# UNIVERSIDADE DOS AÇORES

**Tese de Mestrado em Gestão e Conservação da Natureza**
**Universidade dos Açores**

# FAUNÍSTICA E CONSERVAÇÃO DAS ARANHAS (ORDEM ARANEAE) NAS ILHAS DESERTAS (MADEIRA)

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Orientadores:
Professor Doutor Paulo A.V. Borges
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Angra do Heroísmo, Setembro de 2012

# Faunística e conservação das aranhas (Ordem Araneae) das Ilhas Desertas (Madeira)

Dissertação apresentada na Universidade dos Açores para a obtenção do grau de
Mestre em Gestão e Conservação da Natureza
Universidade dos Açores

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# Lista de abreviaturas

*Ecologia e Conservação*

AOO – Area of Occupancy (Área de Ocupação)

COBRA – Conservation Oriented Biodiversity Rapid Assessment (Levantamento Rápido de Biodiversidade Orientado para Conservação)

DLR – Decreto Legislativo Regional

EOO – Extent of Occurence (Extenção de Ocorrência)

GDM – General Dynamic Model of Oceanic Island Biogeography (Modelo Dinâmico Geral da Biogeografia de Ilhas Oceânicas)

M.a.(y.) – Milhões de anos (Million years)

SAM – Spatial Analysis in Macroecology (Análise Espacial em Macroecologia)

SIE – Single island endemic (Endemismo restrito a uma ilha)

*Taxonomia*

AME – Anterior median eyes (Olhos medio-anteriores)

ALE – Anterior lateral eyes (Olhos latero-anteriores)

PME – Posterior median eyes (Olhos medio-posteriores)

PLE – Posterior laterial eyes (Olhos latero-posteriores)

MOQ – Median ocular quadrangle (Quadrângulo ocular médio)

L Sp Ti = Length of Tibial spines relative to tibia thickness (Comprimento das espinhas tibiais relativamente à espessura da tíbia)

Tm (I, II, III ou IV) – Metatarsal tricobothrium of leg I, II, III or IV (Tricobotrio do metatarso da pata I, II, III ou IV)

*Instituições*

GBA – Grupo de Biodiversidade dos Açores

IUCN – International Union for Conservation of Nature (União Internacional para a Conservação da Natureza)

FMNH – Finnish Museum of Natural History, Helsinki, Finland (Museu Finlandês de História Natural, Helsínquia, Finlândia)

SNM – Senckenberg Naturmuseum, Frankfurt, Germany (Museu de História Natural de Senckenberg, Frankfurt, Alemanha)

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Vista para o Vale da Castanheira, © Pedro Cardoso, 2011

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# Resumo

Apesar do conhecimento relativamente satisfatório da aracnofauna do arquipélago da Madeira, o mesmo não se observa para as Ilhas Desertas, já que até à presente data apenas estavam referenciadas 11 espécies nestas 3 ilhas localizadas a cerca de 20 km a Sudeste da Madeira. Os únicos trabalhos sobre a aracnofauna das Desertas são pertencentes a pioneiros na área da taxonomia. Assim sendo, é importante inventariar a sua comunidade de aranhas. Foram para este efeito usadas várias técnicas de amostragem, tanto padronizadas como *ad-hoc*. São agora conhecidas 49 espécies, muitas das quais a aguardar descrição futura. É notável um caso de radiação explosiva no género *Dysdera* que conta com 6 espécies endémicas na Deserta Grande, uma ilha apenas com 10 km$^2$, e uma espécie adicional do Bugio, estando todas elas por descrever.

De entre as muitas endémicas, a tarântula-das-Desertas (*Hogna ingens* (Blackwall, 1857)) encontra-se restrita a um pequeno vale na zona Norte da Deserta Grande, o Vale da Castanheira. Este Vale encontra-se ocupado pela planta *Phalaris aquatica* L., invasora dominante desde a erradicação do coelho em 1996. O Parque Natural da Madeira tem vindo a efectuar esforços no sentido de a erradicar, mas a eficácia deste esforço ainda não foi avaliada e procurar-se-á estudar o efeito da invasora na presença e abundância da tarântula. O seu porte de 40 mm de corpo torna-a um predador de topo neste habitat, mas pouco se sabe acerca da sua população, sendo os únicos trabalhos publicados sobre esta espécie de natureza taxonómica. O seu habitat restrito e a flora invasora colocam a espécie potencialmente em perigo e exigem que seja determinado um estatuto de ameaça segundo os critérios da União Internacional para a Conservação da Natureza (IUCN), levando à prioritização de medidas de protecção da espécie.

As actividades científicas realizadas foram enquadradas no âmbito do projecto SOST-MAC (ref. MAC/2/C040), financiado pela Secretaria Regional do Ambiente e Recursos Naturais da Região Autónoma da Madeira.

# Abstract

Although the knowledge of the spider fauna of the Madeira archipelago is relatively satisfactory, to the present date only 11 spider species were cited for the Desertas Islands, a small archipelago of 3 islands 20 km Southeast of Madeira. The only works about the spider fauna of the Desertas are works of pioneer taxonomists. Therefore, it is important to build an inventory for spiders. Several sampling methods were used, both standardized as *ad-hoc*. 49 species are now known, many of which waiting for description. A remarkable case of explosive radiation was found in the genus *Dysdera*, in which 6 new species from Deserta Grande, an island with only 10 km$^2$, and one additional new species from Bugio, are accounted for.

Among the many endemics, the Desertas wolf spider (*Hogna ingens* (Blackwall, 1857)) is restricted to a small valley in the North end of Deserta Grande, the Vale da Castanheira. This valley is occupied by the plant *Phalaris aquatica* L., a dominant invasive species since the rabbits were eradicated in 1996. The Natural Park of Madeira has been conducting efforts to eradicate this herb, but the efficacy of this effort was not yet assessed and we aim to study the effect of the invasive plant in the presence and abundance of the wolf spider. Its body size of 40 mm makes it a top predator in this habitat, but little is known about its population, being the only published works about it of taxonomic nature. Its restrict habitat and the invasive flora that dwell within make it a potentially endangered species and demand that an extinction risk assessment according to the International Union for Conservation of Nature (IUCN) should be performed, so that protection measures for the spider can be prioritized.

The scientific activities were part of the project SOST-MAC (ref. MAC/2/C040), financed by the Regional Secretariat of Environment and Natural Resources of the Madeira Autonomous Region.

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Esta tese de Mestrado foi realizada aquando da minha primeira visita aos Açores, onde trabalhei como bolseiro de investigação no Grupo de Biodiversidade dos Açores (GBA, CITA-A), sob a supervisão do Professor Doutor Paulo A.V. Borges. O mesmo mostrou uma constante preocupação pelo meu bem-estar e sempre foi altamente prestável para facilitar a resolução dos habituais problemas logísticos inerentes à deslocação para os Açores. Além disso, não me foi obstruída a possibilidade de escolher o tema da minha tese, dadas as necessidades de alterar o meu calendário de trabalho como bolseiro do GBA, para que pudesse participar no trabalho de campo nas Ilhas Desertas. Gostaria de agradecer aos membros do GBA que mais me apoiaram durante esta estadia, sendo eles: Alison Nielson, Annabella Borges, Carla Rego, Clara Gaspar, Enésima Mendonça, Fernando Pereira, Filomena Ferreira, François Rigal, Konstantinous Triantis, Isabel Rosário, Maria Teresa Ferreira, Nídia Homem, Orlando Guerreiro, Paulo Borges, Rosalina Gabriel e Sofia Terzopoulou.

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Pela oportunidade de trabalhar num motivante e ambicioso projecto de conservação numa área natural praticamente desconhecida, agradeço ao Dinarte Teixeira, da Secretaria Regional do Ambiente e Recursos Naturais da Região

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Uma menção especial é dada ao Isamberto Silva, um naturalista nato e fã das aranhas, que conhece como ninguém o património natural existente no arquipélago da Madeira, tendo contribuído para o trabalho aqui apresentado de uma forma jamais igualável por outrém.

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# Introdução

## 1. Ilhas

Ilhas são normalmente definidas como sendo mais ou menos pequenas porções de terra rodeadas por água, que estão isoladas geograficamente de outras porções de terra (Whittaker & Fernández-Palacios, 2007). Esta definição clássica sendo correcta, pode ser completamentada pela recente noção de ilha ecológica ou biogeográfica. Estas são ilhas que, não estando isoladas por grandes massas de água, estão rodeadas por uma matriz não habitável, que pode variar consoante o grupo estudado (Gillespie & Roderick, 2002; Whittaker & Fernández-Palacios, 2007). São disto exemplos sistemas de grutas para artrópodes cavernícolas, árvores numa floresta para espécies arborícolas ou até lagoas para plantas aquáticas de água doce.

Dependendo da sua génese, as ilhas podem ser ilhas oceânicas ou "darwinianas", caso tenham sido formadas sem nunca antes terem estado em contacto com outras massas semelhantes (p.ex.: uma erupção vulcânica), ou podem ser ilhas continentais ou fragmentárias, caso se tenham originado pela ruptura de uma massa "continental" (dependendo do tipo de ilha, a definição de continente pode variar, mas para simplicidade, adopta-se a nomenclatura clássica, referente às ilhas oceânicas). As ilhas oceânicas possuem uma grande quantidade de nichos ecológicos por preencher e inicialmente há um aumento no número de espécies colonizadoras que, dado um isolamento suficiente, originam espécies neo-endémicas (Whittaker *et al.*, 2008). Caso os nichos disponíveis sejam suficientes, pode haver mesmo uma radiação adaptativa de uma espécie colonizadora em vários neo-endemismos, especializados em diferentes nichos. Já as ilhas fragmentárias apresentam uma dinâmica de colonização diferente, pois como estavam ancestralmente ligadas à massa continental, possuem já um grande número de espécies. O número de espécies presente numa ilha deste tipo irá inicialmente decrescer dado o menor fluxo de espécies e isolamento de algumas populações e caso o isolamento persista e as populações continentais se extingam por diversos factores, poderá resultar na formação de paleo-endemismos (Whittaker & Fernández-Palacios, 2007). As espécies únicas de uma ilha são chamadas de espécies endémicas da ilha ("Single Island Endemics", SIEs), enquanto que as espécies endémicas de mais que uma ilha são designadas por endemismos do arquipélago (Whittaker & Fernández-Palacios, 2007; Triantis *et al.*, 2012).

As dinâmicas de extinção e colonização em ilhas foram abordadas de uma forma revolucionária por MacArthur & Wilson, que elaboraram a Teoria da Biogeografia Insular (MacArthur & Wilson, 1967), que pressupõe um equilíbrio entre as taxas de imigração e extinção. Este equilíbrio é modelado pela distância da ilha à massa continental e também pela área da ilha, como pode ser observado na Figura 1.

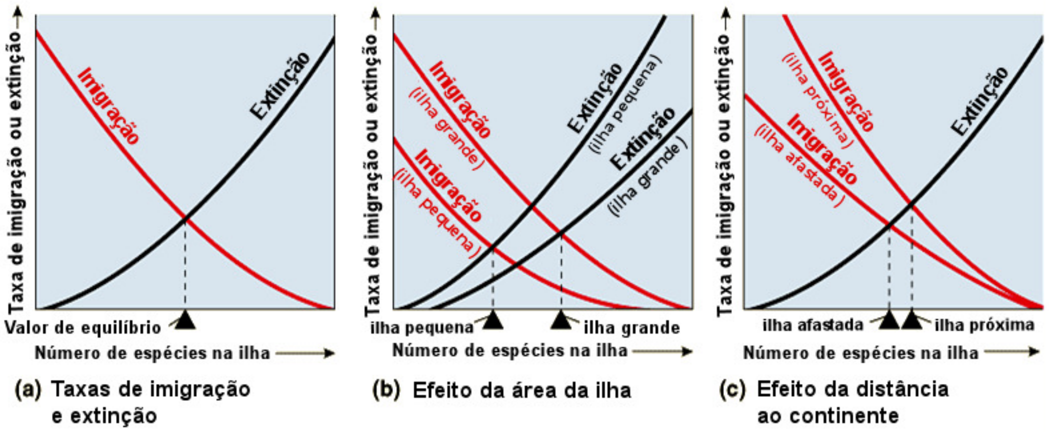

Figure 1 – Modelos de equilíbrio das taxas de imigração e extinção em ilhas segundo MacArthur & Wilson (adaptado de Whittaker & Fernández-Palacios, 2007).

Apesar de esta teoria ter algumas limitações e já ter sido modificada por alguns autores, a mesma veio mostrar que as ilhas são laboratórios naturais que apresentam dinâmicas de colonização, tornando-se assim alvos preferenciais de estudos ecológicos e biogeográficos devido ao isolamento e à presença de espécies endémicas.

Recentemente Whittaker *et al.* (2008) apresentaram um novo modelo, “General Dynamic Model of Oceanic Island Biogeography” (GDM), que explica a biodiversidade nas ilhas com base nos parâmetros de MacArthur & Wilson (1967), mas considerando que a especiação, imigração e extinção ocorrem numa dinâmica temporal que é dependente da ontogenia de cada ilha. Borges & Hortal (2009) testaram este modelo para a fauna de artrópodes dos Açores e verificaram que a validade deste modelo pode ajudar a explicar alguns dos padrões encontrados para os Artrópodes dos Açores. Cardoso *et al.* (2010) testaram o modelo para aranhas Macaronésicas e igualmente encontraram uma concordância entre o GDM e os dados conhecidos.

## 2. A Macaronésia

A região da Macaronésia compreende os arquipélagos dos Açores, Madeira, Ilhas Selvagens, Ilhas Canárias e Cabo Verde (Figura 2).

Figura 2 – Mapa da Macaronésia (adaptado de Borges *et al.,* 2008).

Todas estas regiões têm em comum climas temperados, sem grandes oscilações térmicas anuais, devido à tamponização térmica fornecida pelo clima oceânico. Tal factor permitiu a persistência de comunidades bióticas únicas na Terra, cuja formação precede o último período de glaciações, como são exemplo disso as florestas *laurissilva*.

Estes arquipélagos possuem diferentes idades geológicas. O arquipélago dos Açores é o mais recente; o Pico, a ilha mais recente, tem apenas 0.25 M.a. (milhões de anos) enquanto a que a mais antiga, Santa Maria, tem 8.12 M.a. As ilhas dos Açores apresentam características típicas de ilhas jovens, com um baixo nível de erosão e uma presença de declives muito acidentados. A Madeira apresenta já uma idade geológica que ultrapassa em média a dos Açores, com o Porto Santo, a sua ilha mais antiga, com 14 M.a., e a Madeira e as Desertas com 5 M.a.. As Ilhas Selvagens contêm a ilha mais antiga de toda a Macaronésia, a Selvagem Grande, com 27 M.a. As restantes ilhas das Selvagens são de tamanho muito reduzido e altitude baixíssima, podendo desaparecer em breve, devido à actual subida do nível do mar. As Ilhas Canárias possuem distintas idades geológicas, que vão desde El Hierro com 1 M.a. até Fuerteventura e Lanzarote com cerca de 25 M.a. Cabo Verde possui idades geológicas compreendidas entre 8 M.a. nas ilhas ocidentais e os 20 M.a. das ilhas orientais. Uma perspectiva interessante sobre a evolução da Macaronésia, respeitante à emergência e submergência das suas ilhas e implicações na biogeografia de alguns ecossistemas e grupos de organismos, pode ser vista em Fernández-Palacios *et al.*, 2010.

## 3. As Ilhas Desertas

Pertencentes ao arquipélago da Madeira e a cerca de 20 km a Sudeste da mesma, estão situadas as ilhas Desertas (Figura 3). Estas três ilhas são parte do concelho de Santa Cruz, e as actividades nelas efectuadas (pesca, turismo, etc.) são monitorizadas pelo Parque Natural da Madeira, pois não existem povoamentos humanos permanentes, apesar de várias tentativas históricas (para uma perspectiva histórica sobre as Desertas ver Ribeiro, 1999). O clima presente nestas ilhas é um clima temperado oceânico, com temperaturas médias anuais compreendidas entre os 17º C e os 25º C.

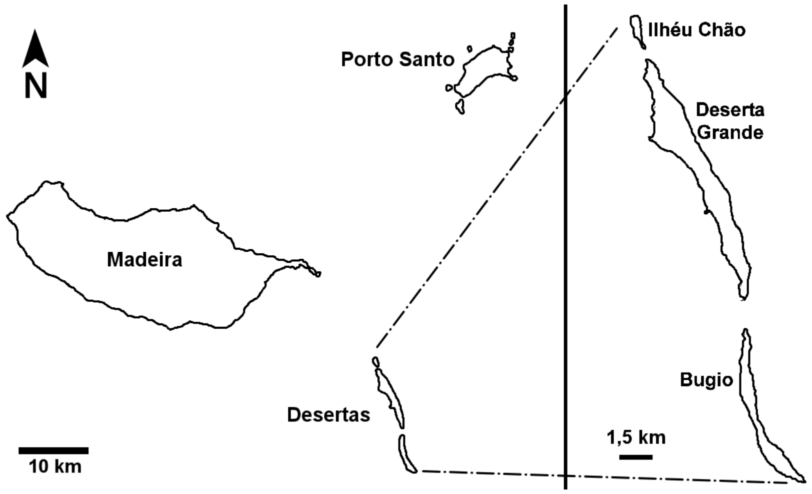

Figura 3 – Mapa do arquipélago da Madeira, com as Desertas destacadas à direita.

A Deserta Grande é a maior destas ilhas, com uma área de cerca de 10 km$^2$. Trata-se uma ilha alongada com um comprimento de 11,7 km e uma largura máxima de 1,9 km. O ancoradouro oficial da ilha encontra-se na Doca, uma fajã causada por uma grande derrocada ocorrida em 1894. Neste local encontra-se também a casa de apoio do Parque Natural da Madeira, e o acesso ao resto da ilha faz-se mediante a subida de uma íngreme vereda, que sobe sensivelmente do nível do mar até aos 400 metros de altitude. No topo da ilha, podem-se observar diversas formações geológicas, como as arribas rochosas espalhadas por toda a costa da ilha e alguns planaltos áridos, desprovidos de vegetação de porte arbóreo. As únicas zonas com uma área considerável relativamente plana situam-se perto das extremidades Norte (Vale da Castanheira e Pedregal), e a Sul (Planalto Sul) da ilha. O ponto mais elevado da Deserta Grande é a Rocha do Barbusano, um pico situado a pouco mais de metade do comprimento da ilha, que se eleva até aos 479 metros de altitude.

Figs. 4 – 5: 4, vista para a casa de apoio do Parque Natural da Madeira e falésia circundante na Doca; 5, vista para os Castelinhos e encosta Oeste da Deserta Grande. © Pedro Cardoso, 2011.

O Bugio, com cerca de 3 km$^2$ de área, é ainda mais acidentado que a Deserta Grande. A sua forma também é alongada, com um comprimento de 7,5 km e uma largura máxima de 700 m. As zonas planas são praticamente inexistentes com excepção de pequenas áreas elevadas no extermo Sul e o seu ponto mais alto chega aos 388 m.

Por último, o Ilhéu Chão é a mais pequena das Desertas, com uma área de cerca de 1 km$^2$, com 1,6 km de comprimento e largura máxima de 500 m. Trata-se de um planalto elevado cerca de 80 m acima do nível do mar e onde está localizado um farol.

A nível de legislação, as Desertas começaram a ser abordadas como uma área sensível que era necessário proteger sobretudo devido à sobre-exploração dos recursos piscícolas em 1990, e, com o Decreto Legislativo Regional (DLR) nº 14/90/M foi criada a Área de Protecção Especial das Ilhas Desertas. Este estatuto de área protegida foi reforçado em 1995, segundo o DLR 9/95/M. Em 2006, a Reserva Natural das Ilhas Desertas foi incluída como Sítio de Importância Comunitária da Região Autónoma da Madeira, segundo o DLR nº 5/2006/M e, mais tarde, segundo a portaria nº 829/2007. Adicionalmente, tem a classificação de Zona de Protecção Especial no âmbito da Directiva Aves (Directiva nº 79/409/CEE) da Rede Natura 2000, o estatuto de Important Bird Area no âmbito da Birdlife Internacional e é também Zona de Protecção Especial de Conservação para o Lobo-marinho no âmbito do Plano de Acção para a Conservação do Lobo-Marinho no Atlântico Oriental.

O ordenamento desta região é orientado por vários planos, sendo os mais importantes:

- Programa Nacional da Política de Ordenamento do Território, lei nº 58/2007;
- Plano de Ordenamento do Território na Região Autónoma da Madeira; DLR nº 12/95/M (alterado pelo DLR 9/97/M);
- Sistema Regional de Gestão Territorial, DLR nº 43/2008/M;
- Rede Fundamental de Conservação da Natureza, DL nº 142/2008;
- Plano Director Municipal de Santa Cruz, ratificado pela Resolução do Governo Regional da Madeira nº 607/2004;
- Estratégia Nacional de Conservação da Natureza e da Biodiversidade, resolução do Conselho de Ministros nº 152/2001.

## 4. Conservação: alguns problemas

Actualmente existem grandes limitações para a conservação de espécies de invertebrados. Essas limitações foram identificadas recentemente por Cardoso *et al.* (2011a, 2012) que sugeriu também algumas medidas para as ultrapassar. Ainda assim, o actual panorama da Biologia da Conservação implica uma quase exclusividade para os estudos direccionados para animais vertebrados, e até que occorra uma mudança de consciência nas entidades políticas e institucionais que gerem a atribuição e gestão de projectos de conservação, a situação dever-se-á manter.

A União Internacional para a Conservação da Natureza (UICN) é actualmente o sistema mais usado para classificar espécies segundo o seu risco de extinção (UICN, 2001) mas também os seus critérios estão especialmente enviesados para o estudo de vertebrados, criando limitações técnicas quando se tenta classificar uma espécie de invertebrado. Estes problemas foram também analisados recentemente por Cardoso *et al.* (2011b), tendo sido feitas propostas para melhorar os critérios de modo a se adaptarem a outros grupos.

A Directiva Habitats (Council of the European Communities, 1992) é outra ferramenta para a prioritização de medidas de conservação a tomar, e ao contrário dos critérios da UICN, é parte integrante das leis referentes à conservação de cada país. Mas também a inclusão de espécies nesta Directiva está caracterizada por várias falhas técnicas e científicas, que foram indicadas e criticadas por Cardoso (2012).

A reflectir os problemas mencionados, o património natural das Desertas não está estudado de forma igual entre os diversos grupos. Na verdade, a maior parte dos projectos e fundos dedicados à conservação da natureza são devidos à presença de duas espécies de animais nesta região, a foca-monge (*Monachus monachus* (Hermann, 1779)) ou lobo-marinho, e a ave marinha freira-do-Bugio (*Pterodroma feae* (Salvadori, 1899)). O conhecimento sobre as comunidades de invertebrados da região é muito incipiente, ainda que se conheçam várias espécies endémicas, de grupos tão distintos como os moluscos (*Discus guerinianus* (Lowe, 1852)) ou as aranhas (*Hogna ingens* (Blackwall, 1857)).

A flora da região é bastante rica em endemismos do arquipélago da Madeira, existindo inclusivamente 3 espécies que são exclusivas da Deserta Grande, a *Muschia isambertoi* Seq., Jardim, Silva & Carvalho, 2007, *Sinapidendron sempervivifolium* Menezes, 2011, e *Frullania sergiae* Sim-Sim *et al.,* 2000.

A Deserta Grande foi alvo de introdução de cabras (*Capra hircus* (L., 1758)) desde que foram feitas as primeiras tentativas de colonização da ilha por parte do Homem, e em conjunto com os coelhos (*Oryctolagus cuniculus* (L., 1758)) estes mamíferos transformaram as comunidades vegetais das Desertas de forma dramática, de tal forma que as plantas endémicas atrás referidas apenas se podem encontrar em escarpas inacessíveis. Além destas espécies, outras plantas invadiram as Desertas, como foi o caso de uma asterácea, espécie *Ageratina adenophora* (Spreng.) R.M. King & H. Rob. ou da tabaqueira (*Nicotiana tabacum* L.), ambas erradicadas com sucesso. No entanto, outras invasoras persistem, como a herbácea *Phalaris aquatica* L.

## 5. Aranhas da Macaronésia

As aracnofaunas dos arquipélagos da Macaronésia não estão uniformemente estudadas. Houve um intenso esforço de amostragem realizado nos Açores (Borges & Wunderlich, 2008; Borges *et al.,* 2010; Crespo *et al.,* 2012, in prep.), e o conhecimento é neste momento bastante satisfatório nesta região. Para as Canárias está igualmente disponível uma lista faunística extensa (Izquierdo *et al.*, 2004; Arechavaleta *et al.*, 2010), apesar do esforço ter sido concentrado em alguns grupos (p.ex. *Dysdera, Pholcus*). Nos arquipélago da Madeira e Selvagens a recente listagem de Borges *et al*. (2008) sugere que o conhecimento das aranhas começa a atingir um nível satisfatório (Wunderlich, 1987, 1992, 1995), pese embora o facto de apenas se conhecerem 11 espécies de aranhas das Desertas, o que se traduz numa relação baixa entre a diversidade de aranhas e a sua área (Figura 6). Por fim, Cabo Verde também tem uma listagem (Arechavaleta *et al.*, 2005), mas esta foi feita compilando os muito poucos registos existentes, maioritariamente de natureza taxonómica, podendo-se considerar este o arquipélago Macaronésico menos conhecido.

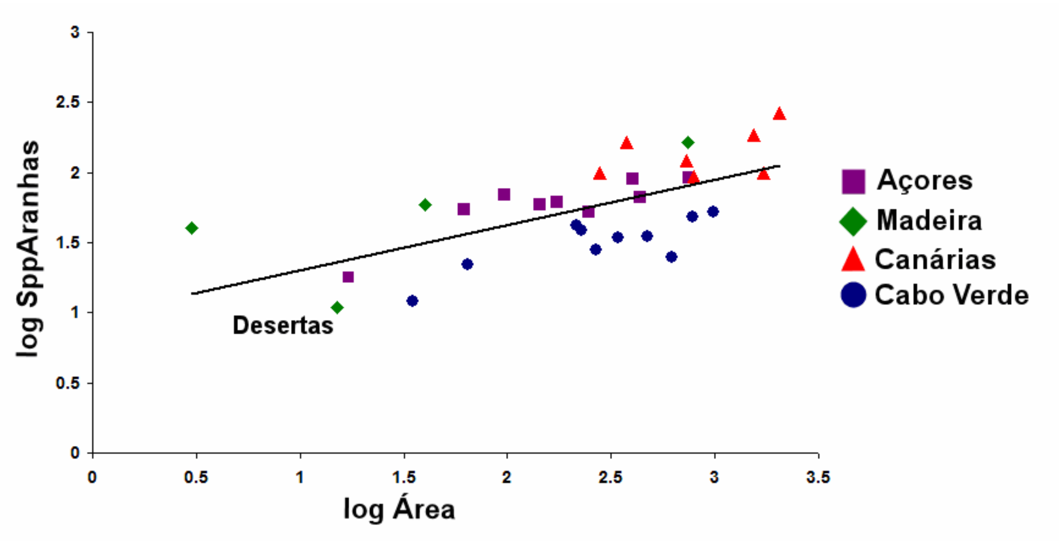

Figura 6 – Relação entre os logaritmos das áreas das ilhas da Macaronésia e o logaritmo das espécies totais de aranhas citada, incluindo espécies exóticas.

Alguns grupos de aranhas na Macaronésia sofreram radiação adaptativa e existem vários géneros com uma grande quantidade de espécies diferentes dispersas pelas ilhas dos vários arquipélagos. Wunderlich (1987, 1992, 1995, 2011) descreveu um grande número de espécies dos géneros *Pholcus,* *Spermophorides, Oecobius, Alopecosa* e *Hogna*. Platnick *et al*. (2001) reportou a radiação do género *Scotognapha* nos arquipélagos das Canárias e Selvagens. Mas de todos os trabalhos taxonómicos, os contributos mais significativos foram os liderados por Miquel Arnedo (Arnedo & Ribera, 1997, 1999, Arnedo *et al*., 2000) sobre o género *Dysdera*, que conta 43 espécies endémicas das Canárias descritas, sendo uma grande parte destas espécies endemismos restritos a uma ilha.

No arquipélago da Madeira, o caso mais notável de especiação até agora conhecido verifica-se no género de aranhas-lobo *Hogna* (Lycosidae). Estas aranhas podem medir 5 cm de tamanho de corpo e são conhecidas 7 espécies de todo o arquipélago. São estas *H. heeri* (Thorell, 1875), *H. maderiana* (Walckenaer, 1837), *H. nonannulata* Wunderlich, 1995, *H. insularum* (Kulczynski, 1899), *H. ingens* (Blackwall, 1857) (Figura 9), *H. schmitzi* Wunderlich, 1992 (Figura 10) e *H. biscoitoi* Wunderlich, 1992 (distribuição na Figura 7).

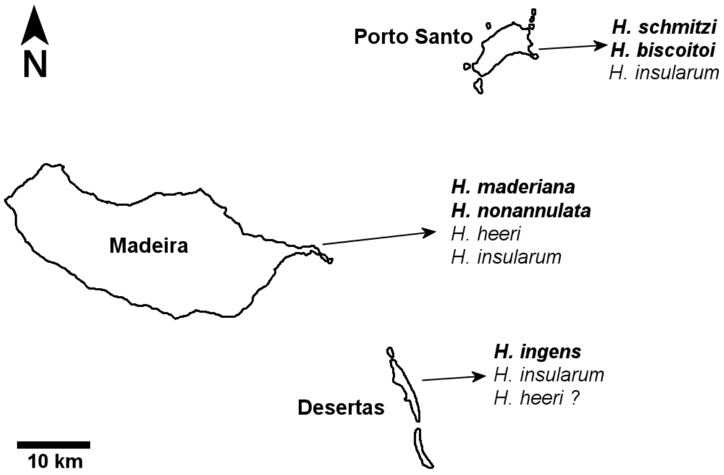

Figura 7 – Distribuição do género *Hogna* no arquipélago da Madeira.

Figs. 8 – 9: 8, *H. ingens* (Blackwall, 1857), endemismo restrito à Deserta Grande; 9, *H. schmitzi* Wunderlich, 1992, endemismo restrito a Porto Santo. © Pedro Cardoso, 2011 (9) e 2008 (8).

No entanto, apesar de uma grande diversidade e elevados níveis de endemismo, as aranhas da Macaronésia sofrem das limitações já referidas atrás, respeitantes à sua conservação. Nenhuma delas está avaliada segundo critérios da UICN e apenas uma foi recentemente incluída como protegida na actualização da Directiva Habitats para a Região Autónoma dos Açores (DLR nº15/2012/A), a *Turinyphia cavernicola* Wunderlich, 2005 (Figura 10).

Figura 10 – *Turinyphia cavernicola* Wunderlich, 2005, espécie endémica da ilha Terceira. © Pedro Cardoso, 2008.

## 6. O projecto SOST-MAC

O projecto SOST-MAC consiste no planeamento e realização de acções integradas com vista a um uso sustentável dos valores naturais e paisagísticos na Macaronésia. A identificação e recuperação de zonas degradadas esperam-se alcançadas de acordo com as realidades legislativas, ambientais e de ordenamento de território de cada zona, através da realização de avaliações de impacto ambiental.

Para atingir os objectivos propostos, o projecto pressupõe um envolvimento da população que se espera alcançado através de uma campanha de informação destinada à aproximação da população às futuras realidades que as intervenções irão provocar, com especial atenção para as escolas e educação ambiental dada às gerações mais novas.

No decorrer de uma prestação de serviços à empresa “Investigação e Transferência de Biotecnologia, Lda.” foi possível participar na tarefa de inventariação e avaliação do estado de conservação, desenho de projecto de monitorização e de um plano de acção para a conservação dos artrópodes da classe Arachnida, com especial foco na espécie *Hogna ingens* (Blackwall, 1857), que ocorrem no Vale da Castanheira, na Deserta Grande. Devido ao grande desconhecimento sobre a aracnofauna da região, decidiu-se alargar os objectivos de modo a englobar toda a Deserta Grande na tarefa de inventariação de espécies.

# Capítulo I

## Rapid biodiversity assessment, faunistics and description of new spider species (Araneae) from Desertas Islands and Madeira (Portugal)

*Luís Carlos Crespo, Isamberto Silva & Pedro Cardoso*

Comunicação a submeter à revista *Journal of Arachnology*, mas formatada de acordo com as normas da tese de Mestrado em Gestão e Conservação da Natureza da Universidade dos Açores.

# Rapid biodiversity assessment, faunistics and description of new spider species (Araneae) from Desertas Islands and Madeira (Portugal)

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## ABSTRACT

The araneofauna of the Desertas Islands was largely neglected until now, with only 11 species recorded. Both standardized and ad-hoc sampling were performed in 2011 and 2012. As expected for small, isolated islands, estimated species richness estimates per sampled hectare range 19 to 23. The updated local checklist now includes 55 species, of which 12 are thought to be new for science, including a new species of *Typhochrestus* Simon, 1884, endemic to the Madeira archipelago. The unknown male of *Zimirina lepida* (Blackwall, 1859) is also described.

## KEYWORDS

Madeira, Macaronesia, islands, Arachnida, taxonomy, ecology, species richness estimates, checklist, faunistics, endemics

## INTRODUCTION

The archipelago of Madeira is composed of the main islands of Madeira, Porto Santo plus the smaller Desertas Islands. The latter are 3 uninhabited small islets located 20 km Southeast of Madeira. Deserta Grande is the largest of these islands, with an area of $10km^2$, followed by Bugio with 3 $km^2$ and Ilhéu Chão with 0,5 $km^2$ (Figure 1). The geologic age of these islands goes back to 5 M.y., making these islands one of the most recent elements of the entire Madeira archipelago (Fernández-Palacios *et al.*, 2011). The geomorphology is mostly rugged, with very steep slopes, ridges and peaks, except for the flat Ilhéu Chão.

Their climate is temperate oceanic and the predominant habitats are rocky slopes and small arid flatlands, with sparse vegetation.

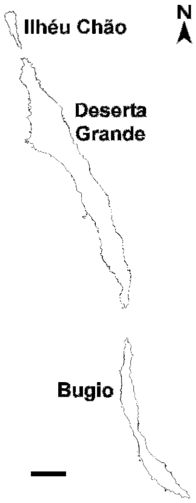

Figure 1 – Map of the Desertas Islands. Scale bar = 1.5 km.

The Deserta Grande has en elongate form, with a maximum length of 11.7 km along a Northwest to Southeast angle and a maximum width of 1.9 km. Only two relatively flat areas can be found, one in the North, Vale da Castanheira, and one in the South, Planalto Sul, and the island summit is at Rocha do Barbusano, with an altitude of 479 m. Only two flat areas are located at sea level, resulting from landslides, one of them, the Doca, being the main access point to the rest of the island.

Bugio is an even steeper and rugged island, with very few and small flat areas, being the largest of these the Planalto Sul. It has a maximum length of 7.5 km and maximum width of 700 m. The highest summit reaches 388 m.

Ilhéu Chão is a small plateau, rising 80 m above the sea level, and only 1.6 km long and maximum width of 500 m. In the North end, it reaches its maximum altitude of 89 m.

All islands constitute protected areas, the Natural Reserve of Desertas Islands, managed by the Natural Park of Madeira. They remain uninhabited, although attempts for colonization of Deserta Grande were made in the past. These historical events also include the introduction of goats (*Capra hircus* (L., 1758)) and rabbits (*Oryctolagus cuniculus* (L., 1758)), which since then caused a negative impact on the native flora of the Desertas. Besides invasive fauna, several exotic species of plants were also introduced in the territory, as is the case of *Ageratina adenophora, Nicotiana tabacum* or, more recently, the herb *Phalaris aquatica*.

The spider fauna of the Madeiran archipelago received some degree of attention by early scholars (Lowe, 1832; Blackwall, 1859, 1862; Johnson, 1863; Warburton, 1892; Bösenberg, 1895; Kulczynski, 1899, 1905; Schmitz, 1895; Bristowe, 1925; Schenkel, 1938; Denis, 1962, 1963, 1964). Later, a comprehensive work about Madeiran and Canarian spiders was performed by Wunderlich (1987, 1992, 1995). Since then, only small faunistics contributions were published with new spider records, focusing on Porto Santo island (Crespo *et al.*, 2009a). A checklist was compiled by Cardoso & Crespo (2008, in Borges *et al.*, 2008). In this checklist, it is possible to verify that only 11 spider species were cited so far to the Desertas. Such a low number reflects a lack of faunistic surveys on these islands.

The main goals of this work are to: 1) obtain species richness estimates for delimeted areas using semi-quantatitave, standardized, sampling; 2) update the Desertas Islands checklist based on standardized and ad-hoc sampling and; 3) describe new species and taxonomic novelties.

## METHODS

### *Sampling methods*

Standardized sampling was made using a modified version of the COBRA protocol (Cardoso, 2009). At Planalto Sul, Vale da Castanheira (Figure 2) and Ponta de São Lourenço (Figure 3), 1 ha (100 x 100 m) sampling plots were delimited and sampled for two weeks in April 2011. Two methods were used, each covering a different fauna. Pitfall trapping, using 48 plastic ups with 33 cl capacity were left open for the entire two weeks. These were filled to two thirds of their capacity with a solution of monoethyleneglicol, and some drops of detergent to decrease surface tension. Each four contiguous traps were clumped in a single sample, resulting in 12 samples per site. Hand sampling, with either an entomologic aspirator or forceps was also performed in one-hour samples at the middle of two-week period. Twenty-four samples were made per site (for more details on the protocol see Cardoso *et al.*, 2009). The previous design of the COBRA protocol used net sweeping for sampling sites with no arboreal stratum, but in the present sites the vegetation was so scarce that even the herbaceous stratum was, in most of the areas, non existent, which rendered net sweeping a very poor sampling technique, initially tested but rapidly abandoned.

Ad-hoc, non-standardized sampling was also performed covering most of Deserta Grande both in 2011 and 2012 (Figure 2).

A small set of ad-hoc samples was collected from the Planalto Sul of Bugio island.

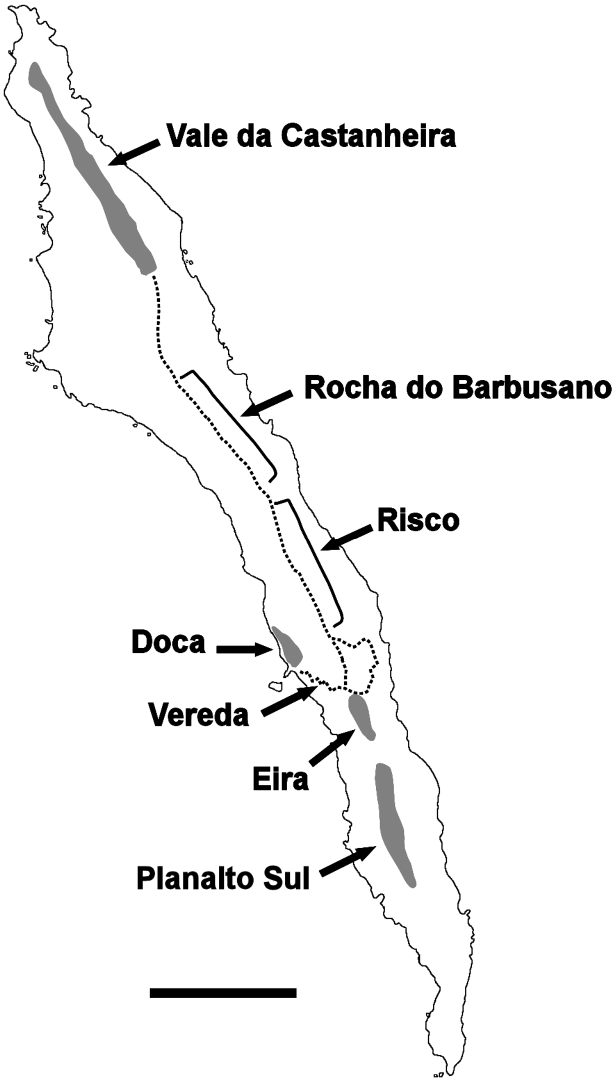

Figure 2 – Map with the sampled areas of Deserta Grande. Scale bar = 1.5 km.

A similar site was sampled in the eastern tip of Madeira island, the Ponta de São Lourenço (Figure 3). This site was a similar to the ones previously mentioned from Deserta Grande island, with only xerophytic shrubs and herbs for vegetation cover, completely devoid of trees, and thus was sampled to compare the importance of local fauna when compared to the regional pool of species.

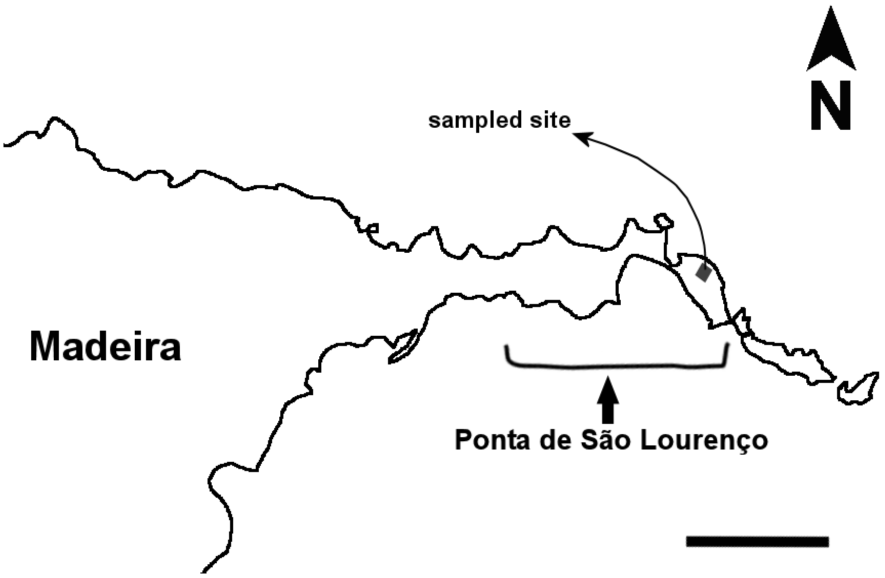

Figure 3 – Map of the eastern side of Madeira island. Scale bar = 2 km.

*Laboratorial methods*

Specimens were analyzed through a Leica MZ9.5, or a Leica MZ16, or a Nikon SMZ1000. Epigynes were cleared using methylsalicilate, after being dissected from the specimen with the help of needles and forceps. The vulvar structure of *Typhochrestus madeirensis* n. sp. was prepared in a slide and analyzed using a Leica ICC50 HD microscope.

All measurements are in mm. The value provided for legs is the average.

Most species nomenclature and their distributions are according to Platnick (2012).

*Statistical analysis*

Standardized sampling following the COBRA protocol allows estimating species richness per plot. This was done using non-parametric species richness estimators, namely Chao1 (Chao, 1984), Chao2 (Chao, 1987), Jackknife1 (Burnham & Overton, 1978) and Jackknife2 (Burnham & Overton, 1979) (see also Colwell & Coddington, 1994 or Hortal, Borges & Gaspar, 2006). These indices are based on the number of observed species and the frequency of rare species, namely singletons (species for which a single individual was sampled), doubletons (species for which two individuals were sampled), uniques (species for which a single sample is available) and duplicates (species for which two samples are available). Even though they require high completeness to be effective, the richness per plot in small isolated islands is relatively low and the protocol used usually allows reliable estimes.

Species accumulation curves and all calculations were computed with the software EstimateS version 8.20 (Colwell, 2006).

## RESULTS

The empyrical data of richness and the estimators can be seen in Table 1.

Table 1 – Richness data from the COBRA protocols conducted in Deserta Grande and Madeira.

| | Deserta Grande | | | | | | Madeira | | |
|---|---|---|---|---|---|---|---|---|---|
| | Vale da Castanheira | | | Planalto Sul | | | Ponta de São Lourenço | | |
| | Ground search | Pitfall trapping | Total | Ground search | Pitfall trapping | Total | Ground search | Pitfall trapping | Total |
| Samples | 12 | 12 | 24 | 12 | 12 | 24 | 12 | 12 | 24 |
| Individuals | 58 | 171 | 229 | 113 | 208 | 321 | 131 | 175 | 306 |
| Individuals / sample | 5 | 14 | 10 | 9 | 17 | 13 | 11 | 15 | 13 |
| Species | 10 | 12 | 16 | 15 | 12 | 20 | 17 | 12 | 21 |
| Species / sample | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sampling intensity | 5.8 | 14.25 | 14.31 | 7.53 | 17.33 | 16.05 | 7.71 | 14.58 | 14.57 |
| Singletons | 3 (30%) | 4 (33%) | 5 (31%) | 2 (13%) | 3 (25%) | 2 (10%) | 5 (29%) | 4 (33%) | 7 (33%) |
| Doubletons | 1 (10%) | 1 (8%) | 1 (6%) | 2 (13%) | 3 (25%) | 5 (25%) | 3 (18%) | 2 (17%) | 3 (14%) |
| Uniques | 3 (30%) | 4 (33%) | 5 (31%) | 3 (20%) | 3 (25%) | 3 (15%) | 6 (35%) | 4 (33%) | 8 (38%) |
| Duplicates | 2 (20%) | 2 (17%) | 2 (13%) | 3 (20%) | 3 (25%) | 6 (30%) | 2 (12%) | 2 (17%) | 2 (10%) |
| Estimates | | | | | | | | | |
| Chao1 | 12 ± 3 | 15 ± 4 | 21 ± 6 | 15 ± 1 | 13 ± 1 | 20 ± 1 | 20 ± 3 | 14 ± 3 | 26 ± 5 |
| Chao2 | 11 ± 2 | 14 ± 3 | 19 ± 4 | 16 ± 1 | 13 ± 1 | 20 ± 1 | 22 ± 5 | 24 ± 3 | 30 ± 9 |
| Jacknife1 | 13 ± 1 | 16 ± 2 | 21 ± 2 | 18 ± 1 | 15 ± 1 | 23 ± 2 | 23 ± 2 | 16 ± 2 | 29 ± 2 |
| Jacknife2 | 14 | 17 | 24 | 18 | 15 | 20 | 26 | 17 | 34 |
| Completeness | 87% | 80% | 76% | 98% | 94% | 99% | 87% | 86% | 80% |

*Standardized species sampling*

Sampling intensity and completeness were computed as in Cardoso *et al.* (2008). 16 species were captured in Vale da Castanheira and 20 in Planalto Sul. A relevant value of completeness for Planalto Sul was obtained, which was further confirmed with the asymptotes of the several estimators used (Figure 4).

The behavior of richness estimators was tested for the two sites in Deserta Grande and one in Madeira where COBRA protocols were conducted, for computations set with 500 randomizations. This can be visualized in Figure 4. For the plots of Vale da Castanheira (Deserta Grande) and Ponta de São Lourenço (Madeira), Chao1 and Chao2 estimators were recomputed using the Classic formula instead of the Bias-Corrected formula. The behavior of richness estimators for both sites sampled in Deserta Grande island diverged: while the Planalto Sul protocol yelded asymptotic curves of estimators, very close to the observed S value, the same did not occur for Vale da Castanheira, which did not show any signs of stabilizing its estimators and in which singleton species kept diverging positively.

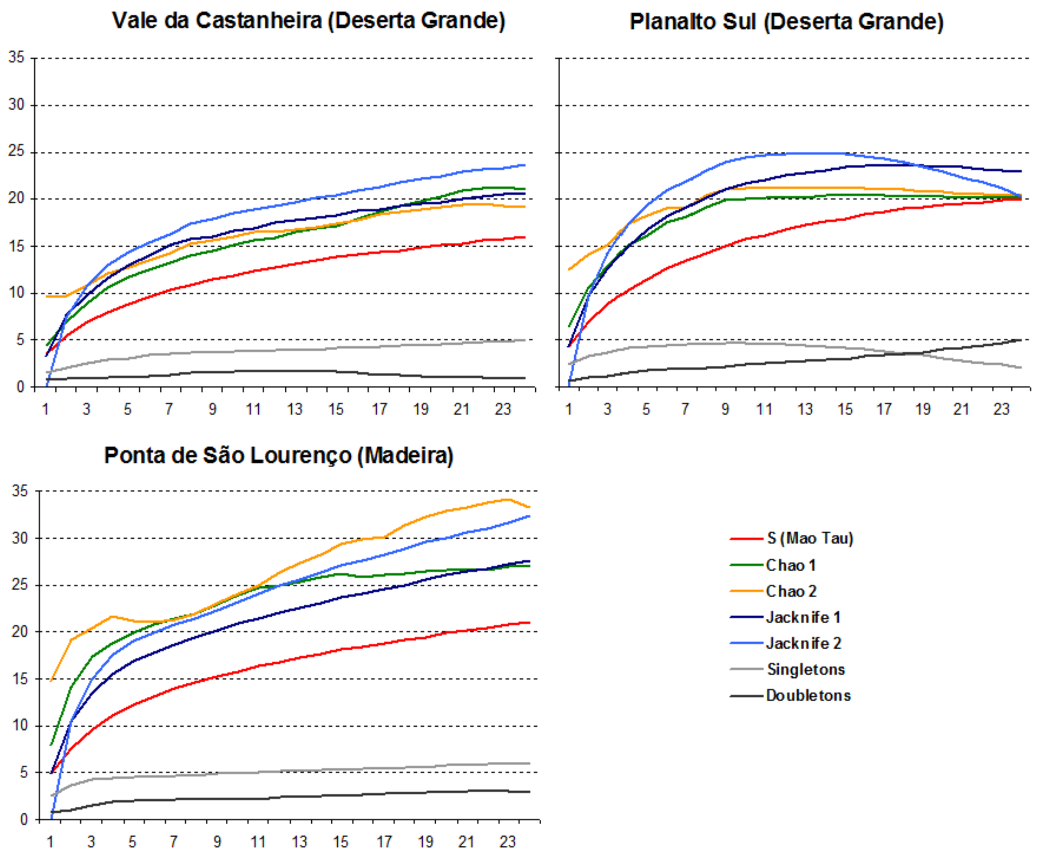

Figure 4 – Accumulation curves of COBRA protocols. Y axis = species; X axis = samples.

*Ad-hoc species sampling, faunistics and taxonomy*

Ad-hoc samples resulted in 55 species, of which 30 were not captured by the standardized sampling. 12 species are thought to be new to science, and of these 11 are supposedly single island endemics (SIEs), which constitutes an important contribution in the current knowledge of Macaronesian endemics (Figure 5).

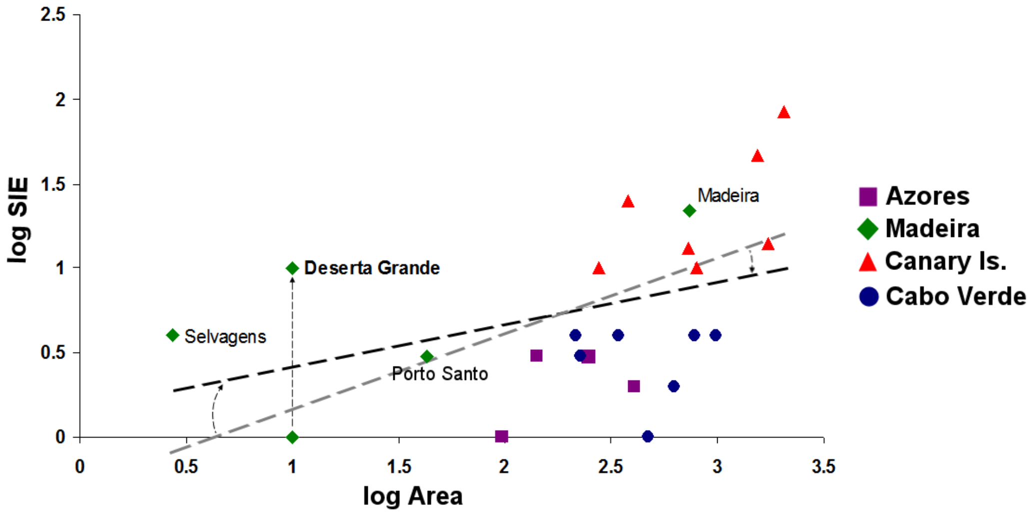

Figure 5 – Scatter plot with the relationship between the logarithmic functions of the single-island endemics (SIE) and the areas of the Macaronesian islands with at least 1 SIE.

*Faunistics*

Family Agelenidae C.L. Koch, 1837 (2 species)

*Tegenaria domestica* (Clerck, 1757)

Material: Deserta Grande – 1 ♀, hand sampling, 19.IV.2011, in a dark shelter at the top of Vereda.

Distribution: Cosmopolitan.

Remarks: First record for the Desertas. It is probably restricted to dark and disturbed habitats.

*Tegenaria pagana* C.L. Koch, 1840

Material: Bugio – 1 ♂, hand sampling, 28.IV.2011, Planalto Sul.

Distribution: Cosmopolitan.

Remarks: First record for the Desertas. Possible juveniles were also spotted in Deserta Grande.

Family Araneidae Clerck, 1757 (2 species)

*Mangora acalypha* (Walckenaer, 1802)
Material: Deserta Grande – 1 ♀, net sweeping, 16.IV.2011, Doca.
Distribution: Palearctic.
Remarks: First record for the Desertas. It is not surprising since its presence has been recorded on most of the Macaronesian archipelagos.

*Zygiella minima* Schmidt, 1968
Material: Deserta Grande – 1 ♂ and 4 ♀, hand sampling, 16.IV.2011, Gruta dos Roques de Castro.
Distribution: Canary Islands.
Remarks: First record for the Desertas and the Madeira archipelago.

Family Dictynidae O. Pickard-Cambridge, 1871 (1 species)

*Lathys* cf. *decolor* Kulczynski, 1899 n. stat.
Material: Deserta Grande – 13 ♀, 18.IV.2011, 11 ♀, 27.IV.2011, 3 ♂ and 11 ♀, 12.IV.2012, Planalto Sul; 4 ♀, 18.IV.2011, 1 ♀, 27.IV.2011, 3 ♀, 9.IV.2012, Eira; 1 ♀, 8.IV.2012, Vale da Castanheira; 1 ♂ and 1 ♀, 11.IV.2012, in the trail leading from Rocha do Barbusano to Risco. All specimens were collected by hand.
Distribution: Desertas and Porto Santo.
Remarks: In its original description, Kulzynski (1899) only illustrated the abdomen of a female collected in Porto Santo island. The male was later described by Denis (1962), but both sexes were synonymized with *L. affinis* (Blackwall, 1862) by Wunderlich (1992). This synonymy seems unjustified, if we consider that *L. affinis* is an endemic species to the island of Madeira, where it lives in humid laurel forest, making its webs in the bark and branches of trees, while in Deserta Grande the habitat is arid with no tree cover, where *Lathys* specimens can only be found in crevices in rocks or on lichens that cover these rocks. After collecting the cited material, both sexes were compared with *L. affinis* from

Madeira and found to be different. Unfortunately, the type material of *L. decolor* was destroyed, and comparison of the cited material with material collected by Denis (1962) was impossible so far, and thus this identification remains obscure. We hope to confirm this in the future.

Family Dysderidae C.L. Koch, 1837 (7 species)

Four species of the genus *Dysdera* Latreille, 1804 were found in Deserta Grande by the authors in the field trips of 2011 and 2012. Two additional species were previously collected by the second author. These six species are all new to science and will be described in a forthcoming publication, regarding the phylogeny and biogeography of this group in the entire archipelago, adding material recently collected from the other islands. Two females were captured in Bugio, and until further observations can add more information, we will assume it being a single-island endemic.

Family Filistatidae Ausserer, 1867 (1 species)

*Pritha pallida* (Kulczynski, 1897)
Material: Deserta Grande – 1 ♂ and 2 ♀, 27.IV.2011, hand collecting, Eira.
Distribution: Mediterranean.
Remarks: First record for the Desertas.

Family Gnaphosidae Pocock, 1898 (11 species)

*Drassodes lutescens* (C.L. Koch, 1839)
Material: Deserta Grande – 1 ♂, 18.IV.2011, 4 ♂ and 6 ♀, 27.IV.2011, hand collecting, 1 ♂ and 2 ♀, 27-IV-11.V.2011, pitfall trapping, Planalto Sul; 1 ♀, 19.IV.2011, hand collecting, Rocha do Barbusano; 1 ♂ and 1 ♀, 19.IV.2011, hand collecting, 1 ♂, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira.
Distribution: Mediterranean to Pakistan.
Remarks: First record for Desertas.

*Haplodrassus dalmatensis* (L. Koch, 1866)

Material: Deserta Grande – 5 ♂ and 3 ♀, 17.IV.2011, 13 ♂♂ and 14 ♀, 27.IV.2011, hand collecting, 32 ♂ and 10 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul; 1 ♂, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira. Madeira – 1 ♀, 2.V.2011, hand collecting, Ponta de São Lourenço.
Distribution: Palearctic, Ethiopia

*Micaria pallipes* (Lucas, 1846)
Material: Madeira – 2 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.
Distribution: Canary Islands to Central Asia.

*Scotophaeus blackwalli* (Thorell, 1871)
Material: Deserta Grande – 1 ♀, 28.IV.2011, hand collecting, Doca, inside a house.
Distribution: Cosmopolitan.
Remarks: First record for the Desertas. It was only found in the most disturbed area of the Deserta Grande.

*Setaphis carmeli* (O. Pickard-Cambridge, 1872)
Material: Deserta Grande – 1 ♂ and 3 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira. Madeira – 2 ♀, 2.V.2011, hand collecting, Ponta de São Lourenço.
Distribution: Mediterranean.
Remarks: First record for the Desertas and Madeira.

*Trachyzelotes holosericeus* (Simon, 1878)
Material: Bugio – 1 ♂ and 2 ♀♀, 28.IV.2012, hand collecting, Planalto Sul. Deserta Grande – 3 ♂, 19.IV.2011, 1 ♀, 23.IV.2011, 10 ♂ and 4 ♀, 25.IV.2011, hand collecting, 59 ♂ and 12 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 1 ♂, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 2 ♂ and 1 ♀, 2.V.2011, hand collecting, 5 ♂ and 2 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.
Distribution: Western Mediterranean.
Remarks: First record for the Desertas.

*Trachyzelotes lyonneti* (Audouin, 1826)

Material: Bugio – 5 ♂♂ and 5 ♀♀, 28.VI.2012, hand collecting, Planalto Sul. Deserta Grande – 2 ♂, 16.IV.2011, hand collecting, Doca. Madeira – 1 ♂, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Mediterranean to Central Asia, USA, Brazil, Peru.

*Zelotes aeneus* (Simon, 1878)

Material: Bugio – 1 ♂, 28.VI.2012, hand collecting, Planalto Sul. Deserta Grande – 1 ♀, 19.IV.2012, hand collecting, Vale da Castanheira. Madeira – 1 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Europe, Madeira archipelago.

Remarks: First record for the Desertas.

*Zelotes civicus* (Simon, 1878)

Material: Deserta Grande – 1 ♂, 19.IV.2012, hand collecting, Vale da Castanheira.

Distribution: Europe, Madeira archipelago.

Remarks: First record for the Desertas.

*Zelotes semirufus* (L. Koch, 1882)

Material: Bugio – 8 ♂♂ and 2 ♀♀, 28.VI.2012, hand collecting, Planalto Sul.

Distribution: Mediterranean.

Remarks: First record for the Desertas.

*Zelotes tenuis* (L. Koch, 1866)

Material: Bugio – 11 ♀♀, 28.VI.2012, Planalto Sul. Deserta Grande – 1 ♂, 7.IV.2011, Doca. All specimens collected by hand.

Distribution: Mediterranean to Ukraine, USA.

Remarks: First record for the Desertas.

Family Hahniidae Bertkau, 1878 (2 species)

Two different species of the genus *Hahnia* C.L. Koch, 1841 were collected from Deserta Grande, and these are thought to be new to science. Given that the authors possess additional new species from the Madeira archipelago we plan to describe them on a revisionary work of this genus at the regional scale.

Family Linyphiidae Blackwall, 1859 (9 species)

*Centromerus phoceorum* Simon, 1929
Material: Deserta Grande – 1 ♂, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira.
Distribution: Iberian Peninsula, France, Algeria, Tunisia.
Remarks: First record for the Desertas.

*Diplocephalus graecus* (O. Pickard-Cambridge, 1872)
Material: Deserta Grande – 1 ♂ and 2 ♀, 22.IV.2011, 1 ♂ and 2 ♀♀, 25.IV.2011, hand collecting, 24 ♂ and 5 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 1 ♂ and 3 ♀, 22.IV.2011, hand collecting, Vereda do Risco; 5 ♂ and 5 ♀, 27.IV.2011, hand collecting, 102 ♂ and 21 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 1 ♂ and 8 ♀, 2.V.2011, hand collecting, 64 ♂ and 24 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.
Distribution: Southern and Central Europe, North Africa.
Remarks: First record for the Desertas and Madeira.

*Meioneta canariensis* (Wunderlich, 1987)
Material: Deserta Grande – 1 ♂ and 3 ♀, 16.IV.2011, hand collecting, Doca; 4 ♂ and 1 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul.
Distribution: Canary Islands, Porto Santo.
Remarks: First record for Desertas. This species was recently cited from Porto Santo island (Wunderlich, 2011) and previously from the Selvagens (Crespo et al., 2009), thus it is not surprising that it was found in the Desertas.

*Meioneta fuscipalpa* (C.L. Koch, 1836)
Material: Deserta Grande – 27 ♂, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 2 ♂, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 1 ♂, 2.V.2011, hand collecting, 19 ♂, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Palearctic.

Remarks: First record for Desertas.

*Microctenonyx subitaneus* (O. Pickard.Cambridge, 1875)

Material: Deserta Grande – 3 ♀, 18.IV.2011, 1 ♀, 27.IV.2011, hand collecting, 12 ♂ and 5 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul; 1 ♀, 19.IV.2011, hand collecting, Vale da Castanheira; 1 ♀, 9.IV.2012, hand collecting, Eira. Madeira – 1 ♂ and 1 ♀, 2.V.2011, hand collecting, 3 ♂ and 5 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Holarctic (elsewhere, introduced).

Remarks: First record for Desertas.

*Ostearius melanopygius* (O. Pickard-Cambridge, 1879)

Material: Deserta Grande – 4 ♀, 18.IV.2011, 1 ♀, 27.IV.2011, hand collecting, 8 ♂ and 3 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul.

Distribution: Cosmopolitan.

Remarks: First record for Desertas.

*Tenuiphantes tenuis* (Blackwall, 1852)

Material: Deserta Grande – 2 ♂ and 4 ♀, 20.IV.2011, hand collecting, Rocha do Barbusano; 1 ♀, 25.IV.2011, hand collecting, Vale da Castanheira.

Distribution: Europe, North Africa, Iran, Afghanistan (elsewhere, introduced).

Remarks: First record for Desertas.

*Tiso vagans* (Blackwall, 1834)

Material: Deserta Grande – 2 ♀, 20.IV.2011, hand collecting, Rocha do Barbusano.

Distribution: Europe, Russia.

Remarks: First record for Desertas.

*Typhochrestus madeirensis* n. sp. (Figure 6)

Material: Madeira – Holotype ♂ (misidentified as *T. acoreensis* Wunderlich, 1992, see Cardoso & Crespo, 2008: 284), V.2006, pitfall trapping, Pico do Areeiro, Mário Boieiro & Carlos Aguiar leg., deposited at SNM.

Deserta Grande - Paratypes: 1 ♂, 27.IV-11.V.2011, pitfall trapping, 1 ♀, 12.IV.2012, 2 ♀, 13.IV.2012, hand collecting, Planalto Sul, deposited at FMNH; 1 ♀, 8.IV.2012, hand collecting, Vale da Castanheira, deposited at SNM.

Etymology: The species name refers to the archipelago where it was found.

Diagnosis: This species can be diagnosed from all other species of *Typhochrestus* in the male by the shape of the prosoma and by the spatulate shape of the tip of the embolus and in the females by the shape of the copulatory ducts.

Description.

Male: Total length 1.3 (1.2 – 1.4). Prosoma 0.7 (0.6 – 0.7) long, 0.5 (0.5) wide. Male cephalic lobe elevated in the normal pattern of the genus, with excavated postocular sulci, the lobe being short and long (Figure 6A). Clypeus height about 6 times the diameter of AME. Anterior row of eyes slightly recurved. Posterior row procurved. AME separated from ALE by the twice the diameter of the latter. AME separated by half their diameter. PME separated from AME roughly 3 times the diameter of the former. PLE touching ALE. PME separated by their diameter. PME separated from PLE by 4 times the diameter of the former. Coloration of prosoma and legs yellowish to brown. Chelicerae with 16 stridulatory striae, with 4 promarginal and 3 retromarginal teeth. Opisthosoma black.

Legs with spination typical of the genus, with 2 dorsal spines on tibia I, II and III and 1 on IV. L Sp Ti I–II = 0.3; L Sp Ti III–IV = 0.2. Tm IV absent. Position of TmI 0.42. Measurements of legs in Table 2.

Table 2 – Leg measurements for male *Typhochrestus madeirensis* n. sp. (n = 2).

| Leg | Femur | Patella | Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|---|
| I | 0.5 | 0.2 | 0.4 | 0.3 | 0.3 | 1.6 |
| II | 0.4 | 0.2 | 0.4 | 0.3 | 0.2 | 1.4 |
| III | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 1.3 |
| IV | 0.5 | 0.2 | 0.5 | 0.3 | 0.2 | 1.7 |

Male palp (Figs. 6B – D). Tibia with an apophysis typical of all Macaronesian *Typhochrestus,* with 3 subequal dorsal teeth. Paracymbium simple, without apophyses or hairs. Embolar apophysis corkscrew in shape, pointing dorsally and retrolaterally. Embolus coiled about 1.5 times, shortening at final third until it widens at its tip, conferring it spatulate shape.

Female. Total length 1.3 (1.3 – 1.4). Prosoma 0.6 (0.6) long, 0.4 (0.4) wide. Clypeus not protruding. Clypeal height 6 times the diameter of AME. Anterior row of eyes recurved. Posterior row straight. AME separated from ALE by 1.5 times the diameter of the former. AME separated by their diameter. PME separated from AME by 1.5 times the diameter of the former. PLE touching ALE. PME separated by their diameter. PME separated from PLE by the diameter of the former. Coloration of legs yellow, with trochanters, endites and coxae suffused with black. Sternum and labium black. Prosoma brown, suffused with black. Chelicerae with 8 small stridulatory striae, with 5 promarginal and retromarginal teeth. Opisthosoma black.

Tibial spination as in male but spines longer, L Sp Ti I–IV= 1.1. Position of TmI: 0.4. Measurements of legs in Table 3.

Table 3 – Leg measurements for female *Typhochrestus madeirensis* n. sp. (n = 4).

| Leg | Femur | Patella | Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|---|
| I | 0.4 | 0.1 | 0.3 | 0.3 | 0.2 | 1.3 |
| II | 0.4 | 0.1 | 0.3 | 0.2 | 0.2 | 1.2 |
| III | 0.3 | 0.1 | 0.2 | 0.2 | 0.2 | 1.1 |
| IV | 0.4 | 0.1 | 0.4 | 0.3 | 0.2 | 1.5 |

Epigyne (Figs. 6E - F). Epigynal entrances surrounded by a rounded plaque. Vulva very similar to that of *T. hesperius* Thaler, 1984 but inner branches of anterior copulatory ducts smaller than outer branches.

Ecology: This species apparently dwells in open undisturbed spaces in the Madeira archipelago. Four females were captured under stones in Deserta Grande.

Phenology: Adults of both sexes were collected in April and May. This should not be regarded as precise information due to the absence of sampling trips outside of the referred months.

Distribution: The archipelago of Madeira. Known from the island of Madeira and Deserta Grande.

Family Liocranidae Simon, 1897 (1 species)

*Mesiotelus grancanariensis* Wunderlich, 1992

Material: Deserta Grande – 1 ♂, 8.IV.2012, 1 ♂, 19.IV.2012, Vale da Castanheira; 1 ♀, 12.IV.2012, Planalto Sul. All specimens collected by hand.

Remarks: First record for Desertas.

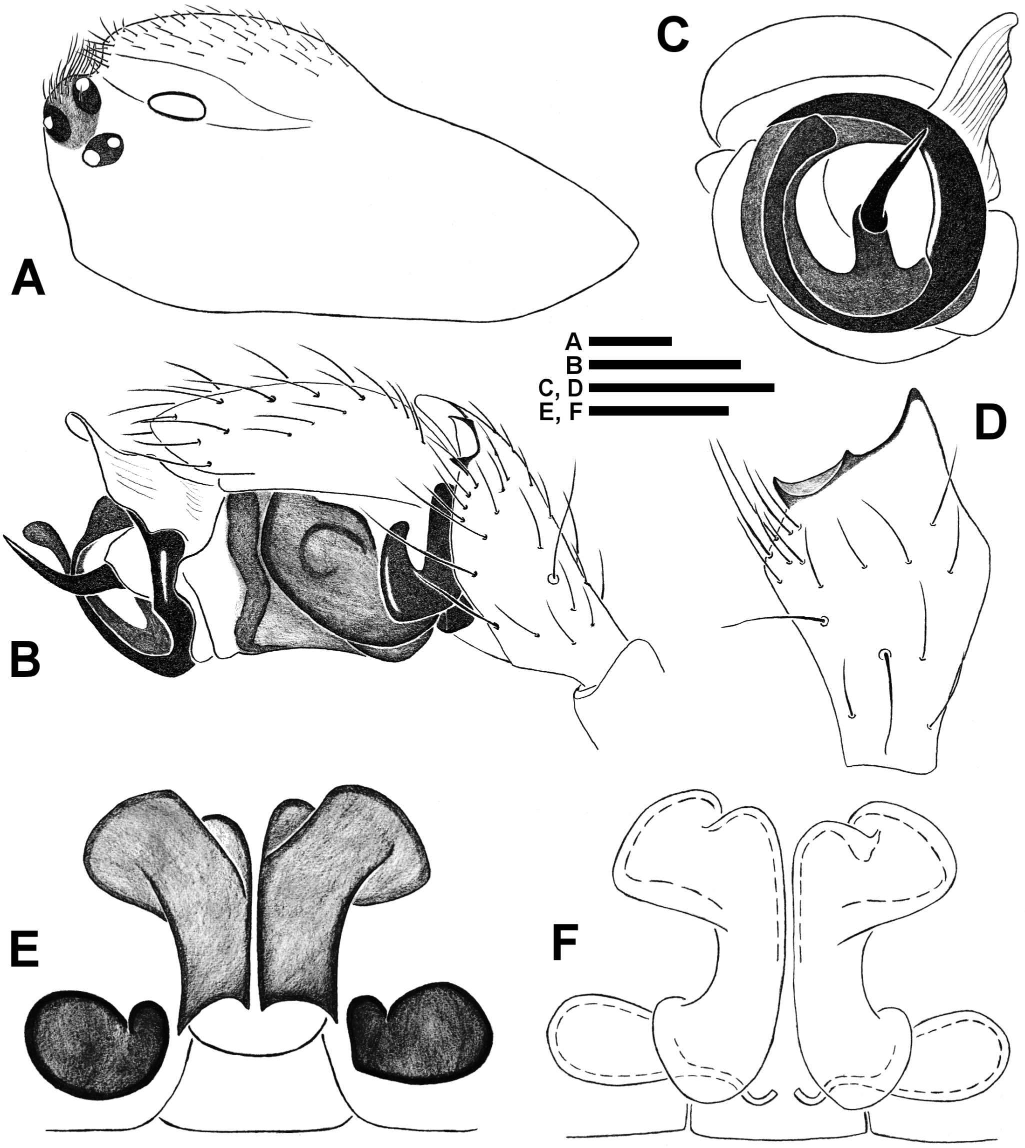

Figure 6: *Typhochrestus madeirensis* n.sp.: Male from Madeira, A – prosoma; B – retrolateral aspect of left pedipalp; C – frontal aspect of left pedipalp; D - dorsal aspect of tibia. Scale bars = 0.1 mm. Female from Deserta Grande, E – ventral aspect of vulva; F – dorsal aspect of vulva. Scale bar = 0.05 mm.

Distribution: This species initially thought endemic to the Canary Islands, but it was recently found in Portuguese mainland (Wunderlich, 2011).

Family Lycosidae Sundevall, 1833 (2 species)

*Hogna ingens* (Blackwall, 1857)
Distribution: This species is restricted to the Vale da Castanheira, the valley in the North of Deserta Grande.

Remarks: The authors have not collected new material of this remarkable endemic species, given that this was readily identifiable in the field.

*Hogna insularum* (Kulczynski, 1899)
Material: Bugio – 4 ♂♂ and 4 ♀♀, 28.VI.2012, hand collecting, Planalto Sul. Deserta Grande – 1 ♀, 17.IV.2011, hand collecting, Eira; 1 ♂, 23.IV.2011, 15 ♀, 25.IV.2011, hand collecting, 1 male, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira. Madeira – 1 ♂ and 4 ♀, 2.V.2011, hand collecting, 4 ♂ and 5 ♀, 2-17.V.2011, pitfall trapping, Vale da Castanheira.
Distribution: Madeira archipelago.

Family Nesticidae Simon, 1894 (1 species)

*Eidmanella pallida* (Emerton, 1875)
Material: Deserta Grande – 1 ♂, 17.IV.2011, 1 ♀, 21.IV.2011, hand collecting, Doca.
Distribution: Cosmopolitan.
Remarks: First record for Desertas.

Family Ochyroceratidae Fage, 1912 (1 species)

Indetermined species
Material: Deserta Grande – 6 ♀, 7.IV.2012, Doca; 2 ♀, 13.IV.2012, Planalto Sul. All specimens collected by hand.
Remarks: These specimens were initially thought to be juvenile oonopid spiders given that these were found to carry their eggs with their chelicerae. After a detailed observation in the laboratory revealed them to be members of the Ochyroceratidae, with all specimens being females and showing the opening of the copulatory ducts in a position situated laterally and posteriorly of the epigastric sulcus, from which a slightly sclerotized arch runs. Furher observations should reveal the identity of these specimens.

Family Oecobiidae Blackwall, 1862 (1 species)

*Oecobius similis* Kulczynski, 1909

Material: Deserta Grande – 4 ♀, 16.IV.2011, 2 ♂ and 2 ♀, 18.IV.2011, hand collecting, Doca; 1 ♂ and 2 ♀, 17.IV.2011, Eira; 13 ♂ and 3 ♀, 25.IV.2011, hand collecting, 15 ♂ and 1 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 5 ♂ and 5 ♀, 27.IV.2011, hand collecting, Planalto Sul. Madeira – 16 ♂ and 33 ♀, 2.V.2011, hand collecting, 29 ♂ and 3 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Madeira, Canary Islands, Azores, St. Helena.

Remarks: First record for Desertas.

Family Oonopidae Simon, 1890 (3 species)

*Gamasomorpha insularis* Simon, 1907

Material: Madeira – 1 ♂, 2.V.2011, hand collecting, 2 ♂, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Madeira, Bioko, São Tomé, St. Helena, Mauritius, Yemen, Seychelles.

*Oonops* cf. *pulcher* Templeton, 1835

Material: Deserta Grande – 2 ♂, 16.IV.2011, 2 ♂ and 1 ♀, 7.IV.2012, Doca. Madeira – 6 ♂ and 8 ♀, 2.V.2011, Ponta de São Lourenço. All specimens were collected by hand.

Distribution: Europe to Ukraine, North Africa, Tasmania.

Remarks: First record for the Desertas and Madeira. This identification is not certain as the observation of the structures of the tip of the bulbus were not clear.

*Opopaea concolor* (Blackwall, 1859)

Material: Deserta Grande – 5 ♂ and 2 ♀, 7.IV.2012, hand collecting, Doca.

Distribution: Pantropical.

Remarks: First record for the Desertas. It was only found in the most disturbed area of the island.

*Orchestina* sp.

Material: Deserta Grande – 1 ♀, 16.IV.2011, 1 ♀, 17.IV.2011, Doca; 2 ♀, 17.IV.2011, 3 ♀, 9.IV.2012, Eira; 1 ♀, 18.IV.2011, 1 ♂ and 4 ♀, 27.IV.2011, 3 ♀, 12.IV.2012, 1 ♂ and 3 ♀, 13.IV.2012, Planalto Sul. All specimens were collected by hand.

Remarks: After being erroneously identified as *O. pavesii* (Simon, 1983) by the first author, these specimens are now believed to be a new species, which will be described in an upcoming work with Arnaud Henrard.

Family Philodromidae Thorell, 1870 (1 species)

*Thanatus atratus* Simon, 1875

Material: Deserta Grande – 1 ♀, 17.IV.2011, hand collecting, Eira; 1 ♀, 27.IV.2011, hand collecting, 1 ♂, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 3 ♀, 2.V.2011, hand collecting, Ponta de São Lourenço.

Distribution: Palearctic.

Remarks: First record for Desertas and Madeira.

Family Pholcidae C.L. Koch, 1850 (1 species)

*Pholcus phalangioides* (Fuesslin, 1775)

Material: Deserta Grande – 1 ♂ and 1 ♀, 18.IV.2011, hand collecting, Doca (in a house).

Distribution: Cosmopolitan.

Remarks: First record for Desertas. It is probably restricted to dark and disturbed habitats.

Family Prodidomidae Simon, 1884 (1 species)

*Zimirina lepida* (Blackwall, 1859) (Figs. 7 – 8)

Material: Deserta Grande – 1 ♀, 16.IV.2011, 3 ♂ and 1 ♀, 17.IV.2011, 1 ♂, 7.IV.2012, Doca. Madeira – 14 ♂ and 13 ♀, 2.V.2011, Ponta de São Lourenço. All specimens were collected by hand.

Distribution: Madeira and Selvagens.

Remarks: First record for Desertas. After identifying this species from the Selvagens (Crespo *et al.*, 2009b) from where the undescribed male was found, some females were caught from Porto Santo island (Crespo *et al.*, 2009a). These were, however, slightly different from the Selvagens specimens, and the authors waited until further material was collected. After observing the males, a striking resemblance to the endemic species *Z. spinicymbia* Wunderlich, 1992, endemic from Gran Canaria in the Canary Islands was found. The type material of the latter species was checked and found to be slightly different from the material caught in the Madeira archipelago, given the differences in the tibial apophysis, cymbial spur and cymbial pilosity.

The material collected from Desertas, in addition to material from Madeira containing both males and females and 2 males from Porto Santo, lead us to conclude that *Z. lepida* occupies the entire archipelago of Madeira and Selvagens. The male of *Z. lepida* is here described for the first time.

Description.

Prosoma 1.2 (1.1 – 1.4) long, 0.9 (0.8 – 1.1) wide. Total length 2.5 (2.2 – 2.9). Eyes: Typical prodidomid arrangement, with the posterior row very procurved and the anterior row slightly recurved, from above. PME rectangular, whitish, PLE quadrangular, light, ALE oval, whitish, AME rounded, dark. MOQ longer than wide and wider at the back than at the front, from behind. AME separated by roughly their radius, nearly touching ALE. ALE nearly touching PLE. PLE nearly touching PME. PME separated by roughly their radius in male. Carapace orange, oval, with widest point between coxae II and III and posteriorly invaginated, fovea absent. Clypeal height at AME roughly their diameter. Sternum pale orange, oval, widest between coxae II and III, protruding between coxa IV, with clusters of stiff setae nested between the coxae. Labium roughly as wide as long, with its anterior margin more or less rounded, each endite converging roughly to a third of labium width. Chelicerae: without teeth, with a relatively long fang, slightly projecting forwards. Opisthosoma: male with a gray opisthossoma, sometimes suffused with red (mostly depending on the preservation of the specimen), strong bristles scattered through most of the ventral opisthosoma. Legs: yellow, tarsal claws with no teeth in their ventral surface, claw tufts present; see leg sizes in table 1; 1 dorsal spine in femurs I and II, 2 dorsal spines in femur III and IV;

tibiae and metatarsi I and II without spines, tibiae and metatarsi III and IV with very variable spination; leg sizes in Table 4.

Table 4 – Leg measurements for male *Zimirina lepida.* (n = 5).

| Leg | Femur | Patella | Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|---|
| I | 0.9 | 0.6 | 0.7 | 0.7 | 0.5 | 3.4 |
| II | 0.8 | 0.5 | 0.7 | 0.6 | 0.4 | 3.0 |
| III | 0.7 | 0.4 | 0.5 | 0.5 | 0.4 | 2.5 |
| IV | 1.1 | 0.5 | 0.9 | 0.8 | 0.6 | 3.9 |

Male palp (Figs. 7A – B): Retrolateral tibial apophysis relatively simple, oblique, with its tip reaching the proximities of the cymbial spur in retrolateral and in ventral view. Cymbial spur well developed, sharply pointed. Embolus a simple curved process. Hairs at the tip of cymbium thick, but not lanceolate.

Ecology: The species was found only in the most disturbed area of Deserta Grande island, which raises the question of it being a native species to the island that prefers low altitude areas or an introduction from surrounding islands. It was always found under stones.

Behavior: In the field, *Z. lepida* moved very fast in short periods, interspaced with periods of slow moving and perhaps sensing the vicinities for tactile or chemical stimuli. The authors noticed that in these moments the strong hairs present in the opisthosoma of this spider were erected, touching the ground (Figure 8).

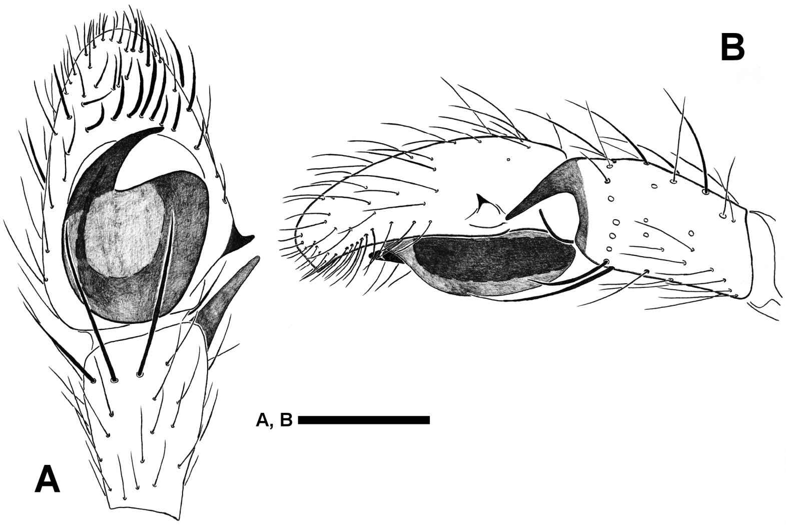

Figure 7 – *Zimirina lepida* (Blackwall, 1859): Male from Deserta Grande, A – ventral aspect of left pedipalp; B – retrolateral aspect of male pedipalp. Scale bar = 0.1 mm.

Figure 8 – *Zimirina lepida* (Blackwall, 1859): Female in Deserta Grande. Note the erect ventral setae in close contact with the ground. © Pedro Cardoso, 2011.

Family Salticidae Blackwall, 1841 (2 species)

*Chalcoscirtus sublestus* (Blackwall, 1867)

Material: Deserta Grande – 3 ♀, 17.IV.2011, hand collecting, Doca; 1 ♀, 19.IV.2011, 1 ♀, 23.IV.2011, hand collecting, 1 ♂ and 1 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 14 ♀, 27.IV.2011, 2 ♀, 12.IV.2012, hand collecting, 1 ♂ and 1 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 7 ♀, 2.V.2011, hand collecting, 1 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.

Distribution: Madeira and Canary Islands.

Remarks: First record for Desertas.

*Macaroeris desertensis* Wunderlich, 1992

Material: Deserta Grande – 1 ♂, 16.IV.2011, Doca; 1 ♀, 18.IV.2011, 1 ♀, 12.IV.2012, Planalto Sul; 1 ♀, 19.IV.2011, 2 ♀, 25.IV.2011, Vale da Castanheira; 1 ♀, 11.IV.2012, trail leading from Rocha do Barbusano to Risco. All specimens were collected by hand.

Distribution: Madeira.

Remarks: This species builds its cocoons mostly on the abundant bush-like lichens covering many rocks.

Family Segestriidae Simon, 1893 (1 species)

*Ariadna maderiana* Warburton, 1892

Material: Deserta Grande – 1 ♀, 16.IV.2011, Doca; 1 ♂ and 2 ♀, 17.IV.2011, Eira; 1 ♂ and 1 ♀, 18.IV.2011, 9 ♀, 27.IV.2011, Planalto Sul; 1 ♂ and 4 ♀, 25.IV.2011, Vale da Castanheira. Madeira – 2 ♀, 2.V.2011, Ponta de São Lourenço. All specimens were collected by hand.

Distribution: Madeira and Selvagens.

Family Sicariidae Keyserling, 1880 (1 species)

*Loxosceles* cf. *rufescens* (Dufour, 1820)

Material: Deserta Grande – 1 ♂ and 4 ♀, 19.IV.2012, hand collecting, Vale da Castanheira.

Distribution: Cosmopolitan.

Remarks: These specimens appear slightly different in size and colour to the typical form present in anthropic habitats, but for now we will attribute this provisional identification to this material.

Family Theridiidae Sundevall, 1833 (3 species)

*Enoplognatha diversa* (Blackwall, 1859)

Material: Deserta Grande – 2 ♀, 17.IV.2011, Eira; 1 ♂ and 2 ♀, 18.IV.2011, 1 ♂ and 3 ♀, 27.IV.2011, Planalto Sul; 1 ♂, 25.IV.2011, Vale da Castanheira. Madeira – 1 ♀, 2.V.2011, Ponta de São Lourenço. All specimens were collected by hand.

Distribution: Madeira, Canary Islands, Spain, Morocco to Greece.

*Steatoda grossa* (C.L. Koch, 1838)

Material: Deserta Grande – 1 ♀, 16.IV.2011, Gruta dos Roques de Castro; 1 ♀, 18.IV.2011, Doca; 1 ♀, 19.IV.2011, Vereda. Madeira – 1 ♀, 2.V.2011, Ponta de São Lourenço. All specimens were collected by hand.

Distribution: Cosmopolitan.

Remarks: First record for Desertas.

*Theridion hannoniae* Denis, 1944

Material: Madeira – 1 ♀, 2.V.2011, hand collecting, Ponta de São Lourenço.
Distribution: Europe and Mediterranean, Madeira and Canary Islands.

*Theridula aelleni* (Hubert, 1970)
Material: Deserta Grande – 1 ♀, 17.IV.2011, Eira; 3 ♂ and 2 ♀, 27.IV.2011, Planalto Sul. All specimens were collected by hand.
Distribution: Spain, Tunisia.
Remarks: First record for Desertas.

Family Thomisidae Sundevall, 1833 (2 species)

*Xysticus grohi* (Wunderlich, 1992)
Material: Deserta Grande – 1 ♀, 28.IV.2011, hand collecting, Vereda.
Distribution: Only known from Desertas.
Remarks: The single specimen of this single island endemic species was caught by the second author in a very steep slope. In flatter sites where the sampling effort was greater the species *X. nubilus* was present instead.

*Xysticus nubilus* Simon, 1875
Material: Deserta Grande – 1 ♀, 22.IV.2011, 1 ♀, 23.IV.2011, 2 ♀, 25.IV.2011, 1 ♀, 8.IV.2012, 1 ♂ and 1 ♀, 19.IV.2012, hand collecting, 8 ♀, 26.IV-10.V.2011, pitfall trapping, Vale da Castanheira; 1 ♀, 27.IV-11.V.2011, pitfall trapping, Planalto Sul. Madeira – 1 ♀, 2-17.V.2011, pitfall trapping, Ponta de São Lourenço.
Distribution: Mediterranean, Macaronesia.
Remarks: First record for Desertas.

## DISCUSSION

The data obtained by standardized sampling reveals a number of interesting phenomena. First, the lack of an asymptote and a large proportion of singletons in Vale da Castanheira might reflect an unstable community composed of early colonizers of disturbed habitats, as only 2 and a half years had gone after the fire and few months after the chemical treatments of the sampled plot. Total abundance of spiders sampled was also smaller in Vale da Castanheira than in

Planalto Sul, which might be an abnormal situation given that Planalto Sul is a more exposed and barren site, with less vegetation than Vale da Castanheira. It would be interesting to repeat the protocols in the same sites in the future and compare the data, to understand how the community shapes itself after the recent interventions by the Natural Park of Madeira in the attempt to eradicate *Phalaris aquatica* from Vale da Castanheira. Second, even though similar in habitat type, the plot in Madeira Island (São Lourenço), presented higher observed and estimated richness than both plots at Deserta Grande. This might suggest an important contribution of the regional pool, larger in the large island, to the local diversity of each plot. The importance of regional pools to local diversity is well known (Ricklefs, 1987; Srivastava, 1999; Borges & Brown, 2004) and it seems reflected in our data.

Until recently, only 11 spider species were known from Desertas (Cardoso & Crespo, 2008). This number increases to 55 with the current work. Although many of the novel species are widely distributed, often preferring disturbed habitats, we also add 12 new species for science, 11 of which endemic to Desertas, 1 to Desertas and Madeira and 4 Macaronesian endemics that were unknown from these islands. This is a big step towards resolving the Linnean and Wallacean shortfalls (see Cardoso *et al.*, 2011) still prevalent in this region (Figure 9), which was undoubtedly one of the less sampled in the whole Macaronesian region (Figure 5). In addition to the faunistic contribution to Desertas, Madeira island gets 4 new species records.

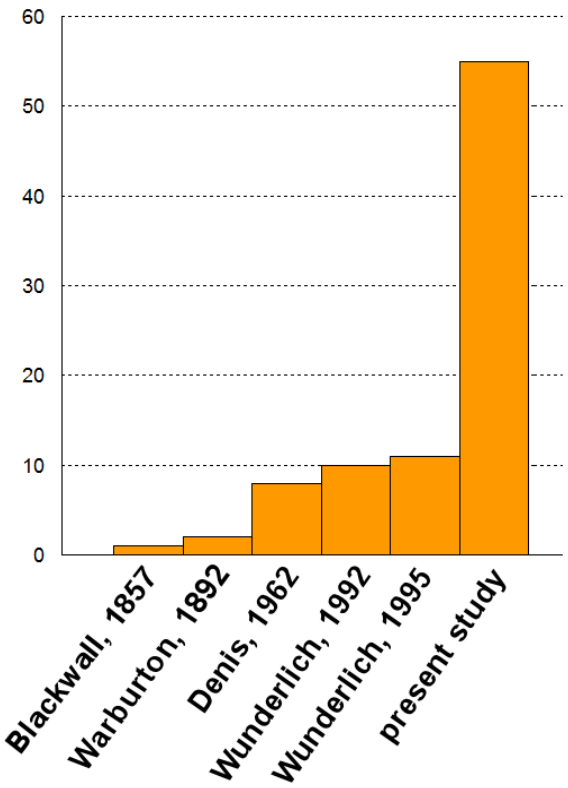

Figure 9 – Cumulative citations of spider species for the Desertas.

Many of the new species belong to genera which speciated in the Macaronesian or Madeiran archipelagos and thus demand generic revisions at least at regional level, at least in the cases where only limited information is available (*Hahnia* spp, *Dysdera* spp., *Orchestina* sp.). Interestingly, nearly all cases of new species were found in the high areas of Deserta Grande, while more common and widespread species were mostly found at the most disturbed, low-altitude site, the Doca, where all visitors arrive. The only way for invasive species to colonize the rest of the island would be overcoming a steep, 400 m high cliff to the top of the island, and this seems to be an obstacle to most species. We stress that in this area we found juveniles of the genus *Dysdera* Latreille, 1804, somatically very similar to the species *D. crocata* C.L. Koch, 1838, known as an invasive species throughout the Macaronesian archipelagos, however, the absence of adults does not allow a precise identification. In any case, it is not surprising to assume that once a cosmopolitan and aggressive species invades a niche previously occupied by native congenerics or other spiders that occupy the same niche, consequent competition might lead to the endemics extinction. This is thought to be the case in the Azorean archipelago where *D. crocata* is present in all the islands even inside native forests, possibly having outcompeted endemic species, which have gone extinct in recent decades (Cardoso *et al.*, 2010).

The number of supposed SIEs of the Deserta Grande now reaches 22% of the known spider community, surpassing the same values for Porto Santo island (5%) and the Selvagens islands (9%), the most similar islands for which comparable data can be drawn, although now with a large difference in terms of sampling effort. This presence of a greater number of SIEs can certainly be attributed to the rugged geomorphology, which rendered this island inapropriate to human colonization, which several authors have related to extinction waves and homogenization of biota in groups ranging from spiders (Cardoso *et al.*, 2010), birds (Vitousek, 1988), land snails (Solem, 1990) and even plants (Cronk, 1989).

Although precise estimates are impossible with the available data, it is certain that about 60 species occur in Deserta Grande. Juveniles belonging to several species (*Dysdera* cf. *crocata*, *Argiope* sp.) were collected and could lead to higher species number in the future, even if all these are all thought to be introduced species.

Many of the undescribed new species are species with highly restrict distribution ranges, such as one of the *Hahnia* species, captured solely in a small erosion cave, and most of the new *Dysdera*, found in very small numbers. Even *Hogna ingens*, a species known to science since 1857, and restricted to the North end of Deserta Grande, Vale da Castanheira, is not attributed with an extinction risk assessment according to IUCN regulations (IUCN, 2001) or protection under the Habitats Directive (Council of the European Communities, 1992), even though its habitat is currently degraded by invasive species and suffered recent interventions by the Madeira Natural Park. The authors addressed the referred issue in another publication (Crespo *et al.,* in prep.), but despite the study on the large wolf spider, other strict endemics will remain uknown until they are described. Feral goats (*Capra hircus* L.) have long been established in the Desertas, like other invasive species, and the efforts in their eradication proved to be unsuccessful. They currently proliferate and have irreversibly altered the local flora. We can only guess if this alteration of the native flora is the cause for the low numbers of *Dysdera* specimens, which could have specialized in different kinds of prey, possibly endemic insects that were somehow related with the native flora. Restoration of native habitats in Desertas is biased towards the protection of some taxa, like birds (such as *Pterodroma deserta*) or mammals (*Monachus monachus*), and conservation projects on such iconic fauna usually disregard other fauna. Future projects should be made to monitor the spiders of the Desertas, especially so due to the possibility of additional new species arising, and the extinction risk of many of the presently accounted (but still undescribed) new species.

## ACKNOWLEDGEMENTS

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# Capítulo II

## Assessing the conservation status of the strict endemic Desertas wolf spider

*Luís Carlos Crespo, Isamberto Silva, Paulo A.V. Borges & Pedro Cardoso*

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# Assessing the conservation status of the strict endemic Desertas wolf spider

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## ABSTRACT

The spider fauna of the Desertas Islands, in the Madeira archipelago, are poorly studied, despite the discovery of a large number of strict endemic species. The largest island of the Desertas is the home a strict endemic wolf spider species, *Hogna ingens* (Blackwall, 1857). It inhabits in a single valley on the North end of the Deserta Grande island, Vale da Castanheira, which is currently being invaded by the herb *Phalaris aquatica*, which competes with native flora and is subject of several eradication experiments by the Madeira Natural Park.

We aim to assess any the effect of the presence of *P. aquatica* and compare the effectiveness of the treatments applied by the Madeira Natural Park to eradicate this invasive plant on the presence and abundance of *Hogna ingens*. Based on data regarding the occupancy of *H. ingens* in its habitat we suggest an IUCN conservation status of Critically Endangered for this species and its inclusion in the Habitats Directive. These classifications will allow lobbying for effective protection measures and further monitoring of the Vale da Castanheira.

## KEYWORDS

Conservation, Arthropods, endemics, islands, IUCN, Macaronesia, Madeira. red list.

## INTRODUCTION

Islands are fluid and dynamic ecosystems in which species composition varies with time due to immigration, extinction and speciation processes (MacArthur & Wilson, 1967; Whittaker & Fernández-Palacios, 2007). When a founder species colonizes the island, if it can resist the selective pressures in this new habitat, with isolation and time speciation and formation of neoendemics may occur. Many islands, especially oceanic islands, thus have large proportins of endemics, some of them being keystone species. The case of the Galapagos' finches described by Charles Darwin, in which several species appear to have radiated from a common ancestor and specialized on different kinds of seeds, is the most popular case of adaptive radiation. Invertebrates have suffered this same process and intricate relations between insular species of endemic invertebrates remain to be understood and described.

The isolated and specific biota found in islands provides researchers with an opportunity to analyze interactions between species and several types of disturbance, being human based disturbance one of the major causes of extinctions (Channel & Lomolino, 2000; Gaston, 2008). The human species severely alters the landscape and transports novel species to colonize islands, which may themselves be harmful to the local communities, by means of predation, competition or altering nutrient cycling processes. These invasive species, when dominant, ultimately lead to a homogeneity of biota throughout the insular ecosystems (Simberloff & Von Holle, 1999) and currently large amounts are spent controlling invasive species (Williamson, 1996; Shigesada & Kawasaki, 1997). Several authors have shown that a decline of native species is associated to dominance of invasive species, but this does not mean that invasive species alone drive the decline of native species decline in all cases. They can rather interact with the local community by means of opportunistic interactions through disturbance, mostly caused by humans (Simberloff & Von Holle, 1999; Gurevitch & Padilla, 2004; Didham *et al.*, 2005; MacDougall & Turkington, 2005).

Spiders are often regarded as top predators of terrestrial ecosystems, being usually abundant and ubiquitious in most biomes (Wise, 1995). They occupy a large array of ecological niches, ranging from aerial weavers, ground weavers or active hunters, to cite the most common. The number of species currently known approaches 43000 (Platnick, 2012) and the description of new species is not reaching an asymptote, as in many other invertebrate taxa, since most species should still remain undescribed (Scheffers *et al.*, 2012). A rough estimate points to the existence of 170.000 spider species worldwide (Coddington & Levi, 1991), and about 600.000 arachnid species (Scheffers *et al.*, 2012).

Moreover, they have been found to be particularly sensitive to habitat disturbance. Cardoso *et al.* (2010) suggested that spider extinctions may provide indication of trends of future extinctions of other taxa, when the study of other insular faunas is not sufficient to make these predictions using quantitative data.

Even though invertebrates in general and spiders in particular are under- and misrepresented (Cardoso *et al.*, 2011a, 2012), the IUCN criteria and Red List (IUCN, 2001) are one of the most commonly used and useful tools for evaluation of extinction risk (Mace *et al.*, 2008; Cardoso *et al.*, 2011b). They provide a framework useful for lobbying for conservation, even if the active conservation measures are the responsibility of the local authorities to whom the conservation of the taxon is assigned to.

The Macaronesia houses a great richness of endemic species. Faunistic checklists are available for all territories (Izquierdo *et al.*, 2004; Arechavaleta *et al.*, 2005; Borges *et al.*, 2008, 2010), although the knowledge about each of these regions is highly ambivalent. Extensive standardized sampling and publishing was conducted in the Azores (revised in Borges *et al.*, 2011), but the same cannot be said about the other archipelagoes, where the Linnean and Wallacean shortfalls (Cardoso *et al.*, 2011) are still considerably significant (see also Lobo & Borges, 2010). The Desertas (Madeira archipelago) are particularly unknown in their arachnofauna, with only 11 spider species reported to date, most of these records being given by pioneer naturalists (Cardoso & Crespo, 2008). However, recent studies have identified 49 species, including many new to science (Crespo *et al.,* in prep).

There are several cases of spider genera experiencing adaptive radiation in the Macaronesian archipelagos, most notably *Dysdera, Pholcus* and *Spermophorides* (Wunderlich, 1987, 1992, 1995; Arnedo & Ribera, 1997, 1999; Arnedo *et al.*, 2000). In a smaller scale, and mainly in Madeira, the large wolf spiders belonging to the genus *Hogna*, is represented by seven species just in this archipelago. Of these, five are single-island endemics. While the taxonomic validity of all these species remains to be clarified (Crespo *et al.*, 2009), some are distinct enough even to the naked eye of an inexperienced observer. One of these is *Hogna ingens* (Blackwall, 1857), an impressive 40 to 50 mm spider, known only from valley at the North tip of Deserta Grande island, Vale da Castanheira.

This small valley is currently dominated by *Phalaris aquatica* L. The settlement of this herb in the Vale da Castanheira was hidden for some years, due to the parallel presence of rabbits (*Oryctolagus cuniculus* L.), who stalled the proliferation of this species by means of grazing. Given that rabbits were recently eradicated from the Vale da Casanheira, *P. aquatica* lost its main predator and now proliferates. This herb appears to not only displace the native herbs (and possibly the native invertebrates that prefer them), but its abundant growth covers the surface of the soil and the rocks, making the undergrowth below the rocks harder to access for the spiders, which take shelter there during daytime. The Natural Park of Madeira tried to eradicate the invasive plant in delimited areas using different methods with unknown results. In this study, we attempt to assess the population abundance of *H. ingens* in natural, invaded and recovered parts of the valley in order to define its conservation status according to the current IUCN criteria, and to predict its evolution in time.

## MATERIAL AND METHODS

### *Study site and species*

The Madeira archipelago is situated in the Atlantic Ocean, at roughly 1000 km from the Iberian Peninsula and 600 km from Africa. Together with the archipelagoes of Azores, Selvagens, Canary Islands and Cape Verde, they constitute the Macaronesia, a region where native ecosystems pre-date the last ice age, mostly due to the buffering capacity of the oceanic climate. The Madeira archipelago is formed by the Madeira island (742 km$^2$, 5.6 M.y.), Porto Santo island (43 km$^2$, 14 M.y.) and the Desertas Islands (13.5 km$^2$, 3.5 M.y.).

The Desertas Islands, 20 km Southeast of Madeira, is composed of 3 islands, the Deserta Grande (10 km$^2$), Ilhéu Chão (0.5 km$^2$) and Bugio (3 km$^2$) (Figure 1). Due to the harsh environment, The Desertas remained unhinhabited, despite historical attempts to colonize the island of Deserta Grande. That was mostly due to the harsh environment for human settlements. The geomorphology is very rugged, with very steep slopes rising from the sea level to about 400 meters being the dominant landscape and sources of fresh water are scarce.

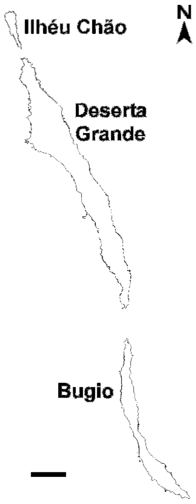

Figure 1 – Map of the Desertas Islands. Scale bar = 1.5 km.

They comprise the Natural Reserve of the Desertas, created due to the urge to protect a sustainable use of the abundant marine resources, as well as to protect the Mediterranean monk-seal (*Monachus monachus* (Hermann, 1779)). The management of human activities in the Desertas belongs to the Natural Park of Madeira, as well as most of the projects that concern the conservation of native species and ecosystems in these islands.

The Vale da Castanheira is approximately 2.8 km long and its width varies between 180 m to 400 m. The estimated area is 83 ha. The geomorphology separates the valley in two distinct areas: for most of its length, two opposing slopes are divided by a small riverbed, which is dry most of the year; in the North end of the valley, near the site where the riverbed meets the ocean, there rises a small plateau, which extends to the end of the island.

Prior to the invasion of the Vale da Castanheira by *P. aquatica*, it was a known fact (Silva, unpublished data) that *H. ingens* inhabited the entire valley. The range of the recent interventions by the Madeira Natural Park can be seen in Figure 2: one area was intervened the means of fire on September of 2010, which has burned out a considerable extent of the Vale da Castanheira, and later one other was intervened with a herbicide specific for plants of the Poaceae family (herbs) on January 2011. After the unsuccessful attempt to eradicate *P. aquatica* by fire, it became present throughout most of Vale da Castanheira, with exception of the North plateau, a secluded hill at the North end of the valley.

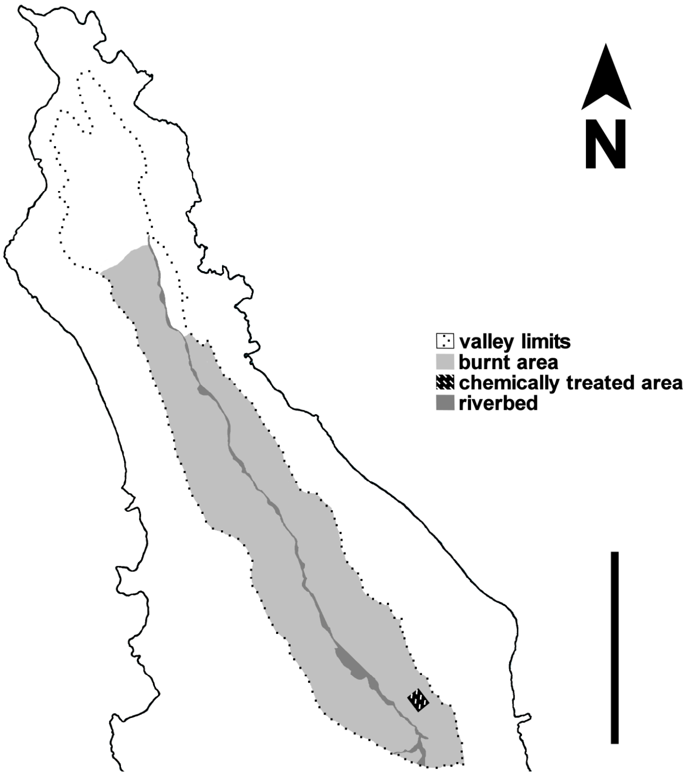

Figure 2 – Map of the Vale da Castanheira. Scale bar = 700 m.

*Experimental design*

Two parallel transects separated by approximately 50 m were created longitudinal to Vale da Castanheira. Each sampling point was separated from the following by 50 meters, except for the 87th and 99th points, which are spaced by roughly 20 m, and roughly forming a square covering the small area used to test the chemical treatment. The transects were designed to cover the entire valley, in both slopes. The coordinates of each point can be seen in Annex 1.

Sampling was conducted by counting all *H. ingens* specimens in a radius of roughly 2 meters around each point. The sex, maturity or presence of egg sacs was counted separately.

At each point, 4 photos of the soil surface were taken, roughly orthogonally, to quantify the soil cover. A 2 x 2 line grid was superimposed to each photo and the cover at each of the 4 connecting points was recorded. This way, each sampling point had 16 surface covers. Each of these could be classified as "rock", "dirt", "native vegetation", "*Phalaris*" and "burned *Phalaris*". This last variable was applied only in the site subject to chemicals where the burned rhizomes of *Phalaris* were still visible. Additionally, at each point we recorded the slope ange (using a clinometer) and orientation (using a compass). The transect sampling was done in April of two consecutive years, 2011 and 2012 (Table 1). Unfortunately, on 2012 the island of Deserta Grande suffered a considerable drought. This lead to a very different soil cover in both years.

*Data analysis*

"Orientation" variable was transformed into two variables, "Eastness" and "Northness", to avoid the circular dimension of the former. Respectively, the trigonometric functions of sin(orientation) and cos(orientation) were used to determine these variables. Simple correlations were tested for each explanatory and response variable. Kruskal-Wallis test for comparison of abundance medians was conducted with Statistica version 4.0.

Spatial regression analysis was performed with SAM version 4.0 (Spatial Analysis in Macroecology) (Rangel *et al.,* 2010) available at www.ecoevol.ufg.br./sam/. Additionally, the tool of Model Selection and Multi-Model Inference was used to analyze the data.

To estimate the population size and the Area of Occupancy (AOO) of *H. ingens* the following method was applied: each sampled point corresponded to a rectangle of 50 meters wide and with length determined by the outer edge of the Vale da Castanheira and the inner riverbed. After the determination of the area of each of these rectangles, a simple extrapolation was calculated based on the specimens observed. Most (11) of the points in the chemically treated area were not used as they do not follow the transect.

Samples from the transect extending across the full length of Vale da Castanheira are not directly comparable, as in 2012 the Deserta Grande was under a severe dry period. This drought led to a different soil cover, much more arid and devoid of vegetation than that observed in 2011. Therefore, the most robust results are provided by the 2011 dataset.

GIS analyses, including estimation of the Extent of Occurrence (EOO) were performed with OziExplorer trial version, available at http://www.oziexplorer.com.

## RESULTS

### *Empirical data*

Table 1 – Abundance data for *H. ingens.*

| | 2011 | | | | 2012 | | | |
|---|---|---|---|---|---|---|---|---|
| | North plateau | Chemically treated area | Valley remainder | Total | North plateau | Chemically treated area | Valley remainder | Total |
| Adult ♀ | 7 | 2 | 0 | 9 | 7 | 0 | 0 | 7 |
| Juveniles | 85 | 54 | 37 | 176 | 27 | 5 | 9 | 41 |
| Total | 92 | 56 | 37 | 185 | 34 | 5 | 9 | 48 |
| Average abundance | 4.38 | 4.7 | 0.55 | 1.85 | 1.6 | 0.42 | 0.13 | 0.48 |

### *Ecology*

Kruskal-Wallis test was performed on the transect covering the whole valley to compare abundance data from different areas. The 2011 data set did not show differences between the chemically treated area and the North plateau, but the remainder of the valley, occupied by *P. aquatica*, showed significative differences. The 2012 data set presented similar results, but for the chemically treated area, which did not differentiate from either of the other areas. P values can be seen in Table 2.

Table 2 – Kruskal-Wallis test for multiple comparisons of abundance data of *H. ingens* in the different areas of Vale da Castanheira. Statistically significative p values in bold.

| | 2011 | | | 2012 | | |
|---|---|---|---|---|---|---|
| | North Plateau | Chemically treated area | Valley remainder | North Plateau | Chemically treated area | Valley remainder |
| North plateau | | 1.0000 | **0.0000** | | 0.2990 | **$1.25\times10^{-3}$** |
| Chemically treated area | 1.0000 | | **$2.32\times10^{-4}$** | 0.2990 | | 0.6198 |
| Valley remainder | **0.0000** | **$2.32\times10^{-4}$** | | **$1.25\times10^{-3}$** | 0.6198 | |

For single variable correlations with spider abundance and the 2011 samples, only the variable "burned *Phalaris*" had statistical significance ($r = 0.371$; $p < 0.001$). For the 2012 samples, "native vegetation" and "*Phalaris*" were the only statistically significant ($r = 0.268$; $p = 0.007$; $r = 0.224$; $p = 0.025$). While the coefficients of variables remained the same in both sets of samples, they differed enough in the statistical significance of each variable so that the most parcimonious models show any shared variables.

The tool of Model Selection and Multi-Model Inference of SAM was used to obtain the best model explaining the abundance of *H. ingens*. For 2011 samples, it resulted in the selection of the following model:

$Abund2011_1 = 0.122\ burn\_Phalaris + 0.025\ native\_vegetation - 0.06\ slope + 1.038$

The coefficient of "slope" was revealed to be non-significant ($p = 0.081$), and the model was computed without the referred variable:

$Abund2011_2 = 0.125\ burn\_Phalaris + 0.023\ native\_vegetation + 0.248$

For 2012 samples, the same procedure was applied, and a different model was obtained:

$Abund2012_1 = -\ 0.013\ Phalaris - 0.02\ dirt - 0.021\ slope + 1.122$

Again, the coefficient of "slope" was found to be non-significant ($p = 0.152$), and the model was computed without it:

$Abund2012_2 = -\ 0.012\ Phalaris - 0.019\ dirt + 0.787$

2011: $r_1 = 0.487$; $r_2 = 0.446$; 2012: $r_1 = 0.339$, $r_2 = 0.309$

The maps of the linear regression analyses by SAM can be seen in Figure 3. For 2011, observed abundance was maximum at the North plateau and the chemically trated area. The abundance estimation predicted a higher presence of spiders than the observed, although smaller values for the North plateau. This could be due to the higher residuals in that area, which themselves might indicate phenomena of spatial aggregation, unexplained by the predictor variables.

Variance partitioning was performed, to assess the weight of spatial phenomena. Variables were set in three groups: (a) Space, with latitude and longitude values; (b) Soil cover, with the variables "*Phalaris*", "burned *Phalaris*", "native vegetation", "dirt" and "rock"; (c) Geomorphology, with "eastness", "northness" and "slope". The results obtained for the 2011 dataset were as illustrated in Figure 4:

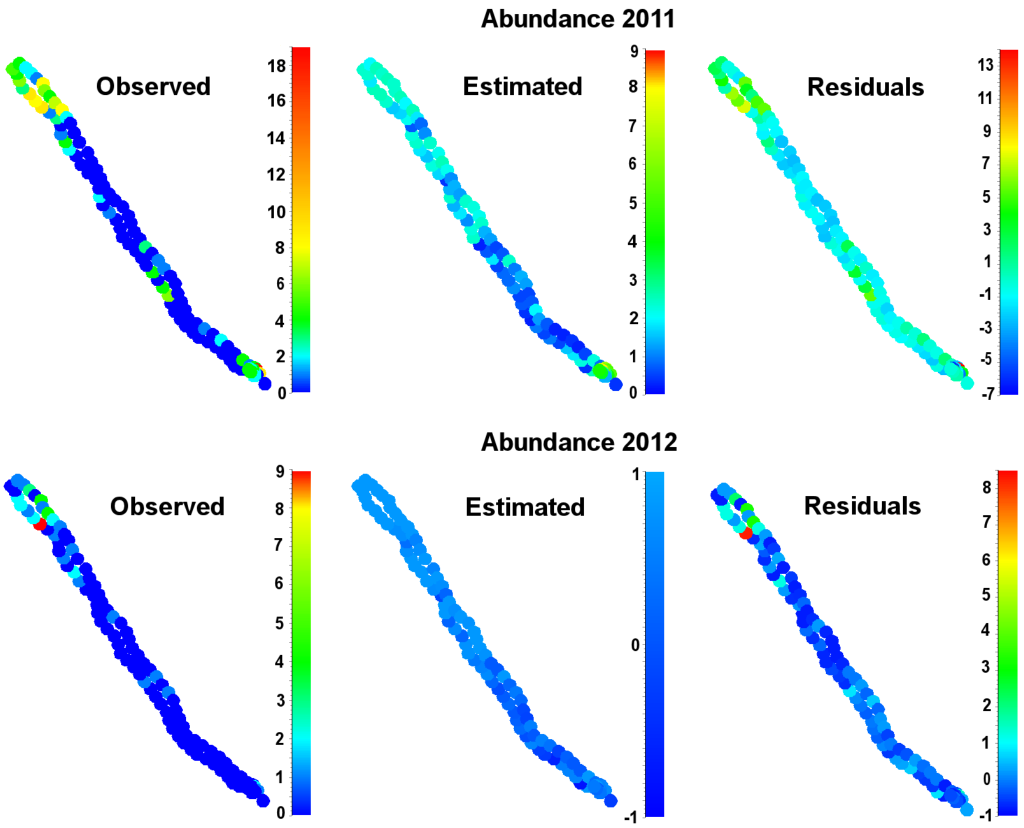

Figure 3 – Observed, estimated and residual values for the abundance of *H. ingens* in Vale da Castanheira.

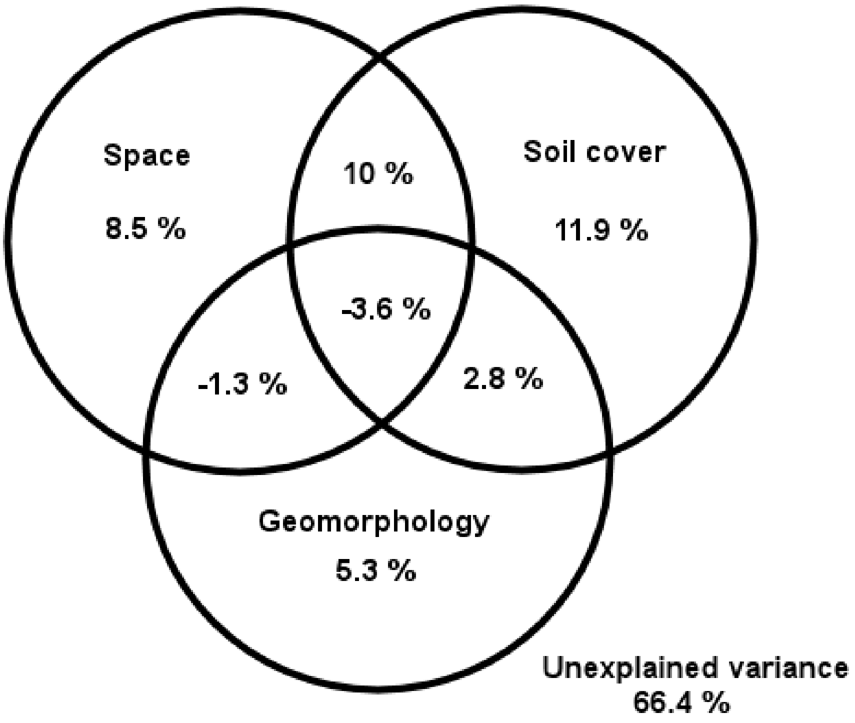

Figure 4 – Schematic view of variance partitioning for the abundance of *H. ingens* in the Vale da Castanheira using the complete dataset of 2011.

The component explaining the largest amount of variance is the soil cover, but it should be noted that the amount of variance explained by the space alone rises up to 8.5% of the total variance, and furthermore, 10% of the variance originated by soil cover can be explained through interaction with spatial phenomena.

### *Conservation*

Using the transect that extends throughout the whole valley, the estimate of the population size of *H. ingens* points to the presence of 4385 adult specimens of *H. ingens* in 2011; the same count using the 2012 dataset points to 4086 adult specimens. The same estimate computed for both adults and juveniles points for 73444 specimens for 2011 and to 24852 specimens for 2012.

The AOO was estimated to be 23 ha for 2011, and 15 ha for 2012. Since the EOO is 81 ha and *H. ingens* was historically present in the whole valley (Silva, personal communication), a decrease of nearly 72% of AOO is accounted for the data taken in 2011, which reaches 81% in the data from 2012.

## DISCUSSION

### *Ecology*

*H. ingens* individuals appear to prefer areas where *P. aquatica* did not occur, either by the action of chemical treatment over the latter, or by the presence of spiders in areas dominated by native vegetation. However, this does not prove that the existence of *P. aquatica* by itself, and its consequent biological interaction with the arthropod communities, is the sole cause for the absence of *H. ingens* from sites where the former occurred. The area burnt by fire, as an erroneous attempt to eradicate *P. aquatica,* was the area that showed lower abundance specimens of *H. ingens* and greater concentrations of *P. aquatica*. Human based disturbance by means of fire, in conjunction with a lesser desirability from *H. ingens* to colonize the areas populated with *P. aquatica*, may account for the regression results, allied with spatially-related phenomena, like dispersion of juveniles to sub-optimal areas or aggregation of spiders in non-disturbed areas such as the North plateau of Vale da Castanheira. This can show a kind of small-scale source-sink population dynamics with juvenile populations while adult specimens are only able to attain their optimum only in less-disturbed patches.

In the experimental area where a specific herbicide for herbs was used, it was observed that indeed the herbicide seemed to affect only herbs and plants of other families were present and apparently proliferate, together with good numbers of *H. ingens*. However, we must be cautious concerning the simple analysis performed, as we did not focus on other groups of animals, and a question still lies if these chemicals provoque a significant impact on the native community of arthropods. Another limitation of this study points to the fact that the chemically treated plot is rather small compared to the area where fire was used and sampling artifacts like biases of the differently treated areas, may account for the small p-values of regression coefficients. Still, burnt areas where *P. aquatica* now thrives appear to be undesirable for establishment of *H. ingens*, and the disappearance of the herb from the chemically treated plot appears to have facilitated the appearance of the spiders.

Being a generalist predator, and able to use an abundant resource as the millipede *Ommatoiulus moreletii* (Lucas, 1860) for prey, as it was readily observed in the field, we can assume that *H. ingens* has a relatively homeostatic refuge from the biotic interactions of native and invasive plants, which might themselves affect the native arthropod community. The same cannot be said about the effects of disturbance by man, especially by means of fire, which is discouraged by the authors to be of any use for the means of eradication of *Phalaris aquatica* from Vale da Castanheira.

### *Conservation*

The five criteria usually used for risk assessment of a particular species are: (a) reduction in population size (over 10 years or 3 generations), (b) geographic range, (c) small population size and decline, (d) very small or restricted population and (e) quantitative analysis of extinction risk (IUCN, 2001).

To estimate criterion (a) a good estimate of the abundance of the species was needed. As pointed out by Cardoso *et al.* (2011a), it is usually difficult to determine the total abundance of a particular species of invertebrate. The same authors suggest that the Area of Occupancy (AOO) should be used instead. However, the case of a large species in an extremely small area, as is the case of *H. ingens* in Vale da Castanheira, is an exception to this impossibility. In the present study, population size was inferred due to a methodology that involved high sampling effort over the entire area. While there weren't past cases of similar sampling procedures, comparable data is not available and this criterion should not be applicable to the risk assessment of *H. ingens*. Comparing the estimates of 2011 and 2012 might provide doubtful data, as the climatic conditions of both years were remarkably different, with a considerable drought in 2012 that forced spiders to find refuge in crevices in the ground, thus being unaccounted for. This comparison would also be insufficient to meet the criterion needs as it only encompasses 2 generations (3 are needed).

Criterion (b) can be analyzed in terms of the Extent of Occurrence (EOO), which is the area encompassing the total and possible available sites for the presence of the target species. The estimated EOO fits the category for Critically Endangered (EOO $< 100$ km$^2$) but EOO is thought to be very similar throughout the years, not meeting the needs required to classify the target species as Critically Endangered (a continuing decline or extreme fluctuations in EOO). In the steep geomorphology of Deserta Grande, landslides are common; the future occurrence of such will probably demand a reassessment of the EOO. The estimated Area of Occupancy (AOO) was likewise below the threshold required for classification under Critically Endangered. Furthermore, our data record a reduction of 72% from the total EOO in data collected in 2011, reaching 81% in 2012. The only available information concerning the AOO of *H. ingens* prior to this work were unrecorded observations by the second author, who has worked in the area for the past two decades and according to the author, *H. ingens* was present roughly in the entire valley. Adding to the fact that Vale da Castanheira is the only available location for the species and that the invasion of the valley by *P. aquatica* diminishes the quality of this habitat (as put by requirement B2(b)(iii)), the authors suggest to classify *H. ingens* as Critically Endangered, and we strongly encourage further monitoring of AOO criterion by replicating the sampling performed.

The use of criteria (c) and (d) might not be applicable without a previous delineation of new abundance thresholds as pointed out by Cardoso *et al.* (2011a), but even with new thresholds these criteria should be used with caution. Gillespie (1999) stressed that "(…) small population size is a natural phenomenon for many species in islands and rarity in itself may not be a reason for immediate conservation concern. What is important is to understand the history of a rare species: is their small population size a natural phenomenon caused by the small scale of local endemism, or have populations been reduced to remnant status as a result of anthropogenic disturbance, either direct or indirect?" This statement summarizes the situation of *H. ingens*, which has been facing artificial disturbance in the recent years in its natural habitat. The population abundance estimation likewise by itself cannot provide a dynamic view of the occupation of the Vale da Castanheira, the single restricted habitat of *H. ingens.*

Criterion (e) demands a large amount of datasets, which are not available so far.

Cardoso (2012) recently suggested an urgent revision of Habitats Directive (Council of the European Communities, 1992) because its classifications are subjective, and lack the use of proper objective data for risk assessment of particular taxa. Indeed, the inclusion of taxa in priority lists usually uses characters such as aesthetic value, large body size and neglects taxa thought as repulsive by the general public. Adopting a different perspective from that, the authors believe that inclusion of *H. ingens* in the Habitats Directive would be a worthy opportunity to begin this needed revision. This species is a strict endemic, being present in solely one island, fits a provisionary status of Critically Endangered according to the IUCN criteria (future monitoring is needed for a better understanding of its current situation), and faces a degradation of its habitat due to biological invasions. The inclusion of *H. ingens* in the Habitats Directive would also be a further motif for the species protection, which, in this case, would favour the protection of the entire Vale da Castanheira, an area harboring several other endemic species of invertebrates, like land snails, or even further undescribed spider species (Crespo *et al.,* 2012).

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# Annex 1

Geographical coordinates of the sampling points in the Vale da Castanheira:

| | | |
|---|---|---|
| 1 | N 32º 33.032’ | W 16º 31.563’ |
| 2 | N 32º 33.045’ | W 16º 31.585’ |
| 3 | N 32º 33.066’ | W 16º 31.601’ |
| 4 | N 32º 33.090’ | W 16º 31.626’ |
| 5 | N 32º 33.114’ | W 16º 31.651’ |
| 6 | N 32º 33.131’ | W 16º 31.680’ |
| 7 | N 32º 33.148’ | W 16º 31.712’ |
| 8 | N 32º 33.168’ | W 16º 31.733’ |
| 9 | N 32º 33.191’ | W 16º 31.758’ |
| 10 | N 32º 33.216’ | W 16º 31.778’ |
| 11 | N 32º 33.244’ | W 16º 31.797’ |
| 12 | N 32º 33.275’ | W 16º 31.810’ |
| 13 | N 32º 33.303’ | W 16º 31.819’ |
| 14 | N 32º 33.333’ | W 16º 31.839’ |
| 15 | N 32º 33.361’ | W 16º 31.858’ |
| 16 | N 32º 33.388’ | W 16º 31.875’ |
| 17 | N 32º 33.415’ | W 16º 31.897’ |
| 18 | N 32º 33.444’ | W 16º 31.913’ |
| 19 | N 32º 33.469’ | W 16º 31.934’ |
| 20 | N 32º 33.493’ | W 16º 31.960’ |
| 21 | N 32º 33.519’ | W 16º 31.981’ |
| 22 | N 32º 33.549’ | W 16º 31.989’ |
| 23 | N 32º 33.582’ | W 16º 32.003’ |
| 24 | N 32º 33.609’ | W 16º 32.029’ |
| 25 | N 32º 33.637’ | W 16º 32.050’ |
| 26 | N 32º 33.667’ | W 16º 32.061’ |
| 27 | N 32º 33.667’ | W 16º 32.064’ |
| 28 | N 32º 33.729’ | W 16º 32.075’ |
| 29 | N 32º 33.754’ | W 16º 32.103’ |
| 30 | N 32º 33.784’ | W 16º 32.127’ |
| 31 | N 32º 33.816’ | W 16º 32.145’ |
| 32 | N 32º 33.840’ | W 16º 32.169’ |
| 33 | N 32º 33.868’ | W 16º 32.182’ |
| 34 | N 32º 33.897’ | W 16º 32.200’ |
| 35 | N 32º 33.929’ | W 16º 32.198’ |
| 36 | N 32º 33.955’ | W 16º 32.213’ |
| 37 | N 32º 33.976’ | W 16º 32.239’ |
| 38 | N 32º 33.976’ | W 16º 32.266’ |
| 39 | N 32º 34.017’ | W 16º 32.289’ |
| 40 | N 32º 34.042’ | W 16º 32.308’ |
| 41 | N 32º 34.063’ | W 16º 32.334’ |
| 42 | N 32º 34.092’ | W 16º 32.344’ |
| 43 | N 32º 34.116’ | W 16º 32.354’ |
| 44 | N 32º 34.134’ | W 16º 32.368’ |
| 45 | N 32º 34.154’ | W 16º 32.344’ |
| 46 | N 32º 34.138’ | W 16º 32.323’ |
| 47 | N 32º 34.118’ | W 16º 32.302’ |
| 48 | N 32º 34.099’ | W 16º 32.283’ |
| 49 | N 32º 34.081’ | W 16º 32.262’ |
| 50 | N 32º 34.056’ | W 16º 32.256’ |
| 51 | N 32º 34.034’ | W 16º 32.238’ |
| 52 | N 32º 34.009’ | W 16º 32.220’ |
| 53 | N 32º 33.985’ | W 16º 32.195’ |
| 54 | N 32º 33.956’ | W 16º 32.179’ |
| 55 | N 32º 33.935’ | W 16º 32.166’ |
| 56 | N 32º 33.899’ | W 16º 32.151’ |
| 57 | N 32º 33.867’ | W 16º 32.133’ |
| 58 | N 32º 33.828’ | W 16º 32.103’ |
| 59 | N 32º 33.795’ | W 16º 32.091’ |
| 60 | N 32º 33.766’ | W 16º 32.073’ |
| 61 | N 32º 33.736’ | W 16º 32.060’ |
| 62 | N 32º 33.706’ | W 16º 32.048’ |
| 63 | N 32º 33.677’ | W 16º 32.028’ |
| 64 | N 32º 33.652’ | W 16º 32.007’ |
| 65 | N 32º 33.629’ | W 16º 31.980’ |
| 66 | N 32º 33.598’ | W 16º 31.961’ |
| 67 | N 32º 33.570’ | W 16º 31.953’ |
| 68 | N 32º 33.539’ | W 16º 31.941’ |
| 69 | N 32º 33.512’ | W 16º 31.921’ |
| 70 | N 32º 33.483’ | W 16º 31.900’ |
| 71 | N 32º 33.458’ | W 16º 31.877’ |
| 72 | N 32º 33.433’ | W 16º 31.854’ |

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| 73 | N 32º 33.404’ | W 16º 31.836’ |
| 74 | N 32º 33.376’ | W 16º 31.812’ |
| 75 | N 32º 33.346’ | W 16º 31.796’ |
| 76 | N 32º 32.312’ | W 16º 31.787’ |
| 77 | N 32º 33.280’ | W 16º 31.775’ |
| 78 | N 32º 33.251’ | W 16º 31.761’ |
| 79 | N 32º 33.218’ | W 16º 31.749’ |
| 80 | N 32º 33.200’ | W 16º 31.720’ |
| 81 | N 32º 33.181’ | W 16º 31.693’ |
| 82 | N 32º 33.160’ | W 16º 31.663’ |
| 83 | N 32º 33.140’ | W 16º 31.634’ |
| 84 | N 32º 33.116’ | W 16º 31.610’ |
| 85 | N 32º 33.089’ | W 16º 31.587’ |
| 86 | N 32º 33.067’ | W 16º 31.557’ |
| 87 | N 32º 33.044’ | W 16º 31.533’ |
| 88 | N 32º 33.039’ | W 16º 31.517’ |
| 89 | N 32º 33.032’ | W 16º 31.510’ |
| 90 | N 32º 33.018’ | W 16º 31.499’ |
| 91 | N 32º 33.013’ | W 16º 31.507’ |
| 92 | N 32º 33.023’ | W 16º 31.517’ |
| 93 | N 32º 33.035’ | W 16º 31.524’ |
| 94 | N 32º 33.033’ | W 16º 31.531’ |
| 95 | N 32º 33.021’ | W 16º 31.525’ |
| 96 | N 32º 33.009’ | W 16º 31.516’ |
| 97 | N 32º 33.007’ | W 16º 31.516’ |
| 98 | N 32º 33.023’ | W 16º 31.530’ |
| 99 | N 32º 33.032’ | W 16º 31.538’ |
| 100 | N 32º 32.979’ | W 16º 31.479’ |

# Conclusões

O estudo ecológico efectuado no Vale da Castanheira permite concluir uma relação negativa entre a abundância da aranha *Hogna ingens* em função da presença da planta *Phalaris aquatica*. Esta relação nem sempre foi significativa através do uso dos métodos de regressão linear utilizados pois apenas se revelou significativa nos dados de 2012, consequentemente fazendo com que a sua quantificação permanecerá um pouco incerta até que se façam novas amostragens. Por outro lado, a área tratada com químicos específicos para Poaceae revelou estar positivamente relacionada com a presença da aranha, e no campo observou-se que as plantas de outras famílias proliferavam. É no entanto de aconselhar que se façam estudos de outros grupos de artrópodes nativos, nomeadamente insectos fitófagos, que poderão ser mais afectados pela alteração da comunidade vegetal que as aranhas, já que estas são predadores generalistas. Temos também um indício que a comunidade de aranhas presente na área tratada por químicos se pode encontrar num estado transitório, com grande percentagem de espécies com grande capacidade de dispersão e distribuições geográficas amplas presentes em grande número, em deterimento de espécies nativas, tal como uma menor abundância de aranhas em comparação com um local amostrado no Planalto Sul, uma zona teoricamente mais agreste para o estabelecimento de aranhas. Verificou-se uma menor presença das aranhas na área do Vale sujeita a um fogo em 2010, e isso poderia indicar que as aranhas sofreriam mais com a perturbação causada pela espécie humana do que propriamente devido às interacções bióticas entre a flora invasora e a flora nativa. No entanto, a área tratada por químicos sugere que haja também uma componente biótica que afecte a presença das aranhas em locais com ou sem *P. aquatica*, pois a remoção desta última está relacionada com uma notória presença das aranhas. A presença das aranhas está também determinada por fenómenos espaciais. Existe uma agregação no planalto Norte do Vale da Castanheira, e os adultos que existem na restante área poderão ser descendentes de sobreviventes do fogo de 2010. A dispersão de juvenis é feita para zonas não óptimas, algumas das quais com a presença de *P. aquatica*.

Dada a sua actual área de ocupação do vale, a sua distribuição restrita, e a perda de qualidade do seu habitat, sugerimos que seja atribuído à espécie *Hogna ingens* o estatuto de conservação de Criticamente Ameaçada. Aconselhamos uma monitorização regular da sua população, para que se possam efectuar futuras estimativas, de modo a obter uma série temporal de dados mais robusta. Devido ao seu estatuto de endemismo restrito e aos dados anteriores, sugerimos também que a espécie possa ser incluída na Directiva Habitats, aquando da sua futura revisão.

O presente trabalho contribui de forma significativa para um aumento do conhecimento da aracnofauna da região, citando 55 espécies para as Desertas. 12 destas espécies serão espécies novas para a ciência e 11 serão endemismos restritos à Deserta Grande ou ao Bugio, o que tornará as Desertas mais ricas em endemismos de aranhas relativamente a Porto Santo e às Selvagens. Infelizmente, a descrição destas espécies requer trabalhos taxonómicos cuidados à escala regional, pelo que a grande parte delas só será descrita posteriormente à publicação deste trabalho, em publicações dependentes do género a tratar. De notar que muitas destas espécies não foram recolhidas nos protocolos padronizados, sendo conhecidas apenas por um punhado de espécimes ou apenas de um local muitíssimo restrito (pequena gruta de erosão, trilho, etc.), o que pode indicar um elevado risco de extinção. Pretende-se classificar estas espécies sob os critérios da IUCN e de inclusão na Directiva Habitats aquando da sua descrição, pese embora esses mesmos critérios necessitem de uma revisão para incluir de melhor forma espécies de invertebrados (Cardoso *et al.*, 2011b).

Espera-se que este trabalho seja parte integrante de uma mudança de mentalidade e abordagem à temática de conservação de invertebrados, com um estudo pioneiro sobre uma espécie de aranha notável, e a descoberta de novas espécies endémicas, que poderão trazer novas luzes sobre a história natural de todo o arquipélago da Madeira.

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