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

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Abstract: The spider fauna of the Desertas Islands (Madeira) has been largely neglected until now, with only 11 species recorded. Both standardized and ad-hoc sampling was performed on organized expeditions to Desertas in the years 2011 and 2012. As expected for small, isolated islands, species richness estimates per sampled hectare are relatively low, ranging from 19 to 23 species. The updated local checklist now includes 57 species, of which 11 are thought to be new for science, including a new species of Typhochrestus Simon, 1884, endemic to the Madeira archipelago, here described. The previously unknown male of Zimirina lepida (Blackwall, 1859) is also described. The family Ochyroceratidae Fage, 1912 is recorded for the first time from a native habitat in Europe.

Key words: Arachnida, ecology, taxonomy, species richness estimates, checklist, new species, Macaronesia, Madeira, Desertas.

Evaluacion rápida de la biodiversidad, faunística y descripción de una especie nueva de araña (Araneae) de islas Desertas y Madeira (Portugal)

Resumen: El conocimiento actual de la araneofauna de las Islas Desertas (Madeira) se puede considerar como deficiente, con sólo 11 especies registradas. Con la finalidad de cubrir este vacío se efectuaron diversas expediciones durante 2011 y 2012, en las cuales se realizaron muestras estandarizadas y capturas manuales. Como era de esperarse para islas pequeñas y aisladas, las estimas de la riqueza de especies por hectárea son relativamente bajas, oscilando entre 19 a 23 especies. La lista de especies local se ha incrementado hasta 57 especies, de las cuales 11 podrían ser nuevas para la ciencia, incluyendo una especie nueva de Typhochrestus Simon, 1884, endémica del archipiélago de Madeira, aquí descrita. También se describe el macho, hasta ahora desconocido, de Zimirina lepida (Blackwall, 1859). La familia Ochyroceratidae Fage, 1912 es citada por primera vez de un hábitat nativo en Europa.

Palabras clave: Arachnida, ecología, taxonomía, estimadores de riqueza de especies, especie nueva, Macaronesia, Madeira, Desertas.

Taxonomía /Taxonomy: Typhochrestus madeirensis Crespo sp. nov.

Introduction

The archipelago of Madeira is composed by the main islands of Madeira and 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 10km², followed by Bugio with 3 km² and Ilhéu Chão with 0.5 km² (Figure 1). The geological age of these islands is 5 M.y., similar to Madeira Island (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.

The Deserta Grande has an 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 exist, one in the extreme North, Vale da Castanheira (and West part of Pedregal), and one in the South, Planalto Sul. The island maximum altitude is 479 m, at Rocha do Barbusano. Additionally, two small 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 with a maximum width of 500 m. In the North end, it reaches its maximum altitude of 89 m.

All islands are protected as part of 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 and whole habitats of the Desertas. Besides invasive fauna, several exotic species of plants were also introduced in the territory, as is the case of Ageratina adenophora (Spreng.) R. M. King & H. Rob, Nicotiana tabacum L. or, more recently, the herb Phalaris aquatica L. The first two plant species were successfully eradicated by the Natural Park of Madeira, but the same does not hold true to the latter, which proliferates in Vale da Castanheira (Figure 2). The Natural Park of Madeira has been trying to eradicate P. aquatica, first with the use of wildfire (which burned throughout most of the valley) and latter with chemicals specific for plants of the family Poaceae. This species is responsible for a recent extreme reduction of the available habitat for Hogna ingens (Blackwall, 1857), and
endemic of Vale da Castanheira (Crespo et al., subm.). The study of this wolf spider species was one of the main reasons behind the recent expeditions to Deserta Grande.

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, 2011, 2012). Since then, only small faunistical contributions were published with new spider records, focusing on Porto Santo (Crespo et al., 2009a). A checklist was compiled by Cardoso & Crespo (2008). In this checklist, only 11 spider species were cited so far for the Desertas. Such a low number mainly reflects a lack of surveys on these islands.

The main goals of this work are threefold: 1) estimate species richness for delimited areas in Deserta Grande using semi-quantitative, standardized sampling and compare them with a similar area in Madeira Island; 2) update the Desertas Islands checklist based on standardized and ad-hoc sampling and; 3) describe new species and taxonomic novelties.

Material and 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 potentially different assemblages. Pitfall trapping, using 48 plastic cups 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 at ground and low vegetation level, with either an entomological aspirator or forceps was also performed in one-hour samples at the middle of the two-week period. Twelve hand samples, four diurnal and eight nocturnal, were made per site (for more details on the protocol see Cardoso, 2009 and 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.

A site similar in both area and habitat was sampled in the eastern tip of Madeira Island, the Ponta de São Lourenço (Figure 3). This site was similarly covered by scarce xerophytic shrubs and herbs and completely devoid of trees.

Ad-hoc, non-standardized sampling was also performed covering most of Deserta Grande both in 2011 and 2012 (Figure 2). A small additional set of ad-hoc samples was collected from the Planalto Sul of Bugio Island in 2012.
Laboratorial methods. Specimens were analyzed through a Leica MZ9.5, 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 and are given in the format “average (minimum – maximum).” Most species nomenclature and their distributions are according to Platnick (2013).

Abreviatures

AME – Anterior median eyes
ALE – Anterior lateral eyes
PME – Posterior median eyes
PLE – Posterior lateral eyes
L Sp Ti – Proportional length of tibial spine relative to diameter of tibia
Tm (I, II, III or IV) – Metatarsal tricobothria of legs I, II, III or IV
MOQ – Median ocular quadrangle
SNM – Senckenberg Naturmuseum, Frankfurt, Germany
FMNH - Finnish Museum of Natural History, Helsinki, Finland

Statistical analysis. Species richness estimates per plot were done using non-parametric estimators, namely Chao1 (Chao, 1984), Chao2 (Chao, 1987), Jackknife1 (Burnham & Overton, 1978) and Jackknife2 (Burnham & Overton, 1979) (see also Colwell & Coddington, 1994 or Hortal, 1998). 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), unique (species present in a single sample) and duplicates (species present in two samples). 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 estimates. Sampling intensity and completeness were computed as in Cardoso et al. (2008, 2009), the first being the ratio of specimens per species captured and the second the ratio between observed and estimated richness. Species accumulation curves and all calculations were computed with the software EstimateS version 8.20 (Colwell, 2006).

Ad-hoc species sampling, faunistics and taxonomy. Ad-hoc samples resulted in 57 species, of which 32 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), significantly upgrading the current knowledge of Macaronesian endemics (Figure 5). 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 as recommended when the coefficient of variation is greater than 0.5 (Colwell, 2006). The behavior of richness estimators for both sites sampled in Deserta Grande differed (Figure 4). While the Planalto Sul sampling yielded asymptotic curves of estimators, reaching final values very close to the observed richness and with the singletons and doubletons curves crossing, the same did not occur for the curves of Vale da Castanheira, which did not show any signs of stabilizing and in which singletons kept rising and doubletons declining. Curves behaviors for the samples of Madeira were intermediate.

Estimated richness was around 20 in both sites of Deserta Grande and 30 in Madeira (Table I). Higher completeness values were obtained for Planalto Sul (Table I).

Results

Standardized species sampling. Sixteen species were captured in Vale da Castanheira, 20 in Planalto Sul and 21 in Madeira (Table I). 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 as recommended when the coefficient of variation is greater than 0.5 (Colwell, 2006). The behavior of richness estimators for both sites sampled in Deserta Grande differed (Figure 4). While the Planalto Sul sampling yielded asymptotic curves of estimators, reaching final values very close to the observed richness and with the singletons and doubletons curves crossing, the same did not occur for the curves of Vale da Castanheira, which did not show any signs of stabilizing and in which singletons kept rising and doubletons declining. Curves behaviors for the samples of Madeira were intermediate.

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**Tegenaria pagana** C.L. Koch, 1840  
**MATERIAL:** Bugio – 1 ♂, hand collecting, 28.IV.2011, Planalto Sul.  
**DISTRIBUTION:** Cosmopolitan.  
**REMARKS:** First record for the Desertas. Possible juveniles were also spotted in Deserta Grande.

**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.

**Zygella cf. minima** Schmidt, 1968  
**MATERIAL:** Deserta Grande – 1 ♂ and 4 ♀♀, hand collecting, 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 (2 species)  
**Lathys affinis** (Blackwall, 1862)  
**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 ♀, 10.IV.2012, in the trail leading from Rocha do Barbusano to Risco. All specimens were collected by hand.  
**DISTRIBUTION:** Madeira archipelago and Canary Islands.  
**Nigma puella** (Simon, 1870)  
**MATERIAL:** Deserta Grande – 1 ♂ and 10 ♀♀, hand collecting, 5.XII.2012, Doca.  
**DISTRIBUTION:** Europe, Azores, Madeira, Canary Islands.  
**REMARKS:** First record for the Desertas. Its presence was expected, due to its widespread distribution over the Macaronesian archipelagoes.

**Family Dysderidae** C.L. Koch, 1837 (1 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 additionally captured in Bugio, but until further observations can be done, we will assign them to one of the species from Deserta Grande.

**Dysdera crocata** C.L. Koch, 1838  
**Material:** Deserta Grande – 1 juvenile, 18.IV.2011, hand collecting, Doca.  
**Distribution:** Cosmopolitan.  
**Remarks:** First record for the Desertas.

**Trachyzelotes hyomneti** (Audouin, 1826)  
**Distribution:** Western Mediterranean.  
**Remarks:** First record for the Desertas.

**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:** The only specimen available was identified using DNA sequencing by Miquel Arnedo.

**Family Gnaphosidae** Pocock, 1898 (11 species)  
*Drassodes lutescens* (C.L. Koch, 1839)  
**Distribution:** Mediterranean to Pakistan.  
**Remarks:** First record for the Desertas.

*Haplodrassus dalmatensis* (L. Koch, 1866)  
**Distribution:** Mediterranean to Pakistan.  
**Remarks:** First record for the Desertas.

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

*Scotophanaeus blackwallii* (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)  
**Distribution:** Mediterranean.  
**Remarks:** First record for the Desertas and Madeira.

*Trachyzelotes holosericeus* (Simon, 1878)  
**Distribution:** Mediterranean.  
**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)  
*Agyneta 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.
Agyneta fuscipalpa (C.L. Koch, 1836)


**DISTRIBUTION:** Paleartic.

**REMARKS:** First record for Desertas.

Centromerus phoeceorum 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 and Madeira.

Diplocephalus graecus (O. Pickard-Cambridge, 1872)


**DISTRIBUTION:** Southern and Central Europe, North Africa.

**REMARKS:** First record for Desertas and Madeira.

Microctenonyx subitaneus (O. Pickard-Cambridge, 1875)


**DISTRIBUTION:** Holarctic (elsewhere, introduced).

**REMARKS:** First record for Desertas.

Osteararius melanopogitus (O. Pickard-Cambridge, 1879)


**DISTRIBUTION:** Cosmopolitan.

**REMARKS:** First record for Desertas.

Temuiphantes tenus (Blackwall, 1852)


**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 Crespo sp. nov. (Figure 6-11)


**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 as usual for the genus, with excavated postocular sulci, the lobe being short and long (Fig. 6A). Clypeus height about 7 times the diameter of AME. Anterior row of eyes slightly recurved. Posterior row straight. AME separated from ALE by the twice diameter of the former. ALE separated by half their diameter. PME separated from ALE by 3 times the diameter of the former. PME separated from PME by 4 times the diameter of the former. Coloration of prosoma and legs yellowish to brown. Chelicerae with 16 stridulating ridges, with 4 promarginal and 3 retromarginal teeth. Opisthosoma black. Legs with spine typical of the genus, with 2 dorsal spines on tibiae 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 0.2. Measurements of legs in Table II.

**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. ALE separated by their diameter. PME separated from AME by 1.5 times the diameter of the former. PME separated from PME by 4 times 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 stridulating ridges, with 5 promarginal and 3 retromarginal teeth. Opisthosoma black.

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. Embolus apophysis corkscrew in shape, pointing dorsally and retrolaterally. Embolus coiled about 1.5 times, shortening at the final third until it widens at its tip, conferring it a 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. ALE separated by their diameter. PME separated from AME by 1.5 times the diameter of the former. PME separated from PME by 4 times 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 stridulating ridges, with 5 promarginal and 3 retromarginal teeth. Opisthosoma black.

**ECOLOGY:** This species apparently dwells in open undisurbed spaces in the Madeira archipelago. The site in Madeira is a high altitude open habitat. 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 outside of the referred months.
Fig. 6-11. *Typhochrestus madeirensis* n.sp.: male from Madeira, 6. prosoma; 7. retrolateral aspect of left pedipalp; 8. frontal aspect of left pedipalp; 9. dorsal aspect of tibia. Scale bars = 0.1 mm. Female from Deserta Grande, 10. ventral aspect of vulva; 11. dorsal aspect of vulva. Scale bars = 0.05 mm. TA – Tibial apophysis; E – Embolus; P – Paracymbium; T – Tegulum; St – Subtegulum; Pt – Protegulum; EA – Embolar apophysis; MM – median membrane; CO – Copulatory openings; CD – Copulatory ducts; R – Receptacula; FD – Fertilization ducts.

**Table II.** Leg measurements for male *Typhochrestus madeirensis* n.sp.

<table>
<thead>
<tr>
<th></th>
<th>Femur</th>
<th>Patella</th>
<th>Tibia</th>
<th>Metatarsus</th>
<th>Tarsus</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Leg I</td>
<td>0.5 (0.4 – 0.5)</td>
<td>0.2 (0.2)</td>
<td>0.4 (0.4)</td>
<td>0.3 (0.3)</td>
<td>0.3 (0.2 – 0.3)</td>
<td>1.6 (1.5 – 1.7)</td>
</tr>
<tr>
<td>Leg II</td>
<td>0.4 (0.4)</td>
<td>0.2 (0.1 – 0.2)</td>
<td>0.4 (0.3 – 0.4)</td>
<td>0.3 (0.3)</td>
<td>0.2 (0.2)</td>
<td>1.4 (1.3 – 1.5)</td>
</tr>
<tr>
<td>Leg III</td>
<td>0.3 (0.3)</td>
<td>0.2 (0.1 – 0.2)</td>
<td>0.3 (0.3)</td>
<td>0.3 (0.2 – 0.3)</td>
<td>0.2 (0.2)</td>
<td>1.3 (1.2 – 1.3)</td>
</tr>
<tr>
<td>Leg IV</td>
<td>0.5 (0.5)</td>
<td>0.2 (0.1 – 0.2)</td>
<td>0.5 (0.4 – 0.5)</td>
<td>0.3 (0.3)</td>
<td>0.2 (0.2)</td>
<td>1.7 (1.6 – 1.7)</td>
</tr>
</tbody>
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**Table III.** Leg measurements for female *Typhochrestus madeirensis* n.sp.

<table>
<thead>
<tr>
<th></th>
<th>Femur</th>
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<th>Tibia</th>
<th>Metatarsus</th>
<th>Tarsus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg I</td>
<td>0.4 (0.4)</td>
<td>0.1 (0.1 – 0.2)</td>
<td>0.3 (0.3)</td>
<td>0.3 (0.2 – 0.3)</td>
<td>0.2 (0.2)</td>
<td>1.3 (1.3 – 1.4)</td>
</tr>
<tr>
<td>Leg II</td>
<td>0.4 (0.4)</td>
<td>0.1 (0.1)</td>
<td>0.3 (0.3)</td>
<td>0.2 (0.2 – 0.3)</td>
<td>0.2 (0.2)</td>
<td>1.2 (1.2 – 1.3)</td>
</tr>
<tr>
<td>Leg III</td>
<td>0.3 (0.3)</td>
<td>0.1 (0.1)</td>
<td>0.2 (0.2)</td>
<td>0.2 (0.2)</td>
<td>0.2 (0.2)</td>
<td>1.1 (1.1)</td>
</tr>
<tr>
<td>Leg IV</td>
<td>0.4 (0.4 – 0.5)</td>
<td>0.1 (0.1 – 0.2)</td>
<td>0.4 (0.4)</td>
<td>0.3 (0.3 – 0.4)</td>
<td>0.2 (0.2)</td>
<td>1.5 (1.4 – 1.6)</td>
</tr>
</tbody>
</table>
**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.  
**DISTRIBUTION:** This species was initially thought to be endemic to the Canary Islands, but it was recently found in the Portuguese mainland (Wunderlich, 2011).

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**Family Oecobiidae** Sundevall, 1833 (3 species)

*Hogna heeri* (Thorell, 1875)  
**MATERIAL:** Bugio – 1 ♂ and 1 ♀, 3.XII.2012, hand collecting, Planalto Sul.  
**DISTRIBUTION:** Madeira Island and Bugio.  
**REMARKS:** Thought to be an endemic restricted to Madeira Island, but it was recently found in Bugio. Interestingly, adult specimens of *H. heeri* were not found with adults of the closely related species, *Hogna insularum* (Kulczynski, 1899). The co-habitation of two similar species of the same genus in such a small island like Bugio could explain the appearance of adults of *H. heeri* solely in Winter and those of *H. insularum* in Spring.

*Hogna ingens* (Blackwall, 1857)  
**DISTRIBUTION:** This species is restricted to the Vale da Castanheira, the valley in the North of Desertas 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)  
**DISTRIBUTION:** Madeira archipelago.

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**Family Nesidiidae** 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.

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**Family Ochyroceratidae** Fage, 1912 (1 species)

Undetermined 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 oonopids because they carry their eggs with their chelicerae. 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. Further observations should reveal the identity of these specimens. This is the first record of the family in a native habitat in Europe (see also Kielhorn, 2008).

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**Family Oecobiidae** Sundevall, 1833 (3 species)

*Oecobius similis* Kulczynski, 1909  
**DISTRIBUTION:** Madeira, Canary Islands, Azores, St. Helena.  
**REMARKS:** First record for Desertas.

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**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 bulb was not clear.

*Opoaea 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.  
**REMARKS:** These specimens are a new species, which will be described in an upcoming revisionary work on the genus *Orchestina* in the Macaronesian and Mediterranean region.

*Thanatus vulgaris* Simon, 1870  
**DISTRIBUTION:** Palearctic.  
**REMARKS:** First record for Desertas.
Fig. 12-13. *Zimirina lepida* (Blackwall, 1859): male from Deserta Grande, 12. ventral aspect of left pedipalp; 13. retrolateral aspect of male pedipalp. Scale bar = 0.1 mm. TA – Tibial apophysis; CS – Cymbial spur; E – Embolus. Fig. 14. *Zimirina lepida* (Blackwall, 1859): female in Deserta Grande. Note the erect ventral setae in close contact with the ground. © Pedro Cardoso, 2011.

**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 sheltered disturbed habitats.

**Family Prodidomidae** Simon, 1884 (1 species)

*Zimirina lepida* (Blackwall, 1859) (Fig. 12-14)

**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 (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 *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 archipelagoes of Madeira and Selvagens. The male of *Z. lepida* is here described for the first time.
Table IV. Leg measurements for male Zimirina lepida.

<table>
<thead>
<tr>
<th>Femur I</th>
<th>Patella</th>
<th>Tibia</th>
<th>Metatarsus</th>
<th>Tarsus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9 (0.8–1.1)</td>
<td>0.6 (0.5–0.7)</td>
<td>0.7 (0.7–0.9)</td>
<td>0.7 (0.6–0.8)</td>
<td>0.5 (0.4–0.5)</td>
<td>3.4 (3.0–4.1)</td>
</tr>
<tr>
<td>0.8 (0.7–1.0)</td>
<td>0.5 (0.4–0.6)</td>
<td>0.7 (0.6–0.9)</td>
<td>0.6 (0.5–0.7)</td>
<td>0.4 (0.4–0.5)</td>
<td>3.0 (2.7–3.7)</td>
</tr>
<tr>
<td>0.7 (0.6–0.8)</td>
<td>0.4 (0.4–0.4)</td>
<td>0.5 (0.5–0.6)</td>
<td>0.5 (0.5–0.5)</td>
<td>0.4 (0.4–0.4)</td>
<td>2.5 (2.3–2.7)</td>
</tr>
<tr>
<td>1.1 (1.0–1.2)</td>
<td>0.5 (0.5–0.6)</td>
<td>0.9 (0.8–1.1)</td>
<td>0.8 (0.7–0.9)</td>
<td>0.6 (0.5–0.7)</td>
<td>3.9 (3.5–4.4)</td>
</tr>
</tbody>
</table>

DESCRIPTION.
Prosome 1.2 (1.1 – 1.4) long, 0.9 (0.8 – 1.1) wide. Total length 2.5 (2.2 – 2.9). Eyes: Typical prodromid arrangement, with the posterior row very procured 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 front, from behind. AME separated by roughly their radius, nearly touching PME. PME separated by nearly 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 or light, ALE oval, whitish, AME rounded, dark.

EOLOGY: The species was found only in the most disturbed area of Deserta Grande, 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, in arid habitats.

BEHAVIOR: In the field, Z. lepida moved very fast in short periods, interspersed 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 14).

Family Salticidae Blackwall, 1841 (2 species)

Chalcocoritus subelectus (Blackwall, 1867)

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♀, 10.IV.2012, trail leading from Rocha do Barbusano to Risco. All specimens were collected by hand.

DISTRIBUTION: the archipelago of 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♀, 2.2.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)

DISTRIBUTION: Cosmopolitan.

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

Family Theridiidae Sundevall, 1833 (4 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 hammoniae Denis, 1944
MATERIAL: Madeira – 1♀, 2.V.2011, hand collecting, Ponta de São Lourenço.
Until recently, only 11 spider species were known from Desertas (Cardoso & Crespo, 2008). This number increases to 57 with the current work. Although many of the novel species are widely distributed, often preferring disturbed habitats, we also add 11 new species for science, 10 of which endemic to Desertas and Madeira. Five Macaronesian endemics were also detected, previously unknown from Desertas. This is a big step towards resolving the Linnean and Wallacean shortfalls (see Cardoso et al., 2011) still prevalent in this region (Figure 15), which was undoubtedly one of the less sampled in the whole Macaronesian region (Figure 5). In addition to the faunistic contribution to Desertas, the list of species known from Madeira Island is increased by 3.

The strange appearance of an unknown species of Ochyroceratidae is reported, if we consider the tropical distribution of the family. Other species were collected with wide and tropical distributions, such as Opheodura concolor and Gamasomorpha insularis. It would be easy to think of the ochyroceratid as a recent introduction to Deserta Grande but besides the samples collected at Doca, the most disturbed site in the island, the authors have also found it in the South Plateau, a site subject to a very small degree of disturbance, with reduced probability of introduction of exotic species.

Many of the new species belong to genera which speciated in the Macaronesian or Madeiran archipelago and thus demand generic revisions at least at regional level, in the cases where only limited information is available (Hainia spp, Dysdera spp., Orchestina sp.). Interestingly, nearly all cases of new species were found in the high altitude areas of Deserta Grande, while common widespread and mostly exotic species were 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 at least for now this seems to be an obstacle to most species. We stress that in this area we found D. crocata, known as an invasive species throughout the Macaronesian archipelagos, this being a recent introduction thought to have occurred after the storms of February 2010 brought large quantities of driftwood to Deserta Grande from Madeira Island. We now fear that D. crocata, being a cosmopolitan and aggressive species, can eventually reach the top of the island and outcompete its endemic congenerics and lead to their 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 driven endemic species to extinction in recent decades (Cardoso et al., 2010).

**Family Thomisidae Sundevall, 1833 (2 species)**

*Theridula accleni* (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.

*Xysticus nubilus* Simon, 1875


**DISTRIBUTION:** Mediterranean, Macaronesia.

**REMARKS:** First record for Desertas.

**Discussion**

The data obtained by standardized sampling revealed 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 2.5 years had gone by after a large wildfire that spread over most of the valley and a few months after chemical treatments were made to fight *Phalaris aquatica* in the sampled plot. Total abundance of spiders 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 Madeira, 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.

**Fig. 15.** Cumulative citations of spider species for the Desertas.
The number of supposed SIEs of the Deserta Grande now reaches 21% of the known spider community, surpassing the values for Porto Santo (5%) and the Selvagens (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 inappropriate 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 more than 60 species occur in Deserta Grande. Juveniles belonging to additional genera (such as Argiope) were collected and could lead to higher species numbers in the future, even if all these are thought to be exotics.

Many of the undescribed new species have highly restricted 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), was never assessed for extinction risk according to the IUCN criteria (IUCN, 2001) neither is it protected by regional, national or international law (e.g. Habitats Directive, Council of the European Communities, 1992). Its habitat is currently degraded by invasive species, namely Phalaris aquatica, and suffered recent interventions by the Madeira Natural Park. The authors address this issue in another publication. In addition, feral goats (Capra hircus) have long been established in the Desertas, like other invasive species, and the efforts to eradicate proved to be unsuccessful. They currently proliferate and have irreversibly altered the local flora. We can only guess if this change 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 dependent on the native flora. Restoration of native habitats in Desertas is biased towards the protection of some taxa, like birds (such as Pterodroma desert) or mammals (Monachus monachus), and conservation projects on such iconic fauna usually disregard other fauna. Future projects should be made to monitor the spiders and other terrestrial invertebrates of the Desertas, in view of the possibility of additional new species being found and the high extinction risk for many of the already known (but still undescribed) species.

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Bibliography


