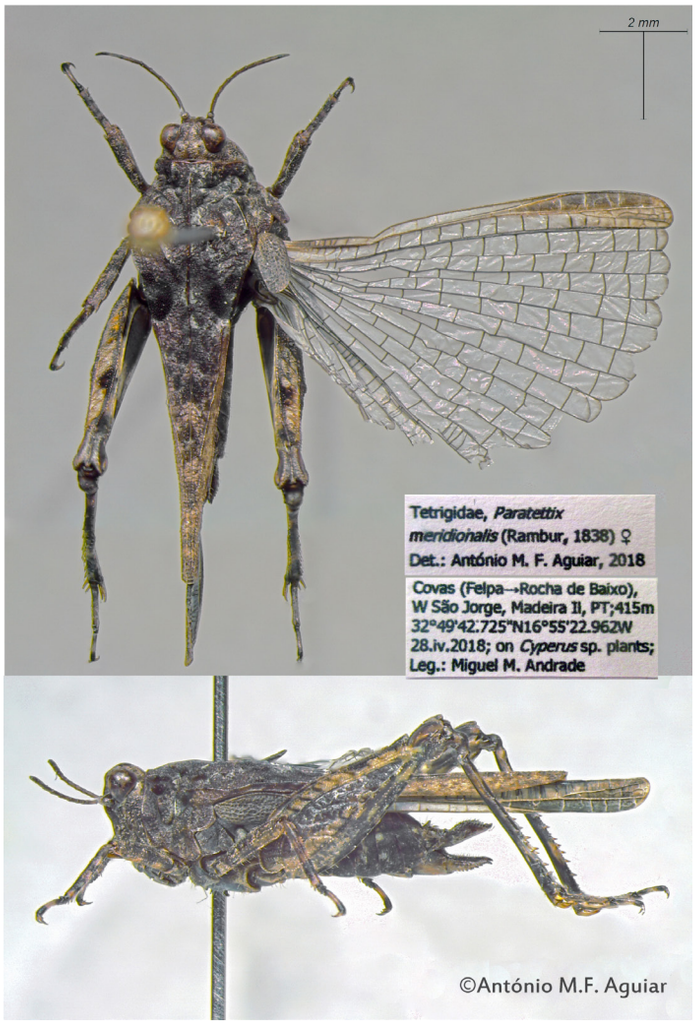

Fig. 1 – Dorsal view and left profile of a *Paratettix meridionalis* female specimen collected in Madeira Island.

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New findings of phytophagous insects (Hemiptera: Coccoidea and Aphidoidea) from Ilhéu Chão (Desertas Islands, Madeira Archipelago)

By Cândida Ramos [1 *], A. M. Franquinho Aguiar [2], Isamberto Silva [3], Ana Mourão [1], Renata Santos [4], Carla Rego [4] & Mário Boieiro [4]

With 6 figures

[1] *Departament of Biology, Faculty of Sciences, University of Porto, Rua do Campo Alegre, s/n, 4169-007 Porto, Portugal.*

[*] *Corresponding author: candidasgramos29@gmail.com*

[2] *Entomology Lab, Laboratório de Qualidade Agrícola, Secretaria Regional de Agricultura e Pescas, Caminho Municipal dos Caboucos, 61, 9135-372 Camacha, Madeira, Portugal.*

[3] *Instituto das Florestas e da Conservação da Natureza, Quinta do Bom Sucesso, Caminho do Meio, 9050-251 Funchal, Madeira, Portugal.*

[4] *Centre for Ecology, Evolution and Environmental Changes (cE3c), Azorean Biodiversity Group and Department of Environmental Sciences and Engineering, University of the Azores, 9700-042 Angra do Heroísmo, Azores, Portugal.*

ABSTRACT: Here we report new taxonomic findings of aphids (Aphidoidea) and scales (Coccoidea) for Ilhéu Chão (Desertas Islands, Madeira Archipelago). *Protaphis pseudocardui* (Theobald, 1915) is for the first time reported to Madeira archipelago while the aphids *Aphis craccivora*, *A. gossypii*, *A. umbrella* and *Uroleucon sonchi*, and the scales *Coccus* cf. *hesperidum*, *Icerya purchasi*, *Pulvinaria urbicola*, *Saissetia coffeae* and *S. oleae* are new findings to the Desertas Islands. We also provide information on the host plant associations of these phytophagous insects. Our results highlight the need for further research on the insect fauna of Desertas Islands.

Keywords: faunistic records, host plant associations, aphids, scales, *Protaphis pseudocardui*, Ilhéu Chão, Desertas Islands, Madeira Archipelago.

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RESUMO: Neste artigo reportamos novas descobertas taxonómicas de afídeos (Aphidoidea) e cochonilhas (Coccoidea) para o Ilhéu Chão (Ilhas Desertas, Arquipélago da Madeira). A presença de *Protaphis pseudocardui* (Theobald, 1915) é pela primeira vez relatada no arquipélago da Madeira, enquanto que os afídeos *Aphis craccivora*, *A. gossypii*, *A. umbrella* e *Uroleucon sonchi*, e as cochonilhas *Coccus* cf. *hesperidum*, *Icerya purchasi*, *Pulvinaria urbicola*, *Saissetia coffeae* e *S. oleae*, são novas descobertas para as Ilhas Desertas. Também fornecemos informações sobre as associações destes insetos fitófagos com as plantas hospedeiras. Os nossos resultados salientam a necessidade de mais estudos sobre a fauna de insetos das Ilhas Desertas.

Palavras-chave: registos faunísticos, associações de plantas hospedeiras, afídeos, cochonilhas, *Protaphis pseudocardui*, Ilhéu Chão, Ilhas Desertas, arquipélago da Madeira.

INTRODUCTION

Phytophagous insects are one of the most speciose groups of living organisms worldwide being also well represented on oceanic islands. In many archipelagos, they are an important fraction of the overall biodiversity and include a high number of endemics and remarkable examples of species diversification and ecological associations (Borges *et al*., 2008a; Percy, 2010; Machado *et al*., 2017). Besides their ecological importance in most natural terrestrial habitats (Olff & Ritchie, 1998; Belovsky & Slade, 2000), phytophagous insects also have a prominent role in human-changed habitats, particularly in forestry and agricultural fields, due to their direct and indirect impacts on the production of goods for human consumption. The dramatic increase in the transportation of goods and commodities during the last decades contributed to the introduction of many phytophagous insect species in island ecosystems, where some have been responsible for huge economic losses, negative social impacts and severe consequences for the conservation of native biodiversity (Pombo *et al*., 2010).

The species checklist of Madeira and Selvagens archipelagos was a major landmark for the knowledge of the biodiversity of these islands by providing updated information on species taxonomy and distribution for most groups of living organisms, including all phytophagous insects groups (Borges *et al*., 2008b). Two recent works updated the information on the scales (Coccoidea) and aphid species (Aphidoidea) from Madeira archipelago, which now comprehend respectively 109 and 183 species (Franco *et al*., 2011; Aguiar *et al*., 2013). However, the knowledge on the phytophagous insects of Madeira is far from being complete since new taxonomic findings are still occurring (Aguiar & Ilharco, 2005) and basic information on abundance, distribution and host plant associations is lacking for most species. The aim of this study is to present new findings of scales and aphids from Ilhéu Chão (Desertas Islands) jointly with information on species distribution and their association with host plants.

MATERIAL AND METHODS

The studied specimens were collected at Ilhéu Chão, in Desertas Islands, between 19 and 22 of June 2017. Ilhéu Chão is the smallest of the three Desertas Islands with 1km^2 and presents a relatively well-preserved plant cover with several vegetation patches dominated by native species (*e.g*. *Artemisia argentea*, *Asphodelus fistulosus*, *Jasminum odoratissimum*, *Suaeda vera*) (Menezes *et al*., 2005). The insects were collected from several plant species (see RESULTS AND DISCUSSION section) and were frequently found in association with the invasive Argentine ant (*Linepithema humile*) (Ramos, 2017). All specimens were captured with the aid of forceps and stored in vials in 70% ethanol. Later, they were identified using a stereomicroscope (Nikon Optiphot-2) and specific literature (Blackman & Eastop, 1989; 1994; 2006; Nieto Nafría *et al*., 2004; Blackman, 2013), at the Laboratório de Qualidade Agrícola (LQA) and have been deposited in the entomological collection (ICLAM) of this institution preserved in 70% ethanol or slide-mounted. Below we present our findings jointly with information on sampling dates, site location, species associations and photographs of some species. The family and species-names are listed alphabetically following Borges *et al*. (2008b) and ecological and distributional information is presented for each species. The collection code is also indicated for the specimens stored in ICLAM.

RESULTS AND DISCUSSION

Overall, many specimens from 12 phytophagous insect species were collected in this study (see below). Six species are scales (Coccoidea) and the other six aphids

(Aphidoidea). All scale (except *Hemiberlesia lataniae*) and aphid species are new findings to Desertas Islands and the aphid *Protaphis pseudocardui* (Theobald, 1915) is recorded for the first time in the archipelago. Comprehensive data on the sampled species is presented below.

Superfamily Coccoidea

Family Coccidae

Coccus cf. *hesperidum* Linnaeus, 1758

Material examined: Ilhéu Chão, 21/06/2017, 1 immature ♀ (ICLAM: C1251).

Remarks: *Coccus hesperidum* was previously known from Madeira and Porto Santo while its congener *C. viridis* Green, 1889 is restricted to Madeira Island (Aguiar, 2008). We found a single specimen matching the description of *C. hesperidum* associated with the endemic plant *Artemisia argentea* (Asteraceae).

Pulvinaria urbicola Cockerell, 1893

Material examined: Ilhéu Chão, 21/06/2017, 28 ♀♀ (ICLAM: C1259, C1267, C1269, C1272).

Remarks: This native species was previously known from Madeira Island (as *Pulvinaria grabhami* a junior synonym of *P. urbicola*) (Aguiar, 2008). In Ilhéu Chão, the species was found in association with the native plants *Plantago coronopus* (Plantaginaceae), *Silene uniflora* (Cariophyllaceae) and the endemic *Artemisia argente*a (Fig. 1).

Fig. 1 – *Pulvinaria urbicola* adult females in association with *Artemisia argentea*. Photo credit: Cândida Ramos.

Saissetia coffeae (Walker, 1852)

Material examined: Ilhéu Chão, 19/06/2017, many immature and adult ♀♀ (ICLAM: C1255).

Remarks: This introduced species was previously known from Madeira and Porto Santo Islands (Aguiar, 2008). Now, it was found in Ilhéu Chão in association with *Silene* sp. (Cariophyllaceae).

Saissetia oleae (Olivier, 1791)

Material examined: Ilhéu Chão, 21/06/2017, many immature and adult ♀♀ (ICLAM: C1252, C1268, C1270).

Remarks: This introduced species was reported from Madeira and Porto Santo Islands (Aguiar, 2008). At Ilhéu Chão, we found it in association with the endemic plants *Artemisia argentea* and *Phagnalon lowei* (Asteraceae).

Family Diaspididae

Hemiberlesia lataniae (Signoret, 1869)

Material examined: Ilhéu Chão, 21/06/2017, many adult ♀♀ (ICLAM: C1250, C1254, C1256, C1268a).

Remarks: This native species was known from Madeira, Porto Santo and Desertas Islands (Aguiar, 2008). In this study it was found in association with the endemic plants *Artemisia argentea* and *Phagnalon lowei*.

Family Monophlebidae

Icerya purchasi Maskell, 1879

Material examined: Ilhéu Chão, 21-22/06/2017, many immature and adult ♀♀ (ICLAM: C1249, C1253, C1257, C1260, C1271).

Remarks: This introduced species was only known to occur in Madeira (Aguiar, 2008). It was now found in Ilhéu Chão, in association with *Artemisia argentea* (Fig. 2) and *Sonchus oleraceus* (Asteraceae).

Fig. 2 – *Icerya purchasi* adult females in association with *Artemisia argentea*. Photo credit: Cândida Ramos.

Superfamily Aphidoidea

Family Aphididae

Aphis craccivora Koch, 1854

Material examined: Ilhéu Chão, 22/06/2017, 5 apterous ♀♀ (ICLAM: A1157).

Remarks: This native species was known from Madeira and Selvagens (Aguiar & Ilharco, 2008) and was now found in Ilhéu Chão associated with *Silene* sp.

Aphis gossypii Glover, 1877

Material examined: Ilhéu Chão, 21/06/2017, 12 apterous ♀♀ (ICLAM: A1162).

Remarks: This native species had been reported from Madeira and Porto Santo Islands (Aguiar & Ilharco, 2008). It was now found in Ilhéu Chão associated with the endemic plant *Crepis divaricata* (Asteraceae) (Fig. 3).

Fig. 3 – *Aphis gossypii* adult females on *Crepis divaricata*. Photo credit: Cândida Ramos.

Protaphis pseudocardui (Theobald, 1915)

Material examined: Ilhéu Chão, 21/06/2017, 4 alate and 8 apterous ♀♀ (ICLAM: A1161).

Remarks: This is the first record of this species in Madeira Archipelago. *Protaphis pseudocardui* was found in association with an unidentified Asteraceae.

Aphis umbrella (Börner, 1950)

Material examined: Ilhéu Chão, 21/06/2017, 5 alate and 4 apterous ♀♀ (ICLAM: A1158).

Remarks: This native species was known from Madeira Island (Aguiar & Ilharco, 2008). We found it in Ilhéu Chão associated with the native plant *Lavatera cretica* (Malvaceae) (Fig. 4).

Fig. 4 – *Aphis umbrella* adult females on the underside of a *Lavatera cretica* leaf, being tended by a worker of the invasive Argentine ant *Linepithema humile*. Photo credit: Cândida Ramos.

Fig. 5 – *Macrosiphoniella* sp. adult females on *Artemisia argentea* leaves. Photo credit: Cândida Ramos.

Macrosiphoniella sp.

Material examined: Ilhéu Chão, 22/06/2017, 1 nymph and 1 apterous ♀ (ICLAM: A1159).

Remarks: This genus is known from Madeira and Porto Santo Islands. Besides the Madeiran endemic *Macrosiphoniella madeirensis* (Aguiar & Ilharco, 2005), four other introduced species are also known to occur in the archipelago – *M. artemisiae* (Fonscolombe, 1841), *M. millefolii* (De Geer, 1773), *M. sanborni* (Gillette, 1908) and *M. tapuskae* (Hottes & Frison, 1931) (Aguiar & Ilharco, 2008). We found two specimens of this genus in Ilhéu Chão in association with *Artemisia argentea* (Fig. 5). It was not possible to identify the species with confidence since both specimens were in bad condition. However, they are most probably *M. artemisiae* since this species is known to associate with *Artemisia argentea* in Madeira.

Uroleucon sonchi (Linnaeus, 1767)

Material examined: Ilhéu Chão, 21/06/2017, many nymphs and apterous ♀♀ (ICLAM: A1160).

Remarks: This native species was known from Madeira and Porto Santo Islands, but also from Selvagens Archipelago (Aguiar & Ilharco, 2008). We found it in Ilhéu Chão associated with *Sonchus oleraceus* (Fig. 6).

Fig. 6 – *Uroleucon sonchi* adult females on *Sonchus oleraceus*. Photo credit: Cândida Ramos.

Our findings considerably increase the knowledge on the scales and aphids from Desertas. The species checklist of these islands is updated and now includes 8 scale (Coccoidea) and 12 aphid species (Aphidoidea). The discovery of the aphid *Protaphis pseudocardui* (Theobald, 1915), a hitherto unknown species in the archipelago, was unexpected and highlights the need for further studies to survey the insect biodiversity of Desertas. These surveys should be carried in all three Desertas Islands since they have been poorly sampled and their differences in geomorphology and historical legacy may translate in distinct taxonomic assemblages. The ecological information on scales and aphids showed that many species feed on the endemic *Artemisia argentea*, which seems to be a key host plant at Ilhéu Chão by supporting large populations of different phytophagous species. On the other hand, some phytophagous insects, particularly aphids, were found associated to a single host plant, which may render them more vulnerable to ecological disturbances in the simplified ecosystem of Ilhéu Chão.

The scales and aphids are engaged in mutualistic interactions with the invasive Argentine ant, benefiting of protection from predators and parasitoids and providing a rich food resource (the honeydew) to these aggressive ants. The consequences of these associations (frequently involving a pair of exotic species) on the natural communities of Ilhéu Chão remain unstudied but may negatively affect native species survival and the structure of natural assemblages.

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Marine algae collection in the Herbarium of the Funchal Natural History Museum (MADM) with new records from the archipelago of Madeira

By Sara J. Ferreira [1, 2*], J. J. Gonçalves Silva [1] & Ricardo Araújo [1, 2]

With 7 figures

[1] *Museu de História Natural do Funchal, Rua da Mouraria, 31, 9004-546 Funchal, Madeira, Portugal.*
[2] *OOM – Observatório Oceânico da Madeira.*
[*] *Corresponding author: sara.ferreira@cm-funchal.pt*

ABSTRACT: The marine algae collection, in the Herbarium of the Funchal Natural History Museum (MADM), contains macroalgae specimens from the archipelago of Madeira, with scientific and historical significance, the bulk of which is a collection of 598 specimens made by Tore Levring between 1968 and 1973. At present the Herbarium holds 967 specimens of marine algae, corresponding to a total of 206 species (39 Chlorophyta, 48 Ochrophyta, 119 Rhodophyta), 6 of which are new records from the archipelago of Madeira (*Ulva pseudorotundata*, *Dictyota adnata*, *Sargassum hystrix*, *Sargassum platycarpum*, *Sargassum polyceratium* and *Gymnophycus hapsiphorus*). Two already recorded species from the Selvagens are now recorded for the first time from the island of Madeira, (*Ulva polyclada* and *Sargassum cymosum*). *Sargassum hystrix* and *Sargassum polyceratium* are not only new for the archipelago of Madeira, but also new records for the whole Macaronesia.

Keywords: marine algae, MADM, Madeira, Porto Santo, Desertas, Selvagens, Macaronesia, new records, Northeast Atlantic Ocean.

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RESUMO: A coleção de algas marinhas do Herbário do Museu de História Natural do Funchal (MADM) contém espécimes de macroalgas colhidas no arquipélago da Madeira, com interesse científico e histórico, tendo na sua génese uma coleção de 598 espécimes colhidos por Tore Levring entre 1968 e 1973. Toda a coleção de algas marinhas, totaliza 967 espécimes (598 da coleção Tore Levring), pertencentes a 206 espécies (39 Chlorophyta, 48 Ochrophyta, 119 Rhodophyta), das quais 6 são novos registos para o arquipélago da Madeira (*Ulva pseudorotundata*, *Dictyota adnata*, *Sargassum hystrix*, *Sargassum platycarpum*, *Sargassum polyceratium* e *Gymnophycus hapsiphorus*) e 2 anteriormente assinalados para as Selvagens, são novos assinalamentos para a ilha da Madeira (*Ulva polyclada* e *Sargassum cymosum*). *Sargassum hystrix* e *Sargassum polyceratium* não somente são espécies novas para o arquipélago da Madeira, como também novos registos para toda a Macaronésia.

Palavras-chave: alga marinha, MADM, Madeira, Porto Santo, Desertas, Selvagens, Macaronésia, novos registos, Oceano Atlântico Nordeste.

INTRODUTION

The algal collection of the Herbarium of the Funchal Natural History Museum (MADM) was initiated, by Günther Maul in the early 1940's. The first marine alga in the MADM is a specimen of *Pterocladiella capillacea* that was collected by Günther Maul in 15/2/1943 at Gorgulho (Funchal). In the late 1960's (1968-1973), 598 specimens collected by Tore Levring, professor of Marine Botany at the University of Göteborg, were added, giving a great increment to the collection.

The MADM collection posseses sixteen specimens collected during the CANCAP-II, CANCAP-III and CANCAP-IV expeditions between 1977 and 1983. During the 1980's and the beginning of the 1990's there were no more algae additions to this Herbarium. New additions started in 1994 and led in part to the publication of a checklist of the benthic marine plants of the archipelago of Madeira, based on published information and new collections (Neto *et al*., 2001). In 2010 and 2011 two large expeditions organized by the Portuguese Government surveyed the Selvagens, Madeira, Desertas and Porto Santo: EMEPC/ M@rbis/ Selvagens 2010 and EMAM/ PEPC_M@rbis/ 2011. Scientists involved in these expeditions deposited 257 specimens of macroalgae in MADM. Also in July 2011, a group of scientists lead by Prof. Ana Neto (University of Azores) visited Madeira and contributed to the enlargement of this algae collection, with 141 new specimens.

MATERIAL AND METHODS

For the purpose of this catalogue, the archipelago of Madeira covers the islands of Madeira, Porto Santo, Desertas and Selvagens (Fig. 1).

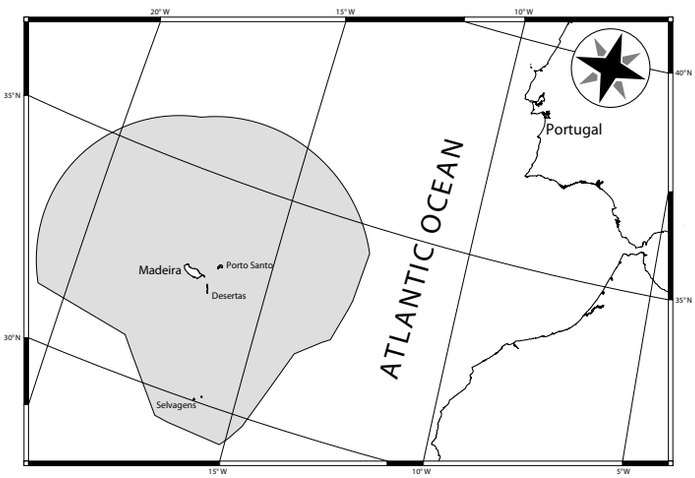

Fig. 1 – Map of the archipelago of Madeira. Grey area shows the Economic Exclusive Zone.

The adopted taxonomic organization follows Neto *et al*. (2001). For each species the original reference containing the first record from the archipelago is given, as well as the specimens deposited in the herbarium.

Abbreviations and other marks used: **M**, Madeira; **PS**, Porto Santo; **D**, Desertas Islands (Deserta Grande); **S**, Salvage Islands; **C**, Canary Islands; **A**, Azores; *, new record for the archipelago; ^{TL}, collected by Tore Levring.

Catalogue of MADM Algae

CHLOROPHYTA

Anadyomenaceae

Microdictyon sp.
Specimens: **M** (MADM 2937) **PS** (MADM 4024).

Microdictyon umbilicatum (Velley) Zanardini
(syn. *Microdictyon boergesenii* Setchell)
First record: **M** (Levring, 1974) as *Microdictyon boergesenii* Setchell.
Specimens: **M** (MADM 3251 [TL]; MADM 3252 [TL]) **PS** (MADM 4023).

Boodleaceae

Phyllodictyon anastomosans (Harvey) Kraft & M. J. Wynne
First record: **M** and **PS** (Audiffred & Prud'homme van Reine, 1985) as *Struvea anastomosans* (Harvey) Piccone & Grunow ex Piccone
Specimens: **C** (MADM 3867; MADM 3868).

Phyllodictyon pulcherrimum J. E. Gray
(syn. *Struvea ramosa* Dickie)
First record: **M** (Levring, 1974) as *Struvea ramosa* Dickie.
Specimens: **M** (MADM 3260 [TL]; MADM 3261 [TL]; MADM 3262 [TL]).

Ulvellaceae

Ulvella viridis (Reinke) R. Nielsen, C. J. O'Kelly & B. Wysor
First record: **M** (Levring, 1974) as *Entocladia viridis* Reinke.
Specimens: **M** (MADM 3831 [TL]; MADM 3832 [TL]).

Ulvaceae

Ulva clathrata (Roth) C. Agardh
(syn. *Enteromorpha clathrata* (Roth) Greville)
First record: **M** (Grunow, 1870) as *Enteromorpha ramulosa* Hook. and *Enteromorpha spinescens* Kutzing.
Specimens: **M** (MADM 3963; MADM 3964; MADM 3817 [TL]; MADM 3818 [TL]).

Ulva compressa Linnaeus
(syn. *Enteromorpha compressa* (Linné) Nees)
First record: **M** (Grunow, 1870) as *Enteromorpha compressa* (Linné) Nees.
Specimens: **PS** (MADM 2548) **M** (MADM 3807 [TL]; MADM 3809 [TL]; MADM 3810 [TL]; MADM 3811 [TL]; MADM 3812 [TL]; MADM 3813 [TL]) D (MADM 3808 [TL]).

Ulva flexuosa subsp. *paradoxa* (C. Agardh) M. J. Wynne
(*Enteromorpha flexuosa* (Wulfen ex Roth) J. Ag. subsp. *paradoxa* (Dillw.) Blinding)
First record: **M** (Levring, 1974) as *Enteromorpha flexuosa* (Wulfen ex Roth) J. Ag. subsp. *paradoxa* (Dillw.) Blinding.
Specimens: **M** (MADM 3814 [TL]).

Ulva intestinalis Linnaeus
(syn. *Enteromorpha intestinalis* (Linné) Nees)
First record: **S** (Gain & Mirande, 1912) as *Enteromorpha intestinalis* (Linné) Nees.
Specimens: **M** (MADM 2984; MADM 3960; MADM 3961; MADM 3962) **S** (MADM 3163).

Ulva linza Linnaeus
(syn. *Enteromorpha ahlneriana* Blinding)
First record: **M** (Taylor, 1882).
Specimens: **M** (MADM 3805 [TL]; MADM 3806 [TL]).

Ulva polyclada Kraft
(syn. *Ulva multiramosa* E. Taskin)
First record: **S** (Parente *et al.*, 2000) as *Enteromorpha multiramosa* Blinding.
Specimens: **M** (MADM 2547).
Remarks: New record from Madeira Island. Locality: Reis Magos, Caniço; Date of collection: 2011/07/01; Collector: Sara Ferreira, EMAM 2011 Expedition; Identified by: Ana Neto & Sara Ferreira.

Ulva prolifera O. F. Müller
(syn. *Enteromorpha prolifera* (O. F. Muller) J. Agardh)
First record: **M** and **D** (Levring, 1974) as *Enteromorpha prolifera* (O. F. Muller) J. Agardh.
Specimens: **M** (MADM 3816 [TL]) **D** (MADM 3815 [TL]).

Ulva rigida C. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 2624; MADM 2938; MADM 2965; MADM 3965; MADM 3966; MADM 3967; MADM 3819 [TL]; MADM 3820 [TL]; MADM 3821 [TL]; MADM 3822 [TL]; MADM 3823 [TL]; MADM 3824 [TL]; MADM 3825 [TL]; MADM 3826 [TL]; MADM 3827 [TL]; MADM 3828 [TL]; MADM 3829 [TL]; MADM 3830 [TL]).

* *Ulva pseudorotundata* Cormaci, G. Furnari & Alongi
(syn. *Ulva rotundata* Bliding) (Fig. 2).
First record: Present paper.

Specimens: **M** (MADM 2546; MADM 4036).
Remarks: Locality: Reis Magos, Caniço; Date of collection: 2011/07/01; Collector: Sara Ferreira, EMAM 2011 Expedition; Identified by: Ana Neto & Sara Ferreira.

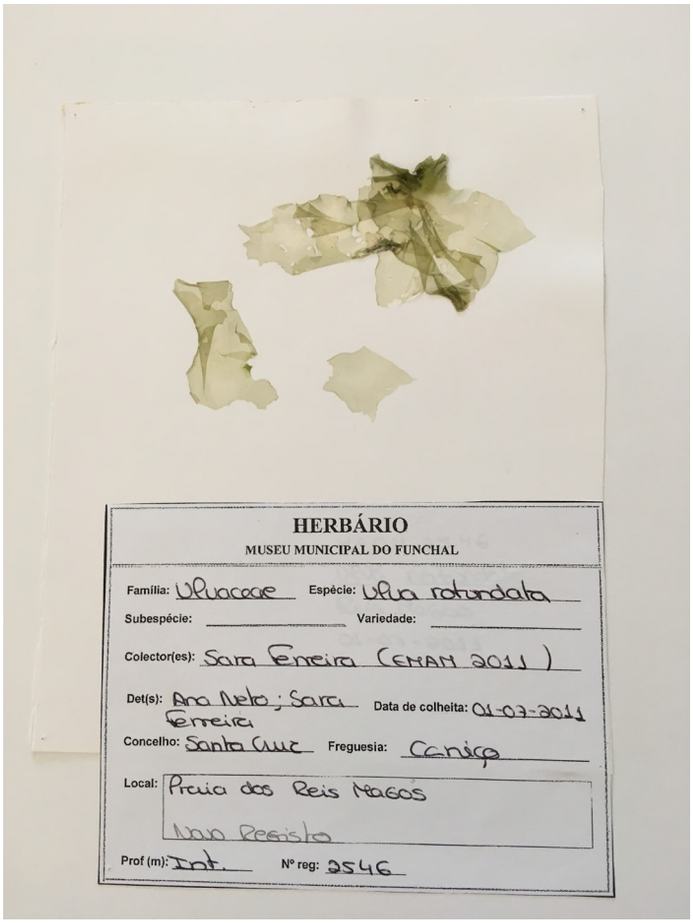

Fig. 2 – *Ulva pseudorotundata* Cormaci, G. Furnari & Alongi (syn. *Ulva rotundata* Bliding) (MADM 2546).

Ulva sp.
Specimens: **M** (MADM 2860; MADM 2862; MADM 2910; MADM 2915; MADM 2969; MADM 2970).

Dichotomosiphonaceae

Avrainvillea canariensis A. Gepp & E. S. Gepp
First record: **M** (Ribeiro *et al*., 2019).
Specimens: **M** (MADM 6979).

Kornmanniaceae

Blidingia minima (Nägeli ex Kützing) Kylin
First record: **M** and **PS** (Levring, 1974).
Specimens: **M** (MADM 3588 [TL]) **PS** (MADM 3589 [TL]; MADM 3590 [TL]).

Cladophoraceae

Chaetomorpha aerea (Dillwyn) Kützing
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 3330 [TL]; MADM 3331 [TL]; MADM 3332 [TL]; MADM 3333 [TL]; MADM 3334 [TL]).

Chaetomorpha ligustica (Kützing) Kützing
(syn. *Chaetomorpha capillaris* (Kützing) Børgesen)
First record: **M** (Levring, 1974) as *Chaetomorpha capillaris* (Kützing) Børgesen.
Specimens: **M** (MADM 3335 [TL]; MADM 3336 [TL]).

Chaetomorpha linum (O. F. Müller) Kützing
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3877; MADM 3878; MADM 3337 [TL]; MADM 3338 [TL]).

Chaetomorpha pachynema (Montagne) Montagne
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3876).
Remarks: According to the collectors Délia Cravo, Ana Neto and José Azevedo this identification needs to be confirmed.

Cladophora sp.
Specimens: **M** (MADM 2888; MADM 2911; MADM 2942; MADM 2943; MADM 2971).

Cladophora coelothrix Kützing
First record: **M** (Grunow, 1870) as *Cladophora repens* (J. Agarth) Harvey.
Specimens: **M** (MADM 3879; MADM 3363 [TL]; MADM 3364 [TL]) **S** (MADM 3362 [TL]).
Remarks: According to the collectors Délia Cravo and Ana Neto the identification of MADM 3879 needs to be confirmed.

Cladophora hutchinsiae (Dillwyn) Kützing
First record: **M**, **S** (Levring, 1974).
Specimens: **M** (MADM 3880; MADM 3348 [TL]; MADM 3349 [TL]; MADM 3350 [TL]; MADM 3351 [TL]; MADM 3352 [TL]; MADM 3353 [TL]; MADM 3354 [TL]; MADM 3355 [TL]).

Cladophora liebetruthii Grunow
First record: **M** (Levring, 1974) as *Cladophora boodleoides* Børgesen.
Specimens: **M** (MADM 2929; MADM 2967).
Remarks: According to the collectors Ana Neto, Mutue

Toyota Fujii and Maria Machín-Sanchez the identification of MADM 2929 needs to be confirmed.

Lychaete pellucida (Hudson) M. J. Wynne
(syn. *Cladophora pellucida* (Hudson) Kützing)
First record: **S** (Gain, 1914) as *Cladophora pellucida* (Hudson) Kützing.
Specimens: **M** (MADM 2856; MADM 2883; MADM 4037) **D** (MADM 3356 TL; MADM 3357 TL).
Remarks: According to the collectors Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez, Helena Encarnação, Eunice Nogueira, Abel Senties and Valeria Cassano the identifications of MADM 2856 and MADM 2883 need to be confirmed.

Cladophora prolifera (Roth) Kützing
First record: **D** (Gain, 1914).
Specimens: **M** (MADM 2549; MADM 2945; MADM 3881; MADM 3882; MADM 3883; MADM 3285 TL; MADM 3358 TL; MADM 3359 TL; MADM 3360 TL; MADM 3361 TL).

Cladophora vagabunda (Linné) van den Hoek
(syn. *Cladophora fascicularis* (Mertens ex Agardh) Kützing).
First record: **M** (Levring, 1974) as *Cladophora fascicularis* (Mertens ex Agardh) Kützing
Specimens: **M** (MADM 3339 TL; MADM 3340 TL; MADM 3341 TL; MADM 3342 TL; MADM 3343 TL; MADM 3344 TL).

Ulotrichaceae

Urospora laeta (Thuret) Børgesen
First record: **D** (Levring, 1974).
Specimens: **D** (MADM 3803 TL; MADM 3804 TL).

Ulvophyceae family *incertae sedis*

Blastophysa rhizopus Reinke
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3833 TL).

Valoniaceae

Valonia sp.
Specimens: **M** (MADM 2928; MADM 2964).

Valonia utricularis (Roth) C. Agardh
First record: **M** (Grunow, 1870).
Specimens: **M** (MADM 2627; MADM 3968; MADM 3969; MADM 3970; MADM 3835 TL) **S** (MADM 2649; MADM 2664; MADM 2687; MADM 3125; MADM 3142; MADM 3187; MADM 3194; MADM 3834 TL; MADM 3836 TL; MADM 3837 TL; MADM 3838 TL).

Derbesiaceae

Derbesia tenuissima
(Morris et De Notaris) P. Crouan et H. Crouan
First record: **D** (Levring, 1974).
Specimens: **D** (MADM 3487 TL).

Pedobesia simplex
(Meneghini ex Kützing) M. J. Wynne & Leliaert
(syn. *Derbesia lamourouxii* (J. Agardh) Solier)
First record: **M**, **D** (Levring, 1974) as *Derbesia lamourouxii* (J. Agardh) Solier.
Specimens: **D** (MADM 3486 TL).

Caulerpaceae

Caulerpa chemnitzia (Esper) J. V. Lamouroux
(syn. *Caulerpa peltata* J. V. Lamouroux)
First record: **S** (Audiffred & Weisscher, 1984) as *Caulerpa racemosa* var. *peltata* (J. V. Lamouroux) Eubank.
Specimens: **S** (MADM 2661) **C** (MADM 3869).

Caulerpa prolifera (Forsskal) J. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3264 TL; MADM 3265 TL; MADM 3266 TL; MADM 3267 TL) **PS** (MADM 4028).

Caulerpa webbiana Montagne
First record: **M**, **PS**, **S** (Levring, 1974).
Specimens: **M** (MADM 2626; MADM 2926; MADM 3870; MADM 3871; MADM 3872; MADM 3268 TL; MADM 3269 TL) **S** (MADM 2682; MADM 3167; MADM 3185; MADM 3232) **PS** (MADM 3270 TL).

Codiaceae

Codium adhaerens C. Agardh
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 2620) **S** (MADM 2726; MADM 3119; MADM 3139; MADM 3165; MADM 3368 TL).

Codium decorticatum (Woodward) Howe
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3884; MADM 3369 TL; MADM 3370 TL) **D** (MADM 3371 TL).

Codium effusum (Rafinesque) Delle Chiaje
First record: **M** (Haroun *et al*., 2002).
Specimens: **M** (MADM 2861; MADM 2884; MADM 2903: MADM 2966).

Dasycladaceae

Dasycladus vermicularis (Scopoli) Krasser
First record: **M** (Barton, 1897) as *Dasycladus claveformis* C. Agardh.
Specimens: **M** (MADM 2899; MADM 2939; MADM 2968; MADM 3892; MADM 3467 TL; MADM 3468 TL; MADM 3469 TL; MADM 3471 TL) **PS** (MADM 3465 TL) **D** (MADM 3464 TL) **S** (MADM 2650; MADM 2662; MADM 3124; MADM 3140; MADM 3186; MADM 3192; MADM 3463 TL; MADM 3466 TL; MADM 3470 TL).

Halimedaceae

Halimeda tuna (J. Ellis & Solander) J. V. Lamouroux
First record: Not recorded from the archipelago of Madeira.
Specimens: **C** (MADM 3909; MADM 3910).
Remarks: According to the collectors from CANCAP 2 Expedition the identification of MADM 3909 needs to be confirmed.

Udoteaceae

Pseudochlorodesmis furcellata (Zanardini) Børgesen
First record: **M**, **S** (Levring, 1974).
Specimens: **S** (MADM 3802 TL).

OCHROPHYTA

Acinetosporaceae

Feldmannia mitchelliae (Harvey) H.-S. Kim
(syn. *Giffordia mitchelliae* (Harv.) Hamel.)
First record: **M** (Levring, 1974) as *Giffordia mitchelliae* (Harv.) Hamel.
Specimens: **M** (MADM 3236 TL; MADM 3240 TL) **D** (MADM 3241 TL).

Chordariaceae

Asperococcus fistulosus (Hudson) W. J. Hooker
(syn. *Asperococcus echinatus* Greville)
First record: **M** (Menezes, 1926) as *Asperococcus echinatus* Greville.
Specimens: **M** (MADM 3319 TL; MADM 3320 TL).

Elachista intermedia P. L. Crouan & H. M. Crouan
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3323 TL).

Leathesia marina (Lyngbye) Decaisne
First record: **S** (Parente *et al*., 2000) as *Leathesia difformis* Areschoug.
Specimens: **M** (MADM 2927).

Liebmannia leveillei J. Agardh
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3324 TL).

Myrionema sp.
Specimens: **M** (MADM 3973; MADM 3978).
Remarks: According to the collectors Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez and Helena Encarnação the identification of MADM 3973 needs to be confirmed.

Myrionema orbiculare J. Agardh
(syn. *Ascocyclus orbicularies* (J. Ag.) Magnus.)
First record: **M** (Levring, 1974) as *Ascocyclus orbicularies* (J. Ag.) Magnus.
Specimens: **M** (MADM 3321 TL; MADM 3322 TL).

Myrionema strangulans Greville
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3325 TL; MADM 3326 TL; MADM 3327 TL; MADM 3328 TL).

Nemacystus hispanicus (Sauvageau) Kylin
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3329 TL).

Sphacelariaceae

Sphacelaria cirrosa (Roth) C. Agardh
First record: **M** (Grunow, 1870) as *Sphacelaria irregularis* Kutzing.
Specimens: **M** (MADM 3747 TL; MADM 3748 TL; MADM 3749 TL).

Sphacelorbus nanus
(Nageli ex Kützing) Draisma, Prud'homme & H. Kawai
(syn. *Sphacelaria nana* Nageli ex Kutzing)
First record: **M**, **PS** (Levring, 1974) as *Sphacelaria britannica* Sauvageau.
Specimens: **M** (MADM 3746 TL).

Stypocaulaceae

Halopteris filicina (Grateloup) Kützing
First record: **M** (Piccone, 1884) as *Sphacelaria filicina* (Grateloup) C. Agardh.
Specimens: **M** (MADM 2875; MADM 2936; MADM 3955; MADM 3771 [TL]; MADM 3772 [TL]; MADM 3773 [TL]; MADM 3775 [TL]) **S** (MADM 2752; MADM 3774 [TL]).

Halopteris scoparia (Linnaeus) Sauvageau
First record: **M** (Buch, 1825) as *Conferva scoparia* Linnaeus.
Specimens: **M** (MADM 2633; MADM 2855; MADM 2874; MADM 3956; MADM 3957; MADM 3958; MADM 3777 [TL]; MADM 3778 [TL]; MADM 3779 [TL]; MADM 3780 [TL]; MADM 3781 [TL]; MADM 3782 [TL]; MADM 3783 [TL]; MADM 3788 [TL]; MADM 3789 [TL]; MADM 3792 [TL]; MADM 3793 [TL]; MADM 3794 [TL]; MADM 3796 [TL]; MADM 3797 [TL]; MADM 3799 [TL]; MADM 3801 [TL]) **PS** (MADM 3776 [TL]; MADM 3786 [TL]; MADM 3787 [TL]; MADM 3800 [TL]; MADM 4021) **D** (MADM 3798 [TL]) **S** (MADM 2723; MADM 3150; MADM 3235; MADM 3784 [TL]; MADM 3785 [TL]; MADM 3790 [TL]; MADM 3791 [TL]; MADM 3795 [TL]) MADM 3959.
Remarks: MADM 3959 location site was not registered.

Cladostephaceae

Cladostephus spongiosus (Hudson) C. Agardh
First record: **M** (Piccone, 1884).
Specimens: **M** (MADM 2864; MADM 2876).

Cladostephus spongiosus f. *verticillatum* (Lightfoot) Prud'homme van Reine
First record: **M** (Levring, 1974) as *Cladostephus verticillatum* (Lightfoot) Lyngbye.
Specimens: **M** (MADM 3365 [TL]; MADM 3367 [TL]) **PS** (MADM 3366 [TL]).

Dictyotaceae

Dictyopteris polypodioides (De Candole) J. V. Lamouroux (syn. *Dictyopteris membranacea* (Stackhouse) Batters)
First record: **M** (Piccone, 1884) as *Haliseris polypodioides* (A. P. de Candolle) C. Agardh.
Specimens: **M** (MADM 2925; MADM 3894; MADM 3895; MADM 3488 [TL]; MADM 3489 [TL]; MADM 3490 [TL]; MADM 3491 [TL]; MADM 3492 [TL]) **PS** (MADM 3493 [TL]; MADM 4029) **C** (MADM 3896; MADM 3897).

Dictyota sp.
Specimens: **M** (MADM 2623; MADM 2982).

* *Dictyota adnata* Zanardini (Fig. 3).
First record: Present paper.
Specimens: **M** (MADM 3898).
Remarks: Locality: Lido, Funchal; Year of collection: 1995; Collectors: José Azevedo & António Domingos Abreu; Identified by: Délia Cravo & Ana Neto.

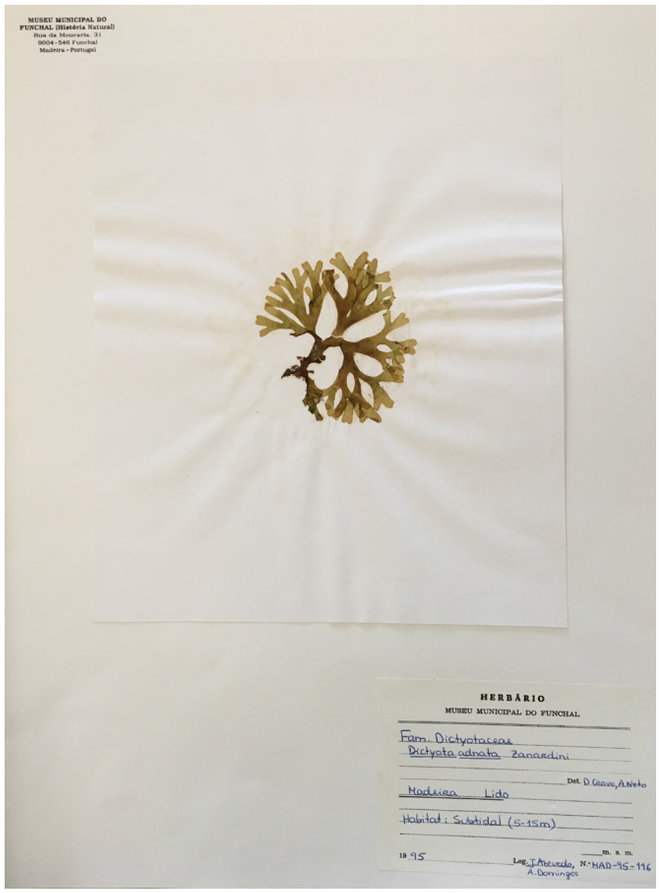

Fig. 3 – *Dictyota adnata* Zanardini (MADM 3898).

Dictyota bartayresiana J. V. Lamouroux
First record: **S** (Audiffred & Weisscher, 1984) as *Dictyota bastayresii* J. V. Lamouroux.
Specimens: **S** (MADM 3221).

Dictyota ciliolata Sonder ex Kützing
First record: **S** (Audiffred & Weisscher, 1984).
Specimens: **M** (MADM 2935).

Dictyota dichotoma (Hudson) J. V. Lamouroux
First record: **M** (Menezes, 1926).
Specimens: **M** (MADM 3899; MADM 3494 [TL]; MADM 3495 [TL]; MADM 3496 [TL]; MADM 3497 [TL]; MADM 3498 [TL]; MADM 3499 [TL]; MADM 3500 [TL]; MADM 3504 [TL]) **S** (MADM 3501 [TL]; MADM 3502 [TL]; MADM 3503 [TL]) **PS** (MADM 4019; MADM 4032).

Dictyota fasciola (Roth) J. V. Lamouroux
First record: **S** (Gain & Mirande, 1912).
Specimens: **PS** (MADM 3508 [TL]) **S** (MADM 3509 [TL]).

Dictyota implexa (Desfontaines) J. V. Lamouroux
(syn. *Dictyota linearis* (C. Agardh) Greville)
First record: **M** (Levring, 1974) as *Dictyota linearis* (C. Agardh) Greville.
Specimens: **M** (MADM 2904; MADM 2972; MADM 3900) **PS** (MADM 2553; MADM 3507 [TL]) **S** (MADM 3505 [TL]; MADM 3506 [TL]).

Dictyota liturata J. Agardh
First record: **S** (Parente *et al*., 2000).
Specimens: **M** (MADM 2933) **PS** (MADM 4020).

Dictyota pinnatifida Kützing
First record: **M**, **S** (John *et al*., 2004).
Specimens: **M** (MADM 2552; MADM 2878).

Lobophora variegata (J. V. Lamouroux) Womersley ex Oliveira
(syn. *Pocockiella variegata* (J. V. Lamouroux) Papenfuss)
First record: **M** (Menezes, 1926) as *Zonaria variegata* J. V. Lamouroux.
Specimens: **M** (MADM 3527 [TL]; MADM 3529 [TL]; MADM 3530 [TL]) **S** (MADM 3528 [TL]) **PS** (MADM 4031).

Padina pavonica (Linné) Thivy
First record: **M** (Grunow, 1870) as *Padina pavonia* (Linnaeus) J. V. Lamouroux.
Specimens: **M** (MADM 2554; MADM 2621; MADM 2857; MADM 2873; MADM 2931; MADM 2973; MADM 3901; MADM 3511 [TL]; MADM 3515 [TL]; MADM 3516 [TL]; MADM 3518 [TL]; MADM 3520 [TL]; MADM 3521 [TL]; MADM 3522 [TL]; MADM 3523 [TL]; MADM 3524 [TL]; MADM 3526 [TL]) **PS** (MADM 2555; MADM 3514 [TL]; MADM 3519 [TL]; MADM 4022) **D** (MADM 3513 [TL]) **S** (MADM 2647; MADM 2665; MADM 2727; MADM 2746; MADM 3121; MADM 3130; MADM 3173; MADM 3179; MADM 3205; MADM 3510 [TL]; MADM 3512 [TL]; MADM 3517 [TL]; MADM 3525 [TL]).

Taonia atomaria (Woodward) J. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 2932; MADM 3902; MADM 3531 [TL]; MADM 3532 [TL]).

Zonaria tournefortii (J. V. Lamouroux) Montagne
First record: **S** (Piccone, 1884).
Specimens: **M** (MADM 3903; MADM 3904; MADM 3905; MADM 3906; MADM 3982; MADM 3533 [TL]; MADM 3534 [TL]; MADM 3535 [TL]; MADM 3536 [TL]; MADM 3537 [TL]; MADM 3539 [TL]; MADM 3540 [TL]; MADM 3541 [TL]; MADM 3542 [TL]).

Scytosiphonaceae

Colpomenia peregrina Sauvageau
First record: **S** (Parente *et al*., 2000).
Specimens: **M** (MADM 3948).

Colpomenia sinuosa (Mertens ex Roth) Derbès et Solier
First record: **M** (Grunow, 1870) as *Asperococcus sinuosus* (Mertens ex Roth) Bory.
Specimens: **M** (MADM 2622; MADM 2950; MADM 3949; MADM 3741 [TL]) **PS** (MADM 3740 [TL]; MADM 4030) **S** (MADM 3141).

Hydroclathrus clathratus (Bory ex C. Agardh) Howe
First record: **S** (Gain & Mirande, 1912) as *Hydroclathrus cancellatus* Bory.
Specimens: **M** (MADM 3950; MADM 3742 [TL]) **PS** (MADM 4027).

Scytosiphon lomentaria (Lyngbye) Link
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3951; MADM 3743 [TL]; MADM 3744 [TL]; MADM 3745 [TL]).

Sporochnaceae

Sporochnus bolleanus Montagne
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3750 [TL]; MADM 3751 [TL]; MADM 3752 [TL]; MADM 3753 [TL]; MADM 3754 [TL]).

Sporochnus pedunculatus (Hudson) C. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3755 [TL]; MADM 3756 [TL]).

Arthrocladiaceae

Arthrocladia villosa (Hudson) Duby
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3253 [TL]).

Sargassaceae

Cystoseira sp.
Specimens: **M** (MADM 2537; MADM 2866; MADM 2902; MADM 2919; MADM 2920; MADM 2941).

Cystoseira abies-marina (S. G. Gmelin) C. Agardh
First record: **M** (Grunow, 1870).
Specimens: **M** (MADM 2538; MADM 2854; MADM 3931; MADM 3932; MADM 3688 [TL]; MADM 3689 [TL]; MADM 3690 [TL]; MADM 3691 [TL]; MADM 3692 [TL]; MADM 3693 [TL]; MADM 3694 [TL]; MADM 3695 [TL]; MADM 3696 [TL]; MADM 3697 [TL]) **S** (MADM 2725; MADM 3160) **C** (MADM 3933).

Cystoseira compressa (Esper) Gerloff & Nizamuddin
First record: **M**, **S** (Levring, 1974) as *Cystoseira fimbriata* Bory.
Specimens: **M** (MADM 2947; MADM 3934) **S** (MADM 2689; MADM 3104; MADM 3132; MADM 3172; MADM 3215).

Cystoseira foeniculacea (Linné) Greville
(syn. *Cystoseira discors* (Linné) C. Agardh)
First record: **M** (Grunow, 1870) as *Cystoseira abrotanifolia* (Linnaeus) C. Agardh.
Specimens: **M** (MADM 3935; MADM 3936; MADM 3699 [TL]; MADM 3719 [TL]; MADM 3720 [TL]; MADM 3721 [TL]; MADM 3722 [TL]; MADM 3724 [TL]) **PS** (MADM 3698 [TL]; MADM 3723 [TL]) **C** (MADM 3937).

Cystoseira humilis Schousboe ex Kützing
First record: **S** (Gain & Mirande, 1912) as *Cystoseira canariensis* Sauvageau.
Specimens: **M** (MADM 3938; MADM 3939; MADM 3940; MADM 3726 [TL]) **PS** (MADM 2536; MADM 2540) **S** (MADM 3725 [TL]; MADM 3727 [TL]) **C** (MADM 3941).

Cystoseira wildpretii Nizamuddin
First record: **M** (Ferreira, 2011).
Specimens: **M** (MADM 2847).

Cystoseira tamariscifolia (Hudson) Papenfuss
First record: **M** (Menezes, 1926) as *Cystoseira ericoides* (Linné) C. Agardh.
Specimens: **M** (MADM 3942; MADM 3728 [TL]; MADM 3729 [TL]).

Sargassum sp.
Specimens: **M** (MADM 4040).

Sargassum cymosum C.Agardh
First record: **S** (Parente *et al.*, 2000).
Specimens: **M** (MADM 2918).
Remarks: New Record for Madeira Island. Locality: Praia da Laje, Seixal; Date of collection: 2011/07/07; Collectors: Eunice Nogueira, Abel Sentiés, Valeria Cassano, Helena Encarnação; Identified by: Ana Neto, Sara Ferreira.

Sargassum desfontainesii (Turner) C. Agardh
First record: **M**, **DG** (Piccone, 1884).
Specimens: **M** (MADM 3943; MADM 3730 [TL]; MADM 3731 [TL]; MADM 3732 [TL]).

Sargassum filipendula C. Agardh
First record: **S** (Parente *et al.*, 2000).
Specimens: **M** (MADM 2545; MADM 2871; MADM 2872).

Sargassum furcatum Kützing
First record: **S** (Parente et al., 2000) **M** (Ferreira, 2011).
Specimens: **M** (MADM 2539).

* *Sargassum hystrix* J. Agardh (Fig. 4).
First record: Present paper.
Specimens: **M** (MADM 2868).
Remarks: Locality: Ponta de S. Jorge, Santana; Date of collection: 2011/07/06; Collectors: Eunice Nogueira, Abel Sentieés, Valeria Cassano; Identified by: Ana Neto, Sara Ferreira.

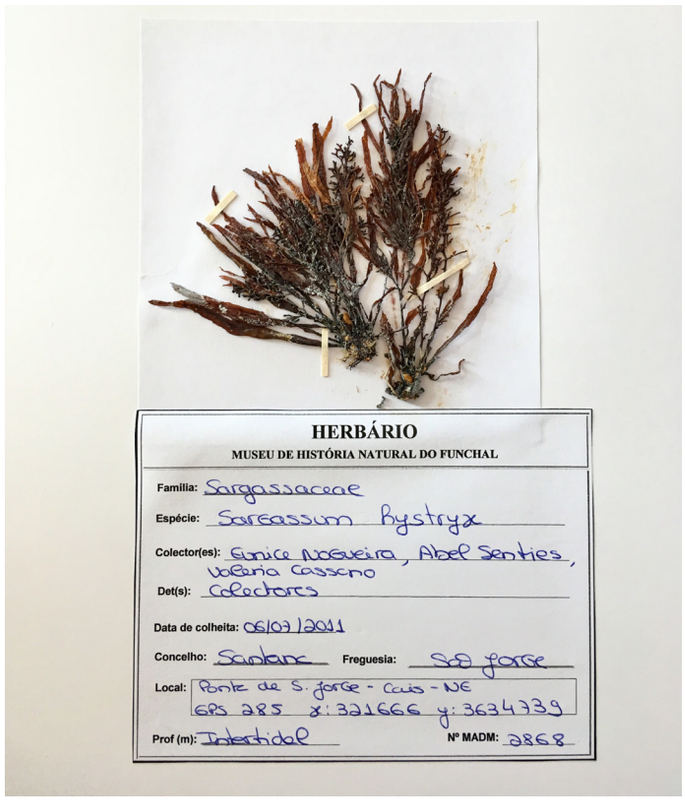

Fig. 4 – *Sargassum hystrix* J. Agardh (MADM 2868).

* *Sargassum platycarpum* Montagne (Fig. 5).
First record: Present paper.
Specimens: **M** (MADM 2975).

Remarks: Locality: Reis Magos, Caniço; Date of collection: 2011/07/08; Collectors: Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez, Helena Encarnação; Identified by: Ana Neto, Sara Ferreira.

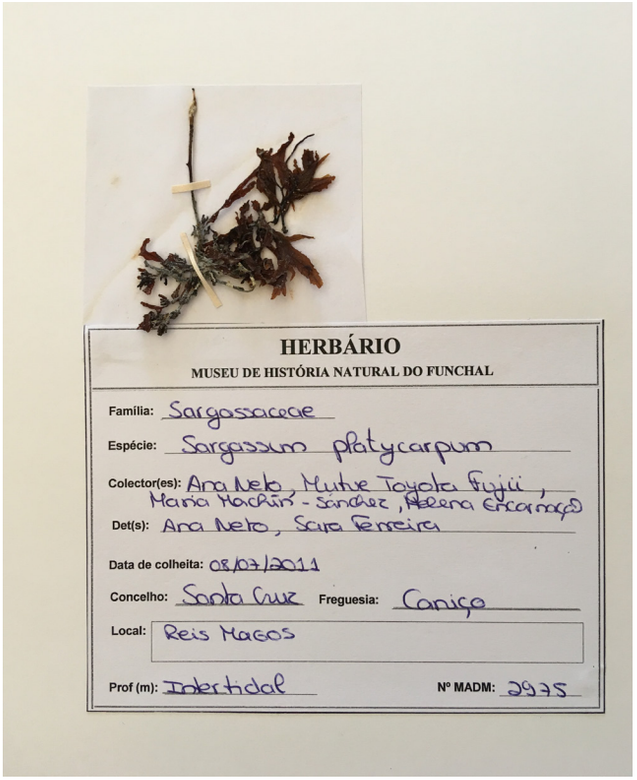

Fig. 5 – *Sargassum platycarpum* Montagne (MADM 2975).

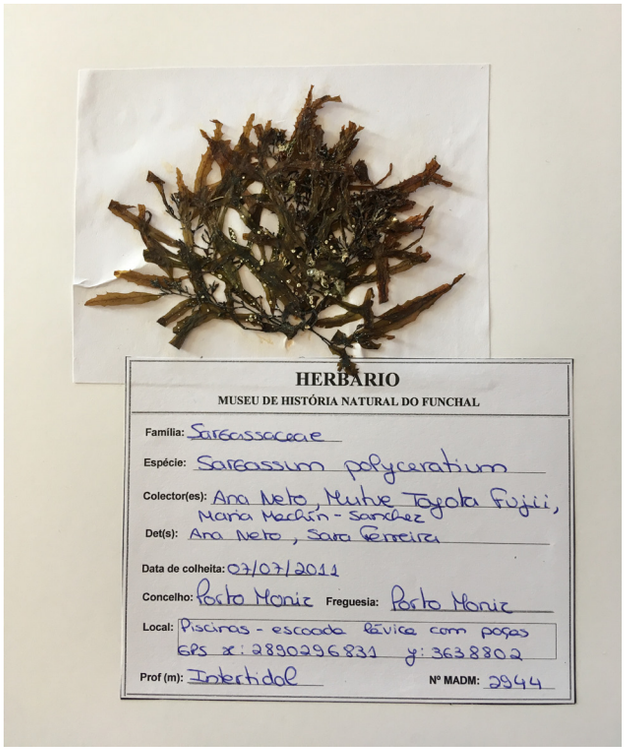

Fig. 6 – *Sargassum polyceratium* Montagne (MADM 2944).

* *Sargassum polyceratium* Montagne (Fig. 6).
First record: Present paper.
Specimens: **M** (MADM 2944).
Remarks: Locality: Porto Moniz (Piscinas); Date of collection: 2011/07/07; Collectors: Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez; Identified by: Ana Neto, Sara Ferreira.

Sargassum vulgare C. Agardh
First record: **S** (Gain, 1914).
Specimens: **M** (MADM 3944; MADM 3945; MADM 3946; MADM 3733 [TL]; MADM 3734 [TL]; MADM 3735 [TL]).

Sphacelariaceae

Sphacelaria sp.
Specimens: **M** (MADM 3972; MADM 3974).

RHODOPHYTA

Acrochaetiaceae

Acrochaetium crassipes Børgesen
First record: **M**, **S** (Levring, 1974).
Specimens: **M** (MADM 3242 [TL]; MADM 3243 [TL]; MADM 3244 [TL]; MADM 3246 [TL]; MADM 3247 [TL]) **S** (MADM 3245 [TL]).

Acrochaetium pulchellum Børgesen
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3248 [TL]).

Acrochaetium robustum Børgesen
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3249 [TL]).

Acrosymphytaceae

Acrosymphyton purpuriferum (J. Agardh) Sjöstedt
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3250 [TL]).

Stylonemataceae

Stylonema alsidii (Zanardini) K. M. Drew
(syn. *Goniotrichum alsidii* (Zanardini) Howe)
First record: **M**, **D**, **S** (Levring, 1974) as *Goniotrichum alsidii* (Zanardini) Howe.
Specimens: **M** (MADM 3765 [TL]) **D** (MADM 3767 [TL]; MADM 3768 [TL]; MADM 3769 [TL]; MADM 3770 [TL]) **S** (MADM 3764 [TL]; MADM 3766 [TL]).

Erythrotrichiaceae

Erythrocladia irregularis Rosenvinge
First record: **M**, **S** (Levring, 1974).
Specimens: **M** (MADM 3544 [TL]).

Erythrotrichia carnea (Dillwyn) J. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3547 [TL]; MADM 3549 [TL]) **S** (MADM 3548 [TL]).

Sahlingia subintegra (Rosenvinge) Kornmann
(syn. *Erythrocladia subintegra* Rosenvinge)
First record: **M**, **S** (Levring, 1974) as *Erythrocladia subintegra* Rosenvinge.
Specimens: **M** (MADM 3545 [TL]; MADM 3546 [TL]).

Colaconemataceae

Colaconema caespitosum
(J. Agardh) Jackelman, Stegenga & J. J. Bolton
(syn. *Rhodothamniella codii* (Hamel) Feldmann)
First record: **M**, **D** (Levring, 1974) as *Rhodothamniella codii* (Hamel) Feldmann.
Specimens: **M** (MADM 3373 [TL]; MADM 3374 [TL]) **D** (MADM 3375 [TL]).

Colaconema daviesii (Dillwyn) Stegenga
(syn. *Acrochaetium daviesii* (Dillwyn) Nageli)
First record: **M** (Taylor, 1882) as *Callithamnion daviesii* (Dillwyn) Lyngbye.
Specimens: **M** (MADM 3372 [TL]).

Callithamniaceae

Callithamnion sp.
Specimens: **M** (MADM 2877; MADM 2951; MADM 2952).

Seirospora sp.
Specimens: **M** (MADM 2980; MADM 2985).
Remarks: According to the collectors Eunice Nogueira, Abel Senties and Valeria Cassano the identification of MADM 2985 needs to be confirmed.

Dumontiaceae

Dudresnaya sp.
Specimens: **M** (MADM 2901).
Remarks: According to the collectors Helena Encarnação, Eunice Nogueira, Abel Senties and Valeria Cassano this identification need to be confirmed.

Liagoraceae

Ganonema sp.
Specimens: **M** (MADM 2529).

Ganonema farinosum
(J. V. Lamouroux) K. C. Fan & Yung C. Wang
First record: **M** (Ferreira, 2011).
Specimens: **M** (MADM 4034).

Liagora sp.
Specimens: **M** (MADM 2895; MADM 2963) **PS** (MADM 2531; MADM 2532; MADM 2534).

Liagora canariensis Børgesen
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3591 [TL]).

Liagora ceranoides J. V. Lamouroux
First record: **M** (Menezes, 1926) as *Liagora pulverulenta* C. Agardh.
Specimens: **M** (MADM 3593 [TL]; MADM 3594 [TL]; MADM 3595 [TL]) **S** (MADM 3592 [TL]).

Liagora distenta (Mertens ex Roth) J. V. Lamouroux
First record: **M** (Harvey, 1863).
Specimens: **M** (MADM 3596 [TL]; MADM 3597 [TL]; MADM 3598 [TL]; MADM 3600 [TL]) **PS** (MADM 3599 [TL]).

Liagora tetrasporifera Børgesen
First record: **S** (Weisscher, 1983).
Specimens: **PS** (MADM 3912; MADM 3914; MADM 3915) **C** (MADM 3913).

Liagora viscida (Forskal) C. Agardh
First record: **S** (Gain & Mirande, 1912).
Specimens: **PS** (MADM 2533).

Nemalion helminthoides (Velley) Batters
First record: **S** (Parente *et al.*, 2000).
Specimens: **M** (MADM 2865).

Neoizziella divaricata
(C. K. Tseng) S. M. Lin, S.-Y. Yang & Huisman
(syn. *Liagora divaricata* C. K. Tseng)
Specimens: **A** (MADM 3911).

Titanophycus validus
(Harvey) Huisman, G. W. Saunders & A. R. Sherwood
(syn. *Liagora valida* Harvey)
First record: **M** (Levring, 1974) as *Liagora valida* Harvey.
Specimens: **M** (MADM 2530; MADM 3601 [TL]; MADM 3602 [TL]) **C** (MADM 3916).

Galaxauraceae

Galaxaura rugosa (J. Ellis et Solander) J. V. Lamouroux
First record: **S** (Pickering & Hansen, 1969) as *Galaxaura flagelliformis* Kjellman.
Specimens: **S** (MADM 3550 [TL]).

Tricleocarpa fragilis (Linnaeus) Huisman & R.A.Townsend
(syn. *Galaxaura oblongata* (J. Ellis et Solander) J. V. Lamouroux)
First record: **S** (Lowe, 1869) as *Galaxaura oblongata* (J. Ellis et Solander) J. V. Lamouroux.
Specimens: **S** (MADM 3551 [TL]; MADM 3552 [TL]; MADM 3553 [TL]).

Scinaiaceae

Scinaia complanata (F. S. Collins) A. D. Cotton
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3738 [TL]; MADM 3739 [TL]) **D** (MADM 3737 [TL]).

Scinaia furcellata (Turner) J. Agardh
First record: **M**, **D** (Levring, 1974), **D** (Cabioch, 1974).
Specimens: **M** (MADM 3947).

Gelidiaceae

Gelidium crinale (Hare ex Turner) Gaillon
First record: **M** (Menezes, 1926).
Specimens: **S** (MADM 3554 [TL]).

Gelidium pusillum (Stackhouse) Le Jolis
First record: **M**, **D**, **S** (Levring, 1974).
Specimens: **M** (MADM 2976; MADM 3555 [TL]; MADM 3557 [TL]) **D** (MADM 3556 [TL]) **S** (MADM 2641; MADM 3558 [TL]; MADM 3559 [TL]).

Gelidium spathulatum (Kützing) Bornet
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3560 [TL]).

Gelidium spinosum (S. G. Gmelin) P. C. Silva
(syn. *Gelidium latifolium* Bornet ex Hauck)
First record: **M** (Haroun *et al*., 2002) as *Gelidium latifolium* Bornet ex Hauck.
Specimens: **M** (MADM 2940, MADM 3907).

Pterocladiaceae

Pterocladiella capillacea
(Gmelin) Santelices et Hommersand
(syn. *Pterocladia capillacea* (S. G. Gmelin) Bornet)
First record: **S** (Gain, 1914) as *Pterocladia capillacea* (S. G. Gmelin) Bornet.
Specimens: **M** (MADM 2550; MADM 2905; MADM 2974; MADM 3917; MADM 3918; MADM 3919; MADM 3606 [TL]; MADM 3607 [TL]; MADM 3608 [TL]; MADM 3609 [TL]; MADM 3610 [TL]; MADM 3611 [TL]; MADM 3612 [TL]; MADM 3613 [TL]; MADM 3614 [TL]; MADM 3615 [TL]; MADM 3616 [TL]; MADM 3617 [TL]; MADM 3618 [TL]) **S** (MADM 3619 [TL]).

Gracilariaceae

Gracilaria armata (C. Agardh) Greville
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3567 [TL]).

Gracilariopsis longissima
(S. G. Gmelin) M. Steentoft, L. M. Irvine & W. F. Farnham
(syn. *Gracilaria verrucosa* (Hudson) Papenfuss)
First record: **M** (Levring, 1974) as *Gracilaria verrucosa* (Hudson) Papenfuss.
Specimens: **M** (MADM 3568 [TL]; MADM 3569 [TL]).

Bonnemaisoniaceae

Asparagopsis armata Harvey
First record: **M**, **D**, **S** (Levring, 1974).
Specimens: **M** (MADM 2632; MADM 3863; MADM 3254 [TL]; MADM 4355 [TL]; MADM 3256 [TL]; MADM 3257 [TL]; MADM 3258 [TL]; MADM 3259 [TL]).

Falkenbergia rufolanosa (Harvey) F. Schmitz
First record: **M** (Neto *et al*., 2001).
Specimens: **M** (MADM 2986).
Remarks: This corresponds to the diploid tetrasporophyte stage of *A. armata*.

Asparagopsis taxiformis (Delile) Trevisan de Saint-Léon
First record: **M**, **D**, **S** (Levring, 1974).
Specimens: **M** (MADM 2556; MADM 3864; MADM 3865 [TL]; MADM 4038; MADM 4039; MADM 4041).

Falkenbergia sp.
Specimens: **M** (MADM 2956; MADM 3866).
Remarks: This corresponds to the diploid tetrasporophyte stage of *Asparagopsis*.

Dumontiaceae

Dudresnaya verticillata (Withering) Le Jolis
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3543 [TL]).

Gloiosiphoniaceae

Thuretella schousboei (Thuret) F. Schmitz
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3564 [TL]; MADM 3565 [TL]; MADM 3566 [TL]).

Peyssonneliaceae

Peyssonnelia rubra (Greville) J. Agardh
First record: **M**, **D** (Levring, 1974), **D** (Cabioch, 1974).
Specimens: **M** (MADM 3603 [TL]; MADM 3604 [TL]; MADM 3605 [TL]).

Hapalidiaceae

Choreonema thuretii (Bornet) F. Schmitz
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3474 [TL]; MADM 3573 [TL]; MADM 3574 [TL]; MADM 3575 [TL]) **S** (MADM 3570 [TL]; MADM 3571 [TL]; MADM 3572 [TL]).

Melobesia membranacea (Esper) J. V. Lamouroux
(syn. *Epilithon membranaceum* (Esper) Heydrich)
First record: **M**, **S** (Levring, 1974) as *Epilithon membranaceum* (Esper) Heydrich.
Specimens: **M** (MADM 3576 [TL]; MADM 3577 [TL]; MADM 3578 [TL]; MADM 3579 [TL]; MADM 3580 [TL]; MADM 3581 [TL]; MADM 3582 [TL]; MADM 3583 [TL]; MADM 3584 [TL]; MADM 3585 [TL]; MADM 3586 [TL]; MADM 3587 [TL]).

Corallinaceae

Amphiroa beauvoisii J. V. Lamouroux
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3376 [TL]; MADM 3377 [TL]).

Corallina sp.
Specimens: **M** (MADM 2893).

Corallina officinalis Linné
First record: **S** (Piccone, 1884).
Specimens: **M** (MADM 3885; MADM 3886; MADM 3887; MADM 3378 [TL]; MADM 3380 [TL]; MADM 3381 [TL]; MADM 3382 [TL]; MADM 3385 [TL]; MADM 3387 [TL]; MADM 3388 [TL]; MADM 3389 [TL]) **PS** (MADM 3384 [TL]; MADM 3386 [TL]) **S** (MADM 3379 [TL]; MADM 3383 [TL]).

Hydrolithon farinosum
(J. V. Lamouroux) D. Penrose & Y. M. Chamberlain
(syn. *Melobesia farinosa* J. V. Lamouroux)
First record: **M**, **S** (Piccone, 1884) as *Melobesia farinosa* J. V. Lamouroux.
Specimens: **M** (MADM 3427 [TL]).

Jania capillacea Harvey
First record: **S** (Weisscher, 1982).
Specimens: **M** (MADM 2916).

Jania pumila J. V. Lamouroux
First record: **M** (Levring, 1974).
Specimens: **PS** (MADM 4033).

Jania rubens (Linné) J. V. Lamouroux
First record: **M** (Taylor, 1882).
Specimens: **M** (MADM 3398 [TL]; MADM 3399 [TL]; MADM 3406 [TL]; MADM 3407 [TL]; MADM 3409 [TL]; MADM 3412 [TL]; MADM 3413 [TL]; MADM 3416 [TL]; MADM 3418 [TL]; MADM 3419 [TL]; MADM 3420 [TL]; MADM 3423 [TL]; MADM 3424 [TL]; MADM 3425 [TL]) **PS** (MADM 3403 [TL]; MADM 3414 [TL]; MADM 3415 [TL]; MADM 3421 [TL]; MADM 3422 [TL]; MADM 3426 [TL]) **S** (MADM 3400 [TL]; MADM 3401 [TL]; MADM 3402 [TL]; MADM 3404 [TL]; MADM 3405 [TL]; MADM 3408 [TL]; MADM 3410 [TL]; MADM 3411 [TL]; MADM 3417 [TL]).

Jania rubens var. *corniculata* (Linnaeus) Yendo
(syn. *Jania corniculata* (Linné) J. V. Lamouroux)
First record: **PS** (Audiffred & Prud'homme van Reine, 1985) as *Jania corniculata* (Linné) J. V. Lamouroux.
Specimens: **C** (MADM 3888).

Lithophyllum corallinae (P. L. Crouan & H. M. Crouan) Heydrich
(syn. *Dermatolithon corallinae* (P. Crouan) Foslie)
First record: **M**, **PS**, **S** (Levring, 1974) as *Dermatolithon corallinae* (P. Crouan) Foslie.
Specimens: **M** (MADM 3392 [TL]) **S** (MADM 3390 [TL]; MADM 3391 [TL]).

Titanoderma pustulatum (J. V. Lamouroux) Nägeli
(syn. *Dermatolithon pustulatum* (J. V. Lamouroux) Foslie)

First record: **M** (Grunow, 1870) as *Melobesia pustulata* J. V. Lamouroux.
Specimens: **M** (MADM 3393 [TL]; MADM 3394 [TL]; MADM 3395 [TL]; MADM 3396 [TL]; MADM 3397 [TL]).

Pneophyllum confervicola (Kützing) Y. M. Chamberlain
(syn. *Melobesia minutula* Foslie)
First record: **M**, **S** (Levring, 1974), **D** (Cabioch, 1974) as *Melobesia minutula* Foslie.
Specimens: **M** (MADM 3430 [TL]; MADM 3431 [TL]; MADM 3432 [TL]; MADM 3433 [TL]).

Pneophyllum fragile Kützing
(syn. *Melobesia lejolisii* Rosanoff)
First record: **M** (Levring, 1974) as *Melobesia lejolisii* Rosanoff.
Specimens: **M** (MADM 3428 [TL]; MADM 3429 [TL]).

Schizymeniaceae

Platoma cyclocolpum (Montagne) F. Schmitz
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3736 [TL]).

Gigartinaceae

Chondracanthus sp.
Specimens: **M** (MADM 2879).

Chondracanthus acicularis (Roth) Fredericq
(syn. *Gigartina acicularis* (Roth) J. V. Lamouroux)
First record: **S** (Piccone, 1884) as *Gigartina acicularis* (Roth) J. V. Lamouroux.
Specimens: **M** (MADM 2863; MADM 2896; MADM 2913; MADM 2983; MADM 3908; MADM 3561 [TL]; MADM 3562 [TL]; MADM 3563 [TL]; MADM 3988).

Furcellariaceae

Halarachnion ligulatum (Woodward) Kützing
First record: **PS** (Audiffred & Prud'homme van Reine, 1985).
Specimens: **M** (MADM 2535).

Cystocloniaceae

Hypnea sp.
Specimens: **M** (MADM 2906; MADM 2907; MADM 2921; MADM 2962).

Hypnea arbuscula P. J. L. Dangeard
First record: **S** (Parente *et al*., 2000).
Specimens: **M** (MADM 2934; MADM 2961).
Remarks: According to the collectors Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez and Helena Encarnação the identifications of MADM 2934 and MADM 2961 need to be confirmed.

Hypnea musciformis (Wulfen) J. V. Lamouroux
First record: **M** (Menezes, 1926).
Specimens: **M** (MADM 2543; MADM 3889; MADM 3890; MADM 3891; MADM 3442 [TL]; MADM 3444 [TL]; MADM 3445 [TL]; MADM 3446 [TL]; MADM 3448 [TL]; MADM 3449 [TL]) **PS** (MADM 3443 [TL]) **S** (MADM 3447 [TL]).

Hypnea spinella (C. Agardh) Kützing
(syn. *Hypnea cervicornis* J. Agardh)
First record: **M**, **PS**, **D**, **S** (Levring, 1974) as *Hypnea cervicornis* J. Agardh.
Specimens: **M** (MADM 2542; MADM 2924; MADM 3434 [TL]; MADM 3435 [TL]; MADM 3436 [TL]; MADM 3438 [TL]; MADM 3439 [TL]; MADM 3440 [TL]; MADM 3441 [TL]) **D** (MADM 3437 [TL]) **PS** (MADM 2544; MADM 4035) **S** (MADM 3188; MADM 3237).

Rhodophyllis sp.
Specimens: **M** (MADM 2959).
Remarks: According to collectors Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez and Helena Encarnação this identification needs to be confirmed.

Rhodophyllis madeirensis Levring
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3450 [TL]; MADM 3451 [TL]; MADM 3452 [TL]; MADM 3453 [TL]).

Caulacanthaceae

Caulacanthus ustulatus (Mertens ex Turner) Kützing
First record: **M**, **S** (Levring, 1974).
Specimens: **S** (MADM 2750; MADM 3147; MADM 3263 [TL]) **PS** (MADM 4025).

Rhodymeniaceae

Botryocladia botryoides (Wulfen) J. Feldmann
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 2629; MADM 3674 [TL]) **S** (MADM 3156).

Botryocladia chiajeana (Meneghini) Kylin

First record: **M** (Levring, 1974).
Specimens: **M** (MADM 2628).

Botryocladia sp.
Specimens: **M** (MADM 2917; MADM 2948; MADM 2977).

Irvinea sp.
Specimens: **M** (MADM 2923).

Champiaceae

Champia parvula (C. Agardh) Harvey
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3318 TL).

Lomentariaceae

Lomentaria articulata (Hudson) Lyngbye
First record: **D** (Gain, 1914).
Specimens: **M** (MADM 2892).

Wrangeliaceae

Anotrichium sp.
Specimens: **M** (MADM 3975).

Anotrichium furcellatum (J. Agardh) Baldock
(syn. *Corynospora furcellata* (J. Agardh) Levring)
First record: **M**, **D** (Levring, 1974) as *Corynospora furcellata* (J. Agardh) Levring.
Specimens: **M** (MADM 2953; MADM 3842 TL; MADM 3843 TL; MADM 3845 TL; MADM 3846 TL) **D** (MADM 3844 TL).

Anotrichium tenue (C. Agardh) Nägeli
(syn. *Griffithsia tenuis* C. Agardh)
First record: **M**, **PS**, **S** (Levring, 1974) as *Griffithsia tenuis* C. Agardh.
Specimens: **M** (MADM 3850 TL; MADM 3851 TL; MADM 3852 TL; MADM 3853 TL).

Compsothamnion thuioides (J. E. Smith) Nägeli
First record: **M** (Taylor, 1882) as *Callithamnion gracillimum* C. Agardh.
Specimens: **M** (MADM 3839 TL; MADM 3840 TL; MADM 3841 TL).

* *Gymnophycus hapsiphorus* Huisman & Kraft (Fig. 7).
First record: Present paper.
Specimens: **M** (MADM 2885).
Remarks: Locality: Porto da Cruz, Machico; Date of collection: 2011/07/06; Collected and identified by Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez, Helena Encarnação.

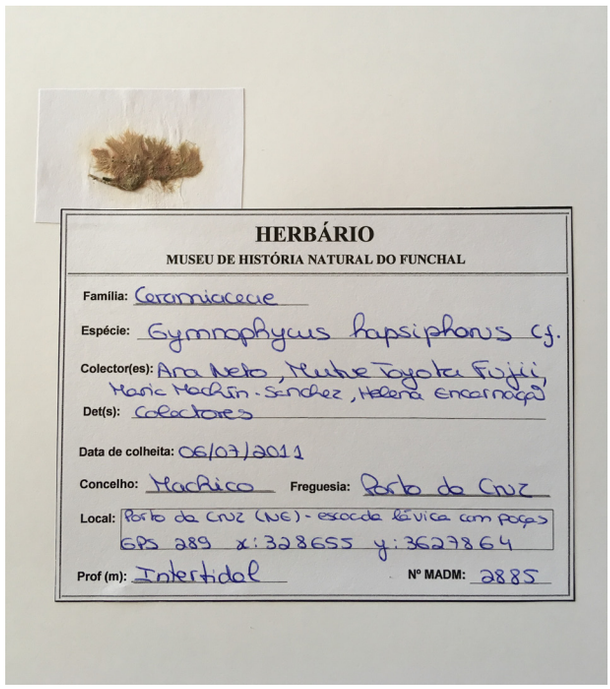

Fig. 7 – *Gymnophycus hapsiphorus* Huisman & Kraft (MADM 2885).

Griffithsia sp.
Specimens: **M** (MADM 2891).

Griffithsia opuntioides J. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 2957).

Griffithsia schousboei Montagne
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3847 TL; MADM 3848 TL; MADM 3849 TL).

Pleonosporium borreri (Smith) Nägeli
First record: **M** (Grunow, 1870) as *Callithamnion borreri* (Smith) C. Agardh.
Specimens: **M** (MADM 2954; MADM 2955; MADM 3854 TL; MADM 3855 TL; MADM 3856 TL).

Monosporus pedicellatus (J. E. Smith) Solier
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3981).

Wrangelia argus (Montagne) Montagne
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3980; MADM 3857 TL; MADM 3858 TL).

Wrangelia penicillata (C. Agardh) C. Agardh
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3859 [TL]; MADM 3860 [TL]; MADM 3861 [TL]; MADM 3862 [TL]).

Ceramiaceae

Antithamnion type
Specimens: **M** (MADM 3873).

Antithamnionella sp.
Specimens: **PS** (MADM 4026).

Antithamnionella spirographidis (Schiffner) Wollaston
(syn. *Antithamnion spirographidis* Schiffner)
First record: **M** (Levring, 1974) as *Antithamnion spirographidis* Schiffner.
Specimens: **M** (MADM 3271 [TL]; MADM 3272 [TL]).

Centroceras clavulatum (C. Agardh) Montagne
First record: **S** (Gain & Mirande, 1912) as *Ceramium clavulatum* C. Agardh.
Specimens: **M** (MADM 2898; MADM 2978; MADM 3874; MADM 3273 [TL]; MADM 3274 [TL]; MADM 3275 [TL]; MADM 3276 [TL]; MADM 3277 [TL]; MADM 3278 [TL]; MADM 3279 [TL]; MADM 3280 [TL]; MADM 3281 [TL]; MADM 3282 [TL]; MADM 3283 [TL]; MADM 3284 [TL]; MADM 3286 [TL]).

Ceramium ciliatum (J. Ellis) Ducluzeau
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 3875; MADM 3287 [TL]; MADM 3288 [TL]; MADM 3289 [TL]; MADM 3290 [TL]).

Ceramium codii (H.Richards) Mazoyer
First record: **SP** (Weisscher, 1983).
Specimens: **M** (MADM 2949).

Ceramium diaphanum (Lightfoot) Roth
(syn. *Ceramium gracillimum* (Kutzing) Zanardini)
First record: **M**, **D**, **S** (Levring, 1974).
Specimens: **M** (MADM 3292 [TL]; MADM 3294 [TL]; MADM 3295 [TL]; MADM 3296 [TL]; MADM 3297 [TL]; MADM 3298 [TL]) **S** (MADM 3291 [TL]).

Ceramium echionotum J. Agardh
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 2958).

Ceramium tenuicorne (Kützing) Waern
(syn. *Ceramium strictum* Harv.)
First record: **M** (Taylor, 1882) as *Ceramium strictum* Harv.
Specimens: **M** (MADM 3299 [TL]; MADM 3312 [TL]; MADM 3313 [TL]; MADM 3316 [TL]; MADM 3317 [TL]) **PS** (MADM 3314 [TL]) **D** (MADM 3315 [TL]).

Spyridiaceae

Spyridia filamentosa (Wulfen) Harvey
First record: **M** (Gain, 1914).
Specimens: **M** (MADM 3763 [TL]) **S** (MADM 3758 [TL]; MADM 3759 [TL]; MADM 3760 [TL]; MADM 3761 [TL]; MADM 3762 [TL]).

Spyridia hypnoides (Bory de Saint-Vincent) Papenfuss
(syn. *Spyridia aculeata* (C. Agardh ex Decaisne) Kutzing)
First record: **M** as *Spyridia aculeata* (C. Agardh ex Decaisne) Kutzing (Levring, 1974).
Specimens: **M** (MADM 3952; MADM 3953; MADM 3954; MADM 3757 [TL]).

Sarcomeniaceae

Cottoniella filamentosa (M. A. Howe) Børgesen
First record: **M** (Gain, 1914).
Specimens: **M** (MADM 3675 [TL]; MADM 3676 [TL]; MADM 3677 [TL]; MADM 3678 [TL]) **S** (MADM 2639).

Cottoniella fusiformis Børgesen
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3679 [TL]; MADM 3680 [TL]; MADM 3681 [TL]; MADM 3682 [TL]; MADM 3683 [TL]; MADM 3684 [TL]; MADM 3685 [TL]; MADM 3686 [TL]; MADM 3687 [TL]).

Delesseriaceae

Acrosorium ciliolatum (Harvey) Kylin
(syn. *Acrosorium venulosum* (Zanardini) Kylin)
First record: **M** (Neto *et al*., 2001) as *Acrosorium venulosum* (Zanardini) Kylin.
Specimens: **M** (MADM 2889; MADM 3893).

Apoglossum sp.
Specimens: **M** (MADM 2894).

Apoglossum ruscifolium (Turner) J. Agardh
First record: **M** (Levring, 1974), **D** (Cabioch, 1974).
Specimens: **M** (MADM 3477 [TL]).

Cryptopleura ramosa (Hudson) L. Newton

(syn. *Acrosorium uncinatum* (Turner) Kylin)
First record: **M**, **D** (Levring, 1974).
Specimens: **M** (MADM 3472 [TL]; MADM 3473 [TL]; MADM 3474 [TL]; MADM 3475 [TL]; MADM 3476 [TL]; MADM 3478 [TL]; MADM 3479 [TL]; MADM 3480 [TL]; MADM 3481 [TL]).

Erythroglossum sandrianum (Zanardini) Kylin
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3482 [TL]).

Haraldia lenormandii (Derbès et Solier) J. Feldmann
First record: **PS**, **D** (Audiffred & Prud'homme van Reine, 1985).
Specimens: **M** (MADM 2960).

Hypoglossum sp.
Specimens: **M** (MADM 2890).

Hypoglossum hypoglossoides
(Stackhouse) F. S. Collins & Hervey
(syn. *Hypoglossum woodwardii* Kutzing)
First record: **M** (Taylor, 1882) as *Delesseria hypoglossum* (Woodward) J. V. Lamouroux.
Specimens: **M** (MADM 3483 [TL]; MADM 3484 [TL]).

Nitophyllum punctatum (Stackhouse) Greville
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3485 [TL]).

Dasyaceae

Dasya sp.
Specimens: **M** (MADM 3977).

Dasya corymbifera J. Agardh
First record: **M** (Taylor, 1882) as *Dasya venusta* Harvey.
Specimens: **M** (MADM 2897; MADM 3984 [TL]; MADM 3985 [TL]; MADM 3986 [TL]; MADM 3987 [TL]; MADM 3454 [TL]).
Remarks: According to the collectors Ana Neto, Mutue Toyota Fujii, Maria Machín-Sanchez and Helena Encarnação the identification of MADM 2897 needs to be confirmed.

Dasya hutchinsiae Harvey
First record: **S** as *Dasya arbuscula* (Dillwyn) C. Agardh (Gain, 1914).
Specimens: **M** (MADM 3455 [TL]).

Dasya rigidula (Kützing) Ardissone
First record: **M**, **S** (Weisscher, 1983).
Specimens: **M** (MADM 2979).

Heterosiphonia crispella (C. Agardh) M. J. Wynne
(syn. *Heterosiphonia wurdemanni* (Baillard) Falkenberg)
First record: **M**, **S** (Levring, 1974) as *Heterosiphonia wurdemanni* (Baillard) Falkenberg.
Specimens: **M** (MADM 3456 [TL]; MADM 3457 [TL]; MADM 3458 [TL]; MADM 3459 [TL]; MADM 3460 [TL]; MADM 3461 [TL]; MADM 3462 [TL]).

Rhodomelaceae

Alsidium corallinum C. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3620 [TL]; MADM 3621 [TL]).

Chondria capillaris (Hudson) Wynne
(syn. *Chondria tenuissima* (Goodenough et Woodward) C. Agardh)
First record: **S** (Gain & Mirande, 1912) as *Chondria tenuissima* (Goodenough et Woodward) C. Agardh.
Specimens: **S** (MADM 2656; MADM 3189; MADM 3623 [TL]).

Chondria coerulescens (J. Agardh) Falkenberg
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3920; MADM 3622 [TL]; MADM 3538 [TL]).

Dipterosiphonia dendritica (C. Agardh) F. Schmitz
First record: **M**, **PS** (Levring, 1974).
Specimens: **PS** (MADM 3624 [TL]).

Erythrocystis montagnei (Derbès et Solier) P. C. Silva
First record: **S** (Gain & Mirande, 1912).
Specimens: **M** (MADM 3971) **S** (MADM 2635; MADM 3170a; MADM 3229a).

Halopithys incurva (Hudson) Batters
First record: **M**, **PS** (Levring, 1974).
Specimens: **M** (MADM 3625 [TL]; MADM 3627 [TL]) **PS** (MADM 3626 [TL]).

Herposiphonia sp
Specimens: **M** (MADM 2912; MADM 3976).

Herposiphonia secunda (C. Agardh) Ambronn
First record: **S** (Gain, 1914).
Specimens: **M** (MADM 3629 [TL]) **S** (MADM 3628 [TL]).

Herposiphonia tenella (C.Agardh) Ambronn
First record: **M** (Levring, 1974), **D** (Cabioch, 1974).
Specimens: **M** (MADM 3630 [TL]).

Janczewskia verruciformis Solms-Laubach
First record: **M**, **S** (Levring, 1974).
Specimens: **S** (MADM 3631 TL).

Laurencia sp.
Specimens: **M** (MADM 2625; MADM 3925).

Laurencia obtusa (Hudson) J. V. Lamouroux
First record: **M** (Grunow, 1870).
Specimens: **M** (MADM 3922; MADM 3923; MADM 3633 TL; MADM 3637 TL; MADM 3638 TL) **PS** (MADM 3634 TL; MADM 3639 TL) **S** (MADM 3635 TL; MADM 3636 TL; MADM 3640 TL).

Laurencia viridis Gil-Rodríguez et Haroun
First record: **PS**, **S** (Gil-Rodríguez & Haroun, 1992).
Specimens: **M** (MADM 2858; MADM 2870).

Lophocladia trichoclados (C. Agardh) J. Agardh
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3644 TL).

Lophosiphonia obscura (C. Agardh) Falkenberg
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3645 TL).

Melanothamnus ferulaceus
(Suhr ex J.Agardh) Díaz-Tapia & Maggs
(syn. *Polysiphonia ferulacea* Suhr ex. J. Agardh)
First record: **M**, **D** (Levring, 1974) as *Polysiphonia ferulacea* Suhr ex. J. Agardh.
Specimens: **M** (MADM 3655 TL; MADM 3656 TL).

Osmundea sp.
Specimens: **M** (MADM 2859; MADM 2880; MADM 2881; MADM 2882; MADM 4042).

Osmundea hybrida (A. P. de Candolle) K. W. Nam
(syn. *Laurencia hybrida* (A. P. de Candolle) T. Lestiboudois)
First record: **M** (Levring, 1974) as *Laurencia hybrida* (A. P. de Candolle) T. Lestiboudois.
Specimens: **M** (MADM 3921; MADM 3932 TL).

Osmundea pinnatifida (Hudson) Stackhouse
(syn. *Laurencia pinnatifida* (Hudson) J. V. Lamouroux)
First record: **M** (Johnson, 1885) as *Laurencia pinnatifida* (Hudson) J. V. Lamouroux.
Specimens: **M** (MADM 3924; MADM 3641 TL; MADM 3642 TL; MADM 3643 TL).

Osmundea truncata (Kützing) K. W. Nam & Maggs
First record: **S** (Parente *et al*., 2000), **M** (Machín-Sánchez, 2016).
Specimens: **M** (MADM 2900; MADM 2930).

Polysiphonia sp.
Specimens: **M** (MADM 2981; MADM 3927).
Remarks: MADM 3927 was identified has *Polysiphonia devoniensis* Maggs & Hommersand, but according to the collectors this identification needs to be confirmed.

Polysiphonia atlantica Kapraun & J. N. Norris
(syn. *Polysiphonia macrocarpa* Harvey)
First record: **M**, **S** (Levring, 1974) as *Polysiphonia macrocarpa* Harvey.
Specimens: **M** (MADM 3659 TL).

Polysiphonia brodiei (Dillwyn) Sprengel
First record: **M** (Taylor, 1882).
Specimens: **M** (MADM 3926).

Polysiphonia denudata (Dillwyn) Greville ex Harvey
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3928; MADM 3929; MADM 3647 TL; MADM 3648 TL; MADM 3649 TL)

Polysiphonia elongata (Hudson) Sprengel
First record: **M** (Levring, 1974).
Specimens: **M** (MADM 3650 TL; MADM 3651 TL; MADM 3652 TL; MADM 3653 TL; MADM 3654 TL).

Polysiphonia fibrillosa (Dillwyn) Sprengel
(syn. *Polysiphonia nutans* Montagne)
First record: **M** (Taylor, 1882) as *Polysiphonia carmichaeliana* Harvey.
Specimens: **M** (MADM 3660 TL).

Polysiphonia opaca (C. Agardh) Moris & De Notaris
First record: **M**, **S** (Levring, 1974).
Specimens: **M** (MADM 3662 TL; MADM 3663 TL; MADM 3664 TL) **S** (MADM 3661 TL).

Polysiphonia scopulorum Harvey
(syn. *Lophosiphonia scopulorum* (Harvey) Womersley)
First record: **D**, **S** (Levring, 1974) as *Lophosiphonia scopulorum* (Harvey) Womersley.
Specimens: **D** (MADM 3646 TL).

Pterosiphonia sp.
Specimens: **M** (MADM 2869; MADM 2887).

Rytiphlaea tinctoria (Clemente) C. Agardh
First record: **M** (Johnson, 1885).
Specimens: **M** (MADM 3669 [TL]; MADM 3670 [TL]) **PS** (MADM 3671 [TL]) **S** (MADM 3672 [TL]; MADM 3673 [TL]).

Vertebrata fucoides (Hudson) Kuntze
(syn. *Polysiphonia fucoides* (Hudson) Greville)
First record: **M** (Taylor, 1882) as *Polysiphonia violacea* (Roth) C. Agardh.
Specimens: **M** (MADM 3930; MADM 3665 [TL]; MADM 3666 [TL]; MADM 3667 [TL]; MADM 3668 [TL]).

Vertebrata furcellata (C. Agardh) Kuntze
(syn. *Polysiphonia furcellata* (C. Agardh) Harvey)
First record: **M**, **D** (Levring, 1974) as *Polysiphonia furcellata* (C. Agardh) Harvey.
Specimens: **M** (MADM 3658 [TL]) **D** (MADM 3657 [TL]).

DISCUSSION AND CONCLUSION

The first alga record from the island of Madeira was in 1687 when the Irish physician and botanist Sir Hans Sloane stayed in Madeira for three days, on his way to Jamaica, where he collected several species of plants belonging to 38 *taxa*, including a brown seaweed (Sequeira *et al*., 2010). Sloane described a specimen that is currently in the collection of the Natural History Museum in London, as *Halopteris* sp. In the original publication, the author described it as "*Muscus marinus plumiformis ramulis & foliis densissimis capillaceis*" (Sloane, 1707). It took almost 120 years for the next algae reference to appear, Buch (1825), followed by Lowe (1869), Grunow (1870), Taylor (1882), Piccone (1884), Johnson (1885) and Barton (1897).

In the 20th century, the first studies were done by Gain & Mirande (1912), Gain (1914), Menezes (1926), Pickering & Hansen (1969) and Cabioch (1974). Levring (1974) based on previous investigations and on his own fieldwork, listed 254 species of macroalgae from the archipelago of Madeira, including the Selvagens. Subsequently, between 1975 and 1986 the CANCAP Expeditions took place in the Atlantic Ocean, and targeted the study area between the Azores and Cape Verde archipelagos (Van der Land, 1987). Part of the material collected was examined and several publications were made concerning the marine algal flora of the archipelago of Madeira (Audiffred & Weisscher, 1984; Audiffred & Prud'homme van Reine, 1985; Haroun & Prud'homme van Reine, 1993; Weisscher, 1982, 1983).

The "Macaronesia 2000" expedition in 2000, recorded 75 species of algae from the archipelago of Madeira (4 Cyanophyta, 35 Rhodophyta, 16 Phaeophyta and 20 Chlorophyta). The collected specimens are deposited in the Herbarium of the University of La Laguna, Tenerife (Haroun *et al*., 2002).

Using all the published information, Neto *et al*. (2001), compiled a list of Marine Plants of the Archipelago of Madeira, which is still used as a reference for algal taxonomy on the these islands. This work lists a total of 359 species of algae: 64 Chlorophyta, 64 Phaeophyta and 231 Rhodophyta. This number was significantly lower than the one from the Canary Islands (642 species) and slightly higher than the one from the Azores (307 species, Neto, 1994), placing the archipelago of Madeira on an intermediate position between the Azores and the Canary Islands (Neto *et al*., 2001).

When considering red algae, Madeira is more closely related to the Canary Islands than to the Azores and when considering green and brown algae, the opposite is true (Prud'homme van Reine & van den Hoek, 1990; Neto *et al*., 2001).

As foreseen by Neto *et al*. (2001), the number of species recorded for the archipelago of Madeira continued to increase. Seventeen years later, 419 species of algae have been recorded from the archipelago of Madeira (Norton & Parkes, 1972; Levring, 1974; Audiffred & Weisscher, 1984; Price, John & Lawson, 1986; Parente *et al*., 2000; Neto *et al*., 2001; Haroun *et al*., 2002; Verlaque *et al*., 2003; John *et al*., 2004; Afonso-Carrillo *et al*., 2006; Verbruggen *et al*., 2006; Tronholm *et al*., 2010; Gabriel, *et al*., 2011; Ferreira, 2011; Guiry, 2012; Machín-Sanchez *et al*., 2014; Machín-Sanchez *et al*., 2016; Ribeiro *et al*., 2018).

With the present contribution, 6 species are new records from the archipelago of Madeira (*Ulva pseudorotundata*, *Dictyota adnata*, *Sargassum hystrix*, *Sargassum platycarpum*, *Sargassum polyceratium* and *Gymnophycus hapsiphorus*) and 2, previously recorded from the Selvagens, are new for island of Madeira (*Ulva polyclada* and *Sargassum cymosum*). The list of algae species of the Archipelago of Madeira is updated to 425 species.

The island of Madeira is now the new northernmost limit of distribution in the Eastern Atlantic Ocean for *Ulva polyclada*, *Sargassum platycarpum* and *Gymnophycus hapsiphorus*, and the new southernmost limit of distribution in the Eastern Atlantic Ocean for *Dictyota adnata*, previously only recorded from the Azores archipelago (Guiry, 2018).

Sargassum hystrix and *Sargassum polyceratium* are not only new for the archipelago of Madeira, but also new records for the whole Macaronesia. *S. hystrix* was

previously known from Senegal, Sierra Leone, the tropical and subtropical Western Atlantic Ocean and Indonesia and *S. polyceratium* from Turkey, Bermuda, the tropical and subtropical Western Atlantic Ocean and Asia (Guiry, 2018).

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