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Fine-scale abundance of rocky shore macroalgae species with distribution limits in NW Iberia in 2020/2021

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Abstract

Background

Climate change has been increasing at an unprecedented rate in the last decades. Warming has been causing a variety of impacts in marine ecosystems, including shifts in the geographical ranges of species. The North-western Iberian Peninsula coast is particularly interesting to study distribution shifts as it features a strong latitude thermal gradient, establishing a biogeographical transitional region where several cold- and warm-adapted species have their equatorward or poleward distributions. In the early 2000s, it appeared that while warm-water species were already responding to warming, cold-water species did not display a coherent response. It is now necessary to gather fresh data on the distribution of the same group of species to understand if current patterns of change confirm or deny those observed back then, which may give us important clues about the mechanisms setting species limits in the area.

New information

This study aims at providing a fine-scale description of the occurrence of intertidal macroalgae species in the rocky shores of the North-western Iberian coast. Specifically, the spatial distribution and semi-quantitative abundance of 34 native and invasive species were assessed at 70 wave-exposed locations. This included 19 species of cold-water affinity, 10 species of warm-water affinity and 5 neutral species. When contrasted with historical observations, these new data can be used to quantify and map biodiversity change in the region, as well as help understanding the mechanisms constraining species distributions.

Keywords

Northwestern Iberia; Macroalgae; Intertidal; Distribution; Rocky shores

Introduction

Climate has been changing at unprecedented rates (IPCC 2021). Among the most pervasive effects of climate change have been shifts in the geographical distribution of species (Parmesan and Yohe 2003), generally tracking isotherms towards the poles (Lenoir et al. 2020).

Intertidal species are considered sensitive indicators of climate change (Southward et al. 1995), as they are particularly vulnerable to environmental extremes, including high temperatures (Sorte et al. 2016, Zamir et al. 2018). The North-western Iberian Peninsula coast features a strong latitude thermal gradient, establishing a biogeographical transitional region where several cold- and warm-adapted species have their equatorward or poleward distribution limits (Araújo et al. 2009, Ardré 1970, Fischer-Piette 1959, Fischer-Piette 1963, Fischer-Piette and Gaillard 1959, Lima et al. 2007), and where shifts in those limits have been described since the 1950s (Berke et al. 2010, Fischer-Piette 1957, Fischer-Piette 1960, Fischer-Piette and Forest 1951, Fischer-Piette and Prenant 1957, Rubal et al. 2013, Sousa et al. 2012, Wethey et al. 2011). In the summer, the latitudinal thermal gradient is further intensified by the cooling effect of the Canary upwelling system, stronger in the northern portion of the coast. Recent studies suggest that this cooling may be, at least partially, buffering coastal ecosystems from decades of global warming (Seabra et al. 2019), but the extent to which this is actually happening has not yet been verified in the field.

Anticipating a prevalence of distributional shifts towards the north, in the early 2000s Lima and colleagues conducted several surveys in the area (Lima et al. 2007, Pereira et al. 2021c), finding that while all warm-water species that were changing were expanding their range northwards, cold-water species showed no particular shifting trend as the number that retreated north or expanded south was the same. It seemed, at the time, that warm-water species were already responding to warming, but the same could not be said about cold-water species (Lima et al. 2007). Although it is likely that communities kept changing since those observations in the early 2000s (Harley et al. 2012), detailed up-to-date information is not available. Budgetary constraints and logistical limitations inherent to field surveys mean that data is often outdated or poor in details (Casado-Amezúa et al. 2019). Most recent surveys in the area lack the necessary taxonomic coverage (Araújo et al. 2011, Assis et al. 2017), geographical span (Piñeiro-Corbeira et al. 2016) or spatial resolution (Meneghesso 2020) to either pinpoint the exact distribution limits of those species or to evaluate changes in abundance towards those limits.

It is essential to gather fresh data on the distribution of the same group of species studied more than one decade ago to understand if current patterns of change confirm or deny

those observed back then. Determining the generalization of those observations is important, as they may give us clues on the mechanisms constraining species distributions (which may even differ between warm and cool range edges, see Paquette and Hargreaves 2021). In an effort to reduce this knowledge gap, this study aimed at reassessing the abundance and the distribution limits of 34 native and invasive species of rocky shore macroalgae species with high spatial accuracy, at 70 wave-exposed locations along the North-western coast of the Iberian Peninsula.

Sampling methods

Study extent: Data were collected between Autumn 2020 and Summer 2021. Sampling was carried out at 70 wave-exposed rocky shore locations along the North-western Iberian coast, covering three major rocky stretches of shoreline in the regions of Galicia, Northern Portugal, and Central Portugal (Table 1, Table 2, Fig. 1, Fig. 2). In Galicia, we sampled the locations of Cabo Touriñán, Corveiro, Quenxe, Ximprón, Punta Outeiriño, Corrubedo, O Touro, Prado, Faro Vello de Silleiro, Oia, and Fedorento. In Northern Portugal we surveyed the locations of Moledo, Vila Praia de Âncora, Afife, Montedor, Forte da Vigia, Praia Norte, Cabedelo (breakwater), Amorosa, Foz do Neiva, Rio de Moinhos, Esposende (breakwater), Ofir (southern breakwater), Pedrinhas, Apúlia, Santo André, Verde, Carvalhido, Póvoa de Varzim (marina), Caxinas, Forte de São João, Azurara (breakwater), Areia, Mindelo, Facho, Sampaio, Labruge, Angeiras (Maelas), Angeiras (Praia dos Barcos), Praia Central, Funtão, Pedras do Corgo, Pedras da Agudela, Memória, Cabo do Mundo, Boa Nova, Leça (Piscina das Marés), Leça (breakwater), Matosinhos (northern breakwater), Castelo do Queijo, Homem do Leme, Salgueiros, Valadares, Senhor da Pedra, Aguda, Bairro Piscatório (northern breakwater), Paramos (southern breakwater), Maceda (breakwater), Torreira (breakwater), Barra (northern breakwater), Barra (southern breakwater), Costa Nova (northern breakwater), Costa Nova (southern breakwater), Poço da Cruz (breakwater), Figueira da Foz and Buarcos. In Central Portugal the locations Figueira da Foz, Nazaré, São Martinho do Porto, Baleal, and Papoa were surveyed. While most of these sites are natural rocky shores (Table 1), 17 are composed by artificial hard substrate among sandy beaches (Table 2). Some sites were surveyed twice.

For this work, we selected 34 intertidal macroalgae species to study possible changes in their abundance close to their geographic range limit (Suppl. material 1). We chose conspicuous macro-algae species as they are not only easy to observe and identify, but also less likely to be overlooked. This is important because reliable absence data is as essential as reliable presence data when assessing distribution change through time. The choice of species followed Lima et al. (2007) in order to obtain a comparable dataset. Briefly, we selected species that either have their absolute range limit or a distribution gap within or near the study area (Lima et al. 2007). We classified the species as warm-water, cold-water or neutral based on how their Species Temperature Index (STI) compares with the median temperature of all surveyed sites in NW Iberia. STI was calculated using the median sea surface temperature (SST) of all coastal sites where the species is present in the North Atlantic Ocean, obtained by averaging 40 years of daily SST (1982–2021) from

NOAA 1/4 arc-degree Daily Optimum Interpolation SST version 2, dOISST.v2 (Banzon et al. 2016). This yielded a list of 19 species of cold-water affinity (macroalgae for which the species STI is lower than the median temperature in the study area), 10 species of warm-water affinity (macroalgae for which the STI is lower than the median temperature of the study area, and 5 neutral species (with STI higher than the median temperature of some sites but lower than others). From these, 30 are considered native species while 4 are invasive species.

Sampling description: All locations were surveyed by a two-people team during spring low tides (the average low tide level was 1.52 +/- 0.14m below mean sea water level, Fig. 3, Table 1, Table 2). Two locations were surveyed per day, one while the tide was still going out and another when the tide was already starting to rise. Each location was thoroughly surveyed for at least 60 minutes, except for most breakwaters which, owing to their relatively small area, were typically surveyed in less time. A semi-quantitative estimation of abundance was assigned to each selected species. We used a modified version of the scale established by Crisp and Southward (1958) — **SACFOR**, where abundances were encoded from 6 to 0 (where 6 means **S**uperabundant; 5, **A**bundant; 4, **C**ommon; 3, **F** requent; 2, **O**ccasional; 1, **R**are; and 0, not found).

Additionally, an herbarium was created with one specimen preserved per observed species and per site, when feasible (Fig. 4). The algae collected were placed on drawing paper together with information on the species name, the location of collection, date, and the sample collectors. Specimens were covered by non-adherent paper and placed between journal paper to dry. All specimens were piled, and a weight was added on top so that the pressure helped to flatten them and stick them to the paper. Photos of each specimen were taken to duplicate the information in digital support. These photos were taken with a Canon EOS 6D camera fitted with a 28-80 mm objective at a fixed distance (55 cm), without zoom and with a €1 coin to serve as scale. Digital photos are available as an occurrence daset in GBIF (Pereira et al. 2021a), described below in Data Resources.

Quality control: In addition to AlgaeBase (Guiry and Guiry 2021), authoritative identification guides and keys for the Eastern Atlantic and Mediterranean were used (Araújo et al. 2009, Bárbara 2009, Bárbara 2013, Benita et al. 2018, Bunker et al. 2017, Hiscock 1979, Chapman and Goudey 1983, Dixon and Irvine 1977, Edwards et al. 2012, Faes and Viejo 2003, Irvine 1983, Molenaar et al. 1996, Poza et al. 2019, Stuart et al. 1999 , Vieira et al. 2010, Christensen 1987, Fletcher 1987, Burrows 1991, Maggs and Hommersand 1993, Hiscock 1986, Irvine and Chamberlain 1994, Brodie and Irvine 2003, Bárbara and Cremades 1987, Cabioc'h et al. 1992, Aziza et al. 2008, Araújo et al. 2011). All scientific names were standardized against the WoRMS - The World Register of Marine Species using the Taxon Match tool accessed on 2021-07-07 (WoRMS Editorial Board 2021).

Step description: The steps that led to the final release of the dataset were as follows: (1) In-situ identification of species and attribution of a semi-quantitative abundance SACFOR score; (2) collection of specimens; (3) preservation of specimens in a herbarium; (4) photographing of each specimen as to duplicate the information in digital support; (5)

standardisation of taxonomy against the World Register of Marine Species; (6) exporting of data as a DarwinCore Archive, and (7) generation of dataset-level metadata.

Geographic coverage

Description: Sampling was done along three major rocky stretches of coast in North-western Iberia, covering the regions of Galicia, Northern Portugal, and Central Portugal.

Coordinates: 39.37344 and 43.04422 Latitude; -8.64943 and -9.37772 Longitude.

Taxonomic coverage

Description: A total of 34 algae species were surveyed (19 Ochrophyta, 13 Rhodophyta and 2 Chlorophyta): *Ascophyllum nodosum*, *Asparagopsis armata*, *Calliblepharis ciliata*, *Chondrus crispus*, *Codium adhaerens*, *Delesseria sanguinea*, *Desmarestia ligulata*, *Dictyopteris polypodioides*, *Dilsea carnosa*, *Dumontia contorta*, *Fucus serratus*, *Fucus spiralis*, *Gelidium corneum*, *Grateloupia turuturu*, *Halidrys siliquosa*, *Halopithys incurva*, *Himanthalia elongata*, *Hypnea musciformis*, *Laminaria ochroleuca*, *Laminaria hyperborea*, *Leathesia marina*, *Padina pavonica*, *Palmaria palmata*, *Pelvetia canaliculata*, *Petalonia fascia*, *Phycodrys rubens*, *Phyllophora crispa*, *Saccharina latissima*, *Saccorhiza polyschides*, *Sargassum flavifolium*, *Sargassum muticum*, *Treptacantha baccata*, *Undaria pinnatifida* and *Valonia utricularis.* When it was not possible to discern between *L. ochroleuca* and *L. hyperborea* (at the juvenile stage), specimens were classified at the genus level, *Laminaria* sp. Full taxonomic description is presented on Suppl. material 1.

Taxa included:

Rank	Scientific Name
phylum	Ochrophyta
phylum	Rhodophyta
phylum	Chlorophyta

Temporal coverage

Data range: 2020-10-15 - 2021-7-26.

Usage licence

Usage licence: Open Data Commons Attribution License

IP rights notes: Data users are free to share, create and adapt the dataset as long as they adequately attribute (cite) this work.

Data resources

Data package title: A survey of intertidal macroalgae species distribution along the Northwestern Iberian coast in 2020/2021 (occurrence/abundance/herbarium specimens)

Resource link: http://ipt.gbif.pt/ipt/resource?r=2021_iberianpeninsula; https://doi.org/10.15468/9t2gxy

Alternative identifiers: https://doi.org/10.15468/247z4g; http://ipt.gbif.pt/ipt/resource?r=herbarium

Number of data sets: 2

Data set name: Intertidal macroalgae species distribution along the Northwestern Iberian coast in 2020/2021

Download URL: https://www.gbif.org/dataset/c1e31227-6595-4797-b75a-d9d9f75e4cca

Data format: Darwin Core archive

Description: The data presented in this paper results from visual surveys done along the Northwestern Iberian rocky intertidal in 2020 and 2021, focusing on 34 macroalgae species. The dataset published in GBIF has the structure of a Sampling event dataset with two data subsets: Events (Core) and Associated occurrences. These data have been published as a Darwin Core Archive (DwCA), which is a standardised format for sharing biodiversity data. The Sampling Event (Core) contains 77 records (eventID). The extension data (Associated Occurrences) sheet has 2632 occurrences.

Column label	Column description
eventID	Unique identifier associated with an event
samplingProtocol	Sampling method used during the event
samplingEffort	Description of effort during the sampling event
eventDate	The date of the event
year	The year of the event
month	The month of the event
day	The day of the event
country	Country where the event took place
countryCode	The unique code of the country where the event took place
Locality	A description commonly associated with the sampling place
locationID	An identifier for the location information from Geonames

decimalLatitude	The geographical latitude of the event
decimalLongitude	The geographical longitude of the event
geodeticDatum	The geodetic datum upon which the geographical coordinates are based
coordinatePrecision	The precision of the coordinates
coordinateUncertaintyInMetres	The uncertainty of the coordinates, in metres
type	Type of dataset
ownerInstitutionCode	Identifier code of the owner institution
habitat	The habitat in which the event took place
waterBody	The water body in which the event took place
rightsHolder	The rights holder of the dataset
occurrenceID	Unique identifier associated with the occurrence of a species
basisOfRecord	The specific nature of the data record
organismQuantity	An enumeration value for the quantity of a species
organismQuantityType	The quantification scale of the quantity of a species
occurrenceStatus	A statement about the presence or absence of a species in a location
scientificName	The full scientific name, with authorship and date information, if known
scientificNameID	Unique identifier of a species, obtained from WoRMS
kingdom	The full scientific name of the kingdom in which the taxon is classified
phylum	The full scientific name of the phylum in which the taxon is classified
class	The full scientific name of the class in which the taxon is classified
order	The full scientific name of the order in which the taxon is classified
family	The full scientific name of the family in which the taxon is classified
genus	The full scientific name of the genus in which the taxon is classified
specificEpithet	The specific epithet of the species
taxonRank	The taxonomic rank of the most specific name in scientificName
recordedBy	People responsible for sampling the occurrence

Data set name: Herbarium collection of intertidal macroalgae biodiversity along the Northwestern Iberian coast in 2020/2021

Download URL: https://www.gbif.org/dataset/e9543008-b26d-458e-b334-a201c5c3b7e5

Description: This collection comprises 378 herbarium specimens preserved dried and stored at CIBIO and 378 photos of these specimens stored digitally. These herbarium specimens were collected while surveying the occurrence and abundance of macroalgae species in North and central Portugal and Northwest Spain.

Column label	Column description
ocurrenceID	Unique identifier associated with an ocurrence
basisofRecord	The specific nature of the data record
eventDate	The date when the occurrence was observed
year	The year when the occurrence was observed
month	The month when the occurrence was observed
day	The day when the occurrence was observed
scientificName	The full scientific name, with authorship and date information, if known
kingdom	The full scientific name of the kingdom in which the taxon is classified
phylum	The full scientific name of the phylum in which the taxon is classified
class	The full scientific name of the class in which the taxon is classified
order	The full scientific name of the order in which the taxon is classified
family	The full scientific name of the family in which the taxon is classified
genus	The full scientific name of the genus in which the taxon is classified
specificEpithet	The specific epithet of the species
taxonRank	The taxonomic rank of the most specific name in scientificName
decimalLatitude	The geographical latitude where the occurrence was recorded
decimalLongitude	The geographical longitude where the occurrence was recorded
geodeticDatum	The geodetic datum upon which the geographical coordinates are based
coordinateUncertaintyInMeters	The uncertainty of the coordinates, in metres
continent	The continent where the occurrence was recorded.
country	The country where the occurrence was recorded.
countryCode	The standard code for the country where the occurrence was recorded
type	The nature or genre of the resource
associatedMedia	A list (concatenated and separated) of identifiers (URI) of media associated with the Occurrence
institutionCode	The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record
recordedBy	People responsible for sampling the occurrence

establishmentMeans	Statement about whether an organism or organisms have been introduced to a given place and time through the direct or indirect activity of modern humans
preparations	A list (concatenated and separated) of preparations and preservation methods for a specimen.
rightsHolder	An organization owning or managing rights over the resource

Additional information

A total of 34 macroalgae species were surveyed: 19 Ochrophyta, 13 Rhodophyta and 2 Chlorophyta (Pereira et al. 2021b). More taxonomic information per species is presented in Suppl. material 1.

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Author contributions

JP: In situ and laboratory identifications, field and laboratory work, data curation and manuscript preparation.

CM: In situ and laboratory identifications, field and laboratory work, data curation and manuscript preparation.

RS: Funding provisioning, data curation and manuscript preparation.

FPL: Study conception and supervision, funding provisioning, data curation, and manuscript preparation.

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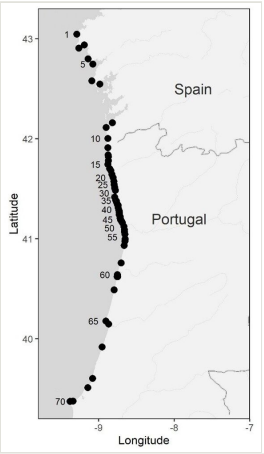

Figure 1.

Study locations along the Northwestern Iberia coast visited in the years of 2020 and 2021. Location details and sampling dates can be found in Table 1 and Table 2.

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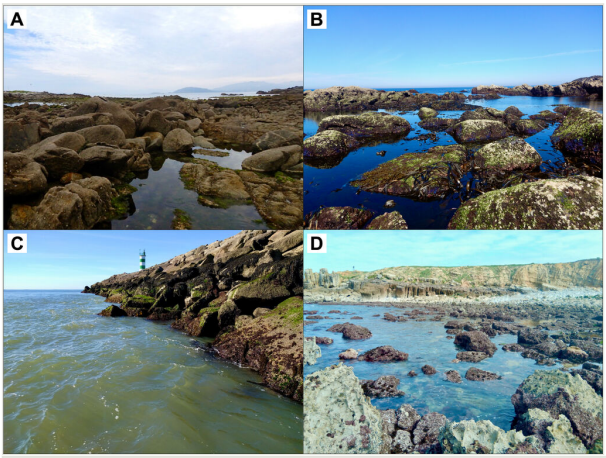

Figure 2.

Examples of shores surveyed in the present study. A - Oia, in Galicia, B – Moledo, in northern Portugal and, C – Cabedelo (breakwater), an artificial site in northern Portugal. D – Papôa, in central Portugal.

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Figure 3.

Two-people team recording SACFOR abundances at Aguda on 18-10-2020.

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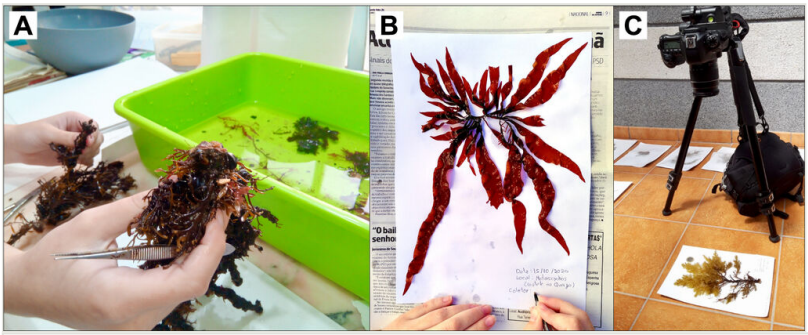

Figure 4.

Representation of steps taken in the creation of herbarium: A - cleaning of specimens; B - identification of specimens, their collection location, date, and collectors; C - photographing specimens.

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Table 1.

Natural rocky shore sites surveyed, their coordinates and date of the survey. The coordinates were obtained from GoogleMaps imagery. Locations are listed from North to South.

ID	Location	Latitude	Longitude	Date	Astronomical low tide height (m below mean sea water level)
1	Cabo Touriñán	43.04423	-9.28810	2021-05-24	-1.52
2	Corveiro	42.90442	-9.26077	2021-05-26	-1.68
3	Quenxe	42.93650	-9.18958	2021-05-26	-1.68
4	Ximprón	42.79679	-9.14016	2021-05-25	-1.63
5	Punta Outeiriño	42.74564	-9.07681	2021-05-25	-1.63
6	Corrubedo	42.57665	-9.08985	2021-06-26	-1.45
7	O Touro	42.54606	-8.98397	2021-06-26	-1.45
8	Prado	42.15921	-8.81940	2021-05-27	-1.62
9	Faro Vello de Silleiro	42.11185	-8.89945	2021-05-27	-1.62
10	Oia	42.00199	-8.87770	2021-05-28	-1.49
11	Fedorento	41.91017	-8.87801	2021-05-28	-1.48
12	Moledo	41.83815	-8.87491	2020-10-19	-1.69
12	Moledo	41.83908	-8.87529	2021-06-25	-1.43
13	Vila Praia de Âncora	41.81940	-8.87205	2020-12-17	-1.45
14	Afife	41.78439	-8.87168	2020-12-17	-1.69
14	Afife	41.78072	-8.87014	2020-10-19	-1.45
15	Montedor	41.74292	-8.87591	2021-01-29	-1.37
16	Forte da Vigia	41.69959	-8.85507	2020-11-16	-1.72
17	Praia Norte	41.69983	-8.85472	2020-11-16	-1.72
19	Amorosa	41.64290	-8.82338	2021-01-12	-1.39
20	Foz do Neiva	41.61095	-8.80893	2020-12-16	-1.55
21	Rio de Moinhos	41.57362	-8.79846	2020-12-16	-1.55
25	Apúlia	41.48267	-8.77886	2020-11-17	-1.62
26	Santo André	41.41663	-8.78827	2021-01-15	-1.42
27	Verde	41.38542	-8.77433	2021-01-15	-1.42
28	Carvalhido	41.38149	-8.77150	2021-03-30	-1.79
30	Caxinas	41.36220	-8.76045	2021-01-13	-1.46
31	Forte de São João	41.34108	-8.75073	2021-01-13	-1.46
33	Areia	41.33355	-8.73993	2021-01-14	-1.49
34	Mindelo	41.31052	-8.74136	2021-01-14	-1.49
35	Facho	41.29241	-8.73419	2020-12-15	-1.58

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36	Sampaio	41.27956	-8.72914	2020-12-15	-1.58
37	Labruge	41.27309	-8.72900	2021-01-16	-1.32
38	Angeiras (Maelas)	41.26615	-8.72829	2021-03-31	-1.68
39	Angeiras (Praia dos Barcos)	41.26510	-8.72818	2021-01-16	-1.32
40	Praia Central	41.26187	-8.72686	2021-01-31	-1.48
41	Funtão	41.26041	-8.72494	2020-11-15	-1.66
42	Pedras do Corgo	41.24931	-8.72591	2020-11-15	-1.66
43	Pedras da Agudela	41.24163	-8.72795	2020-11-14	-1.55
44	Memória	41.23528	-8.72433	2020-10-17	-1.71
45	Cabo do Mundo	41.22115	-8.71577	2020-10-17	-1.71
46	Boa Nova	41.20458	-8.71553	2020-10-16	-1.59
47	Leça (Piscina das Marés)	41.19231	-8.70742	2020-10-16	-1.59
50	Castelo do Queijo	41.16746	-8.69016	2020-10-15	-1.38
50	Castelo do Queijo	41.16722	-8.69020	2021-06-23	-1.35
51	Homem do Leme	41.15903	-8.68538	2020-12-14	-1.54
51	Homem do Leme	41.15903	-8.68538	2021-02-14	-1.37
52	Salgueiros	41.12148	-8.66652	2020-11-18	-1.45
53	Valadares	41.08964	-8.65700	2020-11-18	-1.46
54	Senhor da Pedra	41.06894	-8.65836	2020-10-18	-1.76
54	Senhor da Pedra	41.06846	-8.65848	2021-06-24	-1.40
55	Aguda	41.04554	-8.65282	2020-10-18	-1.76
55	Aguda	41.04613	-8.65325	2021-06-24	-1.40
64	Buarcos	40.17751	-8.90354	2021-03-03	-1.46
65	Pedrogão	39.91612	-8.95537	2021-04-12	-1.31
67	Nazaré	39.60384	-9.08041	2021-03-01	-1.63
68	São Martinho do Porto	39.51151	-9.14207	2021-07-26	-1.28
69	Papôa	39.37344	-9.37773	2021-03-02	-1.58
70	Baleal	39.37586	-9.33981	2021-03-02	-1.58

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Table 2.

Artificial substrate locations surveyed and their correspondent coordinates and date of the survey. The coordinates were obtained from GoogleMaps imagery. Locations are listed from North to South.

ID	Location	Latitude	Longitude	Date	Astronomical low tide height (m below mean sea water level)
18	Cabedelo (breakwater)	41.67923	-9.83669	2021-03-15	-1.35
22	Esposende (breakwater)	41.54149	-8.79361	2021-03-28	-1.65
23	Ofir (southern breakwater)	41.51551	-8.78768	2021-03-28	-1.65
24	Pedrinhas	41.50590	-8.78829	2020-11-17	-1.62
29	Póvoa de Varzim (marina)	41.37615	-8.76433	2021-03-28	-1.65
32	Azurara (breakwater)	41.33919	-8.74709	2021-03-30	-1.79
48	Leça (breakwater)	41.18622	-8.70760	2021-03-31	-1.68
49	Matosinhos (northern breakwater)	41.17800	-8.69908	2021-06-23	-1.35
56	Bairro Piscatório (northern breakwater)	40.99809	-8.64944	2021-03-12	-1.37
57	Paramos (southern breakwater)	40.97362	-8.65141	2021-03-12	-1.37
58	Maceda (breakwater)	40.93121	-8.66139	2021-03-12	-1.37
59	Barra (northern breakwater)	40.64102	-8.75212	2021-03-14	-1.44
60	Barra (southern breakwater)	40.62783	-8.75108	2021-03-14	-1.44
61	Costa Nova (northern breakwater)	40.61955	-8.75398	2021-03-14	-1.44
62	Costa Nova (southern breakwater)	40.61949	-8.74819	2021-04-14	-1.24
63	Poço da Cruz (breakwater)	40.48955	-8.79457	2021-03-13	-1.43
66	Figueira da Foz (marina)	40.14684	-8.86726	2021-03-13	-1.41

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Supplementary material

Suppl. material 1: List of species surveyed, scientific name ID from the World Register of Marine Species (WoRMS) and taxonomic ranks.

Authors: Joana Pereira, Cátia Monteiro, Rui Seabra and Fernando P. Lima
Data type: Taxonomic and biogeographic data
Brief description: Table with taxonomic and biogeographic information.
Download file (4.94 kb)