SLAM Project - Long Term Ecological Study of the Impacts of Climate Change in the Natural Forest of Azores: II - A survey of exotic arthropods in disturbed forest habitats

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Abstract

Background

The data we present consist of an inventory of exotic arthropods, potentially invasive, collected in exotic and mixed forests and disturbed native forest patches of the Azores Archipelago. The study was carried out between 2019 and 2020 in four islands: Corvo, Flores, Terceira and Santa Maria, where a total of 45 passive flight interception SLAM traps were deployed, during three to six consecutive months. This manuscript is the second contribution of the “SLAM Project - Long Term Ecological Study of the Impacts of Climate Change in the Natural Forest of Azores”.

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New information

We provide an inventory of terrestrial arthropods belonging to Arachnida, Diplopoda, Chilopoda and Insecta classes from four Azorean islands. We identified a total of 21,175 specimens, belonging to 20 orders, 93 families and 249 species of arthropods. A total of 125 species are considered introduced, 89 native non-endemic and 35 endemic. We registered 34 new records (nine for Corvo, three for Flores, six for Terceira and 16 for Santa Maria), of which five are new for Azores, being all exotic possibly recently introduced: *Dieckmanniellus nitidulus* (Gyllenhal, 1838), *Gronops fasciatus* Küster, 1851, *Hadroplontus trimaculatus* (Fabricius, 1775), *Hypurus bertrandi* (Perris, 1852) (all Coleoptera, Curculionidae) and *Cardiocondyla mauritanica* Forel, 1890 (Hymenoptera, Formicidae). This publication highlights the importance of planted forests and disturbed native forest patches as reservoirs of potentially invasive arthropods and refuges for some rare relict endemic arthropod species.

Keywords

Arthropoda, Azores, endemic species, exotic species, exotic forest, inventory, Macaronesia, long-term sampling, SLAM traps

Introduction

Arthropod communities, particularly insects, are being affected by unprecedented and rapid population declines (Hallmann et al. 2017, Sánchez-Bayo and Wyckhuys 2019, Cardoso et al. 2020, Harvey et al. 2020Cowie et al. 2022). The most important causes for this biodiversity loss are habitat loss, degradation and fragmentation, climate change and the introduction and spread of invasive species (Russell et al. 2017, Borges et al. 2019a). In this context, the biodiversity of oceanic islands has been especially and dramatically affected by these drivers as consequence of human colonisation, global trade and tourism (Triantis et al. 2010, Borges et al. 2019b, Cowie et al. 2022, Stüben 2022).

In the case of Azores islands, since Portuguese settlement in the 15th century, the original landscape was strongly altered by replacing pristine and native forest areas with exotic tree plantations, crops, pastures and urban areas (Triantis et al. 2010, Borges et al. 2019b, Norder et al. 2020). Currently, the remaining native forest covers only about 5% of the total surface of the Archipelago, being restricted to the higher elevation and inaccessible areas of the islands (Gasparr et al. 2008, Triantis et al. 2010, Stüben and Borges 2019, Norder et al. 2020).

Native forest destruction (Triantis et al. 2010) and the consequent lack of connectivity between forest patches (Aparício et al. 2018), climate change (Ferreira et al. 2016) and invasive species are the main factors that contribute to arthropod decline in Azores (Stüben 2003, Stüben 2004, Borges et al. 2019b). Previous studies demonstrated that endemic species of Azorean arthropods are restricted mainly to native vegetation dominated
habitats, while introduced species usually occupy human-altered habitats (Cardoso et al. 2009, Florencio et al. 2015, Florencio et al. 2016). Additionally, the proportion of introduced arthropod species in Azores is higher than native (around 60%) and, due to the higher adaptability to environmental conditions of many introduced species, they represent one of the main threats to indigenous biota in the native forest areas (Borges et al. 2019b). Moreover, Tsafack et al. (2021) showed the importance of isolated and small native forest patches, as well as exotic and mixed forests close to native areas, which can function as refuges for native and rare endemic species, playing a relevant role for conservation of native biota outside Azorean protected areas.

This publication is the second data paper of the project “SLAM Project - Long Term Ecological Study of the Impacts of Climate Change in the Natural Forest of Azores” (see first in Costa and Borges 2021) that aims to monitor the distribution and abundance of arthropods in native forests from Azores using SLAM traps (Sea, Land and Air Malaise traps). Additional publications, using data coming from this project, tested specific ecological questions, namely patterns of seasonal variation on species abundance (Borges et al. 2017), patterns of temporal beta diversity in native and exotic species (Matthews et al. 2018), the potential decline of endemic insects (Borges et al. 2020), patterns of arthropod diversity in Azorean urban gardens (Arteaga et al. 2020), patterns of species richness and beta diversity in a small elevational gradient (de Vries et al. 2021) and the investigation of the role of small lowland patches of exotic forests as refuges for rare endemic Azorean arthropods (Tsafack et al. 2021).

In this second data paper, we aim to: i) survey arthropods in exotic and mixed forests and small disturbed remnants of native forests; ii) investigate the occurrence and current distribution of exotic (potentially invasive) arthropods in those habitats; and also iii) investigate the occurrence of rare endemic arthropods in those habitats.

**General description**

**Purpose:** This publication provides an inventory of arthropods present in exotic and mixed forests of four Azores Islands (Corvo, Flores, Terceira and Santa Maria), as well as from small remnants of disturbed native forests in three Islands (Flores, Terceira and Santa Maria).

**Additional information:** The data we present are part of the long-term project SLAM (Long Term Ecological Study of the Impacts of Climate Change in the Natural Forest of Azores) that started in 2012 aiming to understand the impact of biodiversity erosion drivers on Azorean native forests (Azores, Macaronesia, Portugal). Passive flight interception SLAM traps (Sea, Land and Air Malaise traps) are being used to sample native forest plots in several Azorean islands (Costa and Borges 2021).
Project description

Title: SLAM Project II - A survey of exotic and endemic arthropods in Azorean disturbed Azorean forest habitats

Personnel: The project was conceived and led by Paulo A.V. Borges.

Fieldwork: Corvo Island - Alejandra Ros-Prieto, Maria Teresa Ferreira, Mário Boieiro, Paulo A. V. Borges, Rosalina Gabriel; Flores Island - Alejandra Ros-Prieto, Maria Teresa Ferreira, Mário Boieiro, Paulo A. V. Borges, Rosalina Gabriel; Terceira Island - Alejandra Ros-Prieto, Paulo A. V. Borges, Rosalina Gabriel; Santa Maria Island - Alejandra Ros-Prieto, Nelson Moura, Paulo A. V. Borges, Rosalina Gabriel.

Parataxonomists: Alejandra Ros-Prieto, Jonne Bonnet and Sébastien Lhoumeau.

Taxonomists: Paulo A. V. Borges, Mário Boieiro and Peter E. Stüben.

Voucher specimen management was mainly undertaken by Alejandra Ros-Prieto and Paulo A. V. Borges.

Study area description: The study area comprises Corvo, Flores, Terceira and Santa Maria Islands, in the Azores Archipelago, located in the North Atlantic, roughly at 38°43'21"N 27°13'14"W and 38°27'30"N 28°19'22"W (Fig. 1). The climate is temperate oceanic, with regular and abundant rainfall, high levels of relative humidity and persistent winds, mainly during the winter and autumn seasons. The exotic forests are located at lower and mid-elevations and are dominated mainly by Pittosporum undulatum Vent., Eucalyptus spp., Cryptomeria japonica D.Don, Acacia melanoxylon R.Br. and Pinus pinaster Aiton. The studied native forests are located at several elevations and are mainly dominated by Erica azorica Hochst. ex Seub., Laurus azorica (Seub.) Franco, Ilex azorica Gand. and Juniperus brevifolia (Hochst. ex Seub.). Mixed forests included both exotic and native tree species.

Design description: Passive flight interception SLAM traps (Sea, Land and Air Malaise traps) (Fig. 2) were used to sample 45 sites in the four study Islands (Corvo (n = 1), Flores (n = 5), Santa Maria (n =16) and Terceira (n = 23)) with one trap being set up at each plot. Although this protocol was originally developed to sample flying arthropods, by working as an extension of the tree, non-flying species can also crawl into the trap (Borges et al. 2017), enhancing the range of groups that can be sampled by this technique. Recent studies have used this sampling technique to study diversity and abundance variations in the communities of arthropod on Azorean native areas (Borges et al. 2017, Matthews et al. 2018, Borges et al. 2020, de Vries et al. 2021, Tsafack et al. 2021). The samples were collected every three or six months depending on sites. The collected specimens were sorted to morphospecies and posteriorly identified at species level by an expert taxonomist in laboratory.

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Figure 1. The Azores Archipelago location (Credit: Enésima Pereira, Azorean Biodiversity Group).

Figure 2. Passive flight interception SLAM trap (Sea, Land and Air Malaise traps) (Credit: Paulo A. V. Borges).
DIRECÇÃO REGIONAL DO AMBIENTE - PRIBES (LIFE17 IPE/PT/000010) (2019-2020).

DIRECÇÃO REGIONAL DO AMBIENTE – LIFE-BETTLES (LIFE18 NAT_PT_000864) (2020-2024).

AZORESBIOPORTAL – PORBIOTA (ACORES-01-0145-FEDER-000072) (2019-2022).

The database management and Open Access was funded by the project “MACRISK-Trait-based prediction of extinction risk and invasiveness for Northern Macaronesian arthropods” Fundação para a Ciência e Tecnologia FCT - PTDC/BIA-CBI/0625/2021 (2022-2024).

**Sampling methods**

**Study extent:** The study was conducted in four Islands of the Azores Archipelago, Corvo, Flores, Terceira and Santa Maria. The sampled habitats included exotic, mixed and disturbed native forest patches (Table 1).

| Island  | Habitat                          | Location ID  | Locality                  | Latitude  | Longitude  | Elevation |
|---------|---------------------------------|--------------|----------------------------|-----------|------------|-----------|
| Corvo   | Mixed Forest - *Picconia*, *Pittosporum* | COR-CORO-Z-16 | Coroa do Pico             | 39.68854  | -31.09191  | 248       |
| Flores  | *Exotic Forest - Cryptomeria*   | FLO-LAFLOR-T29 | Lajes- Estação Florestal   | 39.39416  | -31.20682  | 315       |
| Flores  | *Exotic Forest - Cryptomeria*   | FLO-MAPS-TT25 | Criptomérias ao lado do T16 | 39.48697  | -31.18462  | 607       |
| Flores  | Native Forest                   | FLO-NFFR-T-07 | Encosta Caldeira Funda    | 39.40324  | -31.2175   | 381       |
| Flores  | Native Forest                   | FLO-NFMA-T-08 | Morro Alto Este           | 39.46003  | -31.20941  | 769       |
| Flores  | Mixed Forest                    | FLO-PDEL-Z-11 | Ponta Delgada Km18_Mata das Acácias | 39.50744  | -31.2017   | 106       |
| Santa Maria | Native Forest - *Erica, Picconia* | SMR_PRIBS_T01 | Ponta do Pinheiro         | 37.00336  | -25.12854  | 192       |
| Santa Maria | Mixed Forest - *Erica, Picconia, Hedychium* | SMR_PRIBS_T02 | Miradouro Pedra Rija     | 36.97597  | -25.07578  | 355       |
| Santa Maria | Mixed Forest - *Picconia, Pittosporum, Pinus* | SMR_PRIBS_T03 | Piedade                   | 36.93424  | -25.0668   | 184       |
| Santa Maria | Mixed Forest - *Laurus, Picconia, Ilex* | SMR_PRIBS_T04 | Setada                    | 36.95356  | -25.07398  | 374       |
| Island   | Habitat                        | Location ID | Locality          | Latitude  | Longitude | Elevation |
|----------|--------------------------------|-------------|-------------------|-----------|-----------|-----------|
| Santa Maria | Native Forest - *Laurus, Erica, ilex* | SMR_PRIBS_T05 | Casas Velhas    | 36.95375 | -25.07494 | 377       |
| Santa Maria | Mixed Forest - *Picconia, Pittosporum, Erica, Hedychium, Vaccinium* | SMR_PRIBS_T06 | Fontinhas Florestal | 36.96325 | -25.07505 | 406       |
| Santa Maria | Mixed Forest - *Picconia, Pittosporum* | SMR_PRIBS_T07 | Miradouro Espigão | 36.98215 | -25.0488  | 191       |
| Santa Maria | Mixed Forest - *Erica, Picconia, Pittosporum* | SMR_PRIBS_T08 | Estação Loran    | 37.00931 | -25.05792 | 164       |
| Santa Maria | Mixed Forest - *Erica, Cryptomeria, Hedychium* | SMR_PRIBS_T10 | Piquinhos        | 36.97206 | -25.08278 | 420       |
| Santa Maria | Mixed Forest - *Picconia, Pittosporum* | SMR_PRIBS_T11 | Lapa             | 36.94849 | -25.02598 | 221       |
| Santa Maria | Mixed Forest - *Acacia, Picconia* | SMR_PRIBS_T12 | Monteiro         | 36.97013 | -25.10942 | 191       |
| Santa Maria | Exotic Forest - *Acacia* | SMR_PRIBS_T13 | Aeroporto        | 36.97048 | -25.1549  | 112       |
| Santa Maria | Exotic Forest - *Pittosporum* | SMR_PRIBS_T14 | Figueiral        | 36.94919 | -25.12562 | 142       |
| Santa Maria | Mixed Forest | SMR_PRIBS_T15 | Ribeira dos Lemos | 37.00141 | -25.14769 | 61        |
| Santa Maria | Native Forest - *Erica, Picconia* | SMR_PRIBS_T16 | Caldeira         | 36.99592 | -25.09864 | 304       |
| Santa Maria | Mixed Forest - *Picconia, Erica, Laurus, Vaccinium, Hedychium, Myrcide* | SMR-NFPA-T-01 | Pico Alto T01    | 36.97804 | -25.08756 | 460       |
| Terceira | Exotic Forest - *Pittosporum* | TER_PRIBS_T02 | Universidade     | 38.65868 | -27.23262 | 43        |
| Terceira | Exotic Forest - *Pittosporum* | TER_PRIBS_T04 | Mata Estado Veredas | 38.69814 | -27.2421  | 450       |
| Terceira | Exotic Forest - *Pittosporum* | TER_PRIBS_T07 | Pittosporum Carpintaria dos Biscoitos | 38.79017 | -27.24136 | 93        |
| Terceira | Exotic Forest - *Pittosporum* | TER_PRIBS_T08 | Caldeira Lajes   | 38.77705 | -27.11853 | 18        |
| Terceira | Native Forest - *Juniperus* | TER_PRIBS_T11 | Juniperal Trilho das Bestas | 38.7087 | -27.19133 | 521       |
| Terceira | Native Forest - *Erica* | TER_PRIBS_T12 | Erical Trilho das Bestas | 38.70957 | -27.18324 | 462       |
| Island          | Habitat                                      | Location ID | Locality               | Latitude  | Longitude | Elevation |
|----------------|----------------------------------------------|-------------|------------------------|-----------|-----------|-----------|
| Terceira       | Native Forest - *Juniperus*                  | TER_PRIBS_T13 | Terra-Brava Rocha Cedrorum | 38.74598 | -27.19762 | 652       |
|                | Exotic Forest - *Cryptomeria, Calluna*       | TER_PRIBS_T14 | Pico Alto Cryptomeria_Calluna | 38.75212 | -27.20132 | 584       |
|                | Exotic Forest - *Pittosporum, Eucalyptus*    | TER_PRIBS_T15 | Eucaliptal Agualva    | 38.77109 | -27.1934  | 344       |
|                | Exotic Forest - *Pittosporum*                | TER_PRIBS_T17 | Pittosporum_Eucalito Pizza-UT | 38.75087 | -27.07099 | 87        |
|                | Exotic Forest - *Pittosporum*                | TER_PRIBS_T19 | Pittosporum Maria Vieira | 38.65377 | -27.08076 | 102       |
|                | Exotic Forest - *Eucalyptus*                 | TER_PRIBS_T20 | Ermida Penha França    | 38.66603 | -27.23969 | 118       |
|                | Exotic Forest - *Eucalyptus, Acacia*        | TER_PRIBS_T22 | Eucalipto_Acacia_Canada Entre Picos | 38.6615 | -27.26605 | 78        |
|                | Exotic Forest - *Eucalyptus, Hedychium*     | TER_PRIBS_T23 | Eucalipto_Echinodium Escampador | 38.70309 | -27.27717 | 340       |
|                | Exotic Forest - *Pittosporum, Betula*       | TER_PRIBS_T24 | Betulas_Lagoa das Patas | 38.71833 | -27.28923 | 524       |
|                | Exotic Forest - *Eucalyptus*                 | TER_PRIBS_T27 | Eucaliptal_Gruta Chocolate | 38.77696 | -27.25107 | 298       |
|                | Exotic Forest - *Pittosporum, Eucalyptus*   | TER_PRIBS_T28 | Eucaliptal_Pico Rachado_Altaires | 38.76211 | -27.30704 | 522       |
|                | Mixed Forest - *Eucalyptus, Erica*          | TER-ACAR-T-25 | Eucaliptal Algar do Carvão (TER_PRIBS_T10) | 38.72638 | -27.22258 | 530       |
|                | Exotic Forest - *Pittosporum*               | TER-CABI-T166 | Caparica - Biscoitos  | 38.77094 | -27.26185 | 331       |
|                | Exotic Forest - *Acacia*                    | TER-FTER-T-36 | Fontinhas 1          | 38.73765 | -27.13681 | 245       |
|                | Native Forest - *Laurus, Erica*             | TER-MATE-T-13 | Matela 1              | 38.70063 | -27.26074 | 392       |
|                | Exotic Forest - *Cryptomeria*               | TER-MNEG-T-62 | Lagoa do Negro        | 38.73977 | -27.26341 | 571       |
|                | Exotic Forest - *Pittosporum*               | TER-POSA-T172 | Posto Santo           | 38.68365 | -27.24457 | 246       |

**Sampling description:** A total of 45 passive flight interception SLAM traps (Sea, Land and Air Malaise traps) were used to sample the plots in the four study Islands, with one trap being set up at each plot. Trap size is of approximately 110 x 110 x 110 cm. The trap functions on the basis of intercepting arthropods that crawl up the mesh and then fall inside
the sampling recipient, which is filled with propylene glycol (pure 1,2-propanediol) (Borges et al. 2017). A total of 19 SLAM traps were deployed in exotic forest areas, eight on native forest patches and 18 on mixed forests. The trap samples were collected every three months in Flores and Corvo and six months in Terceira and Santa Maria. In Corvo Island, one trap was available in a mixed forest (Fig. 3; Table 1). In Flores Island, five traps were available in both exotic forests and native forests (Fig. 4; Table 1). In Santa Maria Island, a total of 16 traps were available with only three located in disturbed native forest patches (Fig. 5; Table 1). Finally, in Terceira Island, 23 traps were available with only four in disturbed native forest patches (Fig. 6; Table 1).

Quality control: All sampled individuals were first sorted by trained paratoxonomists (see list above). All specimens were allocated to a taxonomic species by Paulo A. V. Borges. Despite the uncertainty of juvenile identification, juveniles are also included in the data presented in this paper, since the low diversity allowed a relatively precise identification of this life-stage in Azores.

Step description: At the laboratory, specimen sorting and arthropod identification followed standard procedures during the last 20 years or arthropod surveys in Azores. First, a combination of morphological and anatomical characters and reproductive structures was used for morphospecies creation. After, morphospecies were sent to experts for proper identification. With this procedure, a reference collection was made for all collected specimens by assigning them a morphospecies code number and respective taxonomic name and depositing them at the Dalberto Teixeira Pombo Insect Collection, University of
Azores. Colonisation status of the species was obtained from the last updated checklist of Azorean arthropods (Borges et al. 2010).

Figure 4. Map with the location of the sampling sites in Flores Island, Azores. Codes of sites as in Table 1 (Land-use data extracted from Cruz et al. 2007) (Credit: Enésima Pereira, Azorean Biodiversity Group).

Figure 5. Map with the location of the sampling sites in Santa Maria Island, Azores. Codes of sites as in Table 1 (Land-use data extracted from Cruz et al. 2007) (Credit: Enésima Pereira, Azorean Biodiversity Group).
**Geographic coverage**

**Description:** Corvo, Flores, Terceira and Santa Maria Islands, in the Azores Archipelago (Portugal).

**Coordinates:** 36.90597988519294 and 39.740986355883564 Latitude; -31.2945556640625 and -24.949951171875 Longitude.

**Taxonomic coverage**

**Description:** The following Classes and Orders are covered:

- Arachnida: Araneae; Opiliones; Pseudoscorpiones
- Chilopoda: Geophilomorpha; Lithobiomorpha; Scolopendromorpha; Scutigeromorpha
- Diplopoda: Julida; Polydesmida
- Insecta: Archaeognatha; Blattodea; Coleoptera; Dermaptera; Hemiptera; Hymenoptera; Isoptera; Neuroptera; Orthoptera; Phasmatodea; Psocoptera; Thysanoptera; Trichoptera.

Figure 6. [Map with the location of the sampling sites in Terceira Island, Azores. Codes of sites as in Table 1 (Land-use data extracted from Cruz et al. 2007) (Credit: Enésima Pereira, Azorean Biodiversity Group).](Image)
Taxa included:

| Rank | Scientific Name    | Common Name       |
|------|--------------------|-------------------|
| order| Araneae            | Spiders           |
| order| Opiliones          | Harvestmen        |
| order| Pseudoscorpiones   | Pseudoscorpions   |
| class| Chilopoda          | Centipedes        |
| class| Diplopoda          | Millipedes        |
| order| Archaeognatha      | Bristletails      |
| order| Blattodea          | Cockroaches       |
| order| Coleoptera         | Beetles           |
| order| Dermaptera         | Earwig            |
| order| Hemiptera          | Bugs              |
| order| Hymenoptera        | Ants              |
| order| Isoptera           | Termites          |
| order| Neuroptera         | Lacewings         |
| order| Orthoptera         | Grasshoppers, crickets |
| order| Phasmatodea        | Stick insects     |
| order| Psocodea           | Booklice          |
| order| Thysanoptera       | Thrips            |
| order| Trichoptera        | Caddisflies       |

Collection data

**Collection name:** Entomoteca Dalberto Teixeira Pombo (DTP); University of Azores

**Collection identifier:** DTP

**Specimen preservation method:** All specimens were preserved in 96% ethanol.

**Curatorial unit:** Curator: Paulo A. V. Borges

Usage licence

**Usage licence:** Creative Commons Public Domain Waiver (CC-Zero)
Data resources

Data package title: A survey of exotic arthropods in disturbed Azorean forest habitats using SLAM traps.

Resource link: http://ipt.gbif.pt/ipt/resource?r=pribes_exotic_arthropods

Alternative identifiers: https://www.gbif.org/dataset/020231d8-39b6-478f-ac24-715bf97c8ef4

Number of data sets: 2

Data set name: Event Table

Character set: UTF-8

Download URL: http://ipt.gbif.pt/ipt/resource?r=pribes_exotic_arthropods

Data format: Darwin Core Archive format

Data format version: version 1.5

Description: The dataset was published in Global Biodiversity Information Facility platform, GBIF (Borges et al. 2022). The following data table includes all the records for which a taxonomic identification of the species was possible. The dataset submitted to GBIF is structured as a sample event dataset that has been published as a Darwin Core Archive (DwCA), which is a standardised format for sharing biodiversity data as a set of one or more data tables. The core data file contains 45 records (eventID). This IPT (Integrated Publishing Toolkit) archives the data and thus serves as the data repository. The data and resource metadata are available for download in the Portuguese GBIF Portal IPT (Borges et al. 2022).

| Column label          | Column description                                                                 |
|-----------------------|-------------------------------------------------------------------------------------|
| id                    | Unique identification code for sampling event data.                                 |
| eventID               | Identifier of the events, unique for the dataset.                                   |
| samplingProtocol      | The sampling protocol used to capture the species.                                 |
| sampleSizeValue       | The numeric amount of time spent in each sampling.                                 |
| sampleSizeUnit        | The unit of the sample size value.                                                 |
| eventDate             | Date or date range the record was collected.                                        |
| year                  | Year of the event.                                                                 |
| minimumElevationInMetres | The lower limit of the range of elevation (altitude, usually above sea level), in metres. |
| verbatimEventDate     | The verbatim original representation of the date and time information for an Event. |
|                       | In this case, we use the season and year.                                           |
| habitat            | The habitat of the sample. |
|--------------------|---------------------------|
| locationID         | Identifier of the location. |
| islandGroup        | Name of archipelago.       |
| island             | Name of the island.        |
| country            | Country of the sampling site. |
| countryCode        | ISO code of the country of the sampling site. |
| stateProvince      | Name of the region of the sampling site. |
| municipality       | Municipality of the sampling site. |
| locality           | Name of the locality.      |
| decimalLatitude    | Approximate centre point decimal latitude of the field site in GPS coordinates. |
| decimalLongitude   | Approximate centre point decimal longitude of the field site in GPS coordinates. |
| geodeticDatum      | The ellipsoid, geodetic datum or spatial reference system (SRS) upon which the geographic coordinates given in decimalLatitude and decimalLongitude are based. |
| coordinateUncertaintyInMetres | Uncertainty of the coordinates of the centre of the sampling plot in metres. |
| coordinatePrecision | A decimal representation of the precision of the coordinates given in the decimalLatitude and decimalLongitude. |
| georeferenceSources | A list (concatenated and separated) of maps, gazetteers or other resources used to georeference the Location, described specifically enough to allow anyone in the future to use the same resources. |

**Data set name:** Occurrence Table  
**Character set:** UTF-8  
**Download URL:** [https://www.gbif.org/dataset/020231d8-39b6-478f-ac24-715bf97c8ef4](https://www.gbif.org/dataset/020231d8-39b6-478f-ac24-715bf97c8ef4)  
**Data format:** Darwin Core Archive format  
**Data format version:** version 1.5  
**Description:** The dataset was published in Global Biodiversity Information Facility platform, GBIF (Borges et al. 2022). The following data table includes all the records for which a taxonomic identification of the species was possible. The dataset submitted to GBIF is structured as an occurrence table that has been published as a Darwin Core Archive (DwCA), which is a standardised format for sharing biodiversity data as a set of one or more data tables. The core data file contains 2095 records (occurrenceID). This IPT (Integrated Publishing Toolkit) archives the data and thus serves as the data repository. The data and resource metadata are available for download in the Portuguese GBIF Portal IPT (Borges et al. 2022).
| Column label          | Column description                                                                                                                                 |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| id                   | Unique identification code for sampling event data.                                                                                                  |
| type                 | Type of the record, as defined by the Public Core standard.                                                                                           |
| licence              | Reference to the licence under which the record is published.                                                                                          |
| institutionID        | The identity of the institution publishing the data.                                                                                                  |
| institutionCode      | The code of the institution publishing the data.                                                                                                      |
| collectionID         | The identity of the collection publishing the data.                                                                                                   |
| collectionCode       | The code of the collection where the specimens are conserved.                                                                                          |
| basisOfRecord        | The nature of the data record.                                                                                                                        |
| occurrenceID         | Identifier of the record, coded as a global unique identifier.                                                                                         |
| recordedBy           | A list (concatenated and separated) of names of people, groups or organisations who performed the sampling in the field.                                |
| organismQuantity     | A number or enumeration value for the quantity of organisms.                                                                                           |
| organismQuantityType | The type of quantification system used for the quantity of organisms.                                                                                   |
| sex                  | The sex and quantity of the individuals captured.                                                                                                     |
| lifeStage            | The life stage of the organisms captured.                                                                                                              |
| establishmentMeans   | The process of establishment of the species in the location, using a controlled vocabulary: in the GBIF database, we used the Borges et al. (2010) original data: 'native', 'introduced', 'endemic'. |
| eventID              | Identifier of the events, unique for the dataset.                                                                                                     |
| identifiedBy         | A list (concatenated and separated) of names of people, groups or organisations who assigned the Taxon to the subject.                                  |
| dateIdentified       | The date on which the subject was determined as representing the Taxon.                                                                                |
| identificationRemarks| Information about morphospecies identification (code in Dalberto Teixeira Pombo Collection).                                                          |
| scientificName       | Complete scientific name including author and year.                                                                                                    |
| kingdom              | Kingdom name.                                                                                                                                       |
| phylum               | Phylum name.                                                                                                                                          |
| class                | Class name.                                                                                                                                           |
| order                | Order name.                                                                                                                                           |
| family               | Family name.                                                                                                                                           |
| genus                | Genus name.                                                                                                                                           |
| specificEpithet      | Specific epithet.                                                                                                                                     |
We collected a total of 27,958 specimens (Suppl. material 1; Borges et al. 2022) from which it was possible to identify to species level 76% of the specimens (21,175) (Table 2). These identified specimens belong to 20 orders, 93 families and 249 species of arthropods. A total of 125 species are considered introduced, 89 native non-endemic and 35 endemic (Table 2). Additionally, a total of 147 taxa were recorded at genus, family or order level (Suppl. material 1).

### Table 2.

List of arthropod species collected in four islands of Azores, between 2019 and 2020 using SLAM traps. The list includes individuals identified at species-level. Scientific name, colonization status (CS: intr – introduced; nat - native non-endemic; end - endemic) and abundance per island (COR - Corvo; FLO - Flores; TER - Terceira; SMR - Santa Maria). Bold scientific names constitute new records for the Azores and bold numbers new records for a given island.

| Class      | Order    | Family     | Scientific Name               | CS | COR | FLO | TER | SMR |
|------------|----------|------------|------------------------------|----|-----|-----|-----|-----|
| Arachnida  | Araneae  | Agelenidae | Tegenaria pagana C.L. Koch, 1840 | intr | 118 | 1   |     |     |
| Arachnida  | Araneae  | Agelenidae | Textrix caudata L. Koch, 1872 | intr | 3   |     |     |     |
| Arachnida  | Araneae  | Araneidae  | Agalenatea redii (Scopoli, 1763) | intr | 1   |     |     |     |
| Arachnida  | Araneae  | Araneidae  | Araneus angulatus Clerck, 1757 | intr | 1   |     |     |     |
| Arachnida  | Araneae  | Araneidae  | Gibbaranea occidentalis Wunderlich, 1989 | end | 5   | 85  | 3   |     |
| Arachnida  | Araneae  | Araneidae  | Mangora acalypha (Walckenaer, 1802) | intr | 1   |     |     |     |
| Arachnida  | Araneae  | Araneidae  | Zygiella x-notata (Clerck, 1757) | intr | 4   |     |     |     |
| Arachnida  | Araneae  | Cheiracanthiidae | Cheiracanthium erraticum (Walckenaer, 1802) | intr | 2   | 2   |     |     |
| Arachnida  | Araneae  | Cheiracanthiidae | Cheiracanthium floresense Wunderlich, 2008 | end | 5   |     |     |     |
| Class    | Order     | Family             | Scientific Name                                              | CS | COR | FLO | TER | SMR |
|----------|-----------|--------------------|--------------------------------------------------------------|----|-----|-----|-----|-----|
| Arachnida| Araneae   | Cheiracanthiidae   | *Cheiracanthium mildei* L. Koch, 1864                        |    |     |     |     |     |
| Arachnida| Araneae   | Clubionidae        | *Clubiona terrestris* Westring, 1851                         |    |     |     |     |     |
| Arachnida| Araneae   | Clubionidae        | *Porroclubiona decora* (Blackwall, 1859)                     |    |     |     |     |     |
| Arachnida| Araneae   | Clubionidae        | *Porroclubiona genevensis* (L. Koch, 1866)                   |    |     |     |     |     |
| Arachnida| Araneae   | Dictynidae         | *Emblyna acoreensis* Wunderlich, 1992                        |    |     |     |     |     |
| Arachnida| Araneae   | Dictynidae         | *Lathys dentichelis* (Simon, 1883)                          |    | 2   | 16  | 7   |     |
| Arachnida| Araneae   | Dictynidae         | *Nigma puella* (Simon, 1870)                                 |    |     |     |     |     |
| Arachnida| Araneae   | Dysderidae         | *Dysdera crocata* C.L. Koch, 1838                           |    | 5   | 70  | 49  |     |
| Arachnida| Araneae   | Gnaphosidae        | *Marinarozelotes lyonneti* (Audouin, 1826)                   |    |     |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Acortgone acoreensis* (Wunderlich, 1992)                    |    | 1   | 35  | 1   |     |
| Arachnida| Araneae   | Linyphiidae        | *Agyneta fuscipalpa* (C. L. Koch, 1836)                     |    |     |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Canariphantes acoreensis* (Wunderlich, 1992)                |    | 1   |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Canariphantes relictus* Crespo & Bosmans, 2014              |    |     |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Erigone autumnalis* Emerton, 1882                           |    | 12  | 3   |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Erigone dentipalpis* (Wider, 1834)                         |    | 2   | 1   |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Lessertia dentichelis* (Simon, 1884)                       |    |     |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Microlinyphia johnsoni* (Blackwall, 1859)                  |    |     |     |     |     |
| Arachnida| Araneae   | Linyphiidae        | *Minicia floresensis* Wunderlich, 1992                      |    |     |     |     |     |
| Class   | Order     | Family     | Scientific Name                        | CS | COR | FLO | TER | SMR |
|---------|-----------|------------|---------------------------------------|----|-----|-----|-----|-----|
| Arachnida | Araneae   | Linyphiidae | *Neriene clathrata* (Sundevall, 1830) | intr | 2   |     | 1   |     |
| Arachnida | Araneae   | Linyphiidae | *Oedothorax fuscus* (Blackwall, 1834) | intr |     | 8   |     |     |
| Arachnida | Araneae   | Linyphiidae | *Palliduphantes schmitzi* (Kulczynski, 1899) | nat |     | 2   |     |     |
| Arachnida | Araneae   | Linyphiidae | *Pelecopsis parallela* (Wider, 1834) | intr |     | 2   |     |     |
| Arachnida | Araneae   | Linyphiidae | *Prinerigone vagans* (Audouin, 1826) | intr |     | 1   |     |     |
| Arachnida | Araneae   | Linyphiidae | *Savigniorrhips acoreensis* Wunderlich, 1992 | end | 30  | 197 | 7   |     |
| Arachnida | Araneae   | Linyphiidae | *Tenuiphantes miguelensis* (Wunderlich, 1992) | nat |     | 3   | 16  |     |
| Arachnida | Araneae   | Linyphiidae | *Tenuiphantes tenuis* (Blackwall, 1852) | intr | 6   | 17  | 346 | 21  |
| Arachnida | Araneae   | Mimetidae  | *Ero furcata* (Villers, 1789) | intr |     | 10  |     |     |
| Arachnida | Araneae   | Oecobiidae | *Oecobius navus* Blackwall, 1859 | intr |     | 13  |     |     |
| Arachnida | Araneae   | Pisauridae | *Pisaura acoreensis* Wunderlich, 1992 | end |     | 57  |     |     |
| Arachnida | Araneae   | Salticidae | *Macaroeris cata* (Blackwall, 1867) | nat |     | 56  |     |     |
| Arachnida | Araneae   | Salticidae | *Macaroeris diligens* (Blackwall, 1867) | nat | 6   | 17  | 3   |     |
| Arachnida | Araneae   | Salticidae | *Neon acoreensis* Wunderlich, 2008 | end |     |     | 1   |     |
| Arachnida | Araneae   | Salticidae | *Phidippus audax* (Hentz, 1845) | intr |     | 3   |     |     |
| Arachnida | Araneae   | Salticidae | *Pseudeuophrys vafra* (Blackwall, 1867) | intr |     | 1   |     |     |
| Arachnida | Araneae   | Salticidae | *Salticus mutabilis* Lucas, 1846 | intr |     | 3   |     |     |
| Arachnida | Araneae   | Segestiidae | *Segestriella florentina* (Rossi, 1790) | intr |     | 10  | 1   |     |
| Class         | Order    | Family       | Scientific Name                      | CS | COR | FLO | TER | SMR |
|---------------|----------|--------------|--------------------------------------|----|-----|-----|-----|-----|
| Arachnida     | Araneae  | Tetragnathida| *Metellina merianae* (Scopoli, 1763) |    |     |     |     |     |
| Arachnida     | Araneae  | Tetragnathida| *Sancus acoreensis* (Wunderlich, 1992) | end| 1   | 10  |     |     |
| Arachnida     | Araneae  | Theridiidae  | *Cryptachaea blattae* (Urquhart, 1886) | intr| 31  |     |     |     |
| Arachnida     | Araneae  | Theridiidae  | *Lasaeola oceanica* Simon, 1883       | end| 2   | 1   |     |     |
| Arachnida     | Araneae  | Theridiidae  | *Rugathodes acoreensis* Wunderlich, 1992 | end| 7   | 81  | 7   |     |
| Arachnida     | Araneae  | Theridiidae  | *Steatoda grossa* (C. L. Koch, 1838) | intr| 1   | 1   |     |     |
| Arachnida     | Araneae  | Theridiidae  | *Steatoda nobilis* (Thorell, 1875)   | intr| 10  | 10  |     |     |
| Arachnida     | Araneae  | Theridiidae  | *Theridion musivivum* Schmidt, 1956  | nat| 9   | 3   |     |     |
| Arachnida     | Araneae  | Thomisidae   | *Xysticus cor* Canestrini, 1873       | nat| 1   |     |     |     |
| Arachnida     | Opiliones| Leiobunidae  | *Leiobunum blackwalli* Meade, 1861   |     |     | 13  | 857 | 3   |
| Arachnida     | Opiliones| Sclerosomatida| *Homalenotus coriaceus* (Simon, 1879) | nat| 1   | 24  |     |     |
| Arachnida     | Pseudoscorpiones | Chthoniidae | *Chthonius ischnocheles* (Hermann, 1804) |     |     | 7   |     |     |
| Arachnida     | Pseudoscorpiones | Chthoniidae | *Ephippiochthonius tetrachelatus* (Preyssler, 1790) | intr| 11  | 37  | 29  |     |
| Arachnida     | Pseudoscorpiones | Neobisiidae | *Neobisium maroccanum* Beier, 1930   | intr| 1   | 13  |     |     |
| Chilopoda     | Geophilomorpha | Linotaeniidae | *Strigamia crassipes* (C.L. Koch, 1835) |     |     | 3   |     |     |
| Chilopoda     | Lithobiomorpha | Lithobiidae | *Lithobius plicicornis plicicornis* Newport, 1844 | nat| 1   | 37  |     |     |
| Chilopoda     | Scolopendromorpha | Cryptopidae | *Cryptops hortensis* (Donovan, 1810) | nat|     | 1   |     |     |
| Class      | Order           | Family         | Scientific Name                                               | CS | COR | FLO | TER | SMR |
|------------|-----------------|----------------|---------------------------------------------------------------|----|-----|-----|-----|-----|
| Chilopoda  | Scutigeromorpha | Scutigeridae   | *Scutigera coleoptrata* (Linnaeus, 1758)                      | intr | 1   | 4   | 27  | 148 |
| Diplopoda  | Julida          | Blaniulidae    | *Blaniulus guttulatus* (Fabricius, 1798)                     | intr | 1   | 1   | 1   |     |
| Diplopoda  | Julida          | Blaniulidae    | *Nopoiulus kochii* (Gervais, 1847)                           | intr | 4   |     |     |     |
| Diplopoda  | Julida          | Julidae        | *Ommatoiulus moreleti* (Lucas, 1860)                         | intr | 38  | 166 | 23  |     |
| Diplopoda  | Polydesmida     | Paradoxosomatidae | *Oxidus gracilis* (C.L. Koch, 1847)            | intr | 1   | 1   |     |     |
| Diplopoda  | Polydesmida     | Polydesmidae   | *Polydesmus coriaceus* Porat, 1870                         | intr | 5   | 1   |     |     |
| Insecta    | Archaeognatha   | Machilidae     | *Dilta saxicola* (Womersley, 1930)                          | nat | 8   | 582 | 16  |     |
| Insecta    | Archaeognatha   | Machilidae     | *Trigoniophthalmus borgesi* Mendes, Gaju, Bach & Molero, 2000 | end |     |     | 15  |     |
| Insecta    | Blattodea       | Blattellidae   | *Loboptera decipiens* (Germar, 1817)                        | nat | 1   |     |     |     |
| Insecta    | Blattodea       | Corydiidae     | *Zetha simonyi* (Krauss, 1892)                              | nat | 8   | 127 | 79  |     |
| Insecta    | Coleoptera      | Anthicidae     | *Hirticollis quadriguttatus* (Rossi, 1792)                  | nat | 18  |     |     |     |
| Insecta    | Coleoptera      | Apionidae      | *Aspidapion radiolus* (Marsham, 1802)                       | nat | 6   | 25  |     |     |
| Insecta    | Coleoptera      | Apionidae      | *Kalcapion semivittatum semivittatum* (Gyllenhal, 1833)     | nat | 27  | 1   |     |     |
| Insecta    | Coleoptera      | Brentidae      | *Dieckmanniellus nitidulus* (Gyllenhal, 1838)               | intr | 5   |     |     |     |
| Insecta    | Coleoptera      | Carabidae      | *Anisodactylus binotatus* (Fabricius, 1787)                 | intr | 1   |     |     |     |
| Insecta    | Coleoptera      | Carabidae      | *Dromius meridionalis* Dejean, 1825                         | intr | 11  | 2   |     |     |
| Insecta    | Coleoptera      | Carabidae      | *Notiophilus quadripunctatus* Dejean, 1826                  | nat | 1   |     |     |     |
| Class    | Order      | Family    | Scientific Name                                      | CS | COR | FLO | TER | SMR |
|----------|------------|-----------|-----------------------------------------------------|----|-----|-----|-----|-----|
| Insecta  | Coleoptera | Carabidae | *Olisthopus inclavatus* Israelson, 1983             |    |     |     |     | 1   |
| Insecta  | Coleoptera | Carabidae | *Stenolophus teutonus* (Schrank, 1781)              |    |     |     |     | 2   |
| Insecta  | Coleoptera | Cerambycidae | *Monochamus galloprovincialis* (Olivier, 1795) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Chrysomelidae | *Chaetocnema hortensis* (Fourcroy, 1785) |    |     |     |     | 4   |
| Insecta  | Coleoptera | Chrysomelidae | *Chrysolina bankii* (Fabricius, 1775) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Chrysomelidae | *Epitrix cucumeris* (Harris, 1851) |    |     |     |     | 7   |
| Insecta  | Coleoptera | Chrysomelidae | *Epitrix hirtipennis* (Melsheimer, 1847) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Chrysomelidae | *Longitarsus kutscherae* (Rye, 1872) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Chrysomelidae | *Psylliodes chrysocephalus* (Linnaeus, 1758) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Chrysomelidae | *Psylliodes marcida* (Illiger, 1807) |    |     |     |     | 3   |
| Insecta  | Coleoptera | Coccinellidae | *Clitostethus arcuatus* (Rossi, 1794) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Coccinellidae | *Novius cardinalis* (Mulsant, 1850) |    |     |     |     | 9   |
| Insecta  | Coleoptera | Coccinellidae | *Rhyzobius litura* (Fabricius, 1787) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Coccinellidae | *Rhyzobius lophantheae* (Blaisdell, 1892) |    |     |     |     | 1   |
| Insecta  | Coleoptera | Coccinellidae | *Scymnus interruptus* (Goeze, 1777) |    |     |     |     | 5   |
| Insecta  | Coleoptera | Coccinellidae | *Stethorus pusillus* (Herbst, 1797) |    |     |     |     | 12  |
| Insecta  | Coleoptera | Corylophidae | *Sericoderus lateralis* (Gyllenhal, 1827) |    |     |     |     | 89  |

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| Class   | Order     | Family       | Scientific Name                                    | CS | COR | FLO | TER | SMR |
|---------|-----------|--------------|---------------------------------------------------|----|-----|-----|-----|-----|
| Insecta | Coleoptera| Cryptophagidae| Cryptophagus cellaris (Scopoli, 1763)             | intr | 1   | 3   |     |     |
| Insecta | Coleoptera| Curculionidae| Brachypera multifida (Israelson, 1984)           | end  | 7   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Brachytemnus porcatus (Germar, 1823)            | intr | 2   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Calacalles subcarinatus (Israelson, 1984)        | end  | 19  | 86  | 19  |     |
| Insecta | Coleoptera| Curculionidae| Cathormiocerus curvipes (Wollaston, 1854)        | nat  | 4   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Charagmus gressorius (Fabricius, 1792)           | intr | 1   | 7   |     |     |
| Insecta | Coleoptera| Curculionidae| Coccotrypes carpophagus (Hornung, 1842)         | intr | 7   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Dichromacalles dromedarius (Boheman, 1844)      | intr | 1   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Gonipterus platensis (Marelli, 1926)            | intr | 47  |     |     |     |
| Insecta | Coleoptera| Curculionidae| Gronops fasciatus (Küster, 1851)                 | intr | 4   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Hadroplontus trimaculatus (Fabricius, 1775)     | intr | 1   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Hypurus bertrandii (Perris, 1852)               | intr | 1   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Mecinus pascuorum (Gyllenhal, 1813)            | intr | 17  | 4   |     |     |
| Insecta | Coleoptera| Curculionidae| Mogulones geographicus (Goeze, 1777)            | intr | 2   |     |     |     |
| Insecta | Coleoptera| Curculionidae| Naupactus cervinus (Boheman, 1840)             | intr | 49  | 23  |     |     |
| Insecta | Coleoptera| Curculionidae| Otiorhynchus cribicollis (Gyllenhal, 1834)    | intr | 19  | 4   |     |     |
| Insecta | Coleoptera| Curculionidae| Otiorhynchus rugosostriatus (Goeze, 1777)       | intr | 1   |     |     |     |
| Class   | Order   | Family       | Scientific Name                                                                 | CS | COR | FLO | TER | SMR |
|---------|---------|--------------|---------------------------------------------------------------------------------|----|-----|-----|-----|-----|
| Insecta | Coleoptera | Curculionidae | *Pseudophloeophagus tenax borgesi* Stüben, 2022                                |    | 1   | 4   | 260 | 12  |
| Insecta | Coleoptera | Curculionidae | *Rhopalomesites tardyi* (Curtis, 1825)                                         |    | 2   | 4   |     |     |
| Insecta | Coleoptera | Curculionidae | *Sitona discoideus* Gyllenhal, 1834                                            |    |     |     | 9   |     |
| Insecta | Coleoptera | Curculionidae | *Sitona lineatus* (Linnaeus, 1758)                                             |    |     |     | 1   |     |
| Insecta | Coleoptera | Curculionidae | *Xyleborinus alni* Nijima, 1909                                                 |    |     |     | 2   |     |
| Insecta | Coleoptera | Dryopidae    | *Dryops aligerus* (Lucas, 1846)                                                |    | 2   |     | 1   |     |
| Insecta | Coleoptera | Dryopidae    | *Dryops luridus* (Erichson, 1847)                                              |    |     |     | 18  |     |
| Insecta | Coleoptera | Elateridae   | *Aeolus melliculus moreletii* Tarnier, 1860                                     |    |     |     | 1   |     |
| Insecta | Coleoptera | Elateridae   | *Athous azoricus* Platia & Gudenzi, 2002                                        |    |     |     | 21  |     |
| Insecta | Coleoptera | Elateridae   | *Heteroderes azoricus* (Tarnier, 1860)                                         |    | 11  |     | 30  | 47  |
| Insecta | Coleoptera | Elateridae   | *Heteroderes vagus* Candèze, 1893                                             |    |     |     | 2   |     |
| Insecta | Coleoptera | Elateridae   | *Melanotus dichrous* (Erichson, 1841)                                          |    |     |     | 1   |     |
| Insecta | Coleoptera | Histeridae   | *Carcinops pumilio* (Erichson, 1834)                                           |    |     |     | 1   |     |
| Insecta | Coleoptera | Hydrophilidae | *Cercyon haemorrhoidalis* (Fabricius, 1775)                                   |    |     |     | 5   |     |
| Insecta | Coleoptera | Latridiidae  | *Cartodere bifasciata* (Reitter, 1877)                                        |    |     |     | 21  | 1   |
| Insecta | Coleoptera | Latridiidae  | *Cartodere nodifer* (Westwood, 1839)                                         |    |     |     | 16  | 1   |
| Insecta | Coleoptera | Latridiidae  | *Metaphthalmus occidentalis* Israelson, 1984                                  |    |     |     | 15  |     |
| Insecta | Coleoptera | Leiodidae    | *Catops coracinus* Kellner, 1846                                              |    |     |     | 80  | 33  |
| Class      | Order       | Family       | Scientific Name                                      | CS | COR | FLO | TER | SMR |
|------------|-------------|--------------|-----------------------------------------------------|----|-----|-----|-----|-----|
| Insecta    | Coleoptera  | Malachiidae  | *Attalus lusitanicus* Erichson, 1840                 | nat| 4   |     |     |     |
| Insecta    | Coleoptera  | Mycetophagidae | *Litargus baltatus* Le Conte, 1856                   | intr| 3   |     |     |     |
| Insecta    | Coleoptera  | Mycetophagidae | *Typhaea stercorea* (Linnaeus, 1758)                | intr| 3   | 1   |     |     |
| Insecta    | Coleoptera  | Nitidulidae  | *Brassicogethes aeneus* (Fabricius, 1775)           | intr| 6   |     |     |     |
| Insecta    | Coleoptera  | Nitidulidae  | *Carpophilus fumatus* Boheman, 1851                  | intr| 1   |     |     |     |
| Insecta    | Coleoptera  | Nitidulidae  | *Epuraea biguttata* (Thunberg, 1784)                | intr| 1   | 3   |     |     |
| Insecta    | Coleoptera  | Nitidulidae  | *Phenolia limbata tibialis* (Boheman, 1851)         | intr| 2   |     |     |     |
| Insecta    | Coleoptera  | Nitidulidae  | *Steidota geminata* (Say, 1825)                     | intr| 19  | 106 |     |     |
| Insecta    | Coleoptera  | Phalacridae   | *Stilbus testaceus* (Panzer, 1797)                  | nat | 16  | 25  |     |     |
| Insecta    | Coleoptera  | Ptiliidae     | *Ptenidium pusillum* (Gyllenhal, 1808)              | intr| 3   | 47  |     |     |
| Insecta    | Coleoptera  | Ptinidae      | *Anobium punctatum* (De Geer, 1774)                 | intr| 2   | 69  |     |     |
| Insecta    | Coleoptera  | Ptinidae      | *Calymmaderus solidus* (Kiesenwetter, 1877)         | intr| 1   |     |     |     |
| Insecta    | Coleoptera  | Rutelidae     | *Popillia japonica* Newman, 1838                    | intr| 1   | 6   |     |     |
| Insecta    | Coleoptera  | Scraptiidae   | *Anaspis proteus* Wollaston, 1854                   | nat | 1   | 24  | 290 | 1   |
| Insecta    | Coleoptera  | Silvanidae    | *Cryptamorpha desjardinsii* (Guérin-Méneville, 1844)| intr| 1   |     |     |     |
| Insecta    | Coleoptera  | Staphylinidae | *Aleochara bipustulata* (Linnaeus, 1760)            | intr| 19  | 12  |     |     |
| Insecta    | Coleoptera  | Staphylinidae | *Aloconota sulcifrons* (Stephens, 1832)             | nat | 38  | 1   |     |     |
| Insecta    | Coleoptera  | Staphylinidae | *Amischa analis* (Gravenhorst, 1802)                | intr| 1   |     |     |     |
| Class   | Order    | Family         | Scientific Name                                          | CS | COR | FLO | TER | SMR |
|---------|----------|----------------|----------------------------------------------------------|----|-----|-----|-----|-----|
| Insecta | Coleoptera | Staphylinidae  | *Astenus lyonessius* (Joy, 1908)                         | nat | 2   | 3   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Atheta aeneicollis* (Sharp, 1869)                      | intr | 17  | 9   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Atheta fungi* (Gravenhorst, 1806)                      | intr | 5   | 1   | 358 | 282 |
| Insecta | Coleoptera | Staphylinidae  | *Carpelimus corticinus* (Gravenhorst, 1806)             | nat | 2   | 2   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Coproporus pulchellus* (Erichson, 1839)               | intr | 5   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Cordalia obscura* (Gravenhorst, 1802)                 | intr | 2   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Euconnus azoricus* Franz, 1969                        | end | 1   | 2   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Gyrohypnus fracticornis* (Müller, 1776)              | intr | 2   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Hypomedon debilicornis* (Wollaston, 1857)            | nat | 1   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Notothecta dryochares* (Israelson, 1985)             | end | 1   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Ocypus aethiops* (Waltl, 1835)                        | nat | 1   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Oligota pumilio* Kiesenwetter, 1858                  | nat | 5   | 4   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Phloeonomus punctipennis* Thomson, 1867               | nat | 1   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Proteinus atomarius* Erichson, 1840                   | nat | 4   | 2   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Rugilus orbiculatus* (Paykull, 1789)                | nat | 2   | 1   |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Sepedophilus lusitanicus* Hammond, 1973             | nat | 1   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Stenomastax madeirae* Assing, 2003                  | nat | 4   |     |     |     |
| Insecta | Coleoptera | Staphylinidae  | *Tachyporus chrysomelinus* (Linnaeus, 1758)          | intr | 1   | 22  | 14  |     |
| Class       | Order           | Family        | Scientific Name                        | CS | COR | FLO | TER | SMR |
|-------------|-----------------|---------------|----------------------------------------|----|-----|-----|-----|-----|
| Insecta     | Coleoptera      | Staphylinidae | *Tachyporus nitidulus* (Fabricius, 1781) |    |     |     |     |     |
|             |                 |               |                                        | intr| 64  | 42  |     |     |
| Insecta     | Coleoptera      | Staphylinidae | *Trichiua immigrata* Lohse, 1984       |    |     |     |     |     |
|             |                 |               |                                        | intr| 1   |     |     |     |
| Insecta     | Coleoptera      | Staphylinidae | *Trichophya pilicornis* (Gyllenhal, 1810) |    |     |     |     |     |
|             |                 |               |                                        | nat |     |     |     |     |
| Insecta     | Coleoptera      | Staphylinidae | *Xantholinus longiventris* Heer, 1839  |    |     |     | 1   |     |
| Insecta     | Coleoptera      | Tenebrionidae | *Lagna hirta* (Linnaeus, 1758)         |    |     |     | intr| 382 |
| Insecta     | Coleoptera      | Teredidae     | *Anommatus duodecimstriatus* (Müller, 1821) |    |     |     |     |     |
|             |                 |               |                                        | intr|     |     |     |     |
| Insecta     | Coleoptera      | Zopheridae    | *Tarphius rufonodulosus* Israelson, 1984 |    |     |     | end | 6   |
| Insecta     | Dermaptera      | Anisolabididae| *Euborellia annulipes* (Lucas, 1847)   |    |     |     |     |     |
|             |                 |               |                                        | intr|     |     |     |     |
| Insecta     | Dermaptera      | Forficulidae  | *Forficula auricularia* Linnaeus, 1758 |    |     |     |     |     |
|             |                 |               |                                        | intr| 58  | 17  |     |     |
| Insecta     | Hemiptera       | Anthocoridae  | *Anthocoris nemoralis* (Fabricius, 1794) |    |     |     | nat | 3   |
| Insecta     | Hemiptera       | Anthocoridae  | *Brachysteles parvicornis* (A. Costa, 1847) |    |     |     | nat | 2   |
| Insecta     | Hemiptera       | Anthocoridae  | *Buchananiella continua* (White, 1880) |    |     |     |     |     |
|             |                 |               |                                        | intr|     |     |     |     |
| Insecta     | Hemiptera       | Anthocoridae  | *Orius laevigatus laevigatus* (Fieber, 1860) |    |     |     |     |     |
|             |                 |               |                                        | nat | 2   | 4   | 15  |     |
| Insecta     | Hemiptera       | Aphididae     | *Cinara juniperi* (De Geer, 1773)      |    |     |     |     |     |
|             |                 |               |                                        | nat | 4   | 24  | 252 |     |
| Insecta     | Hemiptera       | Cicadellidae  | *Aphrodes hamiltoni* Quartau & Borges, 2003 |    |     |     |     |     |
|             |                 |               |                                        | end | 4   |     | 1   |     |
| Insecta     | Hemiptera       | Cicadellidae  | *Eupteryx azorica* Ribaut, 1941         |    |     |     |     |     |
|             |                 |               |                                        | end | 14  | 64  | 107 | 23  |
| Insecta     | Hemiptera       | Cicadellidae  | *Eupteryx filicum* (Newman, 1853)      |    |     |     |     |     |
|             |                 |               |                                        | nat |     |     |     |     |

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| Class      | Order      | Family       | Scientific Name                                      | CS | COR | FLO | TER | SMR |
|-----------|------------|--------------|-----------------------------------------------------|----|-----|-----|-----|-----|
| Insecta   | Hemiptera  | Cicadellidae | *Euscelidius variegatus* (Kirschbaum, 1858)         | nat| 2   | 3   |     |     |
| Insecta   | Hemiptera  | Cicadellidae | *Sophonia orientalis* (Matsumura, 1912)             | intr| 4   |     |     |     |
| Insecta   | Hemiptera  | Cixiidae     | *Cixius azotterceirae* Remane & Asche, 1979         | end| 45  |     |     |     |
| Insecta   | Hemiptera  | Cixiidae     | *Cixius azomariae* Remane & Asche, 1979             | end| 278 |     |     |     |
| Insecta   | Hemiptera  | Cixiidae     | *Cixius azotterceirae* Remane & Asche, 1979         | end| 968 |     |     |     |
| Insecta   | Hemiptera  | Delphacidae  | *Kelisia ribauti* Wagner, 1938                      | nat| 21  | 8   |     |     |
| Insecta   | Hemiptera  | Flatidae     | *Cyphopterum descendens* (Herrich-Schäffer, 1835) | nat| 1   | 44  | 1613| 49  |
| Insecta   | Hemiptera  | Flatidae     | *Siphanta acuta* (Walker, 1851)                     | intr| 136 | 260 |     |     |
| Insecta   | Hemiptera  | Liviidae     | *Strophingia harteni* Hodkinson, 1981               | end| 340 | 192 |     |     |
| Insecta   | Hemiptera  | Lygaeidae    | *Kleidocerys ericae* Horváth, 1908                 | nat| 138 | 11  |     |     |
| Insecta   | Hemiptera  | Lygaeidae    | *Nysius atlantidum* Horváth, 1890                   | end| 1   | 2   |     |     |
| Insecta   | Hemiptera  | Miridae      | *Loricula elegantula* (Bärensprung, 1858)          | nat| 2   | 77  | 76  |     |
| Insecta   | Hemiptera  | Miridae      | *Campyloneura virgula* (Herrich-Schaeffer, 1835)   | nat| 1   | 128 |     |     |
| Insecta   | Hemiptera  | Miridae      | *Heterotoma planicornis* (Pallas, 1772)             | nat| 1   |     |     |     |
| Insecta   | Hemiptera  | Miridae      | *Monalocoris filicis* (Linnaeus, 1758)             | nat| 8   | 100 | 5   |     |
| Insecta   | Hemiptera  | Miridae      | *Pilophorus confusus* (Kirschbaum, 1856)           | nat| 13  | 3   |     |     |
| Insecta   | Hemiptera  | Miridae      | *Pilophorus perplexus* Douglas & Scott, 1875        | nat| 1   |     |     |     |
| Insecta   | Hemiptera  | Miridae      | *Pinalitus oromii* J. Ribes, 1992                   | end| 1   | 18  | 35  |     |
| Class         | Order      | Family       | Scientific Name                     | CS | COR | FLO | TER | SMR |
|--------------|------------|--------------|-------------------------------------|----|-----|-----|-----|-----|
| Insecta      | Hemiptera  | Miridae      | *Taylorilygus apicalis* (Fieber, 1861) | intr | 1   |     |     |     |
| Insecta      | Hemiptera  | Nabidae      | *Nabis pseudoferus ibericus* Remane, 1962 | nat  | 11  | 7   |     |     |
| Insecta      | Hemiptera  | Pentatomidae | *Plezo dorus lituratus* (Fabricius, 1794) | nat  | 1   |     |     |     |
| Insecta      | Hemiptera  | Psyllidae    | *Acizzia uncatoides* (Ferris & Klyver, 1932) | intr | 288 | 23  |     |     |
| Insecta      | Hemiptera  | Reduviidae   | *Empicoris rubromaculatus* (Blackburn, 1889) | intr | 2   | 3   |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Aphanus rolandri* (Linnaeus, 1758) | nat  | 1   |     |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Beosus maritimus* (Scopoli, 1763) | nat  | 2   |     |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Emblethis denticollis* Horváth, 1878 | nat  | 1   |     |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Eremocoris maderensis* (Wollaston, 1858) | nat  | 1   | 13  |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Plinthusis brevipennis* (Latreille, 1807) | nat  | 2   |     |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Plinthusis minutissimus* Fieber, 1864 | nat  | 1   |     |     |     |
| Insecta      | Hemiptera  | Rhyparochromidae | *Scolopostethus decoratus* (Hahn, 1833) | nat  | 2   | 3   | 71  |     |
| Insecta      | Hemiptera  | Saldidae     | *Saldula palustris* (Douglas, 1874) | nat  | 2   |     |     |     |
| Insecta      | Hemiptera  | Tingidae     | *Tingis auriculata* (A. Costa, 1847) | intr | 1   |     |     |     |
| Insecta      | Hemiptera  | Triozidae    | *Troza laurisilvae* Hodkinson, 1990 | nat  | 56  | 59  |     |     |
| Insecta      | Hymenoptera| Apidae       | *Bombus ruderatus* (Fabricius, 1775) | intr | 6   |     |     |     |
| Insecta      | Hymenoptera| Apidae       | *Bombus terrestris* (Linnaeus, 1758) | intr | 1   | 61  | 2   |     |
| Insecta      | Hymenoptera| Formicidae   | *Cardiocondyla mauritanica* Forel, 1890 | intr | 1   | 4   |     |     |
| Class          | Order       | Family        | Scientific Name                          | CS | COR | FLO | TER | SMR |
|---------------|-------------|---------------|-----------------------------------------|----|-----|-----|-----|-----|
| Insecta       | Hymenoptera | Formicidae    | Hypoponera eduardi (Forel, 1894)         | nat| 1   | 1   | 23  | 173 |
| Insecta       | Hymenoptera | Formicidae    | Hypoponera punctatissima (Roger, 1859)   | intr|     |     |     | 2   |
| Insecta       | Hymenoptera | Formicidae    | Lasius grandis Forel, 1909               | nat| 31  | 38  | 856 | 348 |
| Insecta       | Hymenoptera | Formicidae    | Linepithema humile (Mayr, 1868)          | intr|     |     | 55  | 199 |
| Insecta       | Hymenoptera | Formicidae    | Monomorium carbonarium (F. Smith, 1858)  | nat|      |     | 786 | 310 |
| Insecta       | Hymenoptera | Formicidae    | Plagiolepis schmitzii Forel, 1895        | nat| 18  |     |     | 343 |
| Insecta       | Hymenoptera | Formicidae    | Temnothorax unifasciatus (Latreille, 1798)| nat| 18  |     |     |     |
| Insecta       | Hymenoptera | Formicidae    | Tetramorium bicarinatum (Nylander, 1846) | intr|     |     |     | 230 |
| Insecta       | Hymenoptera | Formicidae    | Tetramorium caespitum (Linnaeus, 1758)   | nat| 52  |     | 4   |     |
| Insecta       | Hymenoptera | Formicidae    | Tetramorium caldarium (Roger, 1857)      | intr|     |     | 121 | 2   |
| Insecta       | Isoptera    | Kalotermitidae| Kalotermes flavicollis (Fabricius, 1793) | intr|     |     | 10  |     |
| Insecta       | Neuroptera  | Hemerobiidae  | Hemerobius azoricus Tjeder, 1948         | end| 2   | 31  | 15  |     |
| Insecta       | Orthoptera  | Gryllidae     | Eumodicogryllus bordagalensis (Latreille, 1804) | intr|     |     | 1   |     |
| Insecta       | Orthoptera  | Tettigoniidae | Phaneroptera nana Fieber, 1853           | nat|     |     | 1   |     |
| Insecta       | Phasmatodea | Phasmatidae   | Carausius morosus (Sinéty, 1901)         | intr|     |     | 1   | 3   |
| Insecta       | Psocodea    | Caeciliusidae | Valenzuela burmeisteri (Brauer, 1876)    | nat|     |     | 136 | 35  |
| Insecta       | Psocodea    | Caeciliusidae | Valenzuela flavidus (Stephens, 1836)     | nat| 5   | 14  | 713 | 74  |
| Insecta       | Psocodea    | Ectopsocidae  | Ectopsocus briggs McLachlan, 1899        | intr| 1   | 23  | 298 | 15  |
| Class       | Order       | Family     | Scientific Name                                      | CS | COR | FLO | TER | SMR |
|-------------|-------------|------------|-----------------------------------------------------|----|-----|-----|-----|-----|
| Insecta     | Psocidea    | Ectopsocidae | *Ectopsocus strauchi* Enderlein, 1906 | nat | 9   | 23  | 25  |     |
| Insecta     | Psocidea    | Elipsocidae | *Elipsocus azoricus* Meinander, 1975 | end | 5   | 523 | 107 |     |
| Insecta     | Psocidea    | Elipsocidae | *Elipsocus brincki* Badonnel, 1963 | end | 12  | 627 | 1   |     |
| Insecta     | Psocidea    | Epipsocidae | *Bertkauia lucifuga* (Rambur, 1842) | nat | 23  | 9   |     |     |
| Insecta     | Psocidea    | Psocidae    | *Atlantopsocus adustus* (Hagen, 1865) | nat | 3   | 74  | 51  |     |
| Insecta     | Psocidea    | Trichopsocidae | *Trichopsocus clarus* (Banks, 1908) | nat | 8   | 56  | 618 | 143 |
| Insecta     | Thysanoptera| Aeolothripidae | *Aeolothrips gloriosus* Bagnall, 1914 | nat | 1   |     |     |     |
| Insecta     | Thysanoptera| Phlaeothripidae | *Hoplothrips corticis* (De Geer, 1773) | nat | 3   | 12  |     |     |
| Insecta     | Thysanoptera| Thripidae   | *Heliothrips haemorrhoidalis* (Bouché, 1833) | intr | 8   | 4   |     |     |
| Insecta     | Thysanoptera| Thripidae   | *Hercinothrips bicinctus* (Bagnall, 1919) | intr | 2   |     |     |     |
| Insecta     | Trichoptera | Limnephilidae | *Limnephilus atlanticus* Nybom, 1948 | end | 3   | 1   |     |     |

Just considering the 249 arthropod species identified at archipelago level, the five most abundant species were the native bug *Cyphopterum adinfens* (Herrich-Schäffer, 1835) (*n* = 1707), the ants *Lasius grandis* Forel, 1909 (*n* = 1273) and *Monomorium carbonarium* (F. Smith, 1858) (*n* = 1096), the endemic cixiid *Cixius azoterceirae* Remane & Asche, 1979 (*n* = 968) and the native harvestmen *Leiobunum blackwalli* Meade, 1861 (*n* = 873) (Table 2).

At island scale, the native ant *Lasius grandis* was also one of the most abundant arthropods in Corvo (*n* = 31) and Santa Maria (*n* = 348). Curiously, in both Islands, one of the two most abundant species represent a new island record, being the exotic spider *Porrhoclubiona genevensis* (L. Koch, 1866) (*n* = 15), new for Corvo and the exotic (possibly invasive) beetle *Lagria hirta* (Linnaeus, 1758) (*n* =382), new for Santa Maria.

In Flores, the native *Trichopsocus clarus* (Banks, 1908) (*n* = 143) and the endemic *Eupteryx azorica* Ribaut, 1941 (*n* = 23) were the most abundant arthropod species. Finally, in Terceira, the native and endemic Hemiptera, respectively *Cyphopterum adinfens* (*n* = 1613) and *Cixius azoterceirae* (*n* = 968), were the most abundant species (Table 2).
New Azores species records

In this study, we registered a total of 34 new records for one or more islands of Azores (nine for Corvo, three for Flores, six for Terceira and 16 for Santa Maria), of which the curculionids *Dieckmanniellus nitidulus* (Gyllenhal, 1838), *Gronops fasciatus* Küster, 1851, *Hadroplontus trimaculatus* (Fabricius, 1775) and *Hypurus bertrandi* (Perris, 1852) are new records for Azores. In addition, the ant *Cardiocondyla mauritanica* Forel, 1890 (Hymenoptera, Formicidae) is also a new record for Azores. All these species are exotics, possibly recently introduced.

*Dieckmanniellus nitidulus* (Gyllenhal, 1838)

*Dieckmanniellus nitidulus* (Brentidae: Nanophyinae) is mainly widespread in the Mediterranean Region and lives monophagously on various Lythraceae (e.g. *Lythrum salicaria* L.). The record on Santa Maria (Azores) probably refers to *Lythrum borysthenicum* (Schrank) Litv. or *Lythrum junceum* Banks & Solander. The species was also introduced on five of the seven Canary Islands, where it lives on *Lythrum hyssopifolia* L., on which one of us (PS) was able to reliably detect it on La Gomera. Characteristic features: Head, funicle and club of antennae mainly black; elytra in front of the white, V-shaped transverse mark with a dark spot on the front third of the sutural strip (see Fig. 7); 1.4 – 2.1 mm (Stüben 2022).

![Image](SLAM_Project.png)

Figure 7. doi

*Dieckmanniellus nitidulus* (Brentidae: Nanophyinae) (Credit: Peter E. Stüben).

*Gronops cf. fasciatus* Küster, 1851

The genus *Gronops* (Curculionidae: Cyclominae: Rhytirrhinini) includes about 20 Palaeartctic species, mainly from the arid regions of North Africa and is only represented with certainty on the Canary Islands by the species *Gronops fasciatus*. The determination
of the specimen of *Gronops cf. fasciatus*, a male, recorded at the airfield of Santa Maria (Azores) in December 2019, must be checked again by a specialist of this group. The biology of these terricolous, flightless species is largely unknown, although they are often found near Caryophyllaceae and Amaranthaceae. Carry-over with soil is conceivable. Characteristic features of *G. fasciatus* compared to *G. lunatus* (Fabricius, 1775): elytra shorter, hardly narrowing towards the apex (subparallel); pronotum wider, strongly widened in the front third (see Fig. 8); length: 2.2–3.2 mm (Stüben 2022).
Hadroplontus trimaculatus (Fabricius, 1775)

Both European species, *Hadroplontus litura* and *H. trimaculatus* (Curculionidae: Ceutorhynchinae) live on thistles. The latter lives on plants of the genus *Carduus*, mainly *C. nutans* and *C. acanthoides*. The single specimen (see Fig. 9) was sampled at Piquinhos, mixed forest with the presence of *Carduus tenuiflorus* W.M.Curtis. *H. trimaculatus* differs from the very similar species *H. litura* by the beige to greyish-brown (not completely white) suture interval of the cruciform elytral spot (Stüben et al. 2014, Stüben 2022).

Hypurus bertrandii (Perris, 1852)

*Hypurus bertrandii* (Perris, 1852) (Curculionidae: Ceutorhynchinae) (see Fig. 10), originally a Mediterranean, now nearly cosmopolitan species, which lives monophagously on *Portulaca oleracea* L. The species was first reported from the Macaronesian Islands by García et al. (2016), collected in the Escuela de Capacitación Agraria near Tacoronte on Tenerife in 2015. The species also occurs in Cape Verde (São Tiago: S. Jorge; Colonnelli 1990) and on the Azores (Terceira: Caldeira Lajes). A characteristic feature is the strongly thickened hind femora (see Fig. 10; Stüben et al. 2012, Stüben 2022).

Cardiocondyla mauritanica Forel, 1890

This ant species is native to northern Africa, Middle East, Afghanistan and Pakistan, but has been introduced in many other regions, including the United States of America, Mexico, Zimbabwe, several European countries and many islands worldwide (Wetterer
2012, Janicki et al. 2016, Seifert et al. 2017). In Macaronesia, *C. mauritanica* was previously known to occur in Madeira and the Canary Islands (Espadaler 2008, Báez and Oromí 2010). These ants are small, inconspicuous and can be separated from other *Cardiocondyla* species using a combination of morphometric characters (Seifert 2003, Seifert et al. 2017) (see Fig. 11). They form polygynous colonies and mating occurs inside the nests (Seifert et al. 2017). These characteristics and their ability to co-exist with other aggressive invasive ant species, like the Argentine ant *Linepithema humile*, are important to explain their ecological success and ongoing spread (Wetterer 2012). However, contrary to other exotic ant species, *C. mauritanica* does not seem to have significant ecological impacts on native biodiversity (Wetterer 2012).

**Conservation remarks**

This publication highlights the importance of exotic and mixed forest areas, as well as small native disturbed forest patches as potential reservoirs of both exotic potentially invasive species, as well as rare endemic species (see also Tsafack et al. 2021).

The high abundance of several native non-endemic (e.g. *Cyphopterum ascendens*; *Lasius grandis*, *Monomorium carbonarium*, *Leiobunum blackwalli*, *Trichopsocus clarus*) and endemic species (e.g. *Cixius azoterceira*, *Elipsocus brincki*, *Elipsocus azoricus*, *Strophingia harteni*) (Table 2) in these habitats is noteworthy.

Within endemics, we wish to comment on the recently-described subspecies *Pseudophloeophagus tenax borgesi* Stüben, 2022 (Curculionidae: Cossoninae) (Fig. 12).
This subspecies, common in many islands of the Azores, was described only in 2022 (Stüben 2022). The nominotypic taxon occurs on Madeira. Accordingly, material of *P. tenax* from trap findings and in collections from the Azores must be assigned to this new subspecies. Type locality of *P. tenax borgesi* is on São Jorge (Vigia da Baleia), but perhaps the subspecies occurs on all islands of the Azores. Apart from clear molecular differences in the mitochondrial COI gene (Stüben et al. 2012), this subspecies of the Azores differs from the nominotypic taxon on Madeira in the following characteristics: elytral striae more strongly and deeply punctured and the interstriae much narrower than in the sister taxon from Madeira; aedeagus narrower (see Fig. 12, Stüben and Borges 2019, Stüben 2022).

Several other rare endemic species were found in this study (see list below), which highlights the importance of expanding surveys in Azores to small isolated forest patches in order to find relict populations of rare endemic species:

- *Canariphantes acoreensis* (Wunderlich, 1992) (Araneae, Linyphiidae). This rare spider is usually found in pristine native forests and is considered Vulnerable (VU) by IUCN (Borges and Cardoso 2021b). In the current study, we sampled a single specimen in a disturbed mixed forest of *Eucalyptus* spp. and *Pittosporum undulatum* at Terceira Island located near a native forest at Pico Rachado.

- *Canariphantes relictus* Crespo & Bosmans, 2014 (Araneae, Linyphiidae). Another very rare species, classified as Critically Endangered (CR) (Borges and Cardoso 2021a). The species was found originally in high elevation at Santa Maria Island (Crespo et al. 2014), but in our study, two females were found at Piedade (PRIBS_T03_12_2019) at low elevation in a mixed forest of *Picconia azorica*, *Pittosporum undulatum* and *Pinus* sp. The species possibly has a larger distribution than originally recorded.
- *Olisthopus inclavatus* Israelson, 1983 (Coleoptera, Carabidae). This is a very rare ground-beetle classified as Critically Endangered (CR) by IUCN (Borges 2018) and currently occurring only in exotic forests (dominated by *Cryptomeria japonica*, *Acacia* spp.). In this study, the unique specimen was sampled in Monteiro (SMR_PRIBS_T12).

- *Athous azoricus* Platia & Gudenzi, 2002 (Coleoptera, Elateridae) (Fig. 13). This is a relatively rare species known from Flores, Graciosa, Terceira and S. Miguel Islands. Considered Endangered by the IUCN (Borges and Lamelas-López 2017a), this species tends to occur at low elevations in disturbed exotic forests. In the current study, we found the species in three places all at mid-elevations (300-500 m) and in three types of forest, one plantation of *Cryptomeria japonica* (Mistérios Negros; TER-MNEG-T-62 corresponding also to code TER_PRIBS_T05), a mixed forest dominated by *Eucalyptus* spp. (Escampadouro; TER_PRIBS_T23) and a mixed forest dominated by *Pittosporum undulatum* (Mata do Estado; TER_PRIBS_T04). At least in Terceira Island, the species seems to be more widespread than previously assumed.

- *Brachypera multifida* (Israelson, 1984) (= *Donus multifudus* (Israelson, 1984)) (Coleoptera, Curculionidae) (Fig. 14). This is a particularly rare curculionid beetle classified as Critically Endangered (CR) (Borges and Lamelas-López 2017b). Previously, it was sampled at high elevation at Pico Alto in Santa Maria Island. In the current survey, we sampled this species in three sites, Estação Loran (SMR_PRIBS_T08), Piquinhos (SMR_PRIBS_T10) and Figueiral (SMR_PRIBS_T14) expanding the range of the species to lower elevations and to different types of forest.
- *Tarphius rufonodulosus* Israelson, 1984 (Coleoptera, Zopheridae) (Fig. 15). This is a rare ironclade beetle also Critically Endangered (CR) (Borges and Lamelas-López 2018) that is associated with the canopies of native trees (e.g. *Picconia azorica*) and under-bark of dead trees, both in native and exotic forests (dominated by *Acacia* sp. and *Cryptomeria japonica*). In the current study, one specimen was collected in mixed forests of *Erica azorica*, *Cryptomeria japonica* and *Pittosporum undulatum* at three locations at high elevation (Piquinhos and Fontinhas forest areas).

Figure 14. [doi](#)

*Brachypera multifida* (Israelson, 1984) (= *Donus multifudus* (Israelson, 1984)) (Coleoptera, Curculionidae) (Credit: Peter E. Stüben).

Figure 15. [doi](#)

*Tarphius rufonodulosus* Israelson, 1984 (Coleoptera, Zopheridae) (Credit: Erno-Endre Gergely; Azorean Biodiversity Group).
Patterns of invasion

The main aim of this study was to investigate the importance of disturbed native forest patches and exotic vegetation areas as potential reservoirs of exotic potentially invasive arthropods. As expected, we found a large number of exotic species, some of them new for Azores, as listed above. In addition to the 125 species identified as introduced (Table 2), many more are waiting a proper identification (Suppl. material 1). In previous studies, we identified thirteen widespread exotic arthropods as new records for Azores (Borges et al. 2013) and some previously unknown exotic species in Azorean urban gardens (Arteaga et al. 2020). This clearly indicates that there is an ongoing continuous flux of new introductions in Azores.

Some of the introduced species found in the current study are a matter of concern for nature conservation in the Azores Archipelago and their populations should be monitored. For instance, Lagria hirta (Linnaeus, 1758) (Coleoptera, Tenebrionidae) that was recently recorded as new for Azores and found originally at Terceira Island (Borges et al. 2021), is expanding dramatically in Santa Maria. In Santa Maria, we found it everywhere at all elevations and habitats. This seems to be a recent introduction in Azores and the impact of this species is still unknown. The Australian exotic plant hopper Siphanta acuta (Walker, 1851) (Hemiptera, Flatidae) was recorded originally for Azores in 2013 (Borges et al. 2013) and is expanding rapidly in several Azorean islands with potential impacts on agriculture. In our study, we found it quite abundant in many sites at Terceira and Santa Maria Islands. The expansion of the Eucalyptus snout beetle Gonipterus platensis (Marelli, 1926) (Coleoptera, Curculionidae) that was found in several sites at Terceira Island is also of concern. This species was originally recorded for Azores by Borges et al. (2013) and is currently known also from São Miguel Island.

In potential expansion in Terceira (and also known from Pico) is the two-spotted leaf hopper Sophonia orientalis (Matsumura, 1912) (Hemiptera; Cicadellidae) (Tarantino et al. 2022). This species is native to south-east Asia and is a highly polyphagous pest, considered an invasive species that affects crops as well as endemic plants (Tarantino et al. 2022).

Several exotic ant species have been recorded in the Azores (Espadaler 2010) and, here, we report new findings at both island and archipelago levels that highlight their rapid spread. Jointly with the first record of Cardiocondyla mauritanica for Azores, we found that two exotic Tetramorium species (T. bicarinatum and T. caldarium) are now present in Santa Maria. Both C. mauritanica and T. caldarium do not seem to have significant impacts on native biodiversity (Wetterer 2012, Wetterer and Hita Garcia 2015), but T. bicarinatum and, particularly, the Argentine ant L. humile, are serious threats to island native invertebrates and natural ecological processes and have also been reported as agricultural pests (Wetterer 2009, Wetterer et al. 2009). The severe consequences of Argentine ant invasion on local biodiversity have been reported from many areas around the world, including oceanic islands, but their effects remain poorly understood in Macaronesian archipelagos (Holway et al. 2002, Wetterer and Espadaler 2010, Boieiro et al. 2018a, Boieiro et al. 2018b).
Finally, it is important to highlight that, amongst the most abundant introduced species in our study, several are listed in the TOP100 worst invasive species of Azores and Macaronesia (Silva et al. 2008), namely the woodlouse spider *Dysdera crocata* C.L. Koch, 1838, the Argentine ant *Linepithema humile* (Mayr, 1868) and the millipede *Ommatoiulus moreleti* (Lucas, 1860).

Our study stresses the need for arthropod biodiversity monitoring in different habitats of oceanic islands as an important strategy for early detection of invasive species that may have severe impacts on the environment, economy and human well-being (see also Borges et al. 2018). It also allows us to assess changes on species abundance and distribution, thus providing valuable information to support decision-making by conservation managers.

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**Author contributions**

PAVB and RG contributed to study conceptualisation. PAVB, ARP, RG, MB and MTF performed the fieldwork. PAVB, MB, PES and ARP performed the species sorting and identification. PAVB, ARP and LLL contributed to dataset preparation and data analysis. All authors contributed to manuscript writing.

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Supplementary material

Suppl. material 1: Complete list of species and morphospecies. doi

Authors: Borges, P.A.V.
Data type: Excel
Brief description: Complete list of arthropod species collected in four islands of Azores, between 2019 and 2020 using SLAM traps. The list includes individuals identified at species-level and also Morphospecies. Abundance per island (COR - Corvo; FLO - Flores; TER - Terceira; SMR - Santa Maria) is provided.
Download file (30.81 kb)