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Data Paper

Biodiversity insights from BioBlitz Surveys on Terceira Island, Azores

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Abstract

Background

This manuscript is the first scientific publication of the project “BioBlitz Azores". The project was launched in 2019 and had a second event in 2023 under the scope of the FCT-MACRISK project, surveying the historic public garden "Jardim Duque da Terceira", in the historical centre of Angra do Heroísmo, Terceira Island (Azores, Portugal). In addition to contributing directly to the knowledge of Azorean biota, BioBlitz Azores aims to engage the non-scientific community - including volunteers, amateur naturalists, students, teachers, families and other garden visitors - to foster a sense of community and raise awareness about Azorean biodiversity and its conservation.

New information

Under the scope of two BioBlitz events, the list of taxa of the historic garden of "Jardim Duque da Terceira" (Terceira, Azores, Portugal) was updated and presently includes 72 lichen species, 55 vascular plant species, 96 arthropod species, 14 bird species and three freshwater vertebrate species.

In the realm of lichens, two species are new records for Portugal and Macaronesia, one species is a new record for the Azores and nine species are new records for Terceira Island. This is the first academic publication for 11 of the 12 lichen species.

The survey of arthropods yielded an inventory encompassing a total of 96 taxa, with 78 of these identified to the species or subspecies level; amongst the identified taxa, three are endemic, 32 are native, but not endemic, one is of indeterminate origin and 42 are introduced. Notably, a single specimen of the rare endemic spider, *Savigniorrhipis acoreensis* Wunderlich, 1992 was observed for the first time at this low elevation (garden elevation: 29-60 m a.s.l.). The species is typically found in the canopies of endemic trees species in native forests at mid- to high elevations (500-1000 m a.s.l.) and its presence in the garden suggests a source-sink dynamic of this extremely dispersive species between native and anthropogenic habitats.

Regarding vascular plants, 54 taxa were recorded in the garden, comprising one endemic, one native, three with indeterminate origin and 49 introduced ornamental species.

Amongst birds, 14 taxa were registered, including seven Azorean endemic subspecies, two native species and four introduced taxa.

Three freshwater vertebrate species were recorded during the survey, all of which are exotic species that have been introduced to the garden.

Keywords

biodiversity, citizen science, historic garden, lichens, vascular plants, arthropods, birds

Introduction

Bioblitz events provide a valuable platform for biodiversity assessment, general public engagement and conservation action, making them a powerful tool to understand and protect the natural world (Parker et al. 2018, Meeus et al. 2023). The Bioblitz concept was first developed in 1996 by the National Park Service in the United States, in which scientists and the public conducted an intensive survey of the biodiversity at the Kenilworth Aquatic Gardens within a 24-hour period, thus setting the model for future BioBlitz events (Ruch et al. 2010). This kind of events are now common and provide several benefits, the most important being arguably public involvement in biodiversity surveys (Parker et al. 2018, Meeus et al. 2023, Palma et al. 2024). Bioblitz events promote non-scientific public-engagement with biodiversity, but are also currently used as a baseline for biodiversity monitoring, helping to track changes over time and provide information for conservation strategies (Palma et al. 2024). More importantly, these events can build stronger connections within the local community, encouraging ongoing collaboration and support for biodiversity initiatives and be a powerful tool for environmental education (Páez-Vacas et al. 2023). Following several of the "Partners" principle (Mishra et al. 2017), which encourage building strong relationships with local people (presence effect), bioblitzes invest in attracting new public (aptness principle), engage in open and honest communication (respect principle) and act as a bridge between local communities and wildlife experts and managers (strategic support principle).

Given the recognition of an increasing disconnection between people and nature (Soga and Gaston 2023), bioblitzes may foster pro-environmental attitudes and behaviour (Dean et al. 2018) and establish long-term engagement and advocacy for biodiversity stewardship (Gass et al. 2021). Bioblitzes may also often attract media coverage, which can further raise awareness about biodiversity issues and promote conservation messages to a broader audience (Francis et al. 2017).

Importantly, BioBlitz events, when combined with digital platforms and apps, can contribute to larger databases, such as GBIF (Global Biodiversity Information Facility) and iNaturalist (Biodiversity4All - Portuguese platform), enhancing global biodiversity records and research (Aristeidou et al. 2021).

In Portugal, bioblitzes are organised periodically since 2013, following the first event led by the Serralves Foundation in Oporto. This event typically involves collaboration with universities, research institutions and environmental organisations, featuring a variety of activities, including species identification workshops, guided tours and educational sessions for all ages (de Vasconcelos Monteiro 2015). Other BioBlitz events occur in Oeiras and Lisbon, often involving local schools, universities and environmental groups,

but also aiming to catalogue urban and peri-urban biodiversity and raising awareness about the natural richness within the city (Tiago et al. 2024). Some events focus on particular groups, such as plants (Chozas et al. 2023, Tiago et al. 2024), pollinators (Fontúrbel et al. 2024) or freshwater microinvertebrates (Laforest et al. 2013), others encompass a broader taxonomic range (see revision in Meeus et al. (2023)), but all provide valuable biodiversity data.

Being part of the Mediterranean biodiversity hotspot (Myers et al. 2000, Neff 2001) and the Macaronesia biogeographical region (Fernández-Palacios et al. 2024), the Azorean Archipelago, located in the North Atlantic Ocean, is of significant biodiversity importance due to its unique combination of geographic isolation, varied habitats and high levels of endemism (Borges et al. 2020, Borges et al. 2022). The Archipelago features a wide range of habitats, including several types of native forests (Elias et al. 2016) that are now restricted to mid- and high elevations and are threatened by the impact of exotic species (Borges et al. 2006, Borges et al. 2020) and climatic changes (Ferreira et al. 2016).

Low elevation habitats are mostly anthropogenic and highly disturbed, not only by urbanisation, but also by the introduction of exotic species (Barreiros et al. 2010, Borges et al. 2013, Lamelas-López et al. 2023, Boieiro et al. 2024). However, recent evidence shows that some Azorean lowland-endemic arthropod species are still present at low isolated forest patches (Tsafack et al. 2021).

Parks and gardens, often located in urban areas at low elevation, may serve as sentinels both for the introduction of new alien species - often coming from ports and airports near the coast, while contributing to the safeguarding of indigenous non-target species due to the high humidity and great diversity of substrates available. Thus, complementary species, such as insects, spiders, lichens and bryophytes, may thrive in gardens, contributing to increasing the ecological complexity of those areas. These spaces may provide shelter from anthropogenic pressures, benefitting rare and/or threatened species. In fact, some historic gardens in the Azores have proven to be quite rich in arthropod species (e.g. Arteaga et al. (2020), Lamelas-López et al. (2023)), while different recreational parks succeed in increasing the bryophyte diversity of the Region (e.g. Polaino-Martín et al. (2020)). Concomitantly, it is also true that many invasive alien species, presently occurring in the Azores and elsewhere, were originally ornamental plant species that escaped gardens and parks (Gabriel 2019).

Therefore, BioBlitz events conducted in low-elevation habitats, such as the public garden in Angra do Heroísmo (29-60 m a.s.l.), are expected to provide novel data on the presence and distribution of rare endemic species on one hand, while also improving the data on recently introduced exotic species' distributions.

General description

Purpose: The main objective of this publication is to share the results of the BioBlitz multi-taxa inventories in the “Jardim Duque da Terceira” in Angra do Heroísmo (Terceira Island,

Azores, Portugal) that took place in 2019 and in 2023. Beyond documenting the rich biodiversity of this unique location, this publication aims also to:

- Inspire local and global communities to engage in citizen-science and biodiversity monitoring initiatives.
- Encourage policy-makers, researchers and conservationists to prioritise the improvement of urban habitats for biodiversity conservation.
- Serve as an educational resource, demonstrating the value of collaborative efforts amongst scientists, citizens and educators in exploring and protecting natural heritage.
- Highlight the cultural and scientific importance of integrating historic gardens like "Jardim Duque da Terceira" into conservation strategies.

Thus, this publication aspires to contribute to the broader goals of biodiversity research, environmental education and the sustainable management of urban green spaces, contributing to biodiversity conservation.

Project description

Title: BioBlitz Azores: Multitaxa inventories of the biodiversity of "Jardim Duque da Terceira" (Duke of Terceira Garden, Angra do Heroísmo,Terceira Island, Azores, Portugal)

Personnel: The project was conceived and is being led by Isabel R. Amorim and Jagoba Malumbres-Olarte.

Fieldwork (site selection and experimental setting): António Félix Rodrigues, Cecília Melo, Isabel R. Amorim, Jagoba Malumbres-Olarte, Lucas Lamelas-López, Paulo Barcelos, Paulo A. V. Borges, Rúben Coelho, Susana Gonçalves.

Fieldwork (authorisation): José Álamo Meneses (Mayor of Angra do Heroísmo).

Fieldwork (Higher taxa coordination): The lichen inventory was coordinated by António Félix Rodrigues; the vascular plants inventory was coordinated by Susana Gonçalves and Paulo J.M. Barcelos; the arthropod inventory was coordinated by Paulo A.V. Borges; the bird inventory was coordinated by Cecília Melo and Rúben Coelho. In the 2019 BioBlitz Azores, the freshwater invertebrate survey was led by Lucas Lamelas-López.

Fieldwork (Trainers in place): Abrão Leite, Alejandra Ros-Prieto, António Félix Rodrigues, Gabor Pozsgai, Guilherme Oyarzabal, Isabel R. Amorim, Jagoba Malumbres-Olarte, Mário Boieiro, Paulo A.V. Borges, Paulo J.M. Barcelos, Paulo Mendonça, Ricardo Costa, Rúben Coelho, Sébastien Lhoumeau, Sophie Wallon, Susana Gonçalves, Cecília Melo.

Parataxonomists (Laboratory): ARTHROPODA - Abrão Leite, Alejandra Ros-Prieto, Laurine Parmentier.

Taxonomists: António Félix Rodrigues and Rosalina Gabriel (lichens); Paulo A.V. Borges (arthropods); Lucas Lamelas-López (freshwater organisms); Susana Gonçalves and Paulo J.M. Barcelos (vascular plants); Cecília Melo and Rúben Coelho (birds).

Arthropod Curation: Voucher specimen management was mainly undertaken by Alejandra Ros-Prieto, Abrão Leite, Ricardo Costa and Paulo A. V. Borges.

Lichens Curation: Voucher specimen management was undertaken by António Félix Rodrigues.

Darwin Core Databases: Paulo A.V. Borges, Sébastien Lhoumeau, Sandra Videira, Rosalina Gabriel.

Study area description: This study was conducted in Angra do Heroísmo, on Terceira Island (Azores, Portugal).

Terceira Island (total area: 400.2 km²; maximum elevation: 1021 m above sea level) is part of the central group of the Azores Archipelago in the North Atlantic, located approximately at coordinates 38°43′40″N, 27°12′48″W. The climate of the Azores Archipelago is temperate oceanic, characterised by regular and abundant rainfall, high levels of relative humidity and persistent western winds (Forjaz 2004). The landscape of the islands is predominantly urban and agricultural at lower elevations, with pasturelands and exotic tree plantations inland and native forests at higher elevations (Elias et al. 2016).

The "Jardim Duque da Terceira" (Fig. 1) is a public historic garden located in the centre of Angra do Heroísmo, the largest city of Terceira Island. This garden is named after the Duke of Terceira, a hero of the Liberal Wars (1832-1834), a title commemorating the island's historical significance and contribution to history. Established on 18 January 1888, the "Jardim Duque da Terceira" features a mix of exotic plant species from around the world (Arteaga et al. 2020, Lamelas-López et al. 2023), most of them with informative plates regarding their taxonomy and biogeographic origin. The layout of "Jardim Duque da Terceira" features winding paths and distinct thematic sections, including rose gardens, tropical plant collections and shaded groves. This garden is both a botanical treasure and a cultural and historical landmark of Angra do Heroísmo City.

Design description: During the BioBlitz Açores, both in 2019 (Malumbres-Olarte et al. 2019) and 2023 (Amorim et al. 2023, Borges et al. 2023), a range of targeted and specialised sampling protocols were employed to assess biodiversity across different taxa (see below).

Each session was about two hours long and participants could choose their area/taxa of interest beforehand: lichens, arthropods, freshwater organisms, birds and vascular plants. The sessions began with a briefing to explain the process and goals of the BioBlitz, setting expectations on what participants would learn and how they would contribute to local biodiversity knowledge. In addition to field observations, a mini-laboratory was set up in the garden where participants could use binocular

stereereomicroscopes and hand lenses to examine finer details of specimens, which are crucial for the identification of smaller species like insects, spiders or lichens. The combination of in situ observations with subsequent laboratory work is a well-established and complementary method in biodiversity assessments. Laboratory work allows for detailed taxonomic verification. Preserved specimens serve as vouchers that can be re-examined, compared against reference collections and used for DNA barcoding, ensuring robustness in species identification. The sampling was conducted under the necessary permits and ethical guidelines. The number of specimens collected was minimised to balance scientific needs with conservation imperatives.

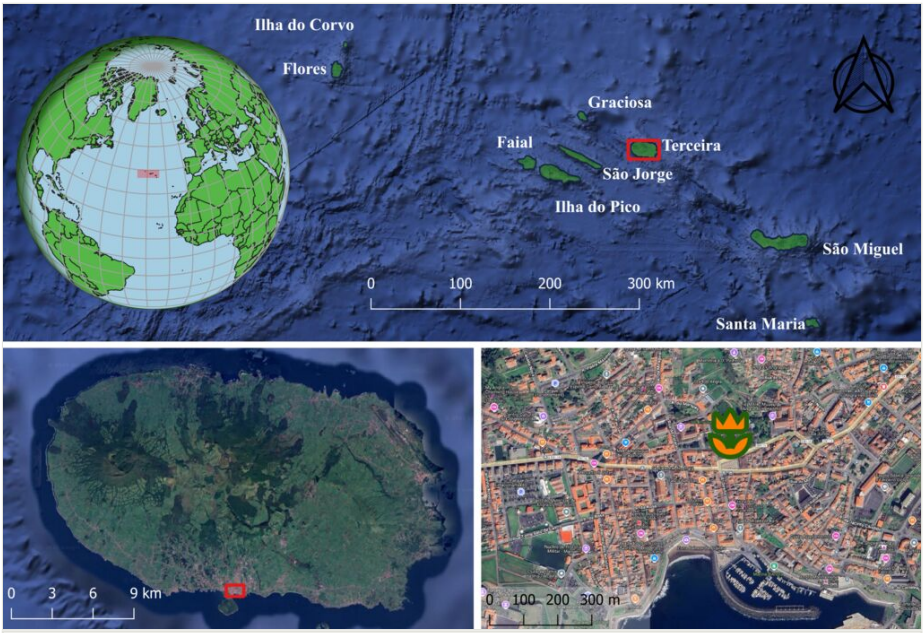

Figure 1. doi

The location of the Garden "Jardim Duque da Terceira" in Terceira Island (Azores) (Credit: Gabor Pozsgai).

Funding: Azorean Regional Secretariat for the Sea, Science and Technology; Azorean Regional Directorate of Science and Technology - BioBLitz Azores (DRCT M3.4.B/CIÊNCIA CIDADÃ/004/2019/RTF/033).

Science and Technology Foundation (FCT) - MACRISK-Trait-based prediction of extinction risk and invasiveness for Northern Macaronesian arthropods (FCT-PTDC/BIA-CBI/0625/2021).

Portal da Biodiversidade dos Açores (2022-2023) - PO Azores Project - M1.1.A/INFRAEST CIENT/001/2022 (2022).

FCT-UIDB/00329/2020-2024, DOI 10.54499/UIDB/00329/2020 (Thematic Line 1–integrated ecological assessment of environmental change on biodiversity).

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Azores DRCT Pluriannual Funding (M1.1.A/FUNC.UI&D/010/2021-2024).

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Sampling methods

Sampling description: Lichens: The search for lichens mainly involved visual inspection of tree bark and rocks. Participants occasionally collected samples for closer examination under magnification tools to accurately identify the species.

Vascular Plants: Participants examined various plant features such as size, leaves, flowers and fruit details and, in some cases, utilised their senses of smell and touch to aid in species identification.

Arthropods: Different capture and observation techniques were applied depending on the habitat and the type of arthropods being studied. These techniques were explained in detail to participants before the start of the session. Two main methods were used: a) **Sweep Netting** through which participants used sweep nets to collect arthropods from vegetation (involving sweeping a net through the foliage where arthropods might be resting or feeding, which is effective for catching flying or jumping insects); and b) **Beat Sampling**, which was used to dislodge arthropods from trees and bushes. For the latter, participants held a sheet or tray under a branch and then shook or beat the branch, causing arthropods to fall on to the sheet for collection and identification.

Birds: Birdwatching required participants to be quiet and observant, using binoculars and listening for bird calls to locate and identify species both in the tree canopy and on the ground.

Freshwater organisms: Fish and amphibians observations required the participants to quietly observe the water stream and pools in several locations of the garden.

Quality control: Species taxonomic nomenclature for arthropods follows Borges et al. (2022). For lichens several sources were followed (Aptroot et al. 2010, Lücking et al. 2017a, Lücking et al. 2017b). Concerning vascular plants, we followed Silva et al. (2010) and, for birds and amphibians, we followed Rodrigues et al. (2010).

Geographic coverage

Description: This study was conducted in a city public garden "Jardim Duque da Terceira" in Angra do Heroísmo on Terceira Island (Azores, Portugal).

Coordinates: 38.655 and 38.661 Latitude; -27.223 and -27.213 Longitude.

Taxonomic coverage

Taxa included:

Rank	Scientific Name	Common Name
phylum	Ascomycota	Lichens
phylum	Ginkgophyta	*Ginkgo*
phylum	Pteridophyta	Ferns
phylum	Pinophyta	Conifers
phylum	Magnoliophyta	Flowering plants
phylum	Arthropoda	Arthropods
class	Actinopterygii	Fish
class	Amphibia	Frog
class	Aves	Birds

Temporal coverage

Notes: BioBlitz Azores was conducted on 27 July 2019 and 17 June 2023.

Collection data

Collection name: For the collected arthropods - Entomoteca Dalberto Teixeira Pombo at University of the Azores.

Collection identifier: DTP

Specimen preservation method: Alcohol.

Usage licence

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

Data resources

Data package title: BioBlitz Azores: Multitaxa inventories of the biodiversity of “Jardim Duque da Terceira” (Angra do Heroísmo, Terceira Island, Azores, Portugal).

Resource link: https://doi.org/10.15468/eqc6n5

Alternative identifiers: https://www.gbif.org/dataset/1c3fa6fb-4242-461a-ba66-742143b3ae57

Number of data sets: 2

Data set name: Event Table

Character set: UTF-8

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

Data format: Darwin Core Archive

Data format version: 1.5

Description: The dataset was published in the Global Biodiversity Information Facility platform, GBIF (Borges et al. 2025). 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 58 records (eventID). This GBIF IPT (Integrated Publishing Toolkit, Version 2.5.6) 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. 2025).

Column label	Column description
id	Unique identification code for sampling event data.
type	The nature or genre of the resource, as defined by the Dublin Core standard. In our case "PhysicalObject" or "Event".
datasetName	The name (or acronym) in use by the institution having ownership of the object(s) or information referred to in the record. In our case, we use different names for each taxonomic group.
eventID	Identifier of the events, unique for the dataset.
samplingProtocol	The sampling protocol used to capture or observe the species.
sampleSizeValue	The numeric amount of time spent in each sampling.
sampleSizeUnit	The unit of the sample size value.
eventDate	Range during which the record was collected.
year	The four-digit year in which the dwc:Event occurred, according to the Common Era Calendar.
month	The integer month in which the dwc:Event occurred.

day	The integer day of the month on which the dwc:Event occurred.
habitat	The habitat from which the sample was obtained.
locationID	Identifier of the location.
continent	The name of the continent in which the dcterms:Location occurs (Europe).
islandGroup	Name of archipelago, always Azores in the dataset.
island	Name of the island, always Terceira in the dataset.
country	Country of the sampling site, always Portugal in the dataset.
countryCode	ISO code of the country of the sampling site, always PT in the dataset.
municipality	Municipality of the sampling site, always Angra do Heroísmo in the dataset.
locality	Name of the locality, always Angra do Heroísmo in the dataset.
minimumElevationInMetres	The lower limit of the range of elevation (altitude, above sea level), in metres.
decimalLatitude	Approximate decimal latitude.
decimalLongitude	Approximate decimal longitude.
geodeticDatum	The ellipsoid, geodetic datum or spatial reference system (SRS), upon which the geographic coordinates given in decimalLatitude and decimalLongitude are based, always WGS84 in the dataset.
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.
fieldNumber	Code for the sample.

Data set name: Occurrence Table

Character set: UTF-8

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

Data format: Darwin Core Archive

Data format version: 1.5

Description: The dataset was published in the Global Biodiversity Information Facility platform, GBIF (Borges et al. 2025). 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 490 records

(occurrenceID). This GBIF IPT (Integrated Publishing Toolkit, Version 2.5.6) 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. 2025).

Column label	Column description
id	Unique identification code for sampling event data.
licence	Reference to the licence under which the record is published.
institutionID	The identity of the institution publishing the data.
collectionID	The identity of the collection publishing the data.
institutionCode	The code of the institution 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.
establishmentMeans	The process of establishment of the species in the location, using a controlled vocabulary: 'native', 'introduced', 'endemic', 'indeterminate'.
occurrenceRemarks	Comments or notes about the dwc:Occurrence, namely the substrate in which some lichens were found.
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	Comments or notes about the dwc:Identification. We mention the AZORES BIOPORTAL code for the vascular plants and vertebrates and the Morphspecies code for the arthropods.
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.
infraspecificEpithet	Infraspecific epithet.
taxonRank	Lowest taxonomic rank of the record.
scientificNameAuthorship	Name of the author of the lowest taxon rank included in the record.

Additional information

In the surveys across several taxonomic groups, a total of 240 taxa was documented, including 221 species or subspecies level identifications.

In the realm of lichens, 72 taxa were identified, highlighting both their ecological significance and diversity. In the past decades, the known diversity of lichens in the Azores has been steadily increasing, reflecting a growing comprehension of this important group in the Archipelago (Aptroot et al. 2009, Aptroot et al. 2010, Rodrigues et al. 2024, Rodrigues and Aptroot 2024). Several species are new records for Terceira (nine species), Azores (one species) and Portugal and Macaronesia (two species) (see Table 1).

Verseghya thysanophora (R.C.Harris) S.Y.Kondr., is a leprose, crustose lichen, with a thallus characterised by a thin, patchy layer of granular soredia, ranging in colour from pale green to yellowish-green, often encircled by a conspicuous white, fibrous prothallus. It was originally described under the genus *Lecanora.* The lichen is widely distributed across the Northern Hemisphere, usually growing on bark of deciduous trees; however, in "Jardim Duque da Terceira" (Angra do Heroísmo, Terceira, Azores), it was found colonising a rocky wall. *Biatora efflorescens* (Hedl.) Räsänan is a crustose lichen, with a granular, greyish to green thallus. This lichen has a Northern Hemisphere distribution and is mainly found on forests, growing on non-saxicolous substrates; indeed, in Terceira Island, it was found colonising a tree. Both lichens are new records for Portugal and Macaronesia.

Table 1.

List of lichens found in Public Garden "Jardim Duque da Terceira" (Angra do Heroísmo, Terceira Island).

Class	**Order**	**Family**	**Scientific Name**
Arthoniomycetes	Arthoniales	Arthoniaceae	*Arthonia atra* (Pers.) A.Schneid.
		Chrysotrichaceae	*Chrysothrix candelaris* (L.) J.R.Laundon
		Lecanographaceae	*Alyxoria varia* (Pers.) Ertz & Tehler
		Opegraphaceae	*Opegrapha vermicellifera* (J.Kunze) J.R.Laundon
			Opegrapha vulgata (Ach.) Ach.

Class	Order	Family	Scientific Name
		Roccellaceae	*Dirina massiliensis* Durieu & Mont.
			Enterographa crassa (DC.) Fée
			Enterographa hutchinsiae (Leight.) A.Massal.
			Pseudoschismatomma rufescens (Pers.) Ertz & Tehler
			Roccella fuciformis (L.) DC.
			Roccella tinctoria DC.
		Roccellographaceae	*Roccellographa circumscripta* (Leight.) Ertz & Tehler
Candelariomycetes	Candelariales	Candelariaceae	*Candelariella vitellina* (Ehrh.) Müll.Arg.
Eurotiomycetes	Verrucariales	incertae sedis	*Botryolepraria lesdainii* (Hue) Canals, Hern.-Mariné, Gómez-Bolea & Llimona
Lecanoromycetes	Caliciales	Caliciaceae	*Amandinea punctata* (Hoffm.) Coppins & Scheid.
			Buellia disciformis (Fr.) Mudd
			Buellia griseovirens (Turner & Borrer ex Sm.) Almb.
			Buellia subdisciformis (Leight.) Vain.
			Diploicia canescens (Dicks.) A.Massal.
			Diplotomma alboatrum (Hoffm.) Flot.
			Diplotomma ambiguum (Ach.) Flagey
			Dirinaria applanata (Fée) D.D.Awasthi
			Pyxine sorediata (Ach.) Mont.
			Pyxine subcinerea Stirt.
		Physciaceae	*Hyperphyscia adglutinata* (Flörke) H.Mayrhofer & Poelt
			Physcia caesia (Hoffm.) Fürnr.
			Physcia dimidiata (Arnold) Nyl.
			Polyblastidium albicans (Pers.) S.Y. Kondr., Lőkös & Hur
	Graphidales	Graphidaceae	*Graphis scripta* (L.) Ach.
	Lecanorales	Cladoniaceae	*Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng.
			Cladonia ochrochlora Flörke
			Herteliana gagei (Sm.) J.R.Laundon
			Lepraria incana (L.) Ach.
			Lepraria lobificans Nyl.

Class	Order	Family	Scientific Name
			Lepraria membranacea (Dicks.) Vain.
		Lecanoraceae	*Carbonicola anthracophila* (Nyl.) Bendiksby & Timdal
			Lecanora campestris (Schaer.) Hue
			Lecanora cenisia Ach.
			Lecanora chlarotera Nyl.
			Myriolecis dispersa (Pers.) Śliwa, Zhao Xin & Lumbsch
			Protoparmeliopsis muralis (Schreb.) M.Choisy
			Pyrrhospora quernea (Dicks.) Körb.
		Parmeliaceae	*Hypotrachyna revoluta* (Flörke) Hale
			Parmotrema reticulatum (Taylor) M.Choisy
			Parmotrema robustum (Degel.) Hale
			Parmotrema tinctorum (Despr. ex Nyl.) Hale
		Ramalinaceae	*Bacidia arceutina* (Ach.) Arnold
			Bacidia laurocerasi (Delise ex Duby) Zahlbr.
			Biatora efflorescens (Hedl.) Räsänan
			Ramalina bourgaeana Mont. ex Nyl.
			Ramalina farinacea (L.) Ach.
			Ramalina lusitanica H.Magn.
			Ramalina requienii (De Not.) Jatta
		Tephromelataceae	*Mycoblastus affinis* (Schaer.) T.Schauer
			Tephromela atra (Huds.) Hafellner
	Lecideales	Lecideaceae	*Clauzadea immersa* (Hoffm.) Hafellner & Bellem.
	Peltigerales	Collemataceae	*Blennothallia crispa* (Hudson) Otálora, P.M.Jørg. & Wedin
			Collema furfuraceum (Arnold) Du Rietz
			Collema subflaccidum Degel.
			Enchylium tenax (Sw.) Gray
		Pannariaceae	*Fuscopannaria nebulosa* (Hoffm.) E.Tripp & Lendemer
	Pertusariales	Ochrolechiaceae	*Ochrolechia androgyna* (Hoffm.) Arnold
		Pertusariaceae	*Pertusaria hymenea* (Ach.) Schaer.
			Pertusaria pertusa (L.) Tuck.

Class	Order	Family	Scientific Name
			Verseghya thysanophora (R.C.Harris) S.Y.Kondr.
		Variolariaceae	*Lepra amara* (Ach.) Hafellner
	Teloschistales	Teloschistaceae	*Caloplaca dalmatica* (A. Massal.) H.Olivier
			Gyalolechia flavorubescens (Huds.) Søchting, Frödén & Arup
			Polycauliona candelaria (Linnaeus) Frödén, Arup & Søchting
			Variospora flavescens (Huds.) Arup, Frödén & Søchting
			Xanthoria parietina (L.) Th.Fr.
	Umbilicariales	Ophioparmaceae	*Hypocenomyce scalaris* (Ach. ex Lilj.) M.Choisy

The first record of *Lepraria membranacea* (Dicks.) Vain. in the Azores was documented during the 2023 BioBlitz event (Amorim et al. 2023) and it has subsequently been cited from two additional locations in Terceira Island (Rodrigues and Aptroot 2024). It is a leprose, crustose lichen characterised by a pale yellowish to cream-coloured thallus, that forms well-defined, lobed, membrane-like rosettes. It is a cosmopolitan lichen species, with widespread distribution across Europe and North America. It generally grows on acidic rocks and, in Terceira Island, was found growing on lapilli.

Finally, according to the latest Azorean checklist (Aptroot et al. 2010) and the Azorean Biodiversity Portal (ABP 2024), nine species are new records for Terceira Island: *Diplotomma ambiguum* (Ach.) Flagey, previously known from Faial Island; *Fuscopannaria nebulosa* (Hoffm.) E.Tripp & Lendemer, previously known from Pico and Faial Islands; *Hypocenomyce scalaris* (Ach. ex Lilj.) M.Choisy (Fig. 2b) and *Opegrapha vermicellifera* (J.Kunze) J.R.Laundon, previously known from São Miguel Island; *Hypotrachyna revoluta* (Flörke) Hale (Fig. 2c) and *Physcia caesia* (Hoffm.) Fürnr., previously known from São Miguel Island and recently observed also in Corvo Island (Rodrigues et al. 2024); *Polycauliona candelaria* (Linnaeus) Frödén, Arup & Søchting (Fig. 2f), previously known from Pico and São Jorge Islands; *Pertusaria pertusa* (L.) Tuck. (Fig. 2d), previously known from Faial and São Miguel Islands; and *Pseudoschismatomma rufescens* (Pers.) Ertz & Tehler (Fig. 2e), previously known from Graciosa Island.

In addition, the species *Botryolepraria lesdainii* (Hue) Canals, Hern.-Mariné, Gómez-Bolea & Llimona (Fig. 2a) was observed for the first time in Terceira Island during the BioBlitz event in 2023 (Amorim et al. 2023) and it has subsequently been cited from two additional locations in the Island (Rodrigues and Aptroot 2024). The crustose lichen *Mycoblastus affinis* (Schaer.) T.Schauer, had been referred to Terceira Island without any precise location by Aptroot et al. (2010) and its presence is now confirmed for the "Jardim Duque da Terceira", Angra do Heroísmo, Terceira, Azores.

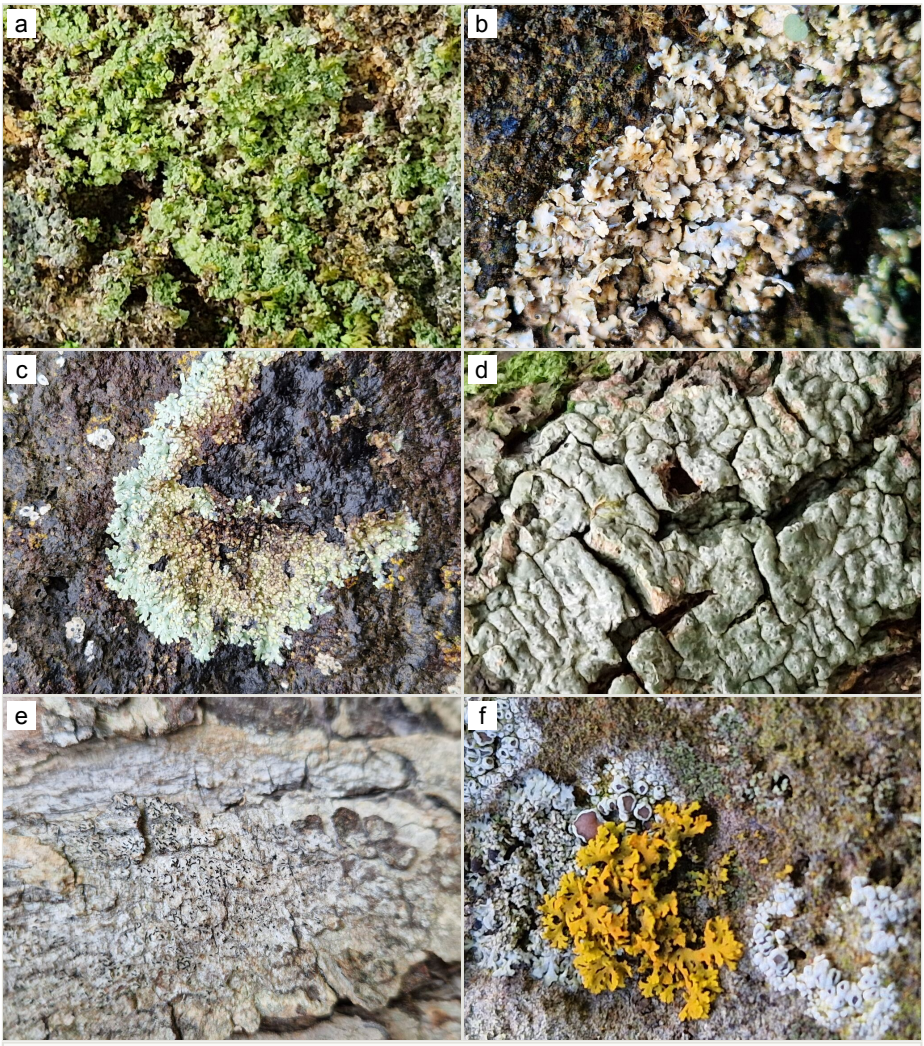

Figure 2.

Pictures of some of the lichens observed for the first time in Terceira Island at "Jardim Duque da Terceira" in Angra do Heroísmo City:

a: *Botryolepraria lesdainii* (Credit: A.F. Rodrigues); doi
b: *Hypocenomyce scalaris* (Credit: A.F. Rodrigues); doi
c: *Hypotrachyna revoluta* (Credit: A.F. Rodrigues); doi
d: *Pertusaria pertusa* (Credit: A.F. Rodrigues); doi
e: *Pseudoschismatomma rufescens* (Credit: A.F. Rodrigues); doi
f: *Polycauliona candelaria* (Credit: A.F. Rodrigues). doi

Regarding vascular plants, 54 taxa were distinguished, comprising 52 identified at species level - including one endemic, one native, one with indeterminate origin and 49 introduced species (Table 2). This mix emphasises the influence of both native and non-native species on the local flora, dominated in this garden by exotic species (Arteaga et

al. 2020, Lamelas-López et al. 2023). Despite being dominated by exotic species, gardens play crucial ecological and human health/well-being functions. Even if the species are not native, they can offer necessary shelter and food for local fauna, contributing to urban biodiversity. Indeed, in this public garden, vascular plants enhance biodiversity by structuring habitats and providing resources for a variety of wildlife, including lichens, bryophytes, arthropods and birds. Moreover, the diversity of plant species in a public garden can serve as a living library that promotes education about different flora from around the world. Thus, notwithstanding the invasive potential, that needs to be assessed, exotic vascular plants can have practical uses in research and education, providing opportunities for botanical studies and supporting programmes that teach about plant taxonomy, biology, ecology and conservation.

Table 2.

List of the identified Vascular Plants. The several Phyla are in bold.

Phylum/Class	Order	Family	Scientific Name	Colonisation Status
Ginkgophyta				
Ginkgoopsida	Ginkgoales	Ginkgoaceae	*Ginkgo biloba* L.	introduced
Magnoliophyta				
Liliopsida	Alismatales	Araceae	*Monstera deliciosa* Liebm.	introduced
	Arecales	Arecaceae	*Phoenix canariensis* H.Wildpret	introduced
	Asparagales	Amaryllidaceae	*Agapanthus africanus* Hoffmanns.	introduced
		Asparagaceae	*Agave attenuata* Salm-Dyck	introduced
			Asparagus densiflorus (Kunth) Jessop	introduced
			Chlorophytum comosum (Thunb.) Jacques	introduced
			Dracaena draco (L.) L.	indeterminate
		Asphodelaceae	*Aloe arborescens* Mill.	introduced
	Commelinales	Pontederiaceae	*Eichhornia crassipes* Solms	introduced
	Poales	Cyperaceae	*Cyperus papyrus* L.	introduced
		Poaceae	*Festuca glauca* Vill.	introduced
			Festuca petraea Guthnick ex Seub.	endemic
	Zingiberales	Cannaceae	*Canna indica* L.	introduced
		Strelitziaceae	*Strelitzia nicolai* Regel & K.Koch	introduced
			Strelitzia reginae Banks	introduced
Magnoliopsida	Apiales	Apiaceae	*Schefflera arboricola* (Hayata) Merr.	introduced

Phylum/Class	Order	Family	Scientific Name	Colonisation Status
	Aquifoliales	Aquifoliaceae	*Ilex perado* Soland. ex Aiton	introduced
	Ericales	Ericaceae	*Rhododendron indicum* Sweet	introduced
		Theaceae	*Camellia japonica* L.	introduced
	Fabales	Fabaceae	*Ceratonia siliqua* L.	introduced
			Trifolium repens L.	introduced
			Wisteria sinensis Sweet	introduced
	Gentianales	Apocynaceae	*Nerium oleander* L.	introduced
			Plumeria rubra L.	introduced
		Rubiaceae	*Coffea arabica* L.	introduced
			Coprosma repens A.Rich.	introduced
	Lamiales	Lamiaceae	*Lavandula dentata* L.	introduced
	Laurales	Lauraceae	*Cinnamomum camphora* (L.) J.Presl	introduced
			Persea americana Mill.	introduced
			Phoebe indica Pax	introduced
	Magnoliales	Magnoliaceae	*Liriodendron tulipifera* L.	introduced
			Magnolia grandiflora L.	introduced
	Malpighiales	Euphorbiaceae	*Acalypha wilkesiana* Mull.Arg.	introduced
	Malvales	Malvaceae	*Brachychiton acerifolius* F.Muell.	introduced
			Ceiba speciosa (A.St.-Hil., A.Juss. & Cambess.) Ravenna	introduced
			Hibiscus rosa-sinensis L.	introduced
			Hibiscus syriacus L.	introduced
			Tilia cordata Mill.	introduced
	Myrtales	Lythraceae	*Lagerstroemia indica* L.	introduced
		Myrtaceae	*Corymbia citriodora* (Hook.) K.D.Hill & L.A.S.Johnson	introduced
			Eugenia uniflora L.	introduced
			Metrosideros excelsa Gaertn.	introduced
	Nymphaeales	Nymphaeaceae	*Nymphaea alba* L.	introduced
	Rosales	Moraceae	*Ficus microcarpa* L.f.	introduced

Phylum/Class	Order	Family	Scientific Name	Colonisation Status
			Ficus pumila L.	introduced
			Morus nigra L.	introduced
	Solanales	Solanaceae	*Brugmansia suaveolens* Bercht. & J.Presl	introduced
Pinophyta				
Pinopsida	Pinales	Araucariaceae	*Araucaria heterophylla* (Salisb.) Franco	introduced
		Podocarpaceae	*Podocarpus macrophyllus* Sweet	introduced
Pteridophyta				
Polypodiopsida	Cyatheales	Cyatheaceae	*Sphaeropteris cooperi* (F. Muell.) R.M.Tryon	introduced
	Polypodiales	Pteridaceae	*Adiantum capillus-veneris* L.	native

The survey of arthropods yielded an inventory encompassing a total of 96 taxa, with 78 of these identified to the species or subspecies level (Table 3). Our findings included three endemic taxa, 32 native, one of indeterminate origin and 42 introduced taxa. Notably, we observed the presence of the rare endemic spider, *Savigniorrhipis acoreensis* Wunderlich, 1992 (Araneae, Linyphiidae) (Fig. 3a). This species is typically restricted to the canopies of endemic trees within native forests at mid- to high elevations. Based on the species' life-history traits (Macías-Hernández et al. 2020) and its widespread distribution across several islands in the Azores (Borges et al. 2022, Pozsgai et al. 2024), this specimen may be indicative of a source–sink dynamic that facilitates dispersal between native environments and anthropogenic habitats. Notably, the individual collected from this garden marks the first record from a coastal, unprotected area on Terceira Island, showing the capacity of certain human-modified habitats to support endemic taxa in the region (Tsafack et al. 2021, Boieiro et al. 2025).

Table 3.

List of identified arthropods at species or subspecies level.

Class	Order	Family	Scientific Name	Colonisation Status
Arachnida	Araneae	Araneidae	*Agalenatea redii* (Scopoli, 1763)	introduced
			Araneus angulatus Clerck, 1757	introduced
			Argiope bruennichi (Scopoli, 1772)	native
			Mangora acalypha (Walckenaer, 1802)	introduced
			Neoscona crucifera (Lucas, 1838)	introduced
		Cheiracanthiidae	*Cheiracanthium mildei* L. Koch, 1864	introduced
		Clubionidae	*Porrhoclubiona decora* (Blackwall, 1859)	native

Class	Order	Family	Scientific Name	Colonisation Status
		Dictynidae	*Emblyna acoreensis* Wunderlich, 1992	endemic
			Nigma puella (Simon, 1870)	introduced
		Linyphiidae	*Erigone autumnalis* Emerton, 1882	introduced
			Mermessus bryantae (Ivie & Barrows, 1935)	introduced
			Mermessus fradeorum (Berland, 1932)	introduced
			Savigniorrhipis acoreensis Wunderlich, 1992	endemic
			Tenuiphantes tenuis (Blackwall, 1852)	introduced
		Mimetidae	*Ero aphana* (Walckenaer, 1802)	introduced
		Salticidae	*Heliophanus kochii* Simon, 1868	introduced
			Macaroeris diligens (Blackwall, 1867)	native
			Pseudeuophrys vafra (Blackwall, 1867)	introduced
			Salticus mutabilis Lucas, 1846	introduced
		Tetragnathidae	*Metellina merianae* (Scopoli, 1763)	introduced
		Theridiidae	*Cryptachaea blattea* (Urquhart, 1886)	introduced
			Paidiscura orotavensis (Schmidt, 1968)	native
			Steatoda nobilis (Thorell, 1875)	native
Diplopoda	Julida	Julidae	*Ommatoiulus moreleti* (Lucas, 1860)	introduced
Insecta	Coleoptera	Apionidae	*Aspidapion radiolus* (Marsham, 1802)	introduced
			Kalcapion semivittatum semivittatum (Gyllenhal, 1833)	indeterminate
		Chrysomelidae	*Longitarsus kutscherai* (Rye, 1872)	introduced
		Coccinellidae	*Clitostethus arcuatus* (Rossi, 1794)	introduced
			Novius cardinalis (Mulsant, 1850)	introduced
			Rhyzobius lophanthae (Blaisdell, 1892)	introduced
			Scymniscus helgae (Fürsch, 1965)	introduced
			Scymnus interruptus (Goeze, 1777)	native
			Stethorus pusillus (Herbst, 1797)	native
		Corylophidae	*Sericoderus lateralis* (Gyllenhal, 1827)	introduced
		Curculionidae	*Coccotrypes carpophagus* (Hornung, 1842)	introduced
			Lixus pulverulentus (Scopoli, 1763)	introduced

Class	Order	Family	Scientific Name	Colonisation Status
			Naupactus cervinus (Boheman, 1840)	introduced
			Sitona discoideus Gyllenhal, 1834	introduced
		Elateridae	*Heteroderes azoricus* (Tarnier, 1860)	endemic
			Heteroderes vagus Candèze, 1893	introduced
		Nitidulidae	*Brassicogethes aeneus* (Fabricius, 1775)	introduced
			Carpophilus fumatus Boheman, 1851	introduced
		Phalacridae	*Stilbus testaceus* (Panzer, 1797)	native
		Silvanidae	*Cryptamorpha desjardinsii* (Guérin-Méneville, 1844)	introduced
		Staphylinidae	*Carpelimus zealandicus* (Sharp, 1900)	introduced
	Hemiptera	Cicadellidae	*Anoscopus albifrons* (Linnaeus, 1758)	native
			Euscelidius variegatus (Kirschbaum, 1858)	native
			Sophonia orientalis (Matsumura, 1912)	introduced
		Delphacidae	*Kelisia ribauti* Wagner, 1938	native
		Flatidae	*Siphanta acuta* (Walker, 1851)	introduced
		Miridae	*Heterotoma planicornis* (Pallas, 1772)	native
			Pilophorus confusus (Kirschbaum, 1856)	native
			Pilophorus perplexus Douglas & Scott, 1875	native
			Taylorilygus apicalis (Fieber, 1861)	introduced
			Trigonotylus caelestialium (Kirkaldy, 1902)	native
		Nabidae	*Nabis pseudoferus ibericus* Remane, 1962	native
		Reduviidae	*Ploiaria chilensis* (Philippi, 1862)	introduced
		Rhyparochromidae	*Heterogaster urticae* (Fabricius, 1775)	native
			Scolopostethus decoratus (Hahn, 1833)	native
		Triozidae	*Trioza laurisilvae* Hodkinson, 1990	native
	Hymenoptera	Formicidae	*Hypoponera eduardi* (Forel, 1894)	native
			Lasius grandis Forel, 1909	native
			Linepithema humile (Mayr, 1868)	introduced
			Monomorium carbonarium (Smith, 1858)	native
			Tetramorium caespitum (Linnaeus, 1758)	native

Class	Order	Family	Scientific Name	Colonisation Status
			Tetramorium caldarium (Roger, 1857)	introduced
	Lepidoptera	Noctuidae	*Autographa gamma* (Linnaeus, 1758)	native
		Tineidae	*Oinophila v-flava* (Haworth, 1828)	introduced
	Neuroptera	Chrysopidae	*Chrysoperla lucasina* (Lacroix, 1912)	introduced
	Odonata	Aeshnidae	*Anax imperator* Leach, 1815	native
	Orthoptera	Tettigoniidae	*Phaneroptera nana* Fieber, 1853	native
	Psocodea	Caeciliusidae	*Valenzuela burmeisteri* (Brauer, 1876)	native
			Valenzuela flavidus (Stephens, 1836)	native
		Ectopsocidae	*Ectopsocus briggsi* McLachlan, 1899	introduced
			Ectopsocus strauchi Enderlein, 1906	native
		Epipsocidae	*Bertkauia lucifuga* (Rambur, 1842)	native
		Trichopsocidae	*Trichopsocus clarus* (Banks, 1908)	native
	Thysanoptera	Phlaeothripidae	*Hoplothrips corticis* (De Geer, 1773)	native

Other interesting sampled endemic species were the spider *Emblyna acoreensis* Wunderlich, 1992 (Fig. 3b) and the beetle *Heteroderes azoricus* (Tarnier, 1860) (Fig. 3c), usually common at low elevations in Azores and associated with both native vegetation and exotic trees.

The BioBlitz event on Terceira Island revealed a limited assemblage of introduced freshwater species (Table 4). The survey recorded *Carassius auratus* (goldfish) from the family Cyprinidae, *Gambusia holbrooki* (eastern mosquitofish) from the family Poeciliidae and *Pelophylax perezi* (Iberian water frog) from the family Ranidae (Fig. 4). These non-native species are clear indicators of human-mediated introductions that have not only reshaped the local freshwater ecosystems in the garden, but also signalled broader alterations to Azorean freshwater habitats. Their presence suggests that ongoing anthropogenic activities are influencing habitat composition and dynamics, potentially leading to alterations in native biodiversity and ecosystem processes. This finding emphasises the importance of monitoring and managing invasive species to safeguard the ecological integrity of freshwater systems in the region, a challenge that is increasingly critical in light of rapid environmental changes and urban expansion.

Regarding birds, this event documented 14 taxa (Table 4) (Fig. 5), including seven Azorean endemic subspecies, two native species and five introduced taxa, reflecting a significant endemic presence at lower elevation.

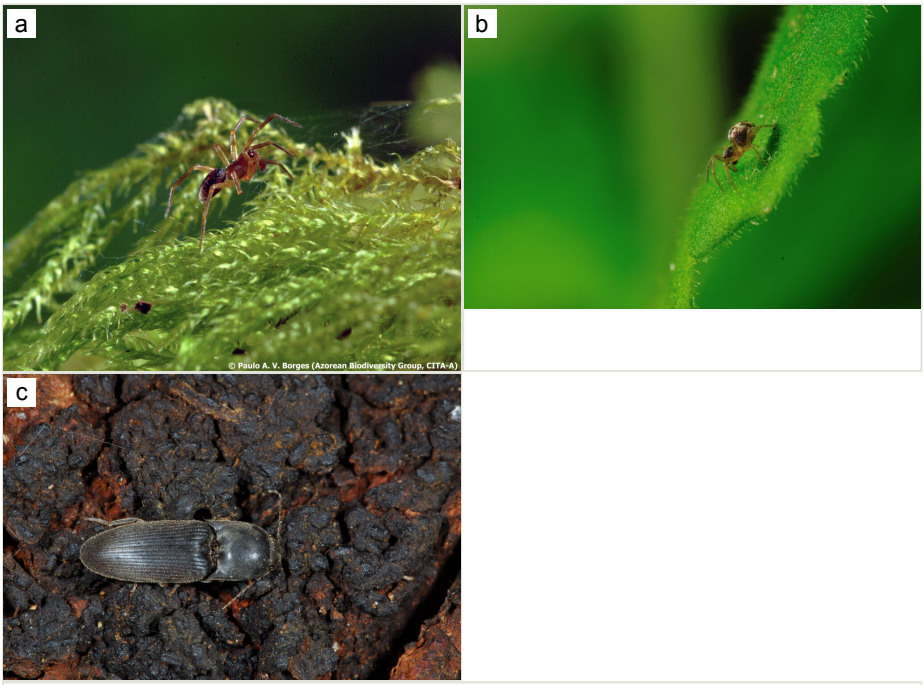

Figure 3.

Examples of endemic arthropods:

a: *Savigniorrhipis acoreensis* (Credit: Paulo A. V. Borges); doi
b: The endemic spider *Emblyna acoreensis* (Credit: Paulo A.V. Borges); doi
c: The elaterid beetle *Heteroderes azoricus* (Credit: Pedro Cardoso). doi

Table 4.

The list of identified Chordata.

Class	Order	Family	Scientific Name	Colonisation status
Actinopterygii	Cypriniformes	Cyprinidae	*Carassius auratus* (Linnaeus, 1758)	introduced
		Poecilidae	*Gambusia holbrooki* Girard, 1859	introduced
Amphibia	Anura	Ranidae	*Pelophylax perezi* (López-Seoane, 1885)	introduced
Aves	Accipitriformes	Accipitridae	*Buteo buteo rothschildi* Swann, 1919	endemic
	Charadriiformes	Laridae	*Larus michahellis atlantis* Dwight, 1922	endemic
	Columbiformes	Columbidae	*Columba livia* Gmelin, JF, 1789	introduced
			Columba palumbus azorica Hartert, E, 1905	endemic
			Streptopelia decaocto (Frivaldszky, 1838)	native
	Passeriformes	Estrildidae	*Estrilda astrild* (Linnaeus, 1758)	introduced

Class	Order	Family	Scientific Name	Colonisation status
		Fringillidae	*Carduelis carduelis parva* Tschusi, 1901	introduced
			Chloris chloris aurantiiventris (Cabanis, 1851)	introduced
			Serinus canaria (Linnaeus, 1758)	native
		Motacillidae	*Motacilla cinerea patriciae* Vaurie, 1957	endemic
		Passeridae	*Passer domesticus* (Linnaeus, 1758)	introduced
		Sturnidae	*Sturnus vulgaris granti* Hartert, E, 1903	endemic
		Sylviidae	*Sylvia atricapilla gularis* Alexander, 1898	endemic
		Turdidae	*Turdus merula azorensis* Hartert, E, 1905	endemic

Figure 4. doi

The Iberian water frog *Pelophylax perezi* (Credit: Pedro Cardoso).

Amongst the larger birds, observed flying over the garden, were two endemic subspecies: *Buteo buteo rothschildi* Swann, 1919 (Azores buzzard), a key avian predator in the Archipelago and *Larus michahellis atlantis* Dwight, 1922 (Atlantic yellow-legged gull), commonly seen patrolling coastal and inland areas. Recorded also were *Columba palumbus azorica* Hartert, E, 1905 (Azores wood pigeon) (Fig. 5a), an endemic subspecies favouring wooded environments and *Columba livia* Gmelin, JF, 1789 (rock pigeon), an introduced species often associated with human settlements. The native *Streptopelia decaocto* (Frivaldszky, 1838) (Eurasian collared dove) was also present. In the garden itself, a variety of passerines were actively feeding and singing. Endemic

species included *Motacilla cinerea patriciae* Vaurie, 1957 (Azores grey wagtail), *Sturnus vulgaris granti* Hartert, E, 1903 (Azores common starling), *Sylvia atricapilla gularis* Alexander, 1898 (Azores blackcap) (Fig. 5c) and *Turdus merula azorensis* Hartert, E, 1905 (Azores blackbird) (Fig. 5d), all of which play vital ecological roles in seed dispersal and insect control. The native *Serinus canaria* (Linnaeus, 1758) (wild canary) (Fig. 5b), was also present. Introduced passeriforms included *Estrilda astrild* (Linnaeus, 1758) (common waxbill), *Carduelis carduelis parva* Tschusi, 1901 (European goldfinch), *Chloris chloris aurantiiventris* (Cabanis, 1851) (European greenfinch) and *Passer domesticus* (Linnaeus, 1758) (house sparrow), species that have established themselves in the Island's urban and rural landscapes. Their presence underscores the influence of human-mediated introductions on local avian biodiversity.

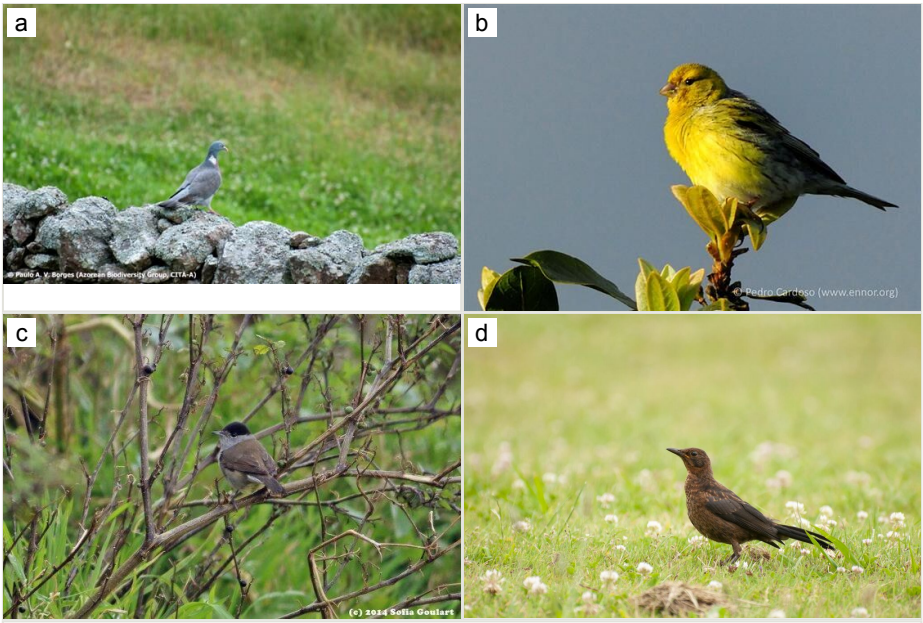

Figure 5.

Examples of birds from the Azores:

a: *Columba palumbis azorenesis* (Credit: Paulo A. V. Borges); doi
b: *Serinus canaria* (Credit: Pedro Cardoso); doi
c: *Sylvia atricapilla gularis* (Credit: Sofia Goulart); doi
d: *Turdus merula azorensis* (Credit: Paulo A. V. Borges). doi

Strengthening the Scientific Contribution

The BioBlitz surveys on Terceira Island provide a valuable opportunity to address critical knowledge gaps in Azorean biodiversity research (Malumbres-Olarte et al. 2019, Amorim et al. 2023, Borges et al. 2023). While the biodiversity of the Azores is well-documented, particularly in natural forested habitats (Borges et al. 2006, Borges et al. 2020, Borges et al. 2022), urban green spaces remain understudied in terms of their potential role in

harbouring both native and exotic species. This study helps to bridge that gap by systematically documenting species occurrences in a public garden, an often overlooked habitat in regional biodiversity assessments.

Comparisons with previous biodiversity studies in the Azores suggest that urban gardens, such as "Jardim Duque da Terceira", act as both a source-sink dynamic between habitats, refuges for native biodiversity, while simultaneously serving as entry points for exotic species (Arteaga et al. 2020, Lamelas-López et al. 2023). The findings from our bioblitzes provide additional records that enhance our understanding of species distributions, particularly for lichens, arthropods and vascular plants. Notably, our study confirms the presence of species previously unrecorded in this urban setting, including both recently introduced non-native species and locally rare endemic species.

Preliminary analyses suggest the detection of new or rare species, reinforcing the value of citizen-science initiatives in biodiversity discovery and monitoring. For example, the identification of a rare lichen species in the 2023 BioBlitz suggests that microhabitats within urban gardens may support cryptic biodiversity that has not been well-documented. Additionally, the presence of Azorean endemic arthropods at low elevations (Tsafack et al. 2021) aligns with recent findings that small patches of urban green spaces can provide microclimatic-suitable conditions for native species facing habitat loss.

Importantly, this dataset holds strong potential for long-term biodiversity monitoring. By providing baseline data from 2019 and 2023, this study establishes a foundation for tracking species turnover, population dynamics and invasion processes in future BioBlitz Azores events. Continued monitoring using standardised survey methods could provide information for conservation management strategies, particularly in urban settings where biodiversity is under pressure from habitat fragmentation/destruction and climate change (Ferreira et al. 2016). Moreover, repetitive sampling can provide information on the population dynamics of the area, which is crucial to assess its adequacy as refuge for indigenous species. Future studies should integrate molecular approaches (genetics/ genomics) to enhance taxonomic resolution and track genetic shifts in populations over time.

By incorporating this dataset into global biodiversity platforms (GBIF), our findings contribute to broader efforts in data compilation, mobilisation and open-access biodiversity research. The combination of community engagement and rigorous scientific methodology ensures that BioBlitz events remain a valuable tool for both public education and biodiversity conservation in the Azores and beyond.

Concluding Remarks

The BioBlitz Azores events at "Jardim Duque da Terceira" have provided critical insights into the biodiversity of urban green spaces in the Azores, reinforcing their ecological and conservation value. These surveys highlight the scientific impact of combining citizen science with rigorous taxonomic assessments, demonstrating that even small, anthropogenic habitats can support native, endemic and newly-introduced species. By

systematically documenting species richness across multiple taxa — including lichens, vascular plants, arthropods, birds and freshwater vertebrates — this initiative has established a baseline dataset that can be used for future biodiversity monitoring and comparative studies. Importantly, the conservation implications of these findings extend beyond scientific discovery. Urban gardens, such as "Jardim Duque da Terceira", may function as microhabitat refuges for native and endemic species, contributing to the resilience of island biodiversity in the face of habitat loss and climate change. In fact, being an historic garden funded in 1822, "Jardim Duque da Terceira" may be providing suitable habitat for many species for the past two centuries.

Future research will build on this dataset by implementing long-term biodiversity monitoring programmes to track species turnover, population trends and the effects of environmental change in urban and semi-natural habitats. Additional efforts will focus on seasonal and day-time and night-time surveys to capture temporal and daily variation in species assemblages, as well as the application of DNA-based identification techniques to improve taxonomic resolution for cryptic or morphologically challenging taxa (e.g. the case of arthropod morphospecies not yet identified). Expanding BioBlitz Azores to other locations within Terceira Island and, more importantly, to other Azorean Islands will further enhance our understanding of island biogeography, species distributions and conservation needs in human-modified landscapes.

By fostering continued public engagement and integrating citizen science with professional biodiversity assessments, BioBlitz Azores serves as a model for participatory biodiversity conservation, strengthening connections between people and nature, while generating high-quality biodiversity data for research and policy development.

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