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Morphological and molecular data from Madeira support the persistence of an ancient lineage of *Taxus baccata* L. in Macaronesia and call for immediate conservation actions
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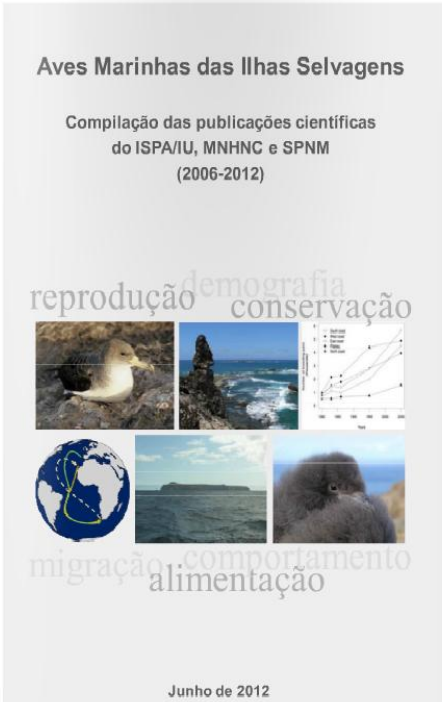
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Vários

2006-2012



of extinct fossil scops owl (Aves: Strigiformes: Strigidae: *Otus*) from the Archipelago of Madeira (North Atlantic Ocean)

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Article

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A new species of extinct fossil scops owl (Aves: Strigiformes: Strigidae: *Otus*) from the Archipelago of Madeira (North Atlantic Ocean)

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Abstract

The extinct Madeiran Scops Owl *Otus maderae* n. sp. is described from fossil bones found in Quaternary sites on Madeira Island (Madeira Archipelago, North Atlantic Ocean). It is the first extinct bird to be described from this archipelago and the first extinct species of Strigiformes known from anywhere in Macaronesia. The forelimb bones of the new taxon are similar in size to those of the Eurasian Scops Owl (*Otus scops* Linnaeus) but the hindlimb bones are longer, especially the tarsometatarsus, which is much longer and more slender than in *O. scops*. The estimated body weight and wing loading, together with the proportions of hindlimb bones (femur, tibiotarsus and tarsometatarsus) in relation to total length of leg bones (femur+tibiotarsus+tarsometatarsus), seem to indicate a ground-dwelling life-style. Human arrival and subsequent habitat alterations (introduction of alien taxa, burning, etc.) are the most probable causes of its extinction. The same species or a close relative is documented from dates on the island of Porto Santo, but the quality of preservation of its bones precludes more certain identification.

Key words: Extinction, evolution of island biotas, Madeiran Scops Owl, *Otus maderae* n. sp., Macaronesia, Quaternary.

Introduction

Existing vertebrate faunas of islands have usually been modified by two recent global events: (1) numerous extinctions and (2) introduction of alien taxa, both mainly caused by human arrival and subsequent alterations of insular ecosystems (Olson & James 1982a; Worrlly & Holdaway 2002; Steadman 2006). Consequently, current autochthonous biotas are essentially human-influenced subsets of those originally present. Knowing the former diversity and species' distributions of pristine island faunas is critical for understanding the evolutionary history, biogeography, and conservation status of remaining species and ecosystems.

The oceanic Macaronesian archipelagos (Azores, Madeira, Selvagens, Canary Islands and Cape Verde) are located in the North Atlantic Ocean (15°N–39°N and 10°W–30°W), and between ~100 km (Canary Islands) and ~1350 km (Azores) from the Old World mainland (Fig. 1). The original Quaternary faunas of these islands have been poorly studied in the Azores, Madeira, Selvagens, and Cape Verde, whereas those from the Canary Islands are better known. The Canary Islands differ from other Macaronesian islands by: (i) the prehistoric presence of endemic non-flying land mammals (three extinct species of *Rodentia* and one of *Soricomorpha*), which are absent from the other archipelagos; and (ii) by their different history of human colonization. In the Canary Islands, two well differentiated waves of human arrival took place: the "aboriginal", from north-west Africa, some time between 756 cal BC–313 cal AD (Alcover *et al.* 2009), and a second wave of colonization from Europe starting in the 14th century (Armat *et al.* 2006). The other Macaronesian archipelagos were first populated from Portugal during the 15th century (Crosby 1988).

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ius species from Molucca (Coleoptera: Zopheridae)

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Two new Tarphius species from Macaronesia (Coleoptera, Zopheridae)

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The diet of Atlantic Yellow-legged Gulls (*Larus michahellis atlantis*): estimating predatory impact upon breeding petrels

For 3 WJL Run
DOI: 10.1080/00144460.2010.481444
ORIGINAL PAPER

The diet of Atlantic Yellow-legged Gulls (*Larus michahellis atlantis*) at an oceanic seabird colony: estimating predatory impact upon breeding petrels

Rafael Matias · Paulo Catry

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Abstract The diet and breeding ecology of Yellow-legged Gulls (*Larus michahellis atlantis*) were studied on Selvagem Grande, North Atlantic in the nesting season of 2007. We collected and analyzed 715 pellets from adults. The most frequent prey were White-faced Storm-petrels (*Phaethon rubricauda*; present on 40.8% of all pellets) and the endemic land snails (*Thais macdonaldi*; present on 36.5% of all pellets). Other birds, namely Cory's Shearwaters (*Calonectris diomedea*), Macaronesian Shearwaters (*Puffinus creatopus*), Bulwer's Petrels (*Bulweria bulwerii*), and Band-rumped Storm-petrels (*Oceanodroma castro*) were relatively less frequent, but overall, seabirds were present in ca. 50% of all pellets, representing an estimated 60.4% of all mass consumed by gulls. We estimate that the contribution of seabirds to the overall caloric balance amounted for 82.5% of all energy consumed. The number of gull pairs breeding on Selvagem Grande was 12 in 2005 and 2007. Breeding success was low (0.92 and 0.25 juveniles per breeding pair, respectively). Using a simple bioenergetics model, we estimate the breeding gull population to have the potential to consume approximately 4,847 adult-individual seabirds in 3.5 months in order to meet its energetic requirements. The importance of the estimated predation levels is discussed and some management actions are suggested.

Keywords Predation · Selvagens · Phaethonidae · Calonectris · Bioenergetics

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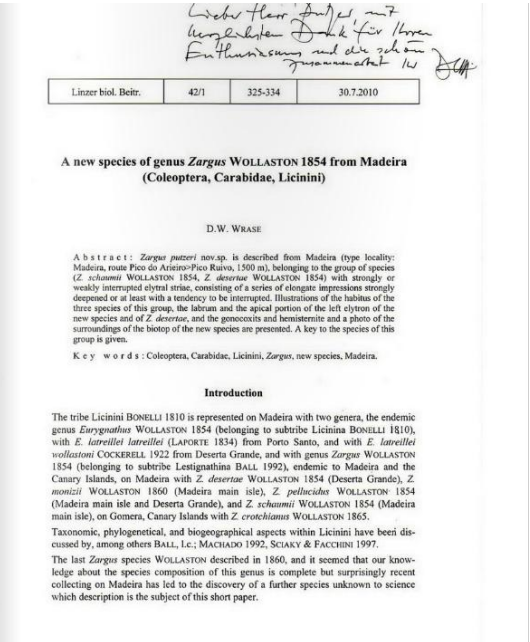
Introduction

Large gulls (*Larus* spp.) are widespread seabird predators. They may play an important role in the population regulation of several prey species, namely auks (Alcidae) and petrels (Procellariiformes). Typically, on islands, the seabird prey includes species of small body size, particularly storm-petrels (Hydrobatidae; e.g., Vidal et al. 1998; Sinthoua and Mammocchia 1999; Oro et al. 2005).

During the last century, there were marked population increases of several large gull species throughout the world; among other factors, the organic waste available at refuse tips and landfills and, especially, fish offal and discards originating from an over-growing fishing industry have been implicated as important causes for rapid population increase in large gulls (e.g., Spain 1971; Furness et al. 1982; Oro et al. 1995; Doherty et al. 2008; but see Harris 1970 and Belant et al. 1993). Such changes led to overpopulation in many areas, which in turn resulted in disproportionate predation rates where gulls coexisted with small petrels and other seabird prey (e.g., Sinthoua and Mammocchia 1999; Oro et al. 2005 and references therein). The impact of predation levels on prey populations can be very severe, particularly when anthropogenic or alternative natural prey resources become scarce; and in some cases, management measures have been applied, albeit with variable success (Oro et al. 2005 and references therein; Oro and Martínez-Ablain 2007).

The Selvagens archipelago (consisting of the islands Selvagem Grande, Selvagem Pequena and Ilhéu de Fora) is classified as an important bird area (Costa et al. 2003) and holds internationally important populations of several seabirds: Cory's Shearwaters (*Calonectris diomedea*), Macaronesian Shearwaters (*Puffinus creatopus*), Bulwer's Petrels (*Bulweria bulwerii*), White-faced Storm-petrels

A new species of the genus WOLLASTON 1854 from Madeira (Coleoptera, Carabidae, Licinini)



Integrative Zoology 2010, 5: 70-83

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ORIGINAL ARTICLE

Successful eradication of the European rabbit (*Oryctolagus cuniculus*) and house mouse (*Mus musculus*) from the island of Selvagem Grande (Macaronesian archipelago), in the Eastern Atlantic

Paulo OLIVEIRA,¹ Dilia MENEZES,¹ Roger TROUT,² Alan BUCKLE,³ Pedro GERALDES¹ and José JESUS¹

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Abstract

The Portuguese island of Selvagem Grande (Great Salvage) in Macaronesia is an important seabird breeding station in the eastern Atlantic. Significant populations of Cory's shearwater *Calonectris diomedea* (Scopoli, 1769), Bulwer's petrel *Bulweria bulwerii* (Jardine & Selby, 1828) and little shearwater *Puffinus assimilis* (Latham, 1826) are present, and white-faced storm-petrel *Pelagodroma marina* (Latham, 1790) and Madeiran storm-petrel *Oceanodroma castro* (Harcourt, 1851) populations are of global significance. Selvagem Grande also provides diverse habitats for an extensive flora, including 11 endemic species. The 270-ha island was also inhabited by two alien invasive mammals: the European rabbit *Oryctolagus cuniculus* (Linnaeus, 1758) and the house mouse *Mus musculus* (Linnaeus, 1758). Both are known to have had adverse impacts on breeding seabirds and island vegetation. In 2002, the Natural Park of Madeira conducted a program using broadleaf bait formulations aimed at rabbit and mouse eradication. Approximately 17,000 individual baiting points were established on a 12.5 × 12.5 m grid. Bait was also applied by hand "seeding" on steep slopes and cliffs where bait stations could not be placed. Rabbits were removed after a month. However, mice persisted for considerably longer and strategic bait applications against them continued for a further six months. Subsequent assessments by trapping, bait takes and systematic observation of signs over three years, has confirmed the removal of both alien invasive species. This paper presents information on these operations, on measures adopted to mitigate adverse impacts of the eradication program on important vertebrate non-target species, including Bother's pipit *Scotopelia boucardi* (Bull., 1862) and a species of gecko *Tarentola hispidula* (Joger, 1984) and on the initial response of the island's ecosystem to the eradication of rabbits and mice.

Key words: alien invasive, island restoration, *Mus musculus*, non-target mitigation, *Oryctolagus cuniculus*.

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INTRODUCTION

The Ilhas Selvagens consist of a sub-archipelago of the three Portuguese Salvage Islands (Selvagem Grande,

earwaters shift with destinations between the hemispheres and across ocean basins

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Breaking the routine: individual Cory's shearwaters shift winter destinations between hemispheres and across ocean basins

Maria P. Dias, José P. Granadeiro, Richard A. Phillips, Hany Alonso and Paulo Catry

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ORIGINAL PAPER

Using taxonomically unbiased criteria to prioritize resource allocation for oceanic island species conservation

José L. Martín · Pedro Cardoso · Manuel Arechavaleta · Paulo A. V. Borges · Bernardo F. Faria · Cristina Abreu · António F. Aguiar · José A. Carvalho · Ana C. Costa · Regina T. Cunha · Francisco M. Fernandes · Rosalina Gabriel · Roberto Jardim · Carlos Lobo · António M. F. Martins · Paulo Oliveira · Pedro Rodrigues · Luís Silva · Dinarte Teixeira · Isabel R. Amorim · Nidia Homem · Berta Martins · Mónica Martins · Encarnação Mendonça

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Abstract Oceanic islands have been the grand stage of documented extinctions. In view of limited resources, efficient prioritization is crucial to avoid the extinction of taxa. This work lists the top 100 management priority species for the European archipelagos of the Macaronesian region (Azores, Madeira and the Canary Islands), taking into account both their protection priority and their management feasibility. Bryophytes, vascular plants, molluscs, arthropods and vertebrates were scored by species experts following two sets of criteria: (i) protection priority, including ecological value, singularity, public institutions' management responsibilities and social value; (ii) management feasibility, including

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eria to prioritize resource allocation for oceanic island species conservation

and its relation with 200 islands of the Madeira and Canary Islands Archipelagos



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Article

The Selvagens Islands bryoflora and its relation with islands of the Madeira and Canary Islands Archipelagos

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With 4 figures and 2 tables

Abstract The bryoflora of the Selvagens Archipelago is characterised and updated based on results from recent fieldwork, and compared with those of Madeira and Canary Islands. The bryoflora of Selvagens Islands includes 16 taxa, four of which are reported for the first time for these islands. As a result of its small area and strong saline influence, low habitat diversity is present on Selvagens Archipelago determining most of its bryophyte diversity, which is dominated by acrocarpous mosses and mainly by species adapted to stressful conditions. Due to its topography, the Selvagens bryoflora is quite distinct from the other islands of Madeira Archipelago. Cluster analysis revealed closest relationships with the closest islands of Madeira Archipelago (Desertas Islands and Porto Santo), and with the Canary Islands of Fuerteventura and Lanzarote. Recent revisions in the course of this comparison also revealed new taxa for the bryoflora of Desertas and Porto Santo, namely one and eight species, respectively.

Key words: Bryoflora, Canary Islands, dry areas, Madeira Archipelago, Selvagens Islands

Introduction

The uninhabited Selvagens Archipelago is situated in the North Atlantic at approximately 300 km south of Madeira Island and 180 km north of the Canary Archipelago (Fig. 1). It consists of a group of small islands of volcanic origin, Selvagens Grande, Selvagens Pequenas and Ilhéu de Fora, which originated from the same volcanic hotspot as the Canary Islands and have an estimated age of 27 Myr (e.g., Geldmacher et al. 2005). This archipelago constitutes the southernmost part of the Portuguese territory and is administered by the Madeira Autonomous Region.

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mountain shrublands of the Macaronesian islands (NW Africa, Atlantic Ocean)

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Trophic habits of feral cats in the high mountain shrublands of the Macaronesian islands (NW Africa, Atlantic Ocean)

Félix M. MEDINA, Paulo OLIVEIRA, Dilia MENEZES, Sérgio TEIXEIRA,
Rafael GARCÍA and Manuel NOGALES

Medina F. M., Oliveira P., Menezes D., Teixeira S., García R. and Nogales M.
2010. Trophic habits of feral cats in the high mountain shrublands of the
Macaronesian islands (NW Africa, Atlantic Ocean). Acta Theriologica 55:
241–250.

Feral cats *Felis catus* Linnaeus, 1758 have contributed to the extinction of numerous native species on islands, which are clearly sources of global biodiversity. We studied the diet of this introduced predator in the Madeira and Cape Verde archipelagos, which harbour important colonies of endangered seabirds in the high mountain habitats, and compared the results with those obtained in the same habitat in the Canary Islands, Macaronesian archipelago. On Madeira, 461 prey were identified from 145 scat groups. Mammals, overall mice, constituted the basic diet appearing in 90% of cat scats. On Fogo (Cape Verde), 657 prey items were obtained from 145 scats, and mammals were also the most important prey, reaching a frequency of occurrence of 88%. Although introduced mammals were the main prey category on all Macaronesian islands, we observed variation in feral cat diet among these islands. Birds were more frequently consumed on Madeira, Islands of Tenerife (Canaries) and invertebrates on Fogo. No specific differences were observed in relation to La Palma. We suggest that the diet composition on these islands varies according to the respective availability of the different prey types.

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Key words: non-native cats, Macaronesia, Madeira, Canaries, Cape Verde, diet, mountain environments

Introduction

Feral cats *Felis catus* Linnaeus, 1758 have become a top predator in the food chains on is-

lands where they were introduced (Nogales et al. 1992), contributing to the decline and extinction of numerous native species worldwide (Lever 1994, Tershy et al. 2002). From continents (Dickman 1996) to islands of continental origin

1811

hygiene Northern Hemisphere Antigua Off-shore petrels evidence for specific status of Bugio and Cape Verde petrels and

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Phylogenetic relationships of gadfly petrels
Pterodroma spp. from the Northeastern Atlantic
Ocean: molecular evidence for specific status of
Bugio and Cape Verde petrels and implications
for conservation

JOSÉ JESUS, DILIA MENEZES, SARA GOMES, PAULO OLIVEIRA,
MANUEL NOGALES and ANTONIO BREHM

Summary

It is widely accepted that the gadfly petrels of the Macaronesian islands comprise three closely related and morphologically similar taxa, *Pterodroma inexpectata* from Madeira island, *P. deserta* (also treated as *P. faveo deserta*) from Bugio and *P. faveo* (also treated as *P. faveo faveo*) from Cape Verde Islands. However, the taxonomic rank of each taxon is not well defined, and has been subject to a long debate. Partial sequences of cytochrome b (563 bp) from 39 individuals (five from Madeira, 18 from nearby Bugio, and 16 from Fogo) and morphometric data from five characters from 111 individuals (24 from Bugio and 87 from Fogo in Cape Verde), were used to compare and estimate phylogenetic relationships and the taxonomic status of these petrels. In the phylogenetic analysis and sequence divergence estimation, we also include 23 sequences of 19 *Pterodroma* species available from GenBank. Our results show that Macaronesian gadfly petrels form a monophyletic clade. Birds from Bugio and Cape Verde are the most closely related taxa followed by those from Madeira. The group formed by the three taxa studied is closely related to Bermuda Petrel *P. cahow* and black-capped Petrel *P. heugeni*. A hypothesis for the colonization of the islands is presented. The level of sequence divergence is sufficient to consider the populations of Bugio and Cape Verde as separate species. Reproductive isolation is supported by exclusive haplotypes and fixed changes. Despite the presence of some significant differences in bill and tarsus measurements, the two species seem to be morphologically similar because the great overlap of variation intervals in the measurements hinders identification. It therefore appears suitable for consideration as a cryptic species. An important conservation implication is that the world population of both species is very small; if treated as a full species, *deserta* on Bugio may qualify for uplisting to 'Vulnerable' on the IUCN Red List.

Introduction

Petrels of the genus *Pterodroma* form the largest group of tube-nosed birds, consisting of 26 species with a geographical distribution range covering the Atlantic, Indian and Pacific Oceans (Imber 1993). Gadfly petrels of the genus *Pterodroma* are represented in the Northeast Atlantic by three breeding colonies, located on Madeira Island itself, Bugio (one of the nearby Desertas islets) and the Cape Verde Islands. The taxonomy of these petrels has been controversial and subject to discussion (see for example Mathews 1934a, b; Imber 1975; Zino and Zino 1976; Zino *et al.* 2003), mainly due to their morphological similarities.

from the Selvagens Islands (Portugal), additional to the current knowledge

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SPIDERS (ARACHNIDA: ARANEAE) FROM THE SELVAGENS ISLANDS
(PORTUGAL): ADDITIONS TO THE CURRENT KNOWLEDGE

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Abstract: A large collection of spiders from Selvagens Grande (Selvagens Islands, Portugal) was gathered to analyze the community response to a vegetation recovery experiment. The presence of several species in this small archipelago is confirmed and new additions to its fauna have been reported. *Pardosa ramulosa* (Purcell, 1775), *Lophocarenum fulvipes* (Simon, 1894), *Urolophora rubra* (L. Koch, 1872), *Zenopsis opita* (Blackwall, 1838), *Mesostoma cf. nanum* (Wunderlich, 1987), *Synschemus cf. maderae* (Lacaze, 1896) & *M. m. m.*, 2007, *Zenopsis opita* (Blackwall, 1838), *Mesostoma cf. nanum* (Wunderlich, 1987), *Synschemus cf. maderae* (Lacaze, 1896) & *M. m. m.*, 2007, *Blattella germanica* (L., 1758), *Thomisus onustus* (Blackwall, 1838) & *Xysticus laevigatus* (Wunderlich, 1982). The archipelago currently comprises 43 species.

Key words: Araneae, Iberian, Selvagens Islands, Portugal.
Spiders (Arachnida: Araneae) de las  las Selvagens (Portugal): aportaciones al conocimiento actual
Resumen: Se recolect  un gran n mero de ar nidos en Selvagens Grande ( las Selvagens, Portugal) con el fin de analizar la respuesta de la comunidad a un experimento de regeneraci n de la vegetaci n. Se confirma la presencia de varias especies en este peque o archipi lago, y se a aden nuevas aportaciones a su fauna de ar nidos: *Pardosa ramulosa* (Purcell, 1775), *Lophocarenum fulvipes* (Simon, 1894), *Urolophora rubra* (L. Koch, 1872), *Zenopsis opita* (Blackwall, 1838), *Mesostoma cf. nanum* (Wunderlich, 1987), *Synschemus cf. maderae* (Lacaze, 1896) & *M. m. m.*, 2007, *Zenopsis opita* (Blackwall, 1838), *Mesostoma cf. nanum* (Wunderlich, 1987), *Synschemus cf. maderae* (Lacaze, 1896) & *M. m. m.*, 2007, *Blattella germanica* (L., 1758), *Thomisus onustus* (Blackwall, 1838) & *Xysticus laevigatus* (Wunderlich, 1982). Actualmente se conocen 43 especies del archipi lago.

Palabras clave: Araneae, Iber nica,  las Selvagens, Portugal.
Introduction
The Selvagens Islands comprise a small group of islands and islets situated about 300 km south of Madeira Island and 180 km north of the Canary Islands. They began emerging 27 m.y. BP. However, at least Selvagens Grande had three eruptive cycles at 24-30 m.y., 8-12 m.y. and 1-4 m.y. (G hlmecher *et al.*, 2001) and its current fauna may have originated after this last eruption, being the previous faunas extinguished by submergence of the island. The Selvagens Grande is also the largest island of the archipelago with about 245 ha and a maximum altitude of 153 m; it is mostly demarcated by a semi-desertic habitat. All collected specimens come from this island. The remainder islets are the Selvagens Pequena, Ilh s de Fora, Ilh s Comprido and Ilh s do Norte.
The spider community of the Selvagens Islands is far from being well known. Previous work on ecological islets expeditions that provided material for Blackwall (1864), Kukulsky (1991) and Simon (1912), however much of the material from these expeditions is supposed to be lost and some species were identified using juveniles, which provides doubtful records. A more thorough approach was followed by Davis (1963). A preliminary checklist of 33 species was compiled by Wunderlich (1992) who, additionally to listing the citation by the previous authors, analyzed some specimens collected by Remble in 1978. Wunderlich (1992) erroneously cited 4 endemic species to the Selvagens but we know now that two were synonyms of other species

(*Dysdera wallacensis* sensu Kukulsky, 1991 is now known as *Dysdera nevadensis* Simon, 1907, and *Scotognatha bewicki* Davis, 1963, is now known as *Scotognatha putrefacta* (Blackwall, 1864)), a third endemic species was added when this same author described *Dicranus selvagensis* Wunderlich, 1995. More recently, a compilation of all previously published literature was made by Cardoso & Crespo (2008), in which material from the work now presented was included.

Material
The invasive plant *Miconia glauca* was removed from the Selvagens Grande during the three years (2000 – 2002). In order to perceive the community changes with this removal, spiders were captured using pitfall traps, hand collecting (along transects and inside 1 m² delimited squares) and vegetation beating from 2002 to 2003. Different collectors at different seasons have done all methods in a non-standardized way. Although such collection did not allow understanding compositional differences before and after the experiment, it provided the material now presented.
Half of the obtained material and the taxonomic and most diagnostic collections are deposited in the National Museum of Natural History of Denmark, Zoological Museum (ZMUC) while the other half of the material is deposited at the Municipal Museum of Funchal (MMF).

phylogenetic relationships of gadfly petrels from the Northeastern Atlantic Ocean: molecular evidence for specific status of Bugio and Cape Verde petrels and implications for conservation

Molecular phylogenetics of the Macaronesian-endemic genus *Bystropogon* (Lamiaceae): palaeo-islands, ecological shifts and interisland colonizations

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Abstract

A molecular phylogenetic study of *Bystropogon* L'Her. (Lamiaceae) is presented. We performed a cladistic analysis of nucleotide sequences of the internal transcribed spacer (ITS), of the nuclear ribosomal DNA, and of the *trnL* gene and *trnL-trnF* intergenic spacer of the chloroplast DNA. *Bystropogon olerativus* is the only species endemic to the Canary Islands that occurs in the three palaeo-islands of Tenerife. This species is not part of an early diverging lineage of *Bystropogon* and we suggest that it has a recent origin. This phylogenetic pattern is followed by most of the species endemic to the palaeo-islands of Tenerife. The two sections currently recognized in *Bystropogon* form two monophyletic groups. Taxa belonging to the section *Bystropogon* clade show interisland colonization limited to the Canary Islands with ecological shifts among three ecological zones. Taxa from the section *Canariense* clade show interisland colonization both within the Canary Islands and between the Canary Islands and Madeira. Speciation events within this clade are mostly limited to the laurel forest. The genus has followed a colonization route from the Canaries towards Madeira. This route has also been followed by at least five other plant genera with species endemic to Macaronesia. Major incongruences were found between the current infra-sectional classification and the molecular phylogeny, because the varieties of *Bystropogon origanifolius* and *Bystropogon canariensis* do not form two monophyletic groups. The widespread *B. origanifolius* appears as progenitor of the other species in section *Bystropogon* with a more restricted distribution.

Keywords: adaptive radiation, biogeography, evolution, molecular phylogenetics, oceanic islands, quantum speciation

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Introduction

The Macaronesian Islands comprise the Atlantic archipelago of the Azores, Madeira, Selvagens, Canaries, and Cape Verde. In the last 10 years, many evolutionary biology studies have focused on this region, and these island systems have played an important role in the understanding of

plant speciation processes in archipelagos worldwide (Baldwin *et al.* 1998; Juan *et al.* 2000; Emerson 2002; Soltow 2004; Valido *et al.* 2004). Research into the interisland relationships of Macaronesian endemics gives insight into the relative roles of dispersal and ecological adaptation as evolutionary processes (Francisco-Ortega *et al.* 1998, 2002; Pardo *et al.* 1999). However, none of these studies have focused on interpreting phylogenetic patterns in the framework of the geological history of Macaronesia. The island of Tenerife (Canary Islands) has a complex geological history

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Chemical polymorphism of populations of *Thymus caespitosus* grown on the islands Corvo, Flores, São Miguel and Terceira (Azores) and on Madeira, assessed by analysis of their essential oils



Chemical polymorphism of populations of *Thymus caespitosus* grown on the islands Corvo, Flores, São Miguel and Terceira (Azores) and on Madeira, assessed by analysis of their essential oils

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Abstract

The composition of the essential oils isolated from 24 populations of *Thymus caespitosus* collected on Corvo, Flores, São Miguel and Terceira (Azores) and on Madeira were studied by GC and GC-MS. All the oil samples analysed were dominated by their monoterpene fraction (66–89%). In the Azorean populations, the proportion of the oxygenated monoterpenes (51–79%) was higher than that of the monoterpene hydrocarbons (11–27%). In contrast, the monoterpene hydrocarbons and the oxygenated monoterpenes represented 35–44 and 42–43%, respectively, of the total oils from the populations grown on Madeira. Cluster analysis of the identified components with a concentration >1% grouped the oils into three main clusters that corresponded with their main components: carvacrol (41–45%), thymol (15–19%) and α -terpineol (15–37%). Although the populations collected on Madeira were grouped in the same cluster, the cluster analysis of subcluster, terpenes 4 and α -terpineol showed that there was a clear chemical polymorphism. Actually, in the oils from two populations (α -1 subcluster, 1–3 terpenes 4 and 4–6 α -terpineol) were the predominant components while in the third population an opposite ratio was found. The chemical polymorphism of the essential oils from *T. caespitosus* may result either from the genetic variability of the populations or from the influence of edaphic factors.

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Keywords: *Thymus caespitosus*; Lamiaceae; Essential oil; Chromatogram; Azores; Madeira; Terceira; Corvo; Flores; Terceira; Chemical analysis

1. Introduction

Thymus caespitosus Brot. is a taxon of the section Micantes; it is endemic of the NW Iberian peninsula, and grows wild also in the Madeira and Azores archipelagos [1–3]. The essential oils obtained from populations of this

species collected in the Portuguese mainland [1,4–6] were all dominated by α -terpineol, whereas those isolated from populations grown on Azorean islands showed a remarkable chemical polymorphism [1–3].

Continuing our studies on *T. caespitosus* from Macaronesia, we report in this paper on the compositions of the essential oils from 24 populations (Table 1): two grown on Corvo, eight on Flores, six on São Miguel, five on Terceira (Azores) and three on Madeira.

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Comparison of the essential oil composition of *Thymus caespitosus* species:

P. bifaria

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Comparison of the essential oil composition of four *Plagiochila* species: *P. bifaria*, *P. maderensis*, *P. retrorsa* and *P. stricta*

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ABSTRACT: Essential oils isolated by distillation-extraction from *P. bifaria*, *P. maderensis*, *P. retrorsa* and *P. stricta*, collected on Madeira, were analysed by GC and GC-MS. Methyl eugenolate (13–35%), pectolinaric acid (13–16%) and eucalyptol (4.15–10.6–1.0%) were the main components in all *P. bifaria* specimens analysed. Terpinolene (34–40%) dominated the oils isolated from *P. maderensis* specimens. β -Phellandrene (16–46%) was the main component of two of the three specimens of *P. retrorsa*, α -thujene (15%), terpinolene (15%), pectolinaric acid (12%) and α -thujene (10%) being the main components of the third specimen. *P. stricta* oils were dominated by pectolinaric acid (11–21%), α -thujene (7–19%), bicyclogermacrene (4–17%), α -thujene (4–11%) and α -thujol (2–14%). Essential oil cluster analysis showed a high degree of similarity between three of the four species studied, the least correlated being *P. maderensis* oils. Copyright © 2005 John Wiley & Sons, Ltd.

KEY WORDS: *Plagiochila bifaria* (Sw.) Lindb.; *Plagiochila maderensis* Gotsche ex Stehl.; *Plagiochila retrorsa* Gotsche; *Plagiochila stricta* Lindb.; Plagiachilaceae; Lamiaceae; essential oil; GC; GC-MS

Introduction

The genus *Plagiochila* comprises over 1600 species, being one of the largest of the Lamiaceae genera. Madiran *Plagiochila* species constitute more than 50% of the total species referred to Europe. According to Schumacher and Viala,¹ Sokolovskii *et al.*,² Kyrilov *et al.*³ and Sim-Sim *et al.*⁴ (2004), nine *Plagiochila* spp. are presently referred to Madeira: *P. bifaria* (Sw.) Lindb., *P. stricta* (Taylor) Taylor, *P. maderensis* Gotsche ex Stehl., *P. pectolinarica* (Torrey ex Nees) Lindb., *P. pumila* (Taylor) Taylor, *P. retrorsa* Gotsche, *P. spinulosa* (Dicks.) Dumort., *P. stricta* Lindb. and *P. virginica* A. Evans.

P. bifaria is the most frequently found of the *Plagiochila* spp. in Madeira's native laurel forest ('laurisilva'). It can be found in sheltered or exposed habitats along water courses, forming loose or dense patches on rocks, boulders and stone walls.⁵ Morphological evidence of the

conspecificity between this Neotropical species and the European *P. bifaria* Pezom., was presented by Heinrich *et al.*⁶ and recent molecular, morphological and phytochemical evidence support a broad species concept of *P. bifaria*.⁷ *P. maderensis* is a Madeira endemic species that was formerly synonymized with *P. spinulosa* (Dicks.) Dumort.⁸ It grows on the north side of the Madeira 'laurisilva'.⁹ *P. retrorsa* occurs in Central America and in the Southern Appalachian Mountains of the eastern USA. It is also known from the Azores and Madeira archipelagos in Macaronesia.¹⁰ On the island of Madeira *P. retrorsa* is a common species, especially in the less humid parts of the 'laurisilva', where it can be found on rocks and slopes.¹¹ *P. stricta* is a Neotropical and Macaronesian Lamiaceae widespread on the Madeira 'laurisilva', where it grows forming scattered or pure mats in shaded slopes located along water rivulets.¹²

With the exception of a recent study on the volatiles of *P. bifaria*,¹³ previous phytochemical studies have examined only the solvent extracts of the four species.^{14–17} As part of our studies on the essential oil-bearing plants of Portugal and with the aim of determining the potential of essential oils as chemical markers, we report on the comparison of the essential oil composition of four *Plagiochila* spp. collected on Madeira.

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ira. Uma das aves marinhas mais ameaçadas do Mundo

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A Freira da Madeira. Uma das aves marinhas mais ameaçadas do Mundo

Dália Meneses
Bióloga do Serviço do Parque Natural da Madeira

Uma das aves marinhas mais ameaçadas do Mundo que ocorre unicamente na Madeira, tendo sido considerada extinta até finais da década de 60. Desde então, tem apresentado uma evolução francamente positiva pelos esforços desenvolvidos em prol da sua conservação.

INTRODUÇÃO

A Freira da Madeira *Pterodroma madeira* é uma ave marinha, endémica da Ilha da Madeira, classificada como *Em Perigo* no Livro Vermelho dos vertebrados de Portugal (www.icn.pt 2004) e está incluída no Anexo I da Directiva Aves e no Anexo II da Convenção de Berna (Oliveira e Meneses 2004). Actualmente apresenta uma população mundial de apenas 65 a 80 casais, com uma área de nidificação restrita ao Maciço Montanhoso Oriental, mais precisamente em pequenos patamares acima dos 1600 metros de altitude, localizados entre o Pico do Arreito e o Pico Ruivo. A presença desta ave, dado o seu estatuto de conservação, é suficiente para conferir à área a designação de Zona de Protecção Especial (ZPE), sendo também um Sítio de Interesse Comunitário (SIC), por apresentar uma elevada biodiversidade, nomeadamente ao nível da vegetação onde são conhecidos vários endemismos.

Reprodução

As aves marinhas pertencentes à ordem dos Procelariiformes, onde se inclui a Freira da Madeira, vivem exclusivamente no mar, apenas vindo a terra durante a época de reprodução. No caso deste endemismo madeirense, que passa o ano em paragens

Dumort.) Dumort. Bioplagioschilaceae, Hepatophyllina) in Madeira Archipelago - Molecular relationships, ecology a

The genus *Plagiochila* (Dumort.) Dumort.
(Plagiochilaceae, Hepaticophytina) in Madeira Archipelago -
Molecular relationships, ecology, and biogeographic affinities

by

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With 3 figures

Sim-Sim, M., M.G. Esquivel, S. Fontinha & M. Stech (2005): The genus *Plagiochila* (Dumort.)
Dumort. (Plagiochilaceae, Hepaticophytina) in Madeira Archipelago - Molecular relationships, ecology,
and biogeographic affinities. - Nova Hedwigia 81: 449-461.

Abstract: *Plagiochila* is one of the most frequent bryophyte genera in Madeira, inhabiting almost all habitats of the Madeiran laurel forest (Laurissilva). Results on the biodiversity, ecology and molecular relationships based on nuclear ribosomal ITS1 and ITS2 sequences of all *Plagiochila* species referred to Madeira Archipelago are summarized with the aims to provide (i) a first molecular confirmation of a species inventory of a bryophyte genus in a specific geographic region and (ii) a bryophyte example for displaying biogeographic affinities of the Madeiran laurel forest. The molecular analyses confirm the presence of nine species in Madeira, which belong to four sections: *Plagiochila* sect. *Arrectae*, sect. *Rutilantes*, sect. *Vagae* and sect. *Plagiochila*. Section *Arrectae* is represented in Madeira by five species, *P. bifaria*, *P. punctata*, *P. retrorsa*, *P. spinulosa*, and *P. stricta*. Section *Rutilantes* is represented by *P. exigua* and the Macaronesian endemic *P. maderensis*, which is reported for the first time to Canary Is. The sections *Vagae* and *Plagiochila* are represented by a single species each, *P. virginica* and *P. porrelloides*, respectively. The molecular data indicate strong biogeographic affinities of the Madeiran *Plagiochila* flora with Central and northern South America, and to a lesser extent with Africa and Continental Europe. The environmental conditions found in Madeira Island, especially

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pupping habitat for the Critically Endangered Mediterranean monk seal *Monachus monachus* in the archipelago of Madeira

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The availability of resting and pupping habitat for the Critically
Endangered Mediterranean monk seal *Monachus monachus* in the
archipelago of Madeira

Alexandros A. Katsanikidis, Rosa Pires, Nadia Carina Silva and Henrique Costa Neves

Abstract In order to describe the resting and pupping habitat of the Critically Endangered Mediterranean monk seal *Monachus monachus* and facilitate the identification of preferences by the species for suitable habitat for resting and pupping, 94 sea caves in the archipelago of Madeira were located, charted, and categorized using six characteristics. A cluster analysis indicated that there are eight different types of caves, in three groups. Observations of cave usage indicate that monk seals in the archipelago do not appear to exhibit a preference for certain cave types for resting. When taking care of young, however, the species appears to prefer sea caves that

have beaches above sea level during high tide and long entrance corridors. Based on these preferences we believe that although there is a large number of caves in the area that are suitable for resting, only 16 (17%) of the caves are suitable for pupping. The survival of the Critically Endangered Mediterranean monk seal will depend on the allocation of sufficient suitable habitat for reproduction.

Keywords Caves, Madeira, marine protected areas, Mediterranean monk seal, *Monachus monachus*, habitat, pupping.

Introduction

The Mediterranean monk seal *Monachus monachus*, is categorized as Critically Endangered on the IUCN Red List, with an estimated 500 individuals surviving in the wild (Johnson, 2000; IUCN, 2003). Habitat loss, direct killing by fishermen, accidental entanglement in fishing gear (Johnson & Lavigne, 1998) and a mass mortality in 1997 caused by distemper-like poisoning and/or a virus epidemic (Costas & Lopez-Rodas, 1998; Harwood, 1998), have caused monk seal populations to decline steeply and confined the species to four isolated subpopulations. These are located at the Cabo Blanco peninsula of Mauritania, on the archipelago of Madeira in the Atlantic Ocean, the western and eastern Mediterranean, and the Black Sea (Aguilar, 1999).

When on land Mediterranean monk seals frequent sea caves, a behaviour that is believed to be a result of relentless persecution by humans (Pires & Neves, 2000). Suitable seal shelters usually have one or multiple entrances (underwater or not) leading to a dry surface or beach, of various substrates (sand, pebbles, stones or rock), which

is used for resting and rearing of pups (Neves & Pires, 1999; Dimitrakis & Dimitrakopoulos, 2003). Because of the species' elusive nature and the inaccessibility of its habitat, knowledge of the preferences and minimum requirements for resting and pupping has remained limited. Circumstantial evidence indicates that for resting monk seals use caves that protect them from wind and wave action (Neves & Pires, 1999; Karamallidis, 2000), and human disturbance (Pancu *et al.*, 1995). The species has, however, often been observed to rest in water (Kouravitos, 1987; Lopez-Jurado *et al.*, 1995; Neves & Pires, 1999) near heavily populated areas and in marginal habitat (Pancu *et al.*, 1995; Johnson & Lavigne, 1999; Gächter *et al.*, 2002). Pupping in contrast has been recorded mainly in well-protected, isolated caves (Marsalaglie, 1986; Neves & Pires, 1999; McMahon, 2001).

Following a steep decline in the last century, the Mediterranean monk seal in the archipelago of Madeira is now found mainly in the Desertas Islands, a group of three uninhabited islands (Desertas Grande, Bugio and Ilhéu Chão) lying c. 20 km south-east of Madeira (Fig. 1). In order to protect this species, the Parque Natural da Madeira Service initiated a Monk Seal Conservation and Monitoring Programme in 1988, and in 1990 the Desertas Islands were declared a Nature Reserve. Due to this protection the monk seal colony, which was estimated to number 6-8 individuals in 1984 (Reiter & dos Santos, 1984), has experienced a remarkable recovery and is now believed to number 25 individuals (Pires & Neves, 2001). In addition, the species is now occasionally sighted on

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of the endangered Mediterranean Monk seal (*Monachus*) at São Lourenço - Madeira

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Habitat of the endangered Mediterranean monk seal (*Monachus monachus*) at São Lourenço-Madeira

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Abstract

The Mediterranean monk seal (*Monachus monachus*) survives in small isolated subpopulations, some of which currently are facing extinction. In the Archipelago of Madeira, the species is found only at the Desertas Islands, where it is legally protected. The last place on the main island of Madeira where monk seals were sighted was the São Lourenço Peninsula, where a protected area was recently created. A habitat survey carried out in the area, and recent sporadic sightings, indicated the existence of suitable resting and pupping habitat. The enforcement of protection measures in the area is intended to promote the establishment of a resident colony and enhance the species' recovery chances.

Key words: *Monachus monachus*, pinniped, Madeira, habitat, wildlife management.

Introduction

The Mediterranean monk seal (*Monachus monachus*) experienced a dramatic population decline in the past century and is considered to be critically endangered (Hilton-Taylor, 2000). The species is found only in isolated subpopulations in the Black Sea, the northeastern and western Mediterranean Sea, and in the Cabo Blanco Peninsula and the Archipelago of Madeira in the Atlantic Ocean (Aguiar, 1999).

Mediterranean monk seals seek refuge in isolated coastal caves to rest and reproduce (Sergeant *et al.*, 1978). Suitable seal shelters generally have one entrance leading to a chamber with a surface above water level (Marsaloglu, 1986). To prevent habitat loss, which is considered to be one of the main threats to the species (Johnson & Lavigne, 1999), conservationists have suggested the creation of Marine Protected Areas (MPAs) that will allocate enough suitable habitat for the continued survival of the species (Johnson & Lavigne, 1998).

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In the Archipelago of Madeira commercial exploitation, deliberate killings by fishermen and accidental deaths in fishing gear led the species to the brink of extinction in the 1980s (Neves & Pires, 1999). Mediterranean monk seals now are found only around the Desertas islands, 11 nautical miles southeast of Madeira (Neves & Pires, 1999). To protect the species, the Parque Natural da Madeira Service (PNMS) initiated a Monk Seal Conservation and Monitoring Project (MSCMP) in 1988. The Desertas islands were declared a Nature Reserve in 1990. Due to the protection measures implemented in the area, the monk seal population of the Desertas, which is currently estimated at 24 individuals (Pires & Neves, 2001), has experienced a remarkable recovery and monk seal sightings on open beaches at the Desertas Islands and around the main island of Madeira have been steadily increasing (Pires & Neves, 2000; Pires, 2001).

Suitable habitat for the species in the Desertas area is limited. In order to enhance the chances of recovery of the monk seal colony, the Parque Natural da Madeira Service promoted the creation of additional protected areas on the main island of Madeira. One of the most promising candidate areas is the São Lourenço Peninsula, which is located at the easternmost tip of Madeira and is the nearest point to the Desertas islands. It is the last place on Madeira where Mediterranean monk seals were regularly sighted (Machado, 1979). The entire Peninsula and the adjacent marine area up to a depth of 50 m have been included in the Natura 2000 Network as a Site of Community Importance (SCI).

In 2001, the Parque Natural da Madeira Service carried out a habitat survey in the protected area of São Lourenço to assess and confirm the location of potential monk seal shelters, which were previously identified during a preliminary survey in 1993 (Neves, 1994). The 2001 survey aimed also at verifying the presence of monk seal individuals in the area. This information will be used in evaluating the suitability of the Peninsula for the future survival of the species.