Monitoring Arthropods in Azorean Agroecosystems: the project AGRO-ECOSERVICES

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Abstract

Background

The data we present are part of the AGRO-ECOSERVICES project (Assessing ecosystem services and disservices provided by arthropod species in Azorean agroecosystems). The project aims to evaluate the relative importance of native and non-native organisms as ecosystem services (ES) and disservices (ED) providers, by combining novel, direct and quantitative tools for monitoring agro-biodiversity. Ecosystem services include evaluation of natural pest control by predation, seed predation on weed plants, pollination, decomposition and ecosystem disservices, herbivory and seed predation on crop plants. Active Aerial Searching (AAS) (only in maize-fields) and pitfall traps were used to sample the arthropod biodiversity (predatory spiders, true-bugs and beetles and main insect pests).
on four agricultural habitats of Terceira Island, namely citrus orchards, low and high elevation maize fields and vineyards.

New information

We provided an inventory of all arthropods recorded in four Azorean agroecosystems (citrus orchards, low and high elevation maize fields and vineyards) from Terceira Island. A total of 50412 specimens were collected, belonging to four classes, 20 orders, 81 families and 200 identified species of arthropods. A total of 127 species are considered introduced (n = 22646) and 69 native non-endemic (n = 24117). Four endemic species were recorded with very few specimens (n = 14) and 3635 specimens belong to unidentified taxa recorded only at genus or family level. Five species are new records for Terceira Island, with *Lagria hirta* (Linnaeus, 1758) (Coleoptera, Tenebrionidae) being also a new record for the Azores. This publication contributes to a better knowledge of the arthropods communities present in agro-ecosystems of Terceira Island and will serve as a baseline for future monitoring schemes targeting the long-term change in arthropod diversity and abundance.

Keywords

Active Aerial Searching (AAS), citrus, dataset, invertebrates, island diversity, Macaronesia, maize, occurrence, orchards, pitfall traps, vineyards.

Introduction

Land-use transformation with associated habitat degradation, is one of the major drivers of biodiversity loss worldwide (Vitousek et al. 1997, Barnosky et al. 2011, Borges et al. 2019a, Harvey et al. 2020). In the case of Azores, since Portuguese colonisation in the 15th century, the original landscape has suffered severe transformations, with the replacement of native forests by exotic tree plantations, pastures, agricultural and urban areas (Gaspar et al. 2008, Borges et al. 2019a, Borges et al. 2019b, Norder et al. 2020).

However, although exotic species have a competitive advantage to colonise new human-altered habitats given that their tolerance to wide range of environmental conditions and habitats (e.g. generalist behaviour) (Rigal et al. 2017), these non-natural habitats also offer opportunities to native biota (McKinney and Lockwood 1999, Blackburn et al. 2004, Sax 2008, Tsafack et al. 2021).

Many species were also introduced because of human settlement (Frutuoso 2011). The current remnants of native forests represent less than 5% of the total area of the archipelago (Gaspar et al. 2008). Currently, the Azorean economy depends greatly on agroecosystems (Gil et al. 2017). Agroecosystems with the largest area are pastures, followed by maize, with the two crops usually grown in rotation. Due to their long co-existence and close taxonomic relationship between pastures and maize (both are grasses), several pests interact with both crops all year round (P. Monjardino, pers.
observ.). These interactions need to be further understood, because of ongoing current significant yield losses in both agroecosystems (P. Monjardino, pers. observ.). Vineyards and citrus orchards are amongst the most important crops on the Azores. Both crops have significant pest and disease problems due to the benign environmental conditions and to improper cultural practices (Lopes et al. 2009).

Azorean terrestrial arthropod fauna have been extensively surveyed in the last two decades. Although most surveys have been conducted in native forests (e.g. Borges et al. 2005, Ribeiro et al. 2005, Borges et al. 2006), several also included anthropogenic habitats, as exotic forest plantations, pastures for cattle grazing and other agricultural areas (Cardoso et al. 2009, Florencio et al. 2015, Rigal et al. 2017, Marcelino et al. 2021, Tsafack et al. 2021).

In 2019 and 2020, we started the project “Assessing Ecosystem Services and Disservices provided by Arthropod species in Azorean Agroecosystems” (AGRO-ECOSERVICES). This project aims to: (i) initiate the monitoring of terrestrial arthropods in agricultural habitats, (ii) implement novel, direct and quantitative tools to quantify ecosystem services (ES) and disservices (ED) and (iii) evaluate the relative importance of native and non-native organisms as ES/ED providers.

Arthropods, especially insects, support ecosystem stability and functioning (Allan et al. 2015, Bennett et al. 2015). Due to their high species richness and abundance, as well as their importance for several ES and ED (Zhang et al. 2007, Ameixa et al. 2018, Noriega et al. 2018, Ecosystem Services 2019), arthropods play a key role in all terrestrial ecosystems. Evaluating the total effect of arthropods that are providers of both ES and ED is challenging (Shapiro and Báldi 2014). For example, when they prey on pests, generalist predators provide biological control, an ES valued at $400 billion/y (Costanza et al. 1997), while their intraguild predation (Lövei and Ferrante 2017) constitutes an ED. A second great challenge is to assess the role of native vs. exotic biodiversity in providing ES/ED, which is essential to manage sustainable landscapes and an important frontier in theoretical ecology. Exotic species often alter ecological processes and cause severe biodiversity loss (Simberloff et al. 2013). Nevertheless, these species may also provide ES: alien plants can increase microbial activity (Vilà et al. 2011), introduced natural enemies can control pests (Heimpel and Mills 2017) or provide ecological “insurance” after the decline of native species (Stavert et al. 2018).

Oceanic islands have a high proportion of endemic species, being very sensitive to biotic disturbance, such as invasions and land-use changes (Stachowicz and Tilman 2005, Kier et al. 2009) - the perfect setting to test the response of ecological communities to disturbance and its effects on ecosystem processes. Several factors contribute to arthropod decline in the Azores (Borges et al. 2019b), including native forest destruction (Triantis et al. 2010), lack of connectivity between forest patches (Aparício et al. 2018) and climate change (Ferreira et al. 2016).

This publication contributes not only to a better knowledge of the arthropods present in agroecosystems of Terceira Island, but will also contribute as a baseline for future
monitoring schemes in Azorean agroecosystems targeting the long-term change in arthropod diversity and abundance.

**General description**

**Purpose:** To provide an arthropod inventory of agro-ecosystems from Terceira Island (Azores), based on data collected in four agro-ecosystems, citrus orchards, low and high elevation maize fields and vineyards. This study will contribute to a better knowledge of the arthropods present in agro-ecosystems and will serve as a baseline for future monitoring schemes in Azorean agro-ecosystems targeting the long-term change in arthropod diversity and abundance.

**Additional information:** The study was conducted between July 2019 and September 2021 in Terceira Island. Active Aerial Searching (only in maize-fields) and pitfall traps were used to sample the arthropod biodiversity (pollinators and predatory spiders, true-bugs and beetles and main insect pests) on four agricultural habitats, namely citrus orchards, vineyards, low elevation maize fields and high elevation maize fields. Information on ecosystem services (ES) and disservices (ED) providers will be the subject of another publication.

**Project description**

**Title:** AgEcSe- AGRO-ECOSERVICES - Assessing ecosystem services and disservices provided by arthropod species in Azorean Agroecosystems (ACORES-01-0145-FEDER-000073)

**Personnel:** Project leaders: Paulo A. V. Borges and António Onofre Soares

Team members: Marco Ferrante, Artur Gil, Marco Girardello, David H. Lopes, Paulo Monjardino, Rui Nunes.

External Consultants: Sven Bacher, Gabor Lövei, François Rigal

Parataxonomists: Jonne Bonnet, Ricardo Costa, Rui Nunes

Darwin Core Database management: Paulo A. V. Borges, Lucas Lamelas-López, Enésima Pereira

**Study area description:** Terceira Island (area: 400.2 km²; elevation: 1021 m a.s.l.) is located in the central group of the Azores Archipelago (North Atlantic), roughly at 38.638 N and -27.0150 W (Fig. 1). Similar to all islands in Azores, Terceira is volcanic and of recent origin (0.4 Ma, see Florencio et al. 2021). 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.
**Design description:** The sampled habitats included citrus orchards, vineyards and low elevation maize fields, all located at low elevation areas and high elevation maize fields (Fig. 2, Table 1). The two types of maize fields differ not only in the elevation, but principally in crop management, the low elevation being an annual rotation of maize and Italian ryegrass and the high elevation (located at intermediate elevation in the Island) being a perennial rotation of maize and perennial ryegrass.

**Table 1.**
Description of the habitat, locality, elevation and coordinates of the 18 sampled sites on Terceira Island, Azores.

| Code Site | Habitat | Location ID | Locality | Elevation (m a.s.l.) | Latitude  | Longitude  |
|-----------|---------|-------------|----------|---------------------|-----------|------------|
| C1        | Citrus  | TER_CITRUS_T1_T206 | Pico da Urze | 117 | 38.66989 | -27.24047 |
| C2        | Citrus  | TER_CITRUS_T2_T207 | Qt. Rosário | 158 | 38.68111 | -27.26206 |
| C3        | Citrus  | TER_CITRUS_T3_T208 | S. Bartolomeu | 189 | 38.6827 | -27.27555 |
| C4        | Citrus  | TER_CITRUS_T4_T209 | S. Bento | 66 | 38.66287 | -27.21019 |
| C5        | Citrus  | TER_CITRUS_T5_T210 | S. Carlos | 69 | 38.6625 | -27.24961 |
| ML1       | Maize   | TER_MAIZE_LOW_T2_T221 | Atalaia | 111 | 38.65631 | -27.18368 |
| ML2       | Maize   | TER_MAIZE_LOW_T1_T220 | Cinco Ribeiras | 90 | 38.6758 | -27.30998 |
| ML3       | Maize   | TER_MAIZE_LOW_T3_T222 | S. Mateus | 42 | 38.66304 | -27.28962 |
| ML4       | Maize   | TER_MAIZE_LOW_T4_T223 | Universidade dos Açores - Campus do Pico da Urze | 36 | 38.659 | -27.23555 |
| Code | Site | Habitat | Location ID     | Locality     | Elevation (m a.s.l.) | Latitude | Longitude |
|------|------|---------|----------------|--------------|---------------------|----------|-----------|
| ML5  | Maize| Low     | TER_MAIZE_LOW_T224 | Vinha Brava  | 167                 | 38.67593 | -27.21684 |
| MH1  | Maize| High    | TER_MAIZE_HIGH_T1_T215 | Casa da Mina | 314                 | 38.68602 | -27.1974  |
| MH2  | Maize| High    | TER_MAIZE_HIGH_T2_T216 | Escampadouro | 309                 | 38.70159 | -27.2852  |
| MH3  | Maize| High    | TER_MAIZE_HIGH_T3_T217 | Granja       | 385                 | 38.70083 | -27.17019 |
| MH4  | Maize| High    | TER_MAIZE_HIGH_T4_T218 | Juncal       | 321                 | 38.69996 | -27.12048 |
| MH5  | Maize| High    | TER_MAIZE_HIGH_T5_T219 | Poejo        | 275                 | 38.6768  | -27.14616 |
| V1   | Vineyards |       | TER_VINE_F1_T211 | Biscoitos Vinha_F1 | 23 | 38.79793 | -27.25567 |
| V2   | Vineyards |       | TER_VINE_F2_T212 | Biscoitos Vinha_F2 | 52 | 38.79664 | -27.26302 |
| V3   | Vineyards |       | TER_VINE_F3_T213 | Biscoitos Vinha_F3 | 28 | 38.80066 | -27.26842 |

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Figure 2. Map of the study area (Terceira Island, Azores). Codes of sites as in Table 1. Maize fields are located in intensive pasture since they are only operating in summer, with the two crops usually grown in rotation (Land-use data extracted from Cruz et al. 2007).
Sampling methods

Study extent: The study was conducted in four agro-ecosystems of Terceira Island (Fig. 2): citrus orchards (Fig. 3), vineyards (Fig. 4), low elevation maize fields (Fig. 5) and high elevation maize fields (Fig. 6). Five citrus orchards were selected, located at low elevation areas. Ten maize fields, five of which are located inland at higher elevation and five other closer to the coast in low elevation areas. Finally, three vineyards located on the coast, north of the Island were sampled (see also Table 1).

Figure 3. doi
A citrus orchard in Terceira Island (C5 - S. Carlos) (Credit: Rui Nunes).

Figure 4. doi
The vineyards in Terceira Island (V3 - Biscoitos) (Credit: Rui Nunes).
Sampling description: Active Aerial Searching (AAS) and pitfall traps were used to sample arthropod diversity. The following main functional groups were collected: predatory arthropods (mostly spiders, true-bugs, beetles and bugs), phytophagous insects and saprophagous arthropods (mostly millipedes and beetles).

AAS consists in picking arthropods found above knee-level by hand, using forceps, pooter or brush and immediately transferring them into vials containing ethanol 96%. It was implemented in five low- and five high-elevation maize fields. Four 1-hour samples were
obtained during the night when the main predators are more active. Sampling was performed in the summer when the maize plants were at maximum development. Samples were taken by Paulo A. V. Borges and Rui Nunes (two hours each per site).

Pitfall traps were standard 330 ml plastic cups, 8 cm wide at the top and approximately 12 cm deep - European standard plastic cups (Fig. 7), partially filled with propylene glycol. The traps were deployed for 14 consecutive days.

In each of five citrus orchards and six (of ten available) maize fields (three in low- and three in high-elevation areas), 16 pitfall traps organised in sets of two connected with a grid (Fig. 8) were deployed, along a transect, from the point closest to the crop edge. The eight sets of two pitfall traps were separated by at least 10 metres. A total of 80 and 96 pitfall traps were deployed on citrus orchards and maize fields, respectively.

For vineyards, a different strategy had to be followed since Azorean vineyards are formed by small rocky enclosures (between 6-20 m²) (Fig. 4) and pitfall traps were deployed in the interior of these enclosures. Following a transect, a total of 144 individual pitfall traps were deployed in three vineyards (48 in each site).

Sampling methods used in citrus and vineyards (pitfall traps) only provide information on the soil-related arthropods; most of crop insect pests (canopy associated species) are not sampled by this sampling technique.

**Quality control:** All sampled specimens were first sorted by trained paratokonomists (Jonne Bonnet, Ricardo Costa, Rui Nunes). All specimens were allocated to a taxonomic species by Paulo A. V. Borges. Juveniles were also included in the data presented in this paper since the low diversity of species in Azores allows their reliable identification.
Colonisation status for each identified species is based on Borges et al. 2010 (END - Endemic; NAT - native non-endemic; INTR - introduced).

**Geographic coverage**

**Description:** Terceira Island, Azores, Portugal.

**Coordinates:** 38.638 and 38.814 Latitude; -27.394 and -27.0150 Longitude.
**Taxonomic coverage**

**Description:** The following classes and orders of arthropods are covered: Arachnida: Araneae, Opiliones, Pseudoscorpiones; Chilopoda: Geophilomorpha, Lithobiomorpha, Scolopendromorpha, Scutigeromorpha; Diplopoda: Chordeumatida, Julida, Polydesmida; and Insecta: Archaeognatha, Coleoptera, Dermaptera, Hemiptera, Hymenoptera, Lepidoptera, Neuroptera, Orthoptera, Psocoptera, Thysanoptera.

**Taxa included:**

| Rank | Scientific Name | Common Name       |
|------|-----------------|-------------------|
| class| Araneae         | Spiders           |
| class| Opiliones       | Opilions          |
| class| Pseudoscorpiones| Pseudoscorpions   |
| class| Diplopoda       | Millipedes        |
| class| Chilopoda       | Centipedes        |
| order| Archaeognatha   | Bristletails      |
| order| Dermaptera      | Earwigs           |
| order| Orthoptera      | Crickets, Grasshoppers |
| order| Psocoptera      | Barklice          |
| order| Thysanoptera    | Thrips            |
| order| Hemiptera       | Bugs              |
| order| Neuroptera      | Lacewings         |
| order| Coleoptera      | Beetles           |
| order| Hymenoptera     | Ants              |
| order| Lepidoptera     | Moths             |

**Traits coverage**

No data available.

**Temporal coverage**

**Notes:** 16 July 2019 to 9 June 2021
Collection data

Collection name:  Entomoteca Dalberto Teixeira Pombo at University of Azores

Collection identifier:  DTP

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

Curatorial unit:  Dalberto Teixeira Pombo insect collection at the University of the Azores (Curator: Paulo A. V. Borges)

Usage licence

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

Data resources

Data package title:  Monitoring Arthropods in Azorean Agroecosystems: the project AGRO-ECOSERVICES (AgEcSe)

Resource link:  https://www.gbif.org/dataset/822f3765-6950-40c5-9353-1f335599007c

Alternative identifiers:  https://doi.org/10.15468/mvtmyx

Number of data sets:  1

   Data set name:  Monitoring Arthropods in Azorean Agroecosystems: the project AGRO-ECOSERVICES

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

   Data format:  Darwin Core Archive

   Data format version:  version 1.10

Description:  The dataset is available on the Global Biodiversity Information Facility platform, GBIF (Borges et al. 2021). 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, with two tables: event (as core) and occurrences (abundance data). The data in this sampling event resource have 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 358 records (eventID) and the occurrences file 5134 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 from Borges et al. (2021).
| Column label                  | Column description                                                                 |
|------------------------------|------------------------------------------------------------------------------------|
| Table of Sampling Events     | Table with sampling events data (beginning of table).                                |
| eventID                      | Identifier of the events, unique for the dataset.                                    |
| stateProvince                | Name of the region of the sampling site.                                            |
| 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.                                        |
| municipality                 | Municipality of the sampling site.                                                  |
| decimalLongitude             | Approximate centre point decimal longitude of the field site in GPS coordinates.    |
| decimalLatitude              | Approximate centre point decimal latitude 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.                  |
| coordinatePrecision          | Precision of the coordinates.                                                      |
| 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.                                                   |
| locationID                   | Identifier of the location.                                                         |
| fieldNumber                  | Code of the sample                                                                  |
| locality                     | Name of the locality.                                                               |
| minimumElevationInMetres     | The lower limit of the range of elevation (altitude, usually above sea level), in  |
|                              | metres.                                                                            |
| habitat                      | The habitat of the sample.                                                          |
| year                         | Year of the event.                                                                  |
| month                        | Month of the event.                                                                 |
| day                          | Day of the event.                                                                   |
| samplingEffort               | The amount of effort expended during an Event.                                       |
| eventDate                    | Date or date range the record was collected.                                        |
| samplingProtocol             | The sampling protocol used to capture the species.                                  |
| Occurrence Table             | Table with species abundance data (beginning of new table).                         |
| eventID                      | Identifier of the events, unique for the dataset.                                    |
| type                         | Type of the record, as defined by the Public Core standard.                          |
| Field                      | Description                                                                 |
|---------------------------|-----------------------------------------------------------------------------|
| 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.               |
| datasetName               | Name of the dataset.                                                        |
| 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. |
| 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.     |
| 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.                                   |
| scientificName            | Complete scientific name including author and year.                         |
| scientificNameAuthorship  | Name of the author of the lowest taxon rank included in the record.        |
| kingdom                   | Kingdom name.                                                               |
| phylum                    | Phylum name.                                                                |
| class                     | Class name.                                                                 |
| order                     | Order name.                                                                 |
| family                    | Family name.                                                                |
| genus                     | Genus name.                                                                 |
| specificEpithet           | Specific epithet.                                                           |
| infraspecificEpithet      | Infrapecific epithet.                                                       |
| taxonRank                 | Lowest taxonomic rank of the record.                                        |
| establishmentMeans        | The process of establishment of the species in the location, using a controlled vocabulary: 'native', 'introduced', 'endemic', "unknown". |
| identificationRemarks     | Information about morphospecies identification (code in Dalberto Teixeira Pombo Collection). |
Additional information

We collected a total of 50412 specimens, belonging to four classes, 20 orders and 81 families of arthropods. A total of 127 species are considered introduced (n = 22646) and 69 native non-endemic (n = 24117). Four endemic species were recorded with very few specimens (n = 14) and 3635 specimens belong to unidentified taxa recorded only at genus or family level.

Arachnids belonged to three orders, Araneae being the most abundant (95% of arachnid specimens belonged to this order). Chilopoda and Diplopoda classes recorded four and three orders, being Lithobiomorpha and Julida, respectively, the most abundant. Insecta was the most abundant class (n = 39590) recorded in the studied agro-ecosystems, with Coleoptera the most abundant order (38% of specimens).

A total of 200 species were identified (Table 2) and an additional 73 morphospecies need proper identification, totalling potentially 273 species (see Suppl. material 1).

| class      | order      | family       | scientificName                        | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|------------|------------|--------------|---------------------------------------|--------|------|--------|---------|---------|-------|
| Arachnida  | Araneae    | Agelenidae   | Tegenaria domestica (Clerck, 1757)     | INTR   | 1    |        | 1       |         |       |
| Arachnida  | Araneae    | Agelenidae   | Tegenaria pagana C.L. Koch, 1840       | INTR   | 3    |        | 2       |         | 5     |
| Arachnida  | Araneae    | Araneidae    | Agalenatae redi (Scopoli, 1763)        | INTR   | 7    |        | 2       |         | 9     |
| Arachnida  | Araneae    | Araneidae    | Araneus angulatus Clerck, 1757         | INTR   | 30   |        |         |         | 30    |
| Arachnida  | Araneae    | Araneidae    | Argiope bruennichi (Scopoli, 1772)     | NAT    | 37   | 50     | 87      |         |       |
| Arachnida  | Araneae    | Araneidae    | Ghibaranea occidentalis Wunderlich, 1989 | END    | 1    |        |         |         |       |
| Arachnida  | Araneae    | Araneidae    | Mangora acalypha (Walckenaer, 1802)    | INTR   | 1    |        |         |         | 1     |
| Arachnida  | Araneae    | Araneidae    | Neoscona crucifera (Lucas, 1838)       | INTR   | 2    | 2      | 4       |         |       |
| Arachnida  | Araneae    | Araneidae    | Zygciella x-notata (Clerck, 1757)      | INTR   | 6    | 12     | 18      |         |       |
| Arachnida  | Araneae    | Clubionidae  | Clubiona terestris Westring, 1851      | INTR   | 2    |        |         |         | 2     |

Table 2.

Inventory of arthropods collected in four agroecosystems in Terceira Island (Azores, Portugal) following an elevation gradient: vineyards (Vine), citrus orchards (Citrus), maize fields at low elevation (Maize L) and at high elevation (Maize H). The list includes only the specimens identified at species-level. Class, order, family, scientific name follow alphabetical sequence. Colonisation status based on Borges et al. 2010 (Origin: END - Endemic; NAT - native non-endemic; INTR - introduced) and abundance per habitat type are provided. Bold scientific names constitute new records for Terceira Island. * - New record for Azores.
| class         | order   | family      | scientificName                          | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|---------------|---------|-------------|----------------------------------------|--------|------|--------|---------|---------|-------|
| Arachnida     | Araneae | Clubionidae | *Porrhoclubiona decora* (Blackwall, 1859) | NAT    | 25   | 4      | 29      |         |       |
| Arachnida     | Araneae | Clubionidae | *Porrhoclubiona genevensis* (L. Koch, 1866) | INTR   | 1    | 1      |         |         |       |
| Arachnida     | Araneae | Dictynidae  | *Lathys dentichelis* (Simon, 1883)      | NAT    | 1    | 1      |         |         |       |
| Arachnida     | Araneae | Dictynidae  | *Nigma puella* (Simon, 1870)            | INTR   | 3    | 3      |         |         |       |
| Arachnida     | Araneae | Dysderidae  | *Dysdera crocata* C. L. Koch, 1838       | INTR   | 4    | 70     | 20      | 15      | 109   |
| Arachnida     | Araneae | Gnaphosida  | *Marinarozelotes lyonneti* (Audouin, 1828) | INTR   | 15   | 15     |         |         | 30    |
| Arachnida     | Araneae | Linyphiidae | *Agyneta decora* (O. Pickard-Cambridge, 1871) | INTR   | 1    | 1      |         |         |       |
| Arachnida     | Araneae | Linyphiidae | *Agyneta fusciapta* (C. L. Koch, 1836)   | INTR   | 28   | 7      | 396     | 18      | 449   |
| Arachnida     | Araneae | Linyphiidae | *Erigone atra* Blackwall, 1833           | INTR   | 1    | 3      | 3       | 13      | 20    |
| Arachnida     | Araneae | Linyphiidae | *Erigone autumnalis* Emerton, 1882       | INTR   | 1    | 309    | 333     | 95      | 738   |
| Arachnida     | Araneae | Linyphiidae | *Erigone dentipalpis* (Wider, 1834)      | INTR   | 2    | 176    | 484     |         | 662   |
| Arachnida     | Araneae | Linyphiidae | *Mermessus bryantae* (Ivie & Barrows, 1935) | INTR   | 2    | 3      | 2       | 7       |       |
| Arachnida     | Araneae | Linyphiidae | *Mermessus tradecorum* (Berland, 1932)   | INTR   | 117  | 7      | 53      | 177     |       |
| Arachnida     | Araneae | Linyphiidae | *Nerinee clahtrata* (Sundevall, 1830)    | INTR   | 3    | 2      | 2       | 7       |       |
| Arachnida     | Araneae | Linyphiidae | *Oedothorax fuscus* (Blackwall, 1834)    | INTR   | 4    | 80     | 577     | 661     |       |
| Arachnida     | Araneae | Linyphiidae | *Ostearius melanopygius* (O. Pickard-Cambridge, 1880) | INTR   | 1    | 6      | 17      | 24      |       |
| Arachnida     | Araneae | Linyphiidae | *Palliduphantes schmitzi* (Kulczynski, 1899) | NAT    | 7    | 1      | 1       | 2       | 11    |
| Arachnida     | Araneae | Linyphiidae | *Pelecopis parallelis* (Wider, 1834)     | INTR   | 32   | 1      | 33      |         |       |
| Arachnida     | Araneae | Linyphiidae | *Prinerigone vagans* (Audouin, 1826)     | INTR   | 130  | 229    | 359     |         |       |
| Arachnida     | Araneae | Linyphiidae | *Tenuiphantes tenuis* (Blackwall, 1852)   | INTR   | 132  | 104    | 177     | 413     |       |
| Arachnida     | Araneae | Lycosidae  | *Arctosa perita* (Latreille, 1799)       | INTR   | 1    | 1      |         |         |       |
| class     | order     | family      | scientificName                          | Origin | VINE | CITRUS L | MAIZE H | Total |
|-----------|-----------|-------------|----------------------------------------|--------|------|----------|---------|-------|
| Arachnida | Araneae   | Lycosida    | *Pardosa acorensis* Simon, 1883         | END    | 6    | 3        | 9       |       |
| Arachnida | Araneae   | Oecobiidae  | *Oecobius navus* Blackwall, 1859        | INTR   | 5    | 5        | 10      |       |
| Arachnida | Araneae   | Salticidae  | *Chalciscorpus infimus* (Simon, 1868)   | INTR   | 14   |          | 14      |       |
| Arachnida | Araneae   | Salticidae  | *Helophasus kochii* Simon, 1868         | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Salticidae  | *Macaroenis diligens* (Blackwall, 1867) | NAT    | 1    | 2        | 3       |       |
| Arachnida | Araneae   | Salticidae  | *Pseudou phosphorys vafra* (Blackwall, 1867) | INTR   | 3    |          | 3       |       |
| Arachnida | Araneae   | Salticidae  | *Salticus mutabilis* Lucas, 1846        | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Salticidae  | *Synageles venator* (Lucas, 1836)      | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Scytolitidae| *Scytodes thoracita* (Latreille, 1802)  | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Segestriidae| *Segestria florentina* (Rossi, 1790)   | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Tetragenathidae | *Pachygnatha degeeri* Sundevall, 1830 | INTR   | 1    | 55       | 56      |       |
| Arachnida | Araneae   | Theridiidae | *Cryptacaea blatta* (Urquhart, 1886)   | INTR   | 5    | 2        | 11      | 18    |
| Arachnida | Araneae   | Theridiidae | *Neottiura bimaculata* (Linnaeus, 1767) | INTR   | 1    |          | 1       |       |
| Arachnida | Araneae   | Theridiidae | *Parasteatoda tepidariorum* (C. L. Koch, 1841) | INTR   | 8    | 69       | 77      |       |
| Arachnida | Araneae   | Theridiidae | *Steatoda grossa* (C. L. Koch, 1838)   | INTR   | 16   | 71       | 87      |       |
| Arachnida | Araneae   | Theridiidae | *Steatoda nobilis* (Thorell, 1875)     | INTR   | 2    |          | 2       |       |
| Arachnida | Araneae   | Theridiidae | *Theridion melanostictum* O. Pickard-Cambridge, 1876 | INTR   | 1    | 3        | 4       |       |
| Arachnida | Araneae   | Theridiidae | *Theridion musivivum* Schmidt, 1956    | NAT    | 1    |          | 1       |       |
| Arachnida | Araneae   | Thomisidae  | *Xysticus nubilus* Simon, 1875          | INTR   | 3    |          | 3       |       |
| Arachnida | Araneae   | Zodariidae  | *Zodarion atlanticum* Pekár & Cardoso, 2005 | INTR   | 934  | 7        | 14      | 1      | 956   |
| Arachnida | Opiliones | Phalangiidae| *Homalenotus coriaceus* (Simon, 1879)   | NAT    | 1    | 156      | 20      | 177   |
| Class          | Order         | Family             | Scientific Name                                      | Origin | VINE | Citrus | Maize | MAIZE | Total |
|---------------|--------------|--------------------|----------------------------------------------------|--------|------|--------|-------|-------|-------|
| Arachnida     | Opiliones    | Phalangiidae       | Leiobunum blackwalli Meade, 1961                    | NAT    | 7    | 12     | 19    |       |       |
| Arachnida     | Pseudoscorpiones | Chthoniidae     | Chthonius ischnocheles (Hermann, 1804)              | INTR   | 8    | 10     | 4     | 22    |       |
| Arachnida     | Pseudoscorpiones | Chthoniidae     | Ehippiumothionis tetrachelatus (Preyssler, 1790)   | INTR   | 18   | 9      | 27    |       |       |
| Arachnida     | Pseudoscorpiones | Neobisiidae    | Neobliaum maroccanum Beier, 1930                    | INTR   | 1    | 2      | 3     |       |       |
| Chilopoda     | Geophilomorpha | Linotaeniidae     | Strigamia crassipes (C.L. Koch, 1835)              | NAT    | 2    | 2      | 2     |       |       |
| Chilopoda     | Lithobiomorpha | Lithobiidae       | Lithobius pilicornis pilicornis Newport, 1844      | NAT    | 15   | 4      | 1     | 1     | 21    |
| Chilopoda     | Scolopendromorpha | Cryptopidae     | Cryptops hortenais (Donovan, 1810)                 | NAT    | 6    | 1      | 2     | 9     |       |
| Chilopoda     | Scutigeromorpha | Scutigeridae      | Scutigera coleoptrata (Linnaeus, 1758)             | INTR   | 34   | 205    | 171   | 27    | 437   |
| Diplopoda     | Chordeumatida | Haplobainosomatida | Haplobainosoma lusitanum Verhoeff, 1900          | INTR   | 6    | 6      | 6     |       |       |
| Diplopoda     | Julida       | Blaniulidae       | Blaniulus gutulatus (Fabricius, 1798)             | INTR   | 1    | 1      | 1     |       |       |
| Diplopoda     | Julida       | Blaniulidae       | Nopoiulus kochii (Gervais, 1847)                 | INTR   | 3    | 3      | 3     |       |       |
| Diplopoda     | Julida       | Blaniulidae       | Proteroiulus fuscus (Am Stein, 1857)              | INTR   | 3    | 3      | 3     |       |       |
| Diplopoda     | Julida       | Julidae           | Brachyiulus pusillus (Leach, 1814)                | INTR   | 138  | 138    |       |       |       |
| Diplopoda     | Julida       | Julidae           | Cylindrocilcius testistriatus (Curtis, 1845)      | INTR   | 1    | 1      | 1     |       |       |
| Diplopoda     | Julida       | Julidae           | Cylindrociulus propinquis (Porat, 1870)           | INTR   | 4    | 14     | 18    |       |       |
| Diplopoda     | Julida       | Julidae           | Ommatoiulus moreleti (Lucas, 1860)                | INTR   | 221  | 1740   | 35    | 217   | 2213  |
| Diplopoda     | Polydesmida  | Polydesmida       | Brachydemos superus Latzel, 1884                  | INTR   | 1    | 1      | 1     |       |       |
| Diplopoda     | Polydesmida  | Polydesmida       | Polydesmus coriaceus Porat, 1870                  | INTR   | 8    | 470    | 12    | 53    | 543   |
| Insecta       | Archaeognatha | Machilidae        | Dilta saxicola (Womersley, 1930)                  | NAT    | 3    | 4      | 7     |       |       |
| class         | order          | family        | scientificName                                                                 | Origin | VINE | CITRUS | MAIZE | MAIZE | Total |
|---------------|----------------|---------------|-------------------------------------------------------------------------------|--------|------|--------|-------|-------|-------|
| Insecta       | Coleoptera     | Anthicidae    | *Hirticollis quadriguttatus* (Rossi, 1792)                                    | NAT    | 1    | 166    | 176   |       | 343   |
| Insecta       | Coleoptera     | Apionidae     | *Aspidapion radiolus* (Marsham, 1802)                                         | NAT    | 1    | 1      | 2     |       | 2     |
| Insecta       | Coleoptera     | Apionidae     | *Ischnopterapion vires* (Herbst, 1797)                                        | INTR   | 6    | 2      | 8     |       | 8     |
| Insecta       | Coleoptera     | Carabidae     | *Acupalpus dubius* Schilsky, 1888                                            | NAT    | 37   | 8      | 45    |       | 45    |
| Insecta       | Coleoptera     | Carabidae     | *Acupalpus flavicollis* (Sturm, 1825)                                         | NAT    | 47   | 1      | 48    |       | 48    |
| Insecta       | Coleoptera     | Carabidae     | *Agonum muehleri muehleri* (Herbst, 1784)                                    | INTR   | 38   | 38     |       |       | 76    |
| Insecta       | Coleoptera     | Carabidae     | *Amara aenea* (De Geer, 1774)                                                | INTR   | 1    | 6      | 15    | 22    | 38    |
| Insecta       | Coleoptera     | Carabidae     | *Anisodactylus birotatus* (Fabricius, 1787)                                   | INTR   | 1    | 3      | 65    | 69    | 69    |
| Insecta       | Coleoptera     | Carabidae     | *Calosoma olivieri* Dejean, 1831                                             | NAT    | 14   | 41     | 55    |       | 55    |
| Insecta       | Coleoptera     | Carabidae     | *Harpalus distinguendus distinguendus* (Duftschmid, 1812)                      | INTR   | 1    | 3      | 40    | 44    | 44    |
| Insecta       | Coleoptera     | Carabidae     | *Laemostenus complanatus* (Dejean, 1828)                                     | INTR   | 5    | 41     | 1      | 47    | 47    |
| Insecta       | Coleoptera     | Carabidae     | *Microlestes negrita negrita* (Wollaston, 1854)                               | NAT    | 6    | 6      |       |       | 6     |
| Insecta       | Coleoptera     | Carabidae     | *Notophilius quadripunctatus* Dejean, 1826                                    | NAT    | 1    | 1      |       |       | 1     |
| Insecta       | Coleoptera     | Carabidae     | *Ocys harpaloides* (Audinet-Serville, 1821)                                  | NAT    | 5    | 5      |       |       | 5     |
| Insecta       | Coleoptera     | Carabidae     | *Paranchus abipes* (Fabricius, 1796)                                         | INTR   | 1    | 16     | 17    |       | 17    |
| Insecta       | Coleoptera     | Carabidae     | *Pseudophonus rufipes* (De Geer, 1774)                                        | INTR   | 7    | 74     | 55    | 6995  | 7131  |
| Insecta       | Coleoptera     | Carabidae     | *Pterostichus vernalis* (Panzer, 1796)                                       | INTR   | 25   | 25     |       |       | 50    |
| Insecta       | Coleoptera     | Chrysomelidae | *Chaetocnema hortensis* (Fourcroy, 1785)                                      | INTR   | 1    | 2      | 3     |       | 3     |
| Insecta       | Coleoptera     | Chrysomelidae | *Chrysolina bankii* (Fabricius, 1775)                                         | NAT    | 10   | 10     |       |       | 10    |
| Insecta       | Coleoptera     | Chrysomelidae | *Epitrix cucumeris* (Harris, 1851)                                           | INTR   | 53   | 4      | 57    |       | 57    |
| class    | order       | family            | scientificName                                      | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|----------|-------------|-------------------|-----------------------------------------------------|--------|------|--------|---------|---------|-------|
| Insecta  | Coleoptera  | Chrysomelidae     | Longitarsus kutcherai (Rye, 1872)                   | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Coccinellidae     | Scymniscus helgae (Fürsch, 1965)                    | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Corylophidae      | Sericoctus lateralis (Gyllenhal, 1827)              | INTR   | 15   | 61     | 268     | 96      | 440   |
| Insecta  | Coleoptera  | Curculionidae     | Calacalles subcarinatus (Israelson, 1984)          | END    | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Curculionidae     | Calthormiocerus curvipes (Wollaston, 1854)         | NAT    | 18   |        |         |         | 18    |
| Insecta  | Coleoptera  | Curculionidae     | Coccotrypes carpophagus (Hornung, 1842)            | INTR   | 71   | 3      | 2       |         | 76    |
| Insecta  | Coleoptera  | Curculionidae     | Naupactus cervinus (Boheman, 1840)                 | INTR   | 4    |        |         |         | 4     |
| Insecta  | Coleoptera  | Curculionidae     | Orthochaetes insignis (Aubé, 1863)                 | NAT    | 1    | 21     |         |         | 22    |
| Insecta  | Coleoptera  | Curculionidae     | Otiorrhynchus crinitus (Gyllenhal, 1834)           | INTR   | 5    |        |         |         | 5     |
| Insecta  | Coleoptera  | Curculionidae     | Otiorrhynchus rugosostriatus (Goeze, 1777)         | INTR   | 4    | 1      |         |         | 5     |
| Insecta  | Coleoptera  | Curculionidae     | Pseudophloeophagus tenax Wollaston, 1854            | NAT    | 2    |        |         |         | 2     |
| Insecta  | Coleoptera  | Curculionidae     | Xyleborinus alni (Nijima, 1909)                    | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Dryophthoridae    | Cosmopolites sordidus (Germar, 1824)               | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Dryophthoridae    | Sphenophorus abbreviatus (Fabricius, 1787)         | INTR   | 4    | 2      | 51      | 57      |       |
| Insecta  | Coleoptera  | Elateridae        | Aeolus melliculus moreleti Tamier, 1860            | INTR   | 8    |        |         |         | 8     |
| Insecta  | Coleoptera  | Elateridae        | Heteroderes azoricus (Tamier, 1860)                | END    | 2    | 1      |         |         | 3     |
| Insecta  | Coleoptera  | Elateridae        | Heteroderes vagus Candèze, 1893                    | INTR   | 3    | 13     |         |         | 16    |
| Insecta  | Coleoptera  | Elateridae        | Melanotus dichrous (Erichson, 1841)                | INTR   | 14   |        |         |         | 14    |
| Insecta  | Coleoptera  | Histeridae        | Caroinops pumilio (Erichson, 1834)                 | INTR   | 1    |        |         |         | 1     |
| class          | order      | family       | scientificName                                                                 | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|----------------|------------|--------------|--------------------------------------------------------------------------------|--------|------|--------|---------|---------|-------|
| Insecta        | Coleoptera | Hydrophiidae | Sphaeridium bipustulatum Fabricius, 1781                                       | INTR   | 1    | 1      | 2       |         |       |
| Insecta        | Coleoptera | Latridiidae  | Cartodore nodifer (Westwood, 1839)                                             | INTR   | 2    | 1      | 3       |         |       |
| Insecta        | Coleoptera | Leiodidae    | Catops coracinus Kellner, 1846                                                 | NAT    | 1    | 1      |         |         |       |
| Insecta        | Coleoptera | Malachiidae  | Altalus lusitanicus lusitanicus Erichson, 1840                                 | NAT    | 2    | 2      |         |         |       |
| Insecta        | Coleoptera | Mycetophagidae | Litargus baleatus Le Conte, 1856                                               | INTR   | 1    | 1      | 2       |         |       |
| Insecta        | Coleoptera | Mycetophagidae | Typhaea stercorea (Linnaeus, 1758)                                             | INTR   | 1    | 642    | 5       | 648     |       |
| Insecta        | Coleoptera | Nilidulidae  | Carpophilus fumatus Boheman, 1851                                              | INTR   | 1    | 1      |         |         |       |
| Insecta        | Coleoptera | Nilidulidae  | Epuraea biguttata (Thunberg, 1784)                                             | INTR   | 49   | 22     | 1       | 72      |       |
| Insecta        | Coleoptera | Nilidulidae  | Phenolia limbata tibialis (Boheman, 1851)                                      | INTR   | 15   | 6      | 1       | 1       | 23    |
| Insecta        | Coleoptera | Nilidulidae  | Stelidota geminata (Say, 1825)                                                 | INTR   | 128  | 18     | 146     |         |       |
| Insecta        | Coleoptera | Phalacridae  | Stilbus testaceus (Panzer, 1797)                                               | NAT    | 1    | 24     | 1       | 26      |       |
| Insecta        | Coleoptera | Ptilidae     | Plenidium pusillum (Gyllenhal, 1808)                                           | INTR   | 4    | 6      | 2       | 12      |       |
| Insecta        | Coleoptera | Scarabaeidae | Calamosternus granarius (Linnaeus, 1767)                                       | INTR   | 7    | 7      |         |         |       |
| Insecta        | Coleoptera | Scarabaeidae | Onthophagus vacca (Linnaeus, 1767)                                             | INTR   | 6    | 6      |         |         |       |
| Insecta        | Coleoptera | Scarabaeidae | Popillia japonica Newman, 1838                                                  | INTR   | 4    | 4      |         |         |       |
| Insecta        | Coleoptera | Silvanidae   | Cryptamorpha desjardinsii (Guetrin-Méneville, 1844)                           | INTR   | 3    | 3      |         |         |       |
| Insecta        | Coleoptera | Staphylinidae | Aleochara bipustulata (Linnaeus, 1760)                                         | INTR   | 1    | 1      | 4       | 6       |       |
| Insecta        | Coleoptera | Staphylinidae | Aloconota sulcifrons (Stephens, 1832)                                         | NAT    | 11   | 11     |         |         |       |
| Insecta        | Coleoptera | Staphylinidae | Amischa analis (Gravenhorst, 1802)                                            | INTR   | 1    | 8      | 48      | 1321    | 1378  |
| class     | order      | family         | scientificName                         | Origin | VINE | CITRUS L | MAIZE H | MAIZE | Total |
|-----------|------------|----------------|----------------------------------------|--------|------|----------|---------|-------|-------|
| Insecta   | Coleoptera | Staphylinidae  | *Anotylus nitidifrons* (Wollaston, 1871) | INTR   | 10   | 377      | 4       | 8     | 399   |
| Insecta   | Coleoptera | Staphylinidae  | *Anotylus nitidulus* (Gravenhorst, 1802) | INTR   | 2    |          |         |       | 2     |
| Insecta   | Coleoptera | Staphylinidae  | *Astenus lyonesius* (Joy, 1908)         | NAT    |      |          |         | 10    | 10    |
| Insecta   | Coleoptera | Staphylinidae  | *Atheta aeneicollis* (Sharp, 1869)      | INTR   | 1    | 2        |         |       | 3     |
| Insecta   | Coleoptera | Staphylinidae  | *Atheta fungi* (Gravenhorst, 1806)      | INTR   | 1    | 76       | 66      | 49    | 192   |
| Insecta   | Coleoptera | Staphylinidae  | *Carpelimus corticinus* (Gravenhorst, 1806) | NAT    |      |          |         | 1     |       |
| Insecta   | Coleoptera | Staphylinidae  | *Coproporus pulchellus* (Erichson, 1839) | INTR   | 6    |          |         |       | 6     |
| Insecta   | Coleoptera | Staphylinidae  | *Cordalia obscura* (Gravenhorst, 1802)  | INTR   | 20   | 17       | 256     | 316   | 609   |
| Insecta   | Coleoptera | Staphylinidae  | *Euplectus infimus* Raaffray, 1910      | INTR   | 1    | 2        |         |       | 3     |
| Insecta   | Coleoptera | Staphylinidae  | *Gabrius nigritulus* (Gravenhorst, 1802) | INTR   |      |          | 2       | 3     | 5     |
| Insecta   | Coleoptera | Staphylinidae  | *Medon apicalis* (Kraatz, 1857)         | NAT    | 1    |          |         | 1     |       |
| Insecta   | Coleoptera | Staphylinidae  | *Ocypus aethiops* (Waltl, 1835)         | NAT    | 308  |          | 1       | 309   |       |
| Insecta   | Coleoptera | Staphylinidae  | *Ocypus olens* (Müller, 1764)          | NAT    | 59   |          | 45      | 104   |       |
| Insecta   | Coleoptera | Staphylinidae  | *Oligota pumilio* Kiesenwetter, 1858    | NAT    | 7    | 70       | 178     | 12    | 267   |
| Insecta   | Coleoptera | Staphylinidae  | *Phloeonomus punctipennis* Thomson, 1867 | NAT    | 1    |          |         | 1     |       |
| Insecta   | Coleoptera | Staphylinidae  | *Proteinus atomarius* Erichson, 1840    | NAT    | 10   |          |         | 10    |       |
| Insecta   | Coleoptera | Staphylinidae  | *Pseudoplectus perplexus* (Jacquelin du Val, 1854) | NAT    | 22   | 4        | 41      | 67    |       |
| Insecta   | Coleoptera | Staphylinidae  | *Quedius curtipennis* Bernhauer, 1908    | NAT    |      |          |         | 1     | 1     |
| Insecta   | Coleoptera | Staphylinidae  | *Rugilus orbiculatus* (Paykull, 1789)   | NAT    | 2    | 365      | 757     | 1124  |       |
| Insecta   | Coleoptera | Staphylinidae  | *Sepedophilus lusitanicus* Hammond, 1973 | NAT    | 4    |          | 4       |       | 4     |
| Insecta   | Coleoptera | Staphylinidae  | *Stenomastax maderae* Assing, 2003      | NAT    | 127  |          |         | 127   |       |
| class    | order       | family       | scientificName                                      | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|----------|-------------|--------------|-----------------------------------------------------|--------|------|--------|---------|---------|-------|
| Insecta  | Coleoptera  | Staphylinidae| *Tachyporus chrysomelinus* (Linnaeus, 1758)         | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Staphylinidae| *Tachyporus nitidulus* (Fabricius, 1781)            | INTR   | 1    | 2      | 5       | 3       | 11    |
| Insecta  | Coleoptera  | Staphylinidae| *Trichiura immigrata* Lohse, 1984                  | INTR   | 3    |        |         |         | 3     |
| Insecta  | Coleoptera  | Staphylinidae| *Xantholinus longiventris* Heer, 1839              | INTR   | 3    | 1      |         |         | 4     |
| Insecta  | Coleoptera  | Tenebrionidae| *Blaps lethifera* Marsham, 1802                     | INTR   | 1    |        |         |         | 1     |
| Insecta  | Coleoptera  | Tenebrionidae| *Lagria hirta* (Linnaeus, 1758)                     | INTR   | 1    |        |         |         | 1     |
| Insecta  | Dermaptera  | Anisolabididae| *Euborellia annulipes* (Lucas, 1847)             | INTR   | 2    | 116    | 26      | 144     |       |
| Insecta  | Dermaptera  | Forficulidae  | *Forficula auricularia* Linnaeus, 1758             | INTR   | 2    | 155    | 232     | 389     |       |
| Insecta  | Hemiptera   | Anthocoridae  | *Anthocoris nemoralis* (Fabricius, 1794)          | NAT    | 1    |        |         |         | 1     |
| Insecta  | Hemiptera   | Anthocoridae  | *Orinus laevigatus laevigatus* (Fieber, 1860)     | NAT    | 1    |        |         |         | 1     |
| Insecta  | Hemiptera   | Aphididae     | *Rhopalosiphoninus latysiphon* (Davidson, 1912)   | INTR   | 6    | 43     | 49      |         | 49    |
| Insecta  | Hemiptera   | Cicadellidae  | *Anoscopus albifrons* (Linnaeus, 1758)            | NAT    | 1    | 3      | 6       | 10      |       |
| Insecta  | Hemiptera   | Cicadellidae  | *Cicadella viridis* (Linnaeus, 1758)              | INTR   | 3    |        |         |         | 3     |
| Insecta  | Hemiptera   | Cicadellidae  | *Euscelidius variegatus* (Kirschbaum, 1858)       | NAT    | 72   | 10     | 82      |         |       |
| Insecta  | Hemiptera   | Cicadellidae  | *Sophonia orientalis* (Matsumura, 1912)            | INTR   | 1    |        |         |         | 1     |
| Insecta  | Hemiptera   | Cydnidae      | *Geotomus punctulatus* (A. Costa, 1847)           | NAT    | 33   | 3      | 3       | 1       | 40    |
| Insecta  | Hemiptera   | Delphacidae   | *Kelisia ribaudi* Wagner, 1938                     | NAT    | 8    | 41     | 116     | 165     |       |
| Insecta  | Hemiptera   | Delphacidae   | *Megamelodes quadrmaculatus* (Signoret, 1865)      | NAT    | 1    |        |         |         | 1     |
| Insecta  | Hemiptera   | Lygaeidae     | *Aphanus rolandri* (Linnaeus, 1758)               | NAT    | 7    | 3      |         | 10      |       |
| Insecta  | Hemiptera   | Lygaeidae     | *Heterogaster urticae* (Fabricius, 1775)          | NAT    | 1    |        |         |         | 1     |
| class     | order       | family        | scientificName                  | Origin | VINE | CITRUS | MAIZE L | MAIZE H | Total |
|-----------|-------------|---------------|---------------------------------|--------|------|--------|---------|---------|-------|
| Insecta   | Hemiptera   | Lygaeidae     | Kleidocerys ericae (Horváth, 1909) | NAT    | 1    |        |         |         | 1     |
| Insecta   | Hemiptera   | Lygaeidae     | Oxyccarenus lavaterae (Fabricius, 1787) | INTR   | 1    |        |         |         | 1     |
| Insecta   | Hemiptera   | Lygaeidae     | Scolopostethus decoratus (Hahn, 1833) | NAT    | 6    | 33     | 1       | 1       | 41    |
| Insecta   | Hemiptera   | Microphysidae | Loricula elegantula (Bärensprung, 1858) | NAT    | 1    |        |         |         | 1     |
| Insecta   | Hemiptera   | Miridae       | Campyloneura virgula (Herrick-Schaeffer, 1835) | NAT    | 1    |        |         |         | 1     |
| Insecta   | Hemiptera   | Miridae       | Heterotoma planicornis (Pallas, 1772) | NAT    | 4    |        |         |         | 4     |
| Insecta   | Hemiptera   | Miridae       | Pilophorus confusus (Kirschbaum, 1856) | NAT    | 1    |        |         |         | 1     |
| Insecta   | Hemiptera   | Miridae       | Trigonotylus caelestialis (Kirkaldy, 1902) | NAT    | 493  | 231    | 724     |         |       |
| Insecta   | Hemiptera   | Nabidae       | Nabis pseudoferus ibericus Remane, 1962 | NAT    | 7    | 46     | 53      |         |       |
| Insecta   | Hemiptera   | Pentatomidae  | Nezara viridula (Linnaeus, 1758) | INTR   | 5    | 6      | 11      |         |       |
| Insecta   | Hemiptera   | Reduviidae    | Empicoris rubromaculatus (Blackburn, 1889) | INTR   | 10   | 1      | 11      |         |       |
| Insecta   | Hemiptera   | Reduviidae    | Ploiaria domestica Scopoli, 1786 | INTR   | 1    |        | 1       |         |       |
| Insecta   | Hemiptera   | Saltidae      | Saldula palustris (Douglas, 1874) | NAT    | 1    |        | 1       |         |       |
| Insecta   | Hemiptera   | Tingidae      | Acalypsa parvula (Fallén, 1807) | NAT    | 5    | 4      | 9       |         |       |
| Insecta   | Hymenoptera | Apidae        | Bombus terrestris (Linnaeus, 1758) | INTR   | 1    | 1      | 2       |         |       |
| Insecta   | Hymenoptera | Formicidae    | Hypoponera educari (Forel, 1894) | NAT    | 12   | 32     | 37      | 99      | 180   |
| Insecta   | Hymenoptera | Formicidae    | Lasius grandis Forel, 1909 | NAT    | 10283| 3058   | 1444    | 1091    | 15876 |
| Insecta   | Hymenoptera | Formicidae    | Linepithema humile (Mayr, 1868) | INTR   | 2    |        | 2       |         |       |
| Insecta   | Hymenoptera | Formicidae    | Monomorium carbonarium (Smith, 1858) | NAT    | 272  | 367    | 1       | 640     |       |
| Insecta   | Hymenoptera | Formicidae    | Tetramorium caespitum (Linnaeus, 1758) | NAT    | 327  | 1329   | 1202    | 451     | 3309  |
| Insecta   | Hymenoptera | Formicidae    | Tetramorium caldarium (Roger, 1857) | INTR   | 215  | 135    | 1       | 351     |       |
The five most abundant species account for 64% of all identified specimens and include two ant species: *Lasius grandis* Forel, 1909 (Hymenoptera: Formicidae) (n = 15876) and *Tetramorium caespitum* (Linnaeus, 1758) (Hymenoptera: Formicidae) (n = 3309), the ground-beetle *Pseudoophonus rufipes* (De Geer, 1774) (Coleoptera, Carabidae (n = 7131), the millipede (Diplopoda: Julida) *Ommatoiulus moreleti* (Lucas, 1860) (n = 2213) and the cricket (Orthoptera: Gryllidae) *Eumodicogryllus bordigalensis* (Latreille, 1804) (n = 1561).

Within the non-identified morphospecies, the most abundant taxa was a millipede (MF 1006) with 1959 specimens mostly sampled in high elevation maize fields (see Suppl. material 1).

Considering only identified species, a total of 10062 (21.48%), 7622 (16.27%), 16390 (34.99%) and 12763 (27.27%) specimens were collected and identified at species level in citrus orchards, low elevation maize fields, high elevation maize fields and vineyards, respectively (Table 2).

The most abundant species in vineyards were the native ant *Lasius grandis* (n = 10283), the introduced spider *Zodarion atlanticum* Pekár & Cardoso, 2005 (n = 934) and the native ant *Tetramorium caespitum* (n = 327) (Table 2).

The most abundant species in citrus orchards were the native ant *L. grandis* (n = 3058), the introduced millipede *Ommatoiulus moreleti* (n = 1740) and the native ant *T. caespitum* (n = 1329) (Table 2).
The most abundant species in low elevation maize fields were also ants, *L. grandis* (n = 1444) and *T. caespitum* (n = 1202), followed by the exotic beetle *Typhaea stercorea* (Linnaeus, 1758) (n = 642) and the mirid bug *Trigonotylus caelestialium* (Kirkaldy, 1902) (n = 493) (Table 2).

Finally, the most abundant species in high elevation maize fields were the introduced ground-beetle *Pseudoophonus rufipes* (n = 6995), the introduced cricket *Eumodicogryllus bordigalensis* (n = 1559), the two rove-beetles *Amischa analis* (Gravenhorst, 1802) (n = 1321) and *Rugilus orbiculatus* (Paykull, 1789) (757) and also the ant *L. grandis* (n =1091).

Two spiders usually very abundant in intensive pastures are also relatively abundant, *Oedothorax fuscus* (Blackwall, 1834) (n = 577) and *Erigone dentipalpis* (Wider, 1834) (n = 484) (Table 2).

Although the introduced species potentially have the ability to colonise and spread in human-disturbed habitats (e.g. Rigal et al. 2017), our results showed that Azorean agroecosystems represent habitat opportunities for native arthropods. Some of the most abundant species are generalist predators with omnivorous behaviour, like the ants and the ground-beetle *P. rufipes*. Remarkable was the high abundance of the predatory spider *Z. atlanticum* in vineyards that feed on ants and may act as an ED provider. Most other predators potentially provide an ES to the Azorean agroecosystem habitats, particularly in maize fields and vineyards, through biological control of pests (e.g. Heimpel and Mills 2017). Introduced species can also affect native species of arthropods, for example, through opportunistic predation. However, introduced species may also supplement the functional traits lost after the decline of native species in these habitats (e.g. Stavert et al. 2018).

Five species are new records for Terceira Island: three beetles (Coleoptera), one millipede (Diplopoda: Julida) and one true bug (Hemiptera). The new beetle records included one specimen sampled of *Lagria hirta* (Linnaeus, 1758), eight of *Ischnopterapion virens* (Herbst, 1797) and six of *Microlestes negrita negrita* (Wollaston, 1854). All these individuals were collected in maize fields. The new millipede record included three specimens of *Nopoiulus kochii* (Gervais, 1847), also collected in maize fields, but at low elevation. Finally, the new hemipteran record included three specimens of *Cicadella viridis* (Linnaeus, 1758) from a citrus orchard. All new records belong to introduced species, with the exception of *M. negrita negrita*, which is native to the Azores.

*Lagria hirta* (Coleoptera, Tenebrionidae) is a new record for Azores. We have also recently sampled this species in the Island of Santa Maria. This seems to be a recent introduction in Azores, being still rare in Terceira, but already widespread in Santa Maria.

**Future perspectives**

Importantly, the EU Biodiversity Strategy 2020 lists, as a priority, the mapping and assessment of the state of biodiversity, ecosystems and their services in all EU member states (Maes et al. 2016). Azores are part of Europe’s nine Outermost Regions (ORs) for
which there is a general lack of ES mapping and assessment as compared with mainland Europe (Sieber et al. 2018).

By focusing on Azorean Island agroecosystems (e.g. maize fields, vineyards, citrus orchards) and having the current baseline monitoring data, we aim to develop in the near future a multifaceted approach to gain more insight to evaluate the relative importance of native and exotic arthropod organisms as ecosystem services (ES)/ ecosystem disservices (ED) providers. In this way, it will be possible to understand the ecosystem processes and functions and the goods and services arthropods provide for improving the resilience of Azorean agro-ecosystems, as well as human well-being.

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Author contributions

PAVB, PM, DHL, AOS, AG, FR, GL and MF contributed to study conceptualisation. PAVB, LLL, RN, PM, DHL and MF performed the fieldwork. PAVB, RN and RC performed the species sorting and identification. PAVB, EP 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 sampled species and mophospecies

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Data type: Occurrences
Brief description: Detailed complete list of sampled species and morphospecies with indication of the morphospecies codes in the column (Identification Remarks)
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