Marine algal (seaweed) flora of Terceira Island, Azores

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Abstract

Background

As for many other Azorean Islands, the macroalgal flora of Terceira (belonging to the central group of the archipelago) is poorly known, the published information reflecting occasional collections of sporadic visitors to the island. In order to overcome this and contribute to improve the knowledge of Azorean macroalgal flora at both local and regional scales, a thorough investigation was conducted. Both collections and presence data recordings were undertaken at the littoral and sublittoral levels down to approximately 40 m around the island, covering a total area of approximately 49 km². This paper lists the taxonomic records and provides information on each species’ ecology and occurrence on the Island’s littoral.
New information

A total of 418 specimens (including taxa identified only to genus level) belonging to 147 taxa of macroalgae, comprising 95 Rhodophyta, 33 Chlorophyta and 19 Ochrophyta (Phaeophyceae) are registered. Of these, 113 were identified to species level (73 Rhodophyta, 24 Chlorophyta and 16 Ochrophyta), encompassing 35 new records for the Island (27 Rhodophyta, 6 Chlorophyta and 2 Ochrophyta). Most species are native, including the Macaronesian endemisms *Codium elisabethiae* O.C.Schmidt, *Millerella tinerfensis* (Seoane-Camba) S.M.Boo & J.M.Rico and *Phyllophora gelidioides* P.Crouan & H.Crouan ex Karsakoff. Eight species are introduced and 15 have uncertain origin.

Keywords

Macroalgae, seaweeds, Rhodophyta, Chlorophyta, Ochrophyta, Azores, Terceira Island, endemism, native, introduced, uncertain, occurrence data

Introduction

The macroalgal flora of the isolated mid-Atlantic Azores archipelago, as a whole, may be considered relatively rich when compared to that of other remote oceanic islands, such as the Shetlands and Faroes in the colder North Atlantic and Ascension and Tristan da Cunha in the Southern Atlantic (Neto et al. 2005, Tittley and Neto 2005, Wallenstein et al. 2009). With approximately 400 species (Freitas et al. 2019), the Azorean algal flora has been considered cosmopolitan, as it shares species with Macaronesia, North Africa, the Mediterranean Sea, Atlantic Europe and America (Tittley 2003, Tittley and Neto 2006, Wallenstein et al. 2009).

The published information, however, reflects data from only a few of the nine islands. Terceira, the second largest island of the central group and the third largest of the archipelago, is amongst the lesser-studied ones. To overcome this and contribute to a better understanding of the seaweed flora of the Azores archipelago, a thorough investigation was conducted in the period between 2000 and 2014, mainly by the Island Aquatic Research Group of the Azorean Biodiversity Centre of the University of the Azores ([https://ce3c.ciences.ulisboa.pt/sub-team/island-aquatic-ecology](https://ce3c.ciences.ulisboa.pt/sub-team/island-aquatic-ecology)). In these surveys, special attention was dedicated to the sheet-like and filamentous forms that are difficult to identify in the wild, the seasonal and fast growing annuals and particularly to the small forms that are often short-lived and fast growing species, very difficult to identify without the aid of a microscope. This paper compiles physical, occurrence and survey data and is intended as a practical resource for biological studies (such as systematics, diversity and conservation, biological monitoring, climate change and ecology) and for academics, students, government, private organisations and the general public.
General description

Purpose: By listing the taxonomic records for Terceira and presenting general information for each taxon's occurrence on the Island's littoral, this paper addresses several biodiversity shortfalls (see Cardoso et al. 2011, Hortal et al. 2015), namely the need to catalogue the Azorean macroalgae (Linnean shortfall) and improve the current information on their local and regional geographic distribution (Wallacean shortfall), as well as on species' abundances and dynamics in space (Prestonian shortfall).

Project description

Title: Marine algal (seaweed) flora of Terceira Island, Azores

Personnel: Collections were undertaken and occurrence data recorded during several years (2000-2014) under the coordination of Ana I. Neto. Main collectors were Afonso Prestes, Albert Cámara, Ana I. Neto, Luís Cabral, Mariana Brito, Marisa Toste, Marlene Terra, Nuno Álvaro and Rita Patarra. Ana I. Neto and Marlene Terra were responsible for the species identification.

Voucher specimen management was mainly undertaken by Afonso Prestes, Ana I. Neto, Eunice Nogueira, Natália Cabral and Roberto Resendes.

Study area description: Located along a WNW-trending strip and spreading over 500 km in the North Atlantic, roughly at 38°43'49"N, 27°19'10"W (Fig. 1), the Azores archipelago is composed of nine islands and several islets. The islands are surrounded by deep waters due to the absence of a continental shelf and, therefore, have a restricted coastal extension, which is subjected to swell and surge most of the year. The tidal range is small (< 2 m, see Hidrográfico 1981) and the shore geomorphology alternates between high cliffs and rocky cobble/boulder beaches (Borges 2004). The climate is temperate oceanic, with regular and abundant rainfall and high levels of relative humidity and persistent winds, mainly during winter and autumn (Morton et al. 1998).

Terceira (in black in Fig. 1), located in the central group roughly at 38°48'50"N, 27°23'25"W, 150 km northeast of São Miguel, is the third largest island of the Azores archipelago. It has an elliptical form, 29 km long and 18 km wide, a maximum altitude of 1021 m at the summit of Serra de Santa Bárbara and a total area of about 397 km². The coastline has a total length of 112 km and is characterised by cliffs that vary from small to moderate heights, interrupted by small bays. Sandy beaches are limited to Praia da Vitória, located on the more protected eastern part of the Island. The northern coast is more exposed and constantly submitted to the wave action (Gomes and Pinto 2004).

The intertidal and shallow subtidal rocky-shore communities of Terceira are dominated by macroalgae, similarly to those of the remaining Azorean Islands (Neto et al. 2005). The frondose species Fucus spiralis Linnaeus (Fig. 2), Ulva rigida C.Agardh and Gelidium microdon Kützing are often present at mid-shore levels, growing interspaced with the small...
chthamalid barnacles. Slightly below this level, the lack of herbivores, resulting from the over-exploitation of limpets (Martins et al. 2011, Martins et al. 2008, Faria et al. 2014), favours an almost homogeneous coverage of the shore by algal turfs (Fig. 3). These are growth forms of either diminutive algae or diminutive forms of larger species that create a dense, compact mat 20-30 mm thick, either monospecific (mainly composed of Caulacanthus ustulatus (Mertens ex Turner) Kützing or Gymnogongrus spp.) or multi-specific and composed of articulate calcareous algae (e.g. Ellisolandia elongata (J.Ellis & Solander) K.R.Hind & G.W.Saunders and Jania spp.) and/or soft algae (e.g. Centroceras clavulatum (C.Agardh) Montagne, Chondracanthus spp. and Laurencia spp.). Lower on the shore, the erect, corticated macrophytes Ellisolandia elongata, Cystoseira spp. and Osmundea pinnatifida (Hudson) Stackhouse are commonly found, frequently epiphyting multi-specific algal turfs (Fig. 4). The shallow subtidal is mainly characterised by associations of two or three frondose macrophytes, predominantly the brown seaweeds Dictyota spp. and Zonaria tournefortii (J.V. Lamouroux) Montagne (Fig. 5).

Design description: The algae, referred to in this paper, were sampled during field studies at littoral and sublittoral levels down to approximately 40 m on Terceira Island, covering an area of 49 km². Presence recordings and physical collections were made by walking over the shores or by scuba diving. The specimens collected were taken to the laboratory for standard procedures and the resulting vouchers were deposited at the AZB Herbarium Ruy Telles Palhinha, at the Faculty of Sciences and Technology of the University of the Azores.
Figure 2. High intertidal level showing *Fucus spiralis* and *Ulva rigida* (by the Island Aquatic Ecology Subgroup of cE3c-ABG).

Figure 3. Mid-shore intertidal covered by algal turf (by the Island Aquatic Ecology Subgroup of cE3c-ABG).
Figure 4. doi
Cystoseira sp., Ellisolandia elongata and Osmundea pinnatifida epiphyting multi-specific algal turf at low intertidal (by the Island Aquatic Ecology Subgroup of cE3c-ABG).

Figure 5. doi
Frondose macrophytes (Dictyota spp. and Zonaria tournefortii) at subtidal level (by the Island Aquatic Ecology Subgroup of cE3c-ABG).
Funding: This study was mainly financed by the following projects/scientific expeditions:

- Campaign CAMAG-TER/2008, under the project “CAMAG/TER - Caracterização das massas de água costeira da Ilha Terceira”. 2008 - 2009. The Azores Regional Government;
- Project “ACORES-01-0145-FEDER-000072 - AZORES BIOPORTAL – PORBIOTA. Operational Programme Azores 2020 (85% ERDF and 15% regional funds);
- Portuguese National Funds, through FCT – Fundação para a Ciência e a Tecnologia, within the projects UID/BIA/00329/2013, 2015 - 2018, and UID/BIA/00329/2019 and UID/BIA/00329/2020-2023;
- Portuguese Regional Funds, through DRCT – Direção Regional da Ciência e Tecnologia, within several projects, since 2013;
- CIRN/DB/UAc (Research Centre for Natural Resources, Universidade dos Açores, Departamento de Biologia);
- CIIMAR (Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal).

Sampling methods

Study extent: This study covers an area of approximately 49 km², encompassing littoral and sublittoral levels down to approximately 40 m around Terceira Island (Table 1, Fig. 6).

| Location No | Location ID     | Municipality    | Locality         | Latitude / Longitude | geodeticDatum | Littoral zone |
|-------------|-----------------|-----------------|------------------|----------------------|---------------|---------------|
| 1           | TER_AH_PJse     | Angra do Herismo| Porto Judeu| Serretinha          | 38.64911, -27.143929 | WGS84         | Intertidal    |
| 2           | TER_AH_SSim     | Angra do Herismo| São Sebastião| lhéu da Mina        | 38.688285, -27.07385 | WGS84         | Intertidal    |
| 3           | TER_PV_Bpi      | Praia da Vitoria| Biscoitos|Piscina             | 38.801473, -27.25893 | WGS84         | Intertidal    |
| 4           | TER_AH_CRem     | Angra do Herismo| Cinco Ribeiras| Entre-marés         | 38.675345, -27.329175 | WGS84         | Intertidal    |
| 5           | TER_AH_CR30     | Angra do Herismo| Cinco Ribeiras|30m                  | 38.672771, -27.330059 | WGS84         | Subtidal      |
| 6           | TER_AH_CRb      | Angra do Herismo| Cinco Ribeiras| Baia                | 38.675145, -27.327739 | WGS84         | Subtidal      |
| 7           | TER_AH_CRem     | Angra do Herismo| Cinco Ribeiras| Entre-marés         | 38.675419, -27.329237 | WGS84         | Intertidal    |
| Location No | Location ID | Municipality | Locality | Latitude / Longitude | geodeticDatum | Littoral zone |
|-------------|-------------|--------------|----------|-----------------------|---------------|--------------|
| 8           | TER_AH_Sb   | Angra do Herísmo | Salga|Baía | 38.645312, -27.097203 | WGS84 | Subtidal |
| 9           | TER_AH_Sem  | Angra do Herísmo | Salga|Entre-marés | 38.646749, -27.099061 | WGS84 | Intertidal |
| 10          | TER_AH_SIb  | Angra do Herísmo | Silveira|Baía | 38.653707, -27.233297 | WGS84 | Subtidal |
| 11          | TER_AH_SIem | Angra do Herísmo | Silveira|Entre-marés | 38.655274, -27.237065 | WGS84 | Intertidal |
| 12          | TER_PV_Bb   | Praia da Vitória | Biscoitos|Baía | 38.800878, -27.260303 | WGS84 | Subtidal |
| 13          | TER_PV_Bpi  | Praia da Vitória | Biscoitos|Piscina | 38.801473, -27.25893 | WGS84 | Intertidal |
| 14          | TER_PV_Bpo  | Praia da Vitória | Biscoitos|Ponta | 38.804734, -27.255472 | WGS84 | Subtidal |
| 15          | TER_PV_PVb  | Praia da Vitória | Praia da Vitória| Baía | 38.7088, -27.048377 | WGS84 | Subtidal |
| 16          | TER_PV_PVem | Praia da Vitória | Praia da Vitória| Entre-marés | 38.707052, -27.046829 | WGS84 | Intertidal |
| 17          | TER_PV_PVp  | Praia da Vitória | Praia da Vitória| Paul | 38.735015, -27.060895 | WGS84 | Intertidal |
| 18          | TER_PV_PVp  | Praia da Vitória | Praia da Vitória| Paul | 38.735015, -27.060895 | WGS84 | Intertidal |

**Sampling description:** Intertidal collections were made at low tide by walking over the shores. Subtidal collections were made by scuba diving around the area. Sampling encompassed both physical collections and species presence recordings. For the former, in each sampling location, collections were made manually by scraping one or two specimens of species found into labelled bags. Species recording data were gathered by registering all species present in the visited locations (Fig. 7).

**Quality control:** The collected taxa were investigated by trained taxonomists with the help of keys and floras. This involved morphological and anatomical examination by eye or under the dissecting and compound microscopes of an entire specimen or slide preparation. In difficult cases, specimens were sent to experts for identification.
Figure 6. Sampling locations around Terceira Island (by Nuno V. Álvaro).

Macroalgae recordings at the rocky subtidal (by the Island Aquatic Ecology Subgroup of cE3c-ABG).
**Step description:** In the laboratory, the specimens were sorted and studied following standard procedures used in macroalgae identification.

Species identification was based on morphological and anatomical characters and reproductive structures. For small and simple thalli, this required observation of the entire thallus by eye and/or using dissecting and compound microscopes (Fig. 8). For larger and more complex algae, the investigation of the thallus anatomy required histological work to obtain longitudinal and transverse sections needed for the observation of cells, reproductive structures and other diagnosing characters.

![Image of someone using a microscope.](image)
Since the Azorean algal flora is composed of taxa from various geographical regions, floras and keys mainly from the Atlantic and Western Mediterranean were used in species identification (e.g. Schmidt 1931, Taylor 1967, Taylor 1978, Levring 1974, Dixon and Irvine 1977, Lawson and John 1982, Irvine 1983, Gayral and Cosson 1986, Fletcher 1987, Afonso-Carrillo and Sansón 1989, Burrows 1991, Boudouresque et al. 1992, Cabioc'h et al. 1992, Maggs and Homersand 1993, Irvine and Chamberlain 1994; Brodie et al. 2007, Lloréns et al. 2012, Rodríguez-Prieto et al. 2013).

For more critical and taxonomically-difficult taxa, specimens were taken to the Natural History Museum (London) for comparison with collections there or sent to specialists. A reference collection was made for all specimens collected by giving them a herbarium code number and depositing them at the AZB Herbarium Ruy Telles Palhinha, University of Azores. Depending on the species and on planned further research, different types of collections were made, namely (i) liquid collections using 5% buffered formaldehyde seawater and then replacing it by the fixing agent Kew (Bridsen and Forman 1999); (ii) dried collections, either by pressing the algae (most species) as described by Gayral and Cosson (1986) or by letting them air-dry (calcareous species) and (iii) silica collections for molecular studies.

Nomenclatural and taxonomic status used here follow Algaebase (Guiry and Guiry 2020). The database was organised on FileMaker Pro.

**Geographic coverage**

**Description:** Terceira Island, Azores, Macaronesia, Portugal (approximately 38°48'50"N, 27°23'25"W).

**Coordinates:** 38.627 and 38.814 Latitude; -27.389 and -27033 Longitude.

**Taxonomic coverage**

**Description:** All macroalgae were identified to genus or species level. In total, 147 taxa were identified belonging to 21 orders and 45 families, distributed by the phyla Rhodophyta (9 orders and 25 families), Chlorophyta (5 orders and 8 families) and Ochrophyta (7 orders and 12 families).

**Taxa included:**

| Rank     | Scientific Name | Common Name  |
|----------|-----------------|--------------|
| phylum   | Rhodophyta      | Red algae    |
| phylum   | Chlorophyta     | Green algae  |
| phylum   | Ochrophyta      | Brown algae  |
Temporal coverage

Notes: Sampling took place in the period between 2000 and 2014.

Collection data

Collection name: AZB | Marine macroalgae collection of Terceira Island (Azores) – Campaign CAMAG-TER/2008; AZB | Marine macroalgae collection of Terceira Island (Azores) – Occasional sampling; Marine macroalgae occurrence on Terceira Island (Azores) – Campaign CAMAG-TER/2008.

Collection identifier: 389ac3c6-6c63-4de0-b5fb-bc7cc93d3791; 247417a8-f838-405e-b5ac-82940e866a9a; 43bb7387-0e2f-47ce-a121-ca66a9abcaab.

Parent collection identifier: AZB Herbarium Ruy Telles Palhinha, Faculty of Sciences and Technology of the University of the Azores; AZB Herbarium Ruy Telles Palhinha, Faculty of Sciences and Technology of the University of the Azores; AZB Herbarium Ruy Telles Palhinha, Faculty of Sciences and Technology of the University of the Azores.

Specimen preservation method: Air-dry, Dried and pressed; Liquid (Formalin; fixing agent Kew), Silica

Curatorial unit: AZB Herbarium Ruy Telles Palhinha, Faculty of Sciences and Technology of the University of the Azores

Usage rights

Use license: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Marine algal (seaweed) flora of Terceira Island, Azores

Resource link: https://www.gbif.org/dataset/b03dce75-cbc2-457b-8725-33885d766a05

Alternative identifiers: http://ipt.gbif.pt/ipt/resource?r=terceira_seaweed_flora

Number of data sets: 1

Data set name: Marine algal (seaweed) flora of Terceira Island, Azores

Download URL: https://doi.org/10.15468/dl.p6pn6w

Data format: Darwin Core Archive

Data format version: version 1.7
**Description:** This data paper presents physical and occurrence data from macroalgal surveys undertaken on Terceira Island between 2000 and 2014. The dataset submitted to GBIF is structured as a sample event dataset, with two tables: event (as core) and occurrences (Neto et al. 2020). 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 table contains 18 records (eventID). The extension data table has 418 occurrences. An extension record supplies extra information about a core record. The number of records in each extension data table is illustrated in the IPT link. This IPT archives the data and thus serves as the data repository. The data and resource metadata are available for downloading in the downloads section.

| Column label                  | Column description                                                                 |
|-------------------------------|------------------------------------------------------------------------------------|
| Table of Sampling Events      | Table with sampling events data (beginning of table)                               |
| eventID                       | Identifier of the event, unique for the dataset                                    |
| country                       | Country of the sampling site                                                       |
| countryCode                  | Code of the country where the event occurred                                       |
| stateProvince                 | Name of the region                                                                 |
| island                        | Name of the island                                                                 |
| municipality                  | Name of the municipality                                                           |
| locality                      | Name of the locality                                                                |
| locationID                    | Identifier of the location                                                         |
| decimalLatitude               | The geographic latitude of the sampling site                                        |
| decimalLongitude              | The geographic longitude of the sampling site                                       |
| geodeticDatum                 | The spatial reference system upon which the geographic coordinates are based        |
| coordinateUncertaintyInMetres | The horizontal distance (in metres) from the given decimalLatitude and decimal-
                              | Longitude describing the smallest circle containing the whole of the Location      |
| eventDate                     | Time interval when the event occurred                                              |
| year                          | The year of the event                                                               |
| samplingProtocol              | Sampling method used during an event                                                |
| locationRemarks               | Zonation level                                                                     |
| minimumDepthInMetres          | The minimum depth in metres where the specimen was found                            |
| maximumDepthInMetres          | The maximum depth in metres where the specimen was found                            |
| eventRemarks                  | Notes about the event                                                              |
| Table of Species Occurrence   | Table with species occurrence data (beginning of new table)                        |
| occurrenceID                  | Identifier of the record, coded as a global unique identifier                      |
| Field                  | Description                                                                                           |
|-----------------------|-------------------------------------------------------------------------------------------------------|
| institutionID         | The identifier for the institution having custody of the object or information referred to in the record |
| institutionCode       | The acronym of the institution having custody of the object or information referred to in the record  |
| collectionID          | An identifier of the collection to which the record belongs                                             |
| collectionCode        | The name of the collection from which the record was derived                                           |
| datasetName           | The name identifying the dataset from which the record was derived                                      |
| eventID               | Identifier of the event, unique for the dataset                                                       |
| kingdom               | Kingdom name                                                                                          |
| phylum                | Phylum name                                                                                            |
| class                 | Class name                                                                                             |
| order                 | Order name                                                                                             |
| family                | Family name                                                                                            |
| genus                 | Genus name                                                                                             |
| specificEpithet       | The name of the first or species epithet of the scientificName                                          |
| infraspecificEpithet  | The name of the lowest or terminal infraspecific epithet of the scientificName, excluding any rank designation |
| acceptedNameUsage     | The specimen accepted name, with authorship                                                           |
| previousIdentifications| Previous name of the specimen, with authorship                                                          |
| scientificName        | The name without authorship applied on the first identification of the specimen                        |
| basisOfRecord         | The specific nature of the data record                                                                  |
| habitat               | Description of the habitat where the specimen was found                                                  |
| organismQuantityType  | The type of quantification system used to quantity the organisms                                        |
| organismQuantity      | Percentage of the organism coverage                                                                   |
| recordedBy            | Person(s) responsible for sampling                                                                     |
| catalogNumber         | Identifying code for a unique sample lot in a biological collection                                     |
| identifiedBy          | Person(s) responsible for taxa identification                                                           |
| type                  | The nature of the resource                                                                             |
| preparations          | The preservation method used for the specimen                                                           |
| establishmentMeans    | The establishment status of the organism in the study region                                             |
| occurrenceRemarks     | New record status assignment                                                                           |
| licence               | Reference to the licence under which the record is published                                            |
Additional information

This paper accommodates the 418 specimens of macroalgae recorded from Terceira Island in 147 taxa (Tables 2, 3) comprising 113 confirmed species and 34 taxa identified only to genus level, belonging to 21 orders and 45 families, distributed by the phyla Rhodophyta (9 orders and 25 families), Chlorophyta (5 orders and 8 families) and Ochrophyta (7 orders and 12 families). The confirmed species include 73 Rhodophyta, 24 Chlorophyta and 16 Ochrophyta (Phaeophyceae). From these, 35 species are newly-recorded for the Island (27 Rhodophyta, 6 Chlorophyta and 2 Ochrophyta). Most species are native, including the three Macaronesian endemics *Millerella tinerfensis* (Seoane-Camba) S.M. Boo & J.M. Rico, *Phyllophora gelidioides* P.Crouan & H.Crouan ex Karsakoff and *Codium elisabethiae* O.C. Schmidt, eight are introduced and 15 have uncertain origin.

| Phylum       | Species (Accepted Name)                                      | Number of records | Establishment Means | Occurrence Remarks |
|--------------|-------------------------------------------------------------|-------------------|---------------------|--------------------|
| Rhodophyta   | *Acrosorium ciliolatum* (Harvey) Kylin                      | 4                 | Native              | New record         |
| Rhodophyta   | *Amphiroa beauvoisii* J.V.Lamouroux                         | 1                 | Native              |                    |
| Rhodophyta   | *Amphiroa fragilissima* (Linnaeus) J.V.Lamouroux            | 2                 | Native              | New record         |
| Rhodophyta   | *Amphiroa rigida* J.V.Lamouroux                             | 1                 | Native              | New record         |
| Rhodophyta   | *Anotrichium tenue* (C.Agardh) Nägeli                      | 2                 | Native              |                    |
| Rhodophyta   | *Aphanocladiad stichidiosa* (Funk) Ardré                    | 4                 | Native              |                    |
| Rhodophyta   | *Asparagopsis armata* Harvey                                | 12                | Introduced          |                    |
| Rhodophyta   | *Asparagopsis armata* Harvey, phase *Falkenbergia rufolanosa* (Harvey) F.Schmitz | 1 | Introduced | New record |
| Rhodophyta   | *Asparagopsis taxiformis* (Delile) Trevisan                 | 5                 | Native              |                    |
| Rhodophyta   | *Bonnemaisonia hamifera* Hariot                            | 1                 | Introduced          |                    |
| Rhodophyta   | *Carradoriella denudata* (Dillwyn) A.M.Savoie & G.W.Saunders | 3                 | Uncertain           |                    |
| Rhodophyta   | *Caulacanthus ustulatus* (Mertens ex Turner) Kützing        | 5                 | Uncertain           |                    |
| Rhodophyta   | *Centroceras clavulatum* (C.Agardh) Montagne                | 4                 | Native              |                    |
| Rhodophyta   | *Ceramium ciliatum* (J.Ellis) Ducluzeau                    | 3                 | Native              |                    |
| Rhodophyta   | *Ceramium cingulatum* Weber Bosse                           | 1                 | Introduced          |                    |
| Rhodophyta   | *Ceramium diaphanum* (Lightfoot) Roth                       | 5                 | Native              |                    |
| Rhodophyta   | *Ceramium echionotum* J.Agardh                             | 2                 | Native              |                    |

Table 2.

Macroalgae species from Terceira Island, with information on their relative abundance, origin and status.
| Phylum       | Species (Accepted Name)                                                                 | Number of records | Establishment Means | Occurrence | Remarks                   |
|--------------|----------------------------------------------------------------------------------------|-------------------|---------------------|------------|---------------------------|
| Rhodophyta   | Ceramium tenerrimum (G.Martens) Okamura                                                 | 1                 | Native              |            | New record                |
| Rhodophyta   | Ceramium virgatum Roth                                                                  | 5                 | Native              |            |                           |
| Rhodophyta   | Chondracanthus acicularis (Roth) Fredericq                                              | 5                 | Native              |            |                           |
| Rhodophyta   | Chondracanthus teedei (Mertens ex Roth) Kützing                                         | 2                 | Native              |            | New record                |
| Rhodophyta   | Chondria coerulescens (J.Agardh) Sauvageau                                              | 1                 | Uncertain           |            |                           |
| Rhodophyta   | Chondria dasyphylla (Woodward) C.Agardh                                                  | 3                 | Uncertain           |            |                           |
| Rhodophyta   | Crouania attenuata (C.Agardh) J.Agardh                                                   | 3                 | Native              |            |                           |
| Rhodophyta   | Dermocorynus dichotomus (J.Agardh) Gargiulo, M.Morabito & Manghisi                       | 2                 | Native              |            |                           |
| Rhodophyta   | Ellisolandia elongata (J.Ellis & Solander) K.R.Hind & G.W.Saunders                      | 10                | Native              |            |                           |
| Rhodophyta   | Gastroclonium clavatum (Roth) Ardisson                                                  | 4                 | Native              |            |                           |
| Rhodophyta   | Gastroclonium ovatum (Hudson) Papenfuss                                                  | 1                 | Native              |            | New record                |
| Rhodophyta   | Gastroclonium reflexum (Chauvin) Kützing                                                 | 4                 | Native              |            |                           |
| Rhodophyta   | Gayliella flaccida (Harvey ex Kützing) T.O.Cho & L.J.Mclvor                              | 1                 | Native              |            | New record                |
| Rhodophyta   | Gelidium microdon Kützing                                                                | 7                 | Native              |            |                           |
| Rhodophyta   | Gelidium pusillum (Stackhouse) Le Jolis                                                  | 5                 | Native              |            |                           |
| Rhodophyta   | Gelidium spinosum (S.G.Gmelin) P.C.Silva in Silva, Basson & Moe                         | 5                 | Native              |            |                           |
| Rhodophyta   | Gymnogongrus crenulatus (Turner) J.Agardh                                               | 5                 | Native              |            |                           |
| Rhodophyta   | Gymnogongrus griffithsiae (Turner) C.Martius                                             | 3                 | Native              |            |                           |
| Rhodophyta   | Herposiphonia secunda f. secunda (C.Agardh) Falkenberg                                  | 4                 | Native              |            |                           |
| Rhodophyta   | Hypnea arbuscula P.J.L.Dangeard                                                        | 1                 | Native              |            | New record                |
| Rhodophyta   | Hypnea musciformis (Wulfen) J.V.Lamouroux                                               | 4                 | Uncertain           |            |                           |
| Rhodophyta   | Jania capillacea Harvey                                                                 | 4                 | Native              |            | New record                |
| Rhodophyta   | Jania longifurca Zanardini                                                              | 1                 | Uncertain           |            |                           |
| Rhodophyta   | Jania pedunculata var. adhaerens (J.V.Lamouroux) A.S.Harvey, Woelkerling & Reviers      | 3                 | Native              |            | New record                |
| Rhodophyta   | Jania pumila J.V.Lamouroux                                                               | 1                 | Native              |            | New record                |
| Rhodophyta   | Jania rubens (Linnaeus) J.V.Lamouroux                                                   | 3                 | Native              |            |                           |
| Rhodophyta   | Jania virgata (Zanardini) Montagne                                                       | 3                 | Uncertain           |            |                           |
| Rhodophyta   | Laurencia chondrioides Børgeesen                                                        | 1                 | Introduced          |            |                           |
| Phylum | Species (Accepted Name)                                                                 | Number of records | Establishment Means | Occurrence Remarks |
|--------|---------------------------------------------------------------------------------------|-------------------|---------------------|--------------------|
| Rhodophyta | Laurencia minuta Vandermeulen, Garbary & Guiry                                          | 2                 | Introduced          | New record         |
| Rhodophyta | Laurencia tenera C.K.Tseng                                                              | 3                 | Native              | New record         |
| Rhodophyta | Lomentaria articulata (Hudson) Lyngbye                                                  | 4                 | Native              |                    |
| Rhodophyta | Lomentaria clavellosa (Lightfoot ex Turner) Gaillon                                     | 1                 | Uncertain           |                    |
| Rhodophyta | Lomentaria orcadensis (Harvey) Collins in W.R.Taylor                                    | 1                 | Uncertain           |                    |
| Rhodophyta | Lomentaria articulata (Hudson) Lyngbye                                                  | 4                 | Native              |                    |
| Rhodophyta | Melanothamnus sphaerocarpus (Børgesen) Diaz-Tapia & Maggs                               | 2                 | Introduced          |                    |
| Rhodophyta | Meredithia microphylla (J.Agardh) J.Agardh                                              | 2                 | Native              | New record         |
| Rhodophyta | Millerella pannosa (Feldmann) G.H.Boo & L.Le Gall                                       | 2                 | Native              | New record         |
| Rhodophyta | Millerella tinerfensis (Seoane-Camba) S.M.Boo & J.M.Rico                               | 3                 | Macaronesian endemism | New record         |
| Rhodophyta | Nitophyllum punctatum (Stackhouse) Greville                                            | 1                 | Native              |                    |
| Rhodophyta | Osmundea hybrida (A.P.de Candolle) K.W.Nam                                              | 1                 | Native              | New record         |
| Rhodophyta | Osmundea pinnatifida (Hudson) Stackhouse                                                | 6                 | Native              |                    |
| Rhodophyta | Osmundea truncata (Kützing) K.W.Nam & Maggs in K.W.Nam, Maggs & Garbary                | 4                 | Native              | New record         |
| Rhodophyta | Peyssonnelia squamaria (S.G.Gmelin) Decaisne ex J.Agardh                               | 1                 | Native              |                    |
| Rhodophyta | Phyllophora gelidioides P.Crouan & H.Crouan ex Karsakoff                                | 2                 | Native              | New record         |
| Rhodophyta | Plocamium cartilagineum (Linnaeus) P.S.Dixon                                            | 3                 | Native              |                    |
| Rhodophyta | Pteroocladiella capillacea (S.G.Gmelin) Santelices & Hommersand                         | 9                 | Native              |                    |
| Rhodophyta | Rhodophyllis divaricata (Stackhouse) Papenfuss                                          | 4                 | Native              | New record         |
| Rhodophyta | Rhodymenia holmesii Ardissone                                                           | 5                 | Native              | New record         |
| Rhodophyta | Sphaerococcus coronopifolius Stackhouse                                                 | 1                 | Native              | New record         |
| Rhodophyta | Sphondylothamnion multifidum (Hudson) Nägeli                                             | 2                 | Native              |                    |
| Rhodophyta | Spyridia filamentosa (Wulfen) Harvey                                                    | 2                 | Native              | New record         |
| Rhodophyta | Symphyoclalia marchantioides (Harvey) Falkenberg                                        | 2                 | Introduced          |                    |
| Rhodophyta | Vertebrata fruticulosa (Wulfen) Kuntze                                                 | 1                 | Native              | New record         |
| Rhodophyta | Vertebrata hypnoides (Welwitsch) Kuntze                                                 | 2                 | Uncertain           |                    |
| Rhodophyta | Vertebrata reptabunda (Suhr) Diaz-Tapia & Maggs                                        | 4                 | Uncertain           |                    |
| Phylum       | Species (Accepted Name)                                                                 | Number of records | Establishment Means | Occurrence Remarks    |
|--------------|----------------------------------------------------------------------------------------|-------------------|---------------------|-----------------------|
| Rhodophyta   | *Vertebrata tripinnata* (Harvey) Kuntze                                                  | 1                 | Native              |                       |
| Rhodophyta   | *Wurdemannia miniata* (Sprengel) Feldmann & Hamel                                       | 2                 | Native              | New record            |
| Chlorophyta  | *Bildingia minima* (Nägeli ex Kützing) Kylin                                             | 1                 | Native              | New record            |
| Chlorophyta  | *Bryopsis cupressina* J.V.Lamouroux                                                     | 1                 | Native              | New record            |
| Chlorophyta  | *Bryopsis plumosa* (Hudson) C.Agardh                                                     | 3                 | Native              |                       |
| Chlorophyta  | *Chaetomorpha aerea* (Dillwyn) Kützing                                                   | 5                 | Native              |                       |
| Chlorophyta  | *Chaetomorpha linum* (O.F.Müller) Kützing                                                | 1                 | Native              |                       |
| Chlorophyta  | *Chaetomorpha mediterranea* (Kützing)                                                   | 1                 | Native              | New record            |
| Chlorophyta  | *Chaetomorpha pachynema* (Montagne) Kützing                                             | 2                 | Native              |                       |
| Chlorophyta  | *Cladophora albida* (Nees) Kützing                                                      | 2                 | Native              |                       |
| Chlorophyta  | *Cladophora coelothrix* Kützing                                                         | 5                 | Native              |                       |
| Chlorophyta  | *Cladophora dalmatica* Kützing                                                          | 1                 | Uncertain           |                       |
| Chlorophyta  | *Cladophora laetevirens* (Dillwyn) Kützing                                              | 2                 | Uncertain           |                       |
| Chlorophyta  | *Cladophora lehmanniana* (Lindenberg) Kützing                                           | 1                 | Native              | New record            |
| Chlorophyta  | *Cladophora prolifera* (Roth) Kützing                                                   | 5                 | Native              |                       |
| Chlorophyta  | *Cladophoropsis membranacea* (Hofman Bang ex C.Agardh) Bergesen                         | 1                 | Uncertain           |                       |
| Chlorophyta  | *Codium adhaerens* C.Agardh                                                             | 4                 | Native              |                       |
| Chlorophyta  | *Codium elisabethiae* O.C.Schmidt                                                       | 1                 | Macaronesian        | endemism              |
| Chlorophyta  | *Gayralia oxysperma* (Kützing) K.L.Vinogradova ex Scagel                                | 1                 | Native              | New record            |
| Chlorophyta  | *Lychaete pellucida* (Hudson) M.J.Wynne                                                 | 3                 | Native              | New record            |
| Chlorophyta  | *Ulva clathrata* (Roth) C.Agardh                                                        | 2                 | Native              |                       |
| Chlorophyta  | *Ulva compressa* Linnaeus                                                                | 6                 | Native              |                       |
| Chlorophyta  | *Ulva intestinalis* Linnaeus                                                             | 5                 | Native              |                       |
| Chlorophyta  | *Ulva polyclada* Kraft                                                                  | 1                 | Native              |                       |
| Chlorophyta  | *Ulva prolifera* O.F.Müller                                                              | 5                 | Native              |                       |
| Chlorophyta  | *Ulva rigida* C.Agardh                                                                   | 6                 | Native              |                       |
| Ochrophyta   | *Asterocladon rhodochortonoides* (Børgesen) S.Uwai, C.Nagasato, T.Motomura & K.Kogame  | 1                 | Native              |                       |
| Ochrophyta   | *Cladostephus spongiosus* (Hudson) C.Agardh                                              | 1                 | Native              |                       |
| Ochrophyta   | *Colpomenia sinuosa* (Mertens ex Roth) Derbès & Solier                                  | 10                | Native              |                       |
## Table 3.
Main taxonomic figures with information on the species origin and status.

| Phylum   | Order | Family | Specimens Number | Total taxa | Total species | Native | Introduced | Uncertain | Macaronesian endemism | New record |
|----------|-------|--------|------------------|------------|---------------|--------|------------|-----------|-----------------------|------------|
| Rhodophyta | 9     | 25     | 248              | 95         | 73            | 53     | 7          | 11        | 2                     | 27         |
| Chlorophyta | 5     | 8      | 77               | 33         | 24            | 20     | 3          | 1         | 1                     | 6          |
| Ochrophyta  | 7     | 12     | 93               | 19         | 16            | 14     | 1          | 1         | 1                     | 2          |
| Total      | 21    | 45     | 418              | 147        | 113           | 87     | 8          | 15        | 3                     | 35         |

Many species were only sporadically recorded on Terceira, but nine were commonly found around the island and occurred quite abundantly in some locations, namely: the Rhodophyta *Asparagopsis armata* Harvey, *Ellisolandia elongata* and *Pterocladiella capillacea* (S.G. Gmelin) Santelices & Hommersand; the Chlorophyta *Ulva rigida* and *Ulva compressa* Linnaeus; and the Ochrophyta *Colpomenia sinuosa* (Mertens ex Roth) Derbès & Solier in Castagne, *Halopteris filicina* (Grateloup) Kützing, *Halopteris scoparia* (Linnaeus) Sauvageau and *Zonaria tournefortii*.

A mismatch regarding the GBIF backbone taxonomy of some of the macroalgae species names was identified as detailed in Suppl. material 1.
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Author contributions

- AIN: Conceptualisation; Methodology; Investigation (field and laboratory work); Resources; Data Curation; Formal analysis and interpretation; Paper writing;
- ACLP: Investigation (field and laboratory work); Resources; Data Curation; Paper writing;
- NVA: Investigation (field and laboratory work); Maps elaboration; Paper writing;
- RR: Resources; Data Curation;
- RMAN: Data Curation; Formal analysis and interpretation; Paper writing;
- IM: Data Curation; Formal analysis and interpretation; Paper writing.

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Supplementary material

Suppl. material 1: DP-TER-id_14160_normalized-redz.csv

Authors: Ana I Neto
Data type: Macroalgae taxonomic mismatching
Brief description: GBIF does not have the more actualised nomenclature for some of the macroalgae species names. Therefore, the matching tools of its platform were applied to the species list, as required by Pensoft's data auditor, to identify the problematic taxonomic situations. The resulting file (DP-TER-id_14160_normalized-redz.csv) is included here, since the names will not be immediately updated in the GBIF Taxonomic Backbone. A request was already sent to GBIF helpdesk to resolve this situation.

Download file (3.27 kb)