diversity

MDPI

Article

Non-Native Marine Macroalgae of the Azores: An Updated Inventory

Daniela Gabriel [1,2,*], Ana Isabel Ferreira [1], Joana Micael [3] and Suzanne Fredericq [4]

[1] Faculty of Sciences and Technology, University of the Azores, 9500-321 Ponta Delgada, Portugal; isabelferreira98@hotmail.com
[2] BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO—Research Center in Biodiversity and Genetic Resources, 4485-661 Vairão, Portugal
[3] Southwest Iceland Nature Research Centre, 245 Suðurnesjabær, Iceland; joana@natturustofa.is
[4] Department of Biology, University of Louisiana at Lafayette, Lafayette, LA 70504-3602, USA; sfredericq@yahoo.com
* Correspondence: danielalgabriel@gmail.com; Tel.: +351-296-650-105

Abstract: Non-native species (NNS) represent a threat to biodiversity, and their occurrence and distribution should be periodically updated and made easily available to researchers and policymakers. An updated inventory of macroalgal NNS currently present in the Azores was produced based on published reports. Data concerning the first report and the distribution in the archipelago are provided for each species, as well as their respective native ranges and possible vectors of introduction. The resulting list comprises 42 taxa, i.e., 8.05% of the marine flora presently reported in the Azores, with 16 new NNS recorded over the last decade. The most isolated islands of the Western Group presented lower numbers of NNS (4.25% and 6.25%). In contrast, the two islands with the most used marina for transatlantic recreational sailing presented higher numbers (12.90% and 16.87%). Shipping is the main introduction vector (68%), whereas most macroalgal NNS are originally from the Pacific Ocean (31%) and the Indo-Pacific (31%). The presence of 13 species is restricted to single islands, and no species is reported exclusively in the Western group. *Asparagopsis armata* is the only algal NNS reported from all islands of the Azores. Future work is proposed to support policymaking.

Keywords: Azores; introduction vectors; marine macroalgae; non-native species; oceanic islands; seaweeds

Citation: Gabriel, D.; Ferreira, A.I.; Micael, J.; Fredericq, S. Non-Native Marine Macroalgae of the Azores: An Updated Inventory. *Diversity* **2023**, *15*, 1089. https://doi.org/10.3390/d15101089

Academic Editor: Ipek Kurtboke

Received: 6 September 2023
Revised: 10 October 2023
Accepted: 13 October 2023
Published: 17 October 2023

1. Introduction

The presence of Non-Native Species (NNS), i.e., taxa that are introduced or facilitated by human activities to a given area, is considered one of the major threats to global biodiversity, the economy, and public health [1,2]. Since algae have an important role in the marine ecosystem, an algal invasion changes key characteristics such as community abundance, resource allocation, nutrient acquisition rates, and competition mechanisms [2]. Research and policy activities related to NNS require that current and historical data, including species status, introduction pathway, and degree of establishment, are accessible and useful [3].

The Azores is a remote archipelago in the North Atlantic, comprising nine main volcanic islands and several islets, separated into three groups (Figure 1). These islands have a relatively recent origin and are spread over 500 km from east to west [4]. The warm Gulf Stream, acting as a thermal buffer, contributes to the moderate sea water temperatures in the Azores, which in turn influences its climate [5]. Despite its high latitude, the archipelago's climate is subtropical, with moderate temperatures, low insolation rates, regular and abundant rainfall, and vigorous winds [6]. The marine flora of the Azores presents connections with subtropical and tropical Atlantic America [7] but mainly with the Eastern Atlantic, the Mediterranean, and other Macaronesian islands [8].

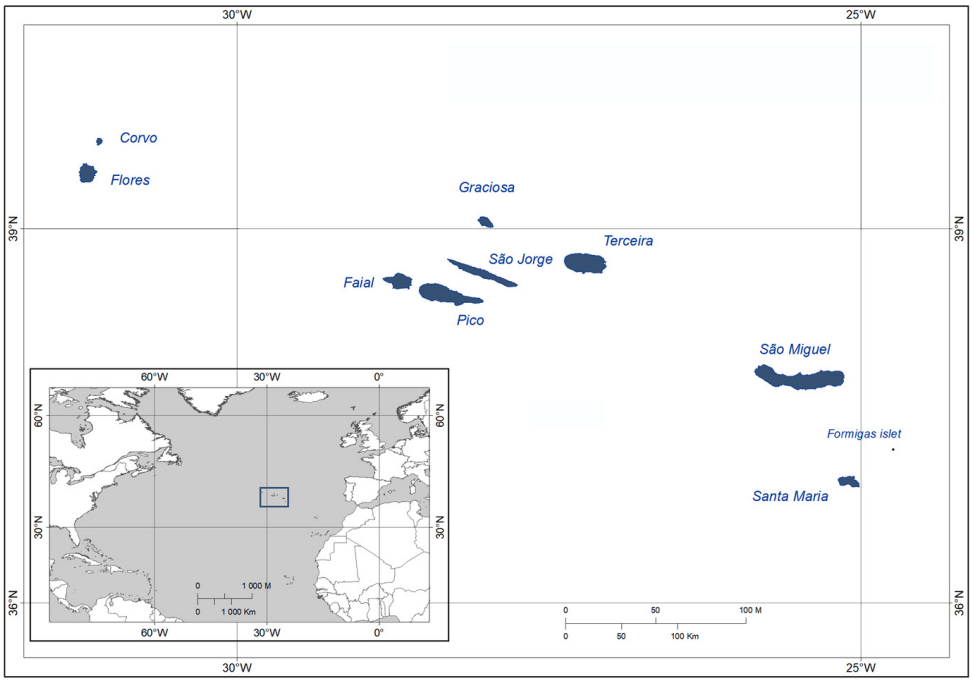


Figure 1. The archipelago of the Azores and its location in the North Atlantic (box).

In 2006, Cardigos et al. [9] reported 33 introduced species (12 macroalgae and 21 invertebrates) in the first inventory of non-native species in the Azores. Later, updated inventories were published (e.g., [10,11]), as well as other isolated reports (e.g., [12–14]). Castro et al. [11] registered 66 NNS in the Azores, 22 of which are macroalgal species, the most representative group of the archipelago. In fact, the Azores were reported to have double the global ratio of non-native macroalgal species [10]. Hence, this archipelago poses as a crossroad for native species distribution [15] but also for non-native species introductions [11].

The current study aims to produce an updated inventory of the non-native macroalgal species reported for the Azores and their respective introduction histories based on data from the literature. The updated list increases the number of macroalgal NNS reported for the archipelago, corrects taxonomic changes or conflicts, and amends previously reported distributions, representing a support tool for research and policymaking.

2. Materials and Methods

The study area comprises the nine Azorean islands and Formigas islets (Figure 1), here included due to the relevance of the marine flora found in their shallow banks [16]. The present inventory includes alien, non-indigenous, introduced, and non-native species, i.e., species currently present but with native distribution ranges other than the Azores, reported in published scientific articles, monitoring programs, technical reports, and Ph.D. theses. Cryptogenic species, i.e., those whose statues that are not clearly native or non-native [9,10], and those classified with uncertain status [16–24] in the archipelago, were not included. The criteria used by the mentioned authors to classify the species as non-native were not evaluated; therefore, their statuses are based on the reported data. Nevertheless, a few decisions were made regarding conflicting reports: 1—*Asparagopsis taxiformis* is kept as an NNS despite the suggestion of Neto et al. (2021) to change its status to native, and this study agrees with other publications based on distributional and molecular data (e.g., [10,11,25]); 2—*Antithamnion nipponicum* and *Corynomorpha prismatica* were reincluded in the NNS list since Castro et al. [11] based their removal only on their sporadicity; 3—records of *Lophocladia trichocladus* were removed from Faial, *Codium fragile* from Graciosa, *Asparagopsis taxiformis* from São Jorge and Corvo, and *Grateloupia turuturu* (reported as *G. filicina*) from Santa Maria, Graciosa, Terceira, São Jorge, and Flores, after verification

of the references given by Castro et al. [11]. The conservative aspect of such decisions is based on the confirmation of species identifications during the exhaustive works of Neto et al. [16–24]. *Scytosiphon dotyi*, for example, was collected twice in 30 years, with a 15-year gap [26]; *Antithamnionella ternifolia* remained a single record for 17 years [10], with multiple specimens found afterwards [24,27]. Native distribution of macroalgal NNS and possible vectors are given as reported by each respective author.

The framework, taxonomy, nomenclature, and authorities in this checklist are built upon the current synthesis of taxa in AlgaeBase [28]. It is beyond the scope of this paper to provide a rigorous assessment of the misapplication of species and genus names reported for the Azores without a critical examination of the macroalgal vouchers from the region.

For statistical purposes, native distribution was grouped as Pacific Ocean, Western Pacific, Northwestern Pacific, Indo-Pacific, Indian Ocean, Northeastern Atlantic, and Western Atlantic. Hull fouling and ballast water were grouped as 'shipping', while aquaculture/aquarium were grouped as 'escape from confinement'. Natural dispersal mechanisms such as rafting were not considered when analyzing the introduction vectors. When the first report of a species is given as a period of years, only the first year is considered.

3. Results

3.1. Species Invetory

The resulting list comprises a total of 42 non-native macroalgal species (8.05% of the Azorean marine flora of 522 taxa), with the correction of previously reported distributional ranges based on taxonomy and the literature review (Table 1, Supplementary Material File S1).

Table 1. Inventory of the non-native macroalgal species currently reported for the Azores, including the respective native distribution, possible introduction vector to the Azores, distribution per island, and year of first report in the archipelago. Taxa indicated with a "+" denotes additions to the previous inventory listed in Castro et al. [11]. Taxa with distribution restricted to a single island are indicated with "*". Taxa based on a single record are indicated with "°".

Taxon	Native Range	Distribution in the Azores	Possible Vector	First Record for the Azores
Phylum **Ochrophyta** Class **Phaeophyceae** Order **Dictyotales** Family **Dictyotaceae**				
Rugulopteryx okamurae +	Subtropical to temperate Western Pacific Ocean [14]	São Miguel [14]; Faial [14]	Ballast waters, Hull fouling [14]	2019 [14]
Order **Ectocarpales** Family **Chordariaceae**				
Papenfussiella kuromo	Northwestern Pacific [10]	São Miguel [10,11,24,29]; Santa Maria [10,11,22,30]; Terceira [10]; Graciosa [10,11,21,29,31]; Pico [10]; Faial [10,11,29]; Flores [23]	Unknown [10]	1990 [29]
Family **Scytosiphonaceae**				
Hydroclathrus tilesii +	Pacific Ocean (based on [28])	Formigas [16]; Santa Maria [22]; Graciosa [21]; Pico [20]; Faial [17]; Flores [23]	Unknown	1989 [20]
Petalonia binghamiae	Western Pacific [10]	São Miguel [9–11,24,31–33], Terceira [9–11,19,31,32]; Graciosa [10,11,21,31]; Pico [9–11,20,31,32]; Faial [9–11,32,34]	Ballast water, Hull fouling [10]	1989 [34]
Scytosiphon dotyi + [1]	Indo-Pacific [35]	Formigas [16]; São Miguel [26]	Hull fouling [36]	1990 [26]

Table 1. *Cont.*

Taxon	Native Range	Distribution in the Azores	Possible Vector	First Record for the Azores
Phylum **Rhodophyta** Class **Florideophyceae** Order **Nemaliales** Family **Liagoraceae**				
Neoizziella divaricata +	Indo-Pacific (based on [28])	Formigas [16]; São Miguel [24]; Flores [23]	Unknown	1989 [24]
Family **Scinaiaceae**				
Scinaia acuta *	Australia, New Zealand [11]	Santa Maria [11,22,37]	Unknown	2005 [37]
Order **Bonnemaisoniales** Family **Bonnemaisoniaceae**				
Asparagopsis armata	Australia, New Zealand [9]	Formigas [16]; São Miguel [9–11,24,31,32]; Santa Maria [9–11,22,31]; Terceira [9–11,19,31]; Graciosa [9–11,21,31,38]; São Jorge [9,11,18,31]; Pico [9–11,20,31]; Faial [9–11]; Flores [9–11,23]; Corvo [9–11,23]	Hull fouling [10]	1988 [38]
Asparagopsis taxiformis	Indo-Pacific [10]	São Miguel [10,11,31,32,39]; Santa Maria [9–11,31,40]; Terceira [39]; Graciosa [9]; Pico [9–11,31]; Faial [9,11,39]; Flores [9–11,41]	Hull fouling [10]	1928 [39]
Bonnemaisonia hamifera	Northwestern Pacific [10]	São Miguel [24]; Santa Maria [22]; Terceira [10,11,19,31]; Graciosa [9–11,38]; Faial [9–11,34]; Flores [9]	Ballast water or Hull fouling [10]	1988 [38]
Order **Ceramiales** Family **Callithamniaceae**				
Aglaothamnion cordatum +	Indian Ocean [10]	Graciosa [10,21,31]; Pico [10,20,31]	Ballast water, Hull fouling [10]	2006 [31]
Scageliopsis patens	Indo-Pacific [10]	São Miguel [10,11,24,32]; Faial [10,11,42,43]	Ballast water, Hull fouling [10]	1989 [43]
Family **Ceramiaceae**				
Acrothamnion preissii *	Indo-Pacific [12]	Santa Maria [11,12,22]	Hull fouling [12]	2009 [12]
Antithamnion densum *	Indo-Pacific [10]	Pico [10,11,31]	Hull fouling [44]	2007 [31]
Antithamnion diminuatum	Indo-Pacific [10]	São Miguel [10,11,24,31,32]; Graciosa [10,11,21,31]; São Jorge [10,11,31]; Pico [10,11,20,31]; Faial [10,11,34,42,43]	Ballast water, Hull fouling [10]	1989 [43]
Antithamnion hubbsii +	Indian Ocean [45]	São Miguel [24]; Santa Maria [22]	Ballast water, Hull fouling [45]	1989 [22]
Antithamnion nipponicum + * °	Northwestern Pacific [10]	Faial [9,10,42,43]	Ballast water, Hull fouling [10]	1989 [43]
Antithamnionella elegans + * °	Indo-Pacific [35]	São Miguel [26]	Hull fouling [26]	2018 [26]
Antithamnionella spirographidis +	Indo-Pacific [35]	São Miguel [24]; Graciosa [21]	Ballast water, Hull fouling [45]	2012 [21]
Antithamnionella ternifolia * [2]	Indo-Pacific [10]	São Miguel [10,11,24,27,46]	Hull fouling [10]	1987 [46]
Ceramium cingulatum	Indian Ocean [10]	São Miguel [10,11,31]; Terceira [10,11,19,31]; São Jorge [10,11,31]; Pico [10,11,20,31]	Unknown [10]	2007 [31]
Family **Delesseriaceae**				
Hypoglossum heterocystideum + *	Indo-Pacific (based on [28])	Graciosa [21]	Unknown	2014 [21]

Table 1. *Cont.*

Taxon	Native Range	Distribution in the Azores	Possible Vector	First Record for the Azores
Family **Rhodomelaceae**				
Laurencia brongniartii + [3]	Pacific Ocean [10]	São Miguel [24]; Graciosa [10,31]; São Jorge [10,18,31]; Pico [10,20,31]	Unknown [10]	1994 [24]
Laurencia chondrioides +	Western Atlantic [10]	Terceira [10,19,31]; Graciosa [10,31]; São Jorge [10,18,31]; Pico [10,20,31]	Unknown [10]	2006 [31]
Laurencia dendroidea +	Indian Ocean [10]	Formigas [16]; São Miguel [10,24,31]; Graciosa [10,21,31]; São Jorge [10,31]; Pico [10,20,31]; Faial [17]	Unknown [10]	1990 [16]
Laurencia minuta +	Indian Ocean (based on [28])	Terceira [19]; Graciosa [21]; Pico [20]	Unknown	2006 [21]
Lophocladia trichoclados [4]	Western Atlantic [47]	São Miguel [11,48]; Santa Maria [11,48]	Hull Fouling [48]	2016 [48]
Melanothamnus harveyi	Northwestern Pacific [10]	Santa Maria [22]; Graciosa [10,11,21,31]	Ballast water, Hull fouling [10]	2005 [31]
Melanothamnus sphaerocarpus +	Western Atlantic [10]	São Miguel [10,31]; Terceira [10,19,31]; Pico [10,31]	Ballast water, Hull fouling [10]	2007 [31]
Symphyocladia marchantioides	Pacific [10]	Formigas [10,42,49]; São Miguel [10,11,24,31,42,46,49]; Santa Maria [10,11,22,31,42,49]; Terceira [10,11,19,31]; Graciosa [10,11,21,42,49]; São Jorge [10,11,31]; Pico [10,11,20,31,34,42,50]; Faial [9–11,34,42,50]; Flores [9,23]	Ballast water, Hull fouling [10]	1971 [49]
Xiphosiphonia pennata + [5]	Atlantic and Pacific Oceans [51]	São Miguel [24,31,42,46]; Santa Maria [31]; Graciosa [31]; São Jorge [31]	Unknown	1987 [46]
Xiphosiphonia pinnulata + [6]	Northwestern Pacific [10]	São Miguel [10,24,31]; Santa Maria [10,31]; Graciosa [10,21,31]	Hull fouling [10]	2005 [31]
Family **Wrangeliaceae**				
Grallatoria reptans + *	Western Atlantic [10]	São Miguel [10,24,31]	Unknown [10,44]	2007–2008 [31]
Gymnophycus hapsiphorus *	Australia, New Zealand [11]	São Miguel [11,24,26,27,48]	Hull fouling [48]	2009–2010 [27]
Spongoclonium caribaeum +	Indo-Pacific [10]	São Miguel [10,31]; Pico [10,20,31]	Hull fouling, Aquaculture [10]	2007 [31]
Order **Gigartinales** Family **Cystocloniaceae**				
Hypnea flagelliformis	Indo-Pacific [10]	São Miguel [10,11,31]; Pico [10,11,24,31]	Hull fouling [10]	2007 [31]
Order **Halymeniales** Family **Halymeniaceae**				
Corynomorpha prismatica + * °	Indian Ocean [10]	São Miguel [10,42,52]	Unknown [10]	1990 [52]
Family **Grateloupiaceae**				
Grateloupia turuturu [7]	Northwestern Pacific [10]	São Miguel [11,31]; Pico [11,31]	Hull fouling [10]	2007 [31]
Phylum **Chlorophyta** Class **Ulvophyceae** Order **Bryopsidales** Family **Caulerpaceae**				
Caulerpa prolifera	Western Atlantic [13]	São Miguel [11,13,24,48]; Faial [11,48,53]	Rafting, Ballast water [53], Hull fouling, Escape from aquarium [13]	2013 [53]
Caulerpa webbiana *	Indian Ocean [10]	Faial [9–11,17]	Hull fouling [54]	2002 [9]

Table 1. *Cont.*

Taxon	Native Range	Distribution in the Azores	Possible Vector	First Record for the Azores
Family **Codiaceae**				
Codium fragile	Northwestern Pacific [10]	São Miguel [7,10,11,24]; Santa Maria [11,22]; Graciosa [21]; Pico [20]; Flores [23]; Corvo [7,10,11,23]	Ballast water, Hull fouling [10]	1993 [7]
Family **Halimedaceae**				
Halimeda incrassata *	Western Atlantic and Indo-Pacific [55]	Santa Maria [11,48]	Hull Fouling [48]	2016 [48]

[1] The species is established in the Mediterranean where it was introduced from shellfish aquaculture [45]. [2] Castro and Viegas [46] reported the species *Antithamnion sarniensis*, with Neto [42] further amending this record as the heterotypic synonym *Antithamnionella spirographidis*. Since *Antithamnion sarniensis* is currently regarded as a homotypic synonym of *Antithamnionella ternifolia* [28], the record is only considered for the latter species. [3] The species is established in the Atlantic coast of France where it was introduced from shellfish aquaculture [44,56]. [4] Molecular-based identification is needed to confirm this record since the true *Lophocladia trichoclados* is apparently an Atlantic species [47], therefore not an NNS. [5] *Xiphosiphonia pennata* is a complex species reported in the Atlantic and the Indo-Pacific. Molecular-based identification is needed to confirm this record, since the *true X. pennata* is apparently restricted to European shores [51], therefore probably not an NNS. [6] *Xiphosiphonia pennata* is a complex species (including *X. pinnulata*) reported in the Atlantic and the Indo-Pacific. Molecular-based identification is needed to confirm this record, since the true *X. pinnulata* is apparently restricted to the Atlantic [51], therefore probably not an NNS. [7] According to Gavio and Fredericq [57], the Atlantic non-native *Grateloupia doryphora* should be referred to as *G. turuturu*; therefore, the distribution in the Azores is based only on reports of the first species. All reports based on *G. filicina* (since [58]) are removed from the previous inventory [11]. Nevertheless, vouchers of this species reported to the Azores should be re-examined, since reports of *G. filicina* var. *luxurians*, currently referred as *G. subpectinata*, are thought to be introductions in Ireland and Britain [59].

3.2. Species Composition

The updated list is composed of (Figure 2a):

- Five brown algae (5% of the Ochrophyta reported in the Azores);
- Thirty-three red algae (9% of the Rhodophyta reported in the Azores);
- Four green algae (5% of the Chlorophyta reported in the Azores);
- Therefore, 12% of the non-native macroalgal species belong to the Ochrophyta, 79% to the Rhodophyta, and 9% to the Chlorophyta.

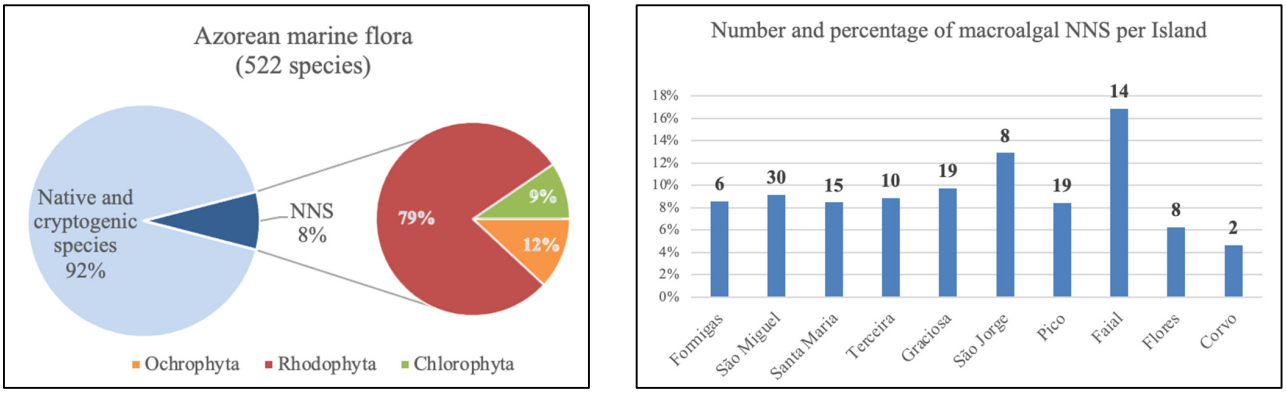


Figure 2. Non-native macroalgal species in the Azores: (**a**) Composition of the Azorean marine flora in relation to the species' native status and composition of the non-native species (NNS) in relation to the main groups of algae; (**b**) Number of macroalgal non-native species (NNS) and its percentage in relation to the reported marine flora, for each island of the Azores.

Within the three macroalgal Phylla, the most represented orders are (Table 1):

- Four of the five (80%) Ochrophyta species belong to the Ectocarpales, characterized by isomorphic gametophyte and sporophyte composed of uniseriate, branched, or unbranched filaments [28];
- 25 of the 33 (76%) Rhodophyta species belong to the Ceramiales, an order characterized by isomorphic gametophyte and sporophyte of widely varying morphology of uniaxial structure [28];
- All four (100%) Chlorophyta species belong to the Bryopsidales, an order characterized by simple to complex siphonous thalli [28].

3.3. Non-Native Species Distribution

3.3.1. General Distribution

All islands host non-native macroalgal species, with the following percentage in relation to the reported marine flora (Figure 2b):

- Formigas, São Miguel, Santa Maria, Terceira, Graciosa, and Pico present similar percentage of NNS (8.44–9.74%);
- The most isolated islands in the Western Group (Flores and Corvo) present lower percentages of NNS (6.25% and 4.25%, respectively);
- The islands with the most used marina for transatlantic recreational sailing (São Jorge and Faial) present higher percentages of NNS (12.90% and 16.87%, respectively).

3.3.2. Specific Distribution (Maps in Supplementary Material File S2)

The presence of 13 species is restricted to single islands, namely:

- *Antithamnionella elegans*, *Antithamnionella ternifolia*, *Corynomorpha prismatica*, *Grallatoria reptans*, and *Gymnophycus hapsiphorus* in São Miguel;
- *Acrothamnion preissii*, *Halimeda incrassata*, and *Scinaia acuta* in Santa Maria;
- *Hypoglossum heterocystideum* in Graciosa;
- *Antithamnion densum* in Pico;
- *Antithamnion nipponicum* and *Caulerpa webbiana* in Faial.

The distribution of six species is restricted to the different Groups of islands, namely:

- *Antithamnion hubbsii*, *Lophocladia trichoclados*, and *Scytosiphon dotyi* in the Eastern Group;
- *Aglaothamnion cordatum*, *Laurencia chondrioides*, and *Laurencia minuta* in the Central Group;
- No species is exclusively found in the Western Group.

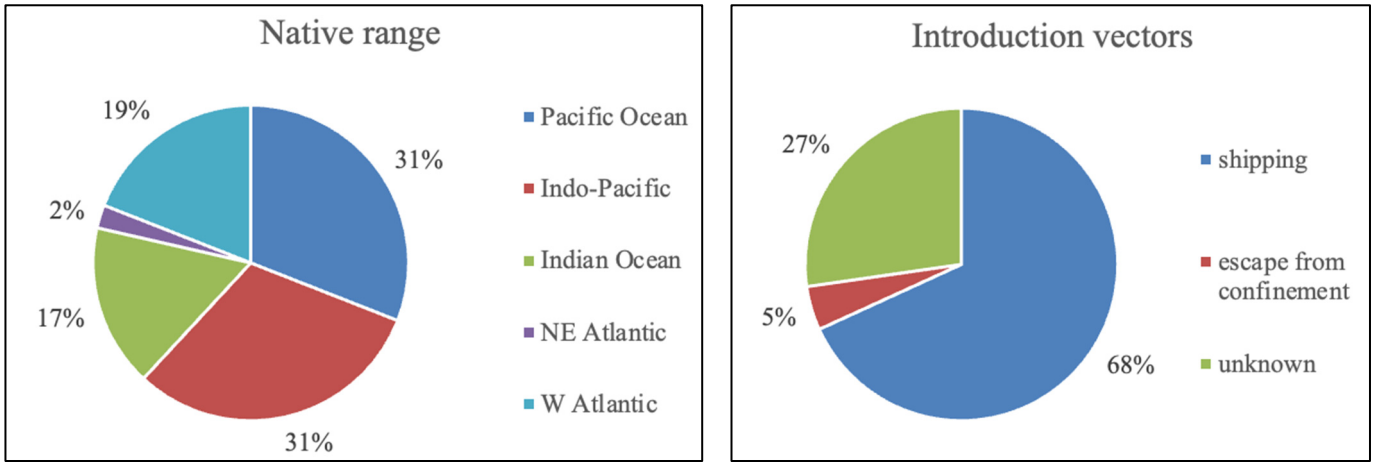
Asparagopsis armata is the only species reported from all islands of the archipelago.

3.4. Species Introduction

3.4.1. Native Range

The original distributional ranges of the non-native macroalgal species of the Azores are (Figure 3a):

- 7% from the Pacific Ocean, 7% from the Western Pacific, and 17% from the Northwestern Pacific;
- 31% from the Indo-Pacific;
- 17% from the Indian Ocean;
- 2% from the Northeastern Atlantic, and 19% from the Western Atlantic.



(**a**) (**b**)

Figure 3. Introduction of the non-native macroalgal species in the Azores: (**a**) Native range of the reported species; (**b**) Possible vectors of introduction.

3.4.2. Introduction Vectors

The possible vectors of introduction (based on published reports) for the non-native macroalgal species in the Azores are (Figure 3b):

- 68% from shipping, i.e., through hull fouling or ballast water;
- 5% due to escape from confinement, i.e., from aquarium or aquaculture;
- 27% unknown.

3.4.3. History of First Reports

The cumulative number of non-native macroalgal species shows the following trend (Figure 4):

- First NNS reported in 1928;
- First surge of NNS reports in the late 1980s;
- Second surge of NNS reports in the mid-2000s;
- Steady increase in the number of NNS reports in the last 15 years.

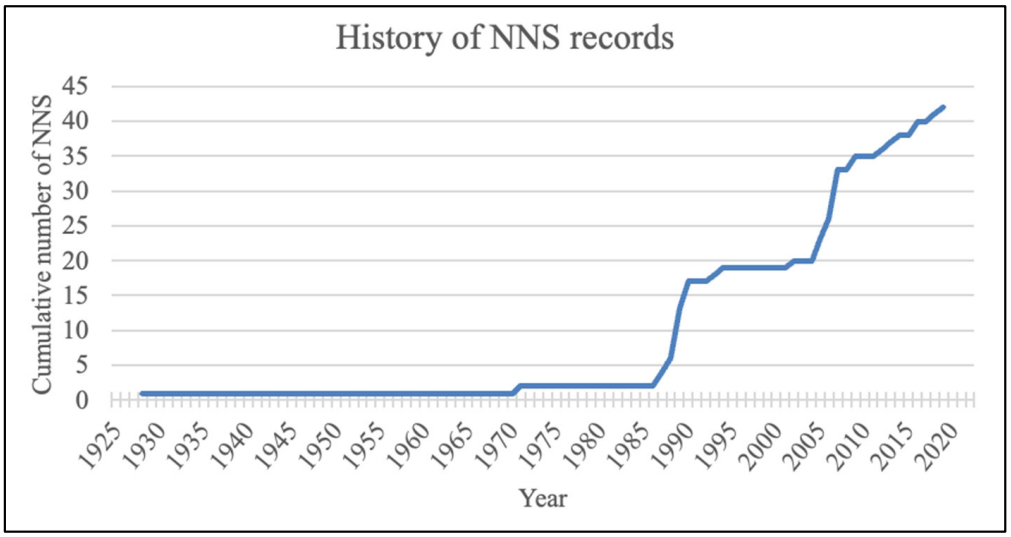


Figure 4. The cumulative number of non-native macroalgal species, according to their year of record in the Azores.

4. Discussion

The list of non-native macroalgal species in the Azores is here increased to 42 species, 20 more species than in the last inventory by Castro et al. [11]. This expansion includes the reintroduction of species previously recorded by Micael et al. [10] as well as additional species reported as non-native by other authors in the last five years (e.g., [12–14,21,24]). Since the extensive study by Micael et al. [10], the known marine flora from the Azores encompasses 83 more species (439 to 522, [26]), including 16 more NNS. Nevertheless, the newly reported macroalgal NNS increases the ratio that Micael et al. [10] reported from 6 to 8% of the Azorean marine flora, rising from double the global percentage (3%) to almost triple.

The ratio of non-native species belonging to Rhodophyta has also increased from that reported by Micael et al. [10], namely from 65 to 79%, and is now higher than the global pattern [60]. As discussed by Micael et al. [61], red algae appear to be particularly efficient in introduction and invasive events. Their success can be attributed to the combination of various factors, including: 1—the ability to reproduce by fragmentation, increasing the potential pool of propagules [62]; 2—the ability to use the entire light spectrum, enabling them to establish in shadow environments [63]; and 3—their high bromophenol content which might help to deter predators [64].

Despite the low representation of the Chlorophyta in the present inventory, all the green algae reported as NNS in the Azores belong to the Bryopsidales. Members of this order present rapid growth from fragmented thalli (e.g., [65]), and many taxa became invasive out of their native range (e.g., [66]). In fact, *Caulerpa webbiana* was classified as one of the species to be prioritized for monitoring and eradication measures in the Azores [67].

Likewise, although only five species of brown algae are reported in the updated inventory, it includes *Rugulopteryx okamurae*, an extremely invasive species with high propagation capacity [68] This species has caused major impacts in communities where it has invaded (e.g., [69]), and has quickly made its way to the European list of invasive non-native species [70]. *R. okamurae* is also the only macroalga with specific legislation for its monitorization and control in the Azores [71].

The ratio of non-native macroalgal species with native distribution in the Pacific Ocean (31%) and the Indo-Pacific (31%) remains equal to those reported by Micael et al. [10], even with the now increased number of NNS (from 26 to 42 species). Instead, the ratio of species from the Indian Ocean decreased (23% to 17%), and the ratio from the Atlantic Ocean increased (15% to 21%). The main difference is the increase in species from the Western Atlantic (11% to 19%), a trend also observed in other Macaronesian archipelagos, namely Madeira (e.g., [72]) and the Canary Islands (e.g., [73]). NNS originally distributed in the Atlantic Ocean might include species that reached the archipelago by rafting in the dominant Atlantic currents, with their subsequent establishment facilitated by the increase in seawater temperatures [13,72]. Although not directly introduced by human activities, the growing accumulation of marine litter facilitates new introductions by offering new habitats for drifting macroalgae [74].

The updated distribution of non-native macroalgal species in the Azores shows that previously reported species [9,10] have spread to other islands. This rise is probably due to further transport between harbors and marinas but may also result from additional efforts to identify non-native species [75].

No experimental or empirical evidence of introduction vectors for the non-native macroalgal species currently found in the Azores has been found. Nevertheless, different authors reporting on those species suggested possible vectors for their introductions (see detailed reports in Section 3.1). Transport via shipping is the most representative possible vector, which probably contributed to 68% of the non-native macroalgal species reported. This ratio is similar to that reported by Micael et al. [10], even though those authors studied fewer species than the present work. This possible ratio is higher than that reported for marine species in other European waters [76], mostly due to the low representation of other vectors (such as artificial channels and aquaculture). The introduction vector of 27% of the

NNS currently present in the Azores is still unknown, and further studies are necessary to identify other possible existing vectors.

Although studies of the marine flora of the Azores started in 1844 [77], the first record of a non-native macroalgal species dates from 1928 [39]. This date coincides with the second wave of marine species introductions that happened at the beginning of the 20th century, associated with the increase in maritime traffic [78]. Two surges in first reports of NNS were observed in this study and coincided with increased sampling efforts in the Azores. In the late 1980s, the Biology Department of the University of the Azores organized various scientific expeditions (Graciosa/88, Faial e Pico/89, Flores e Corvo/89, Santa Maria e Formiga/90), which resulted in the report of nine new NNS. Furthermore, 11 NNS were newly reported after the expeditions conducted by the Marine Biology Section of the University of the Azores between 2005 and 2008 (PARQMAR/2005, PADEL/2006, PICOBEL/2007, TAPES/2007, CAMAG-ORI/2008, CAMAG-TER/2008). Since the publication of the European Union Marine Strategy Framework Directive [79], which included the level of NNS introduced by human activities as a qualitative descriptor, new records of non-native macroalgal species have been steadily reported.

Further taxonomic work is necessary to correct possible misidentifications in previous reports (e.g., [16–24]). Consequently, many species names may not be accurate because the taxonomic concepts of previous reports were based mostly on morphological similarities without comparative molecular systematics (with a few exceptions such as [13,14]). Species distribution in the Azores might also be underrepresented, especially in islands where sampling is sporadic [22] or in habitats not specifically investigated [26]. Therefore, further investigation is still needed. Additionally, the invasiveness risk of NNS should be assessed to support policymakers [80,81] in preventing, minimizing, or mitigating their impact in a cost-efficient manner [76].

Nevertheless, this list contributes to estimating the presence of non-native species throughout the Azores, providing updated and accessible data for invasiveness risk assessments and subsequent policymaking [3].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d15101089/s1, Supplementary Material File S1: List of non-native species of marine macroalgae reported to the Azores, with the respective native distribution, possible introduction vector to the Azores, distribution per island, and year of first report in the Archipelago; Supplementary Material File S2: Distribution maps of non-native macroalgal species in the Azores.

Author Contributions: Conceptualization, D.G. and S.F.; data curation, D.G. and A.I.F.; formal analysis, D.G. and J.M.; funding acquisition, D.G.; investigation, D.G. and A.I.F.; writing—original draft preparation, D.G., A.I.F., J.M. and S.F.; writing—review and editing, D.G., J.M. and S.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Programa Operacional AÇORES 2020, grant number ACORES-01-0145-FEDER-000091 (85% by the European Regional Development Fund and 15% by funds from the Autonomous Region of the Azores), DG is supported by Fundação para a Ciência e a Tecnologia, grant number DL57/2016/CP1440/CT0025, CIBIO is maintained by Fundação para a Ciência e a Tecnologia, grant number UIDB/50027/2020.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: The data presented in this study are available in Supplementary Material File S1.

Acknowledgments: The present work was generated in the context of the Project CRYPTO–Molecular Identification of Cryptogenic Macroalgae with Invasive Potential in the Azores, with administrative support of Fundação Gaspar Frutuoso. The authors would like to thank António Medeiros for providing the map of the study area and Joana Vilaverde for contributing to earlier versions of the distribution maps. We also thank the two anonymous reviewers for their constructive suggestions.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. UN. *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets*; Document UNEP/CBD/COP/DEC/X/2; Secretariat of the Convention on Biological Diversity: Nagoya, Japan, 2010.
2. Li, H.; Geng, Y.; Shi, H.; Wu, C.; Yu, Z.; Zhang, H.; Chen, L.; Xing, R. Biological Mechanisms of Invasive Algae and Meta-Analysis of Ecological Impacts on Local Communities of Marine Organisms. *Ecol. Indic.* **2023**, *146*, 109763. [CrossRef]
3. Groom, Q.J.; Adriaens, T.; Desmet, P.; Simpson, A.; De Wever, A.; Bazos, I.; Cardoso, A.C.; Charles, L.; Christopoulou, A.; Gazda, A.; et al. Seven Recommendations to Make Your Invasive Alien Species Data More Useful. *Front. Appl. Math. Stat.* **2017**, *3*, 13. [CrossRef]
4. León-Cisneros, K.; Tittley, I.; Terra, M.R.; Nogueira, E.M.; Neto, A.I. The Marine Algal (Seaweed) Flora of the Azores: 4, Further Additions. *Arquipel. Life Mar. Sci.* **2012**, *29*, 25–32.
5. Meirelles, M.; Carvalho, F.; Porteiro, J.; Henriques, D.; Navarro, P.; Vasconcelos, H. Climate Change and Impact on Renewable Energies in the Azores Strategic Visions for Sustainability. *Sustainability* **2022**, *14*, 15174. [CrossRef]
6. Brito de Azevedo, E.; Rodrigues, M.; Fernandes, J. O Clima Dos Açores. In *Atlas Básico dos Açores*; Forjaz, V.H., Ed.; Observatório Vulcanológico e Geotérmico dos Açores: Ponta Delgada, Portugal, 2004; pp. 25–48. ISBN 9729746648.
7. Tittley, I.; Neto, A.I. The Marine Algal (Seaweed) Flora of the Azores: Additions and Amendments. *Bot. Mar.* **2005**, *48*, 248–255. [CrossRef]
8. Freitas, R.; Romeiras, M.; Silva, L.; Cordeiro, R.; Madeira, P.; González, J.A.; Wirtz, P.; Falcón, J.M.; Brito, A.; Floeter, S.R.; et al. Restructuring of the 'Macaronesia' Biogeographic Unit: A Marine Multi-Taxon Biogeographical Approach. *Sci. Rep.* **2019**, *9*, 15792. [CrossRef] [PubMed]
9. Cardigos, F.; Tempera, F.; Ávila, S.; Gonçalves, J.; Colaço, A.; Santos, R.S. Non-Indigenous Marine Species of the Azores. *Helgol. Mar. Res.* **2006**, *60*, 160–169. [CrossRef]
10. Micael, J.; Parente, M.I.; Costa, A.C. Tracking Macroalgae Introductions in North Atlantic Oceanic Islands. *Helgol. Mar. Res.* **2014**, *68*, 209–219. [CrossRef]
11. Castro, N.; Carlton, J.T.; Costa, A.C.; Marques, C.S.; Hewitt, C.L.; Cacabelos, E.; Lopes, E.; Gizzi, F.; Gestoso, I.; Monteiro, J.G.; et al. Diversity and Patterns of Marine Non-native Species in the Archipelagos of Macaronesia. *Divers. Distrib.* **2022**, *28*, 667–684. [CrossRef]
12. Parente, M.I.; Gabriel, D.; Micael, J.; Botelho, A.Z.; Ballesteros, E.; Milla, D.; dos Santos, R.; Costa, A.C. First Report of the Invasive Macroalga *Acrothamnion preissii* (Rhodophyta, Ceramiales) in the Atlantic Ocean. *Bot. Mar.* **2018**, *61*, 85–90. [CrossRef]
13. Cacabelos, E.; Faria, J.; Martins, G.M.; Mir, C.; Parente, M.I.; Gabriel, D.; Sánchez, R.; Altamirano, M.; Costa, A.C.; Prud'homme van Reine, W.; et al. First Record of *Caulerpa prolifera* in the Azores (NE Atlantic). *Bot. Mar.* **2019**, *62*, 155–160. [CrossRef]
14. Faria, J.; Prestes, A.C.L.; Moreu, I.; Martins, G.M.; Neto, A.I.; Cacabelos, E. Arrival and Proliferation of the Invasive Seaweed *Rugulopteryx okamurae* in NE Atlantic Islands. *Bot. Mar.* **2022**, *65*, 45–50. [CrossRef]
15. Tittley, I.; Neto, A.I. The Marine Algal Flora of the Azores: Island Isolation or Atlantic Stepping-Stones? *Occas. Publ. Ir. Biogeogr. Soc.* **2006**, *9*, 40–54.
16. Neto, A.I.; Prestes, A.C.L.; Azevedo, J.M.N.; Resendes, R.; Álvaro, N.; Neto, R.M.A.; Moreu, I. Marine Algal Flora of Formigas Islets, Azores. *Biodivers. Data J.* **2020**, *8*, e57510. [CrossRef]
17. Neto, A.I.; Prestes, A.C.L.; Resendes, R.; Neto, R.M.A.; Moreu, I. Marine Algal (Seaweed) Flora of Faial Island, Azores. 2020. Sampling Event Dataset. Available online: https://doi.org/10.15468/jnkr5k (accessed on 9 June 2023).
18. Neto, A.I.; Prestes, A.C.L.; Resendes, R.; Neto, R.M.A.; Moreu, I. Marine Algal (Seaweed) Flora of São Jorge Island, Azores. 2020. Available online: https://doi.org/10.15468/93phf6 (accessed on 9 June 2023).
19. Neto, A.I.; Prestes, A.C.L.; Álvaro, N.; Resendes, R.; Neto, R.M.A.; Moreu, I. Marine Algal (Seaweed) Flora of Terceira Island, Azores. *Biodivers. Data J.* **2020**, *8*, e57462. [CrossRef] [PubMed]
20. Neto, A.I.; Prestes, A.C.L.; Álvaro, N.; Resendes, R.; Neto, R.M.A.; Tittley, I.; Moreu, I. Marine Algal Flora of Pico Island, Azores. *Biodivers. Data J.* **2020**, *8*, e57461. [CrossRef]
21. Neto, A.I.; Parente, M.I.; Botelho, A.Z.; Prestes, A.C.L.; Resendes, R.; Afonso, P.; Álvaro, N.V.; Milla-Figueras, D.; Neto, R.M.A.; Tittley, I.; et al. Marine Algal Flora of Graciosa Island, Azores. *Biodivers. Data J.* **2020**, *8*, e57201. [CrossRef]
22. Neto, A.I.; Parente, M.; Cacabelos, E.; Costa, A.; Botelho, A.; Ballesteros, E.; Monteiro, S.; Resendes, R.; Afonso, P.; Prestes, A.; et al. Marine Algal Flora of Santa Maria Island, Azores. *Biodivers. Data J.* **2021**, *9*, e61909. [CrossRef]
23. Neto, A.I.; Parente, M.; Tittley, I.; Fletcher, R.; Farnham, W.; Costa, A.; Botelho, A.; Monteiro, S.; Resendes, R.; Afonso, P.; et al. Marine Algal Flora of Flores and Corvo Islands, Azores. *Biodivers. Data J.* **2021**, *9*, e60929. [CrossRef]
24. Neto, A.I.; Moreu, I.; Rosas Alquicira, E.; León-Cisneros, K.; Cacabelos, E.; Botelho, A.; Micael, J.; Costa, A.; Neto, R.; Azevedo, J.; et al. Marine Algal Flora of São Miguel Island, Azores. *Biodivers. Data J.* **2021**, *9*, e64969. [CrossRef] [PubMed]
25. Santos, R.; Ferreira, A.; Micael, J.; Gil-Rodríguez, M.C.; Machín, M.; Costa, A.C.; Gabriel, D.; Costa, F.O.; Parente, M.I. Genetic Characterization of the Red Algae *Asparagopsis armata* and *Asparagopsis taxiformis* (Bonnemaisoniaceae) from the Azores. *Genome* **2015**, *58*, 276. [CrossRef]

26. Neto, A.I.; Cacabelos, E.; Prestes, A.C.L.; Díaz-Tapia, P.; Moreu, I. New Records of Marine Macroalgae for the Azores. *Bot. Mar.* **2022**, *65*, 105–120. [CrossRef]
27. Vaz-Pinto, F.; Torrontegi, O.; Prestes, A.C.L.; Álvaro, N.V.; Neto, A.I.; Martins, G.M. Invasion Success and Development of Benthic Assemblages: Effect of Timing, Duration of Submersion and Substrate Type. *Mar. Environ. Res.* **2014**, *94*, 72–79. [CrossRef]
28. Guiry, M.D.; Guiry, G.M. AlgaeBase. World-Wide Electronic Publication. National University of Ireland, Galway. 2023. Available online: http://www.algaebase.org (accessed on 9 June 2023).
29. Tittley, I.; Neto, A.I.; Parente, M.I. The Marine Algal (Seaweed) Flora of the Azores: Additions and Amendments 3. *Bot. Mar.* **2009**, *52*, 7–14. [CrossRef]
30. Botelho, A.Z.; Dionísio, M.A.; Cunha, A.; Monteiro, S.; Geraldes, D.; Hipólito, C.; Parente, M.; Angélico, M.M.; Costa, A.C. *Contributo Para a Inventariação da Biodiversidade Marinha da ilha de Santa Maria*; Relatórios e Comunicações do Departamento de Biologia da Universidade dos Açores 36; Universidade dos Açores: Ponta Delgada, Protugal, 2009; pp. 75–87.
31. Wallenstein, F. Rocky Shore Macroalgae Communities of the Azores (Portugal) and the British Isles: A Comparison for the Development of Ecological Quality Assessment Tool. Ph.D. Thesis, Heriot-Watt University, Edinburgh, UK, 2011.
32. Neto, A.I.d.M.A. Studies on Algal Communities of São Miguel, Azores. Ph.D. Thesis, University of the Azores, Ponta Delgada, Portugal, 1997.
33. Parente, M.I.; Neto, A.I.; Fletcher, R.L. Morphology and Life History Studies of *Endarachne binghamiae* (Scytosiphonaceae, Phaeophyta) from the Azores. *Aquat. Bot.* **2003**, *76*, 109–116. [CrossRef]
34. Tittley, I.; Neto, A.I. "Expedition Azores 1989": Benthic Marine Algae (Seaweeds) Recorded from Faial and Pico. *Archipélago. Life Mar. Sci.* **1994**, *12*, 1–13.
35. Verlaque, M.; Ruitton, S.; Mineur, F.; Boudouresque, C.F. CIESM Atlas of Exotic Macrophytes in the Mediterranean Sea. *Rapp. Comm. Int. Mer. Médit.* **2007**, *38*, 14.
36. ICES. *Working Group on Introductions and Transfers of Marine Organisms (WGITMO)*; ICES Scientific Reports; ICES: Copenhagen, Denmark, 2022; Volume 4. [CrossRef]
37. León-Cisneros, K.; Riosmena-Rodríguez, R.; Neto, A.I. A Re-Evaluation of *Scinaia* (Nemaliales, Rhodophyta) in the Azores. *Helgol. Mar. Res.* **2011**, *65*, 111–121. [CrossRef]
38. Neto, A.I. *Algas Marinhas do Litoral da Ilha Graciosa. Graciosa/88, Relatório Preliminar*; Relatórios e Comunicações do Departamento de Biologia da Universidade dos Açores 17; Universidade dos Açores: Ponta Delgada, Protugal, 1989; pp. 61–65.
39. Schmidt, O.C. Beitrage Zur Kenntnis Der Meeresalgen Der Azoren II. *Hedwigia* **1929**, *69*, 165–172.
40. Torres, P.; Lopes, C.; Dionísio, M.A.; Costa, A.C. *Espécies Exóticas Invasoras Marinhas da Ilha de Santa Maria, Açores*; Relatórios e Comunicações do Departamento de Biologia da Universidade dos Açores 36; Universidade dos Açores: Ponta Delgada, Protugal, 2010; pp. 103–111.
41. Dionísio, M.A.; Micael, J.; Parente, M.I.; Norberto, R.; Cunha, A.; Brum, J.M.M.; Cunha, L.; Lopes, C.; Monteiro, S.; Palmero, A.M.; et al. *Contributo Para o Conhecimento da Biodiversidade Marinha da Ilha das Flores*; Relatórios e Comunicações do Departamento de Biologia da Universidade dos Açores 35; Universidade dos Açores: Ponta Delgada, Protugal, 2008; pp. 65–84.
42. Neto, A.I. Checklist of the Benthic Marine Macroalgae of the Azores. *Arquipel. Life Mar. Sci.* **1994**, *12A*, 15–34.
43. Athanasiadis, A.; Tittley, I. Antithamnioid Algae (Rhodophyta, Ceramiaceae) Newly Recorded from the Azores. *Phycologia* **1994**, *33*, 77–80. [CrossRef]
44. EC. European Commission, Joint Research Centre, European Alien Species Information Network (EASIN). 2023. Available online: https://easin.jrc.ec.europa.eu (accessed on 9 June 2023).
45. Marchini, A.; Ferrario, J.; Sfriso, A.; Occhipinti-Ambrogi, A. Current Status and Trends of Biological Invasions in the Lagoon of Venice, a Hotspot of Marine NIS Introductions in the Mediterranean Sea. *Biol. Invasions* **2015**, *17*, 2943–2962. [CrossRef]
46. Castro, M.L.; Viegas, M.C. Contribuição Para o Estudo da Zona Intertidal (Substrato Rochoso) da Ilha de São Miguel-Açores. Fácies de *Corallina elongata* Ellis & Solander. Resultados Preliminares. *Cuad. Marisq.* **1987**, *11*, 59–69.
47. Golo, R.; Vergés, A.; Díaz-Tapia, P.; Cebrian, E. Implications of Taxonomic Misidentification for Future Invasion Predictions: Evidence from One of the Most Harmful Invasive Marine Algae. *Mar. Pollut. Bull.* **2023**, *191*, 114970. [CrossRef] [PubMed]
48. ICES. *Interim Report of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO)*; Document CM 2018/HAPISG; ICES: Madeira, Portugal, 2018.
49. Ardré, F.; Bouderesque, C.; Cabioch, J. Présence Remarquable Du *Symphyocladia marchantioides* (Harvey) Falkenberg (Rhodomélacées, Céramiales) Aux Açores. *Bull. Soc. Phycol. Fr.* **1974**, *19*, 178–182.
50. Fralick, R.A.; Hehre, E.; Mathieson, A. Observations on the Marine Algal Flora of the Azores I: Notes of the Epizoic Algae Occurring on the Marine Molluscs Patella spp. *Arquipel. Life Mar. Sci* **1985**, *6*, 39–43.
51. Díaz-Tapia, P.; Maggs, C.A.; Macaya, E.C.; Verbruggen, H. Widely Distributed Red Algae Often Represent Hidden Introductions, Complexes of Cryptic Species or Species with Strong Phylogeographic Structure. *J. Phycol.* **2018**, *54*, 829–839. [CrossRef] [PubMed]
52. Fredericq, S.; Serrão, E.; Norris, J. New Records of Marine Red Algae from the Azores. *Arquipel. Life Mar. Sci.* **1992**, *10*, 1–4.
53. Cardigos, F.; Tempera, F.; Fontes, J.; Ribeiro, P.; Sala, I.; Caldeira, R.; Santos, R.S. *Relatório Sobre a Presença de Uma Nova Espécie No Norte da Ilha do Faial*; Departamento de Oceanografia e Pescas da Universidade dos Açores: Horta, Portugal, 2013.
54. Amat, J.N. The Recent Northern Introduction of the Seaweed *Caulerpa webbiana* (Caulerpales, Chlorophyta) in Faial, Azores Islands (North-Eastern Atlantic). *Aquat. Invasions* **2008**, *3*, 417–422. [CrossRef]

55. Alós, J.; Tomas, F.; Terrados, J.; Verbruggen, H.; Ballesteros, E. Fast-Spreading Green Beds of Recently Introduced *Halimeda incrassata* Invade Mallorca Island (NW Mediterranean Sea). *Mar. Ecol. Prog. Ser.* **2016**, *558*, 153–158. [CrossRef]
56. Goulletquer, P.; Bachelet, G.; Sauriau, P.G. Noel P Open Atlantic Coast of Europe a Century of Introduced Species into French Waters. In *Invasive Aquatic Species of Europe. Distribution, Impacts and Management*; Leppäkoski, E., Gollasch, S., Olenin, S., Eds.; Springer: Dordrecht, The Netherlands, 2002; pp. 276–290, ISBN 978-90-481-6111-9.
57. Gavio, B.; Fredericq, S. *Grateloupia turuturu* (Halymeniaceae, Rhodophyta) Is the Correct Name of the Non-Native Species in the Atlantic Known as *Grateloupia doryphora*. *Eur. J. Phycol.* **2002**, *37*, 349–359. [CrossRef]
58. Gain, L. Algues Provenant Des Campagnes de l'Hirondelle II (1911–1912). *Bull. L'Institut Océanogr. Monaco* **1914**, *279*, 1–23.
59. Wilkes, R.J.; McIvor, L.M.; Guiry, M.D. Using *Rbc*L Sequence Data to Reassess the Taxonomic Position of Some *Grateloupia* and *Dermocorynus* Species (Halymeniaceae, Rhodophyta) from the North-Eastern Atlantic. *Eur. J. Phycol.* **2005**, *40*, 53–60. [CrossRef]
60. Guiry, M.D. How Many Species of Algae Are There? *J. Phycol.* **2012**, *48*, 1057–1063. [CrossRef]
61. Micael, J.; Rodrigues, P.; Gíslason, S. Native vs. Non-Indigenous Macroalgae in Iceland: The State of Knowledge. *Reg. Stud. Mar. Sci.* **2021**, *47*, 101944. [CrossRef]
62. Williams, S.L.; Smith, J.E. A Global Review of the Distribution, Taxonomy, and Impacts of Introduced Seaweeds. *Annu. Rev. Ecol. Evol. Syst.* **2007**, *38*, 327–359. [CrossRef]
63. Hoffman, R.; Dubinsky, Z. Invasive and Alien Rhodophyta in the Mediterranean and along the Israeli Shores. In *Red Algae in the Genomic Age*; Seckbach, J., Chapman, D.J., Eds.; Springer: Dordrecht, The Netherlands, 2010; pp. 45–60. ISBN 978-90-481-3794-7.
64. Maggs, C.A.; Stegenga, H. Red Algal Exotics on North Sea Coasts. *Helgol. Mar. Res.* **1998**, *52*, 243–258. [CrossRef]
65. González, A.V.; Beltrán, J.; Santelices, B. Colonisation and Growth Strategies in Two *Codium* Species (Bryopsidales, Chlorophyta) with Different Thallus Forms. *Phycologia* **2014**, *53*, 353–358. [CrossRef]
66. Sauvage, T.; Payri, C.; Draisma, S.G.A.; van Reine, W.F.P.; Verbruggen, H.; Belton, G.S.; Gurgel, C.F.D.; Gabriel, D.; Sherwood, A.R.; Fredericq, S. Molecular Diversity of the *Caulerpa racemosa—Caulerpa peltata* Complex (Caulerpaceae, Bryopsidales) in New Caledonia, with New Australasian Records for *C. racemosa* var. *cylindracea*. *Phycologia* **2013**, *52*, 6–13. [CrossRef]
67. RAA Resolução n.º 15/2012/A da Assembleia Legislativa da Região Autónoma dos Açores de 2 de Abril de 2012. Regime Jurídico da Conservação da Natureza e da Proteção da Biodiversidade. *Diário da República*. 2012, pp. 1625–1713. Available online: https://diariodarepublica.pt/dr/detalhe/decreto-legislativo-regional/15-2012-553893 (accessed on 9 June 2023).
68. García-Gómez, J.C.; Sempere-Valverde, J.; González, A.R.; Martínez-Chacón, M.; Olaya-Ponzone, L.; Sánchez-Moyano, E.; Ostalé-Valriberas, E.; Megina, C. From Exotic to Invasive in Record Time: The Extreme Impact of *Rugulopteryx okamurae* (Dictyotales, Ochrophyta) in the Strait of Gibraltar. *Sci. Total Environ.* **2020**, *704*, 135408. [CrossRef]
69. Faria, J.; Prestes, A.C.L.; Moreu, I.; Cacabelos, E.; Martins, G.M. Dramatic Changes in the Structure of Shallow-Water Marine Benthic Communities Following the Invasion by *Rugulopteryx okamurae* (Dictyotales, Ochrophyta) in Azores (NE Atlantic). *Mar. Pollut. Bull.* **2022**, *175*, 113358. [CrossRef]
70. EC European Commission Implementing Regulation 2022/1203 of 12 July 2022. Amending Implementing Regulation (EU) 2016/1141 to Update the List of Invasive Alien Species of Union Concern. *Off. J. Eur. Union* **2022**, *186*, 10–13.
71. RAA Resolução n.º 33/2022/A da Assembleia Legislativa da Região Autónoma dos Açores de 10 de Outubro de 2022 Número 195. Implemen-Tação Urgente de Medidas Para Combater o Impacto da Alga Rugulopteryx okamurae nos Ecossistemas Marinhos. *Diário da República*. 2022, pp. 5–7. Available online: https://files.dre.pt/gratuitos/1s/2022/10/19500.pdf (accessed on 9 June 2023).
72. Ribeiro, C.; Sauvage, T.; Ferreira, S.; Haroun, R.; Silva, J.; Neves, P. Crossing the Atlantic: The Tropical Macroalga *Caulerpa ashmeadii* Harvey 1858 as a Recent Settler in Porto Santo Island (Madeira Archipelago, North-Eastern Atlantic). *Aquat. Bot.* **2023**, *184*, 103595. [CrossRef]
73. Sangil, C.; Martín-García, L.; Afonso-Carrillo, J.; Barquín, J.; Sansón, M. *Halimeda incrassata* (Bryopsidales, Chlorophyta) Reaches the Canary Islands: Mid- and Deep-Water Meadows in the Eastern Subtropical Atlantic Ocean. *Bot. Mar.* **2018**, *61*, 103–110. [CrossRef]
74. Kiessling, T.; Gutow, L. Thiel M Marine Litter as Habitat and Dispersal Vector. In *Marine Anthropogenic Litter*; Bergmann, M., Gutow, L., Klages, M., Eds.; Springer International Publishing: Cham, Switzerland, 2015; pp. 141–181. ISBN 978-3-319-16509-7.
75. Tempesti, J.; Mangano, M.C.; Langeneck, J.; Lardicci, C.; Maltagliati, F.; Castelli, A. Non-Indigenous Species in Mediterranean Ports: A Knowledge Baseline. *Mar. Environ. Res.* **2020**, *161*, 105056. [CrossRef]
76. Tsiamis, K.; Azzurro, E.; Bariche, M.; Çinar, M.E.; Crocetta, F.; De Clerck, O.; Galil, B.; Gómez, F.; Hoffman, R.; Jensen, K.R.; et al. Prioritizing Marine Invasive Alien Species in the European Union through Horizon Scanning. *Aquat. Conserv.* **2020**, *30*, 794–845. [CrossRef]
77. Seubert, M. *Flora Azorica*; Apud Adolphum Marcum: Bonna, Germany; Hong Kong, China, 1844.
78. Cardigos, F.; Monteiro, J.; Fontes, J.; Parretti, P.; Santos, R.S. Fighting Invasions in the Marine Realm, a Case Study with *Caulerpa webbiana* in the Azores. In *Biological Invasions in Changing Ecosystems*; Canning-Clode, J., Ed.; De Gruyter Open: Warsaw, Poland, 2015; pp. 279–300. [CrossRef]
79. European Union. EC Directive 56/EC of the European Parliament and of the Council of 17 June 2008. Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive). *Off. J. Eur. Union* **2008**, *164*, 19–40.

80. Copp, G.; Vilizzi, L.; Tidbury, H.; Stebbing, P.; Tarkan, A.S.; Miossec, L.; Goulletquer, P. Development of a Generic Decision-Support Tool for Identifying Potentially Invasive Aquatic Taxa: AS-ISK. *Manag. Biol. Invasions* **2016**, *7*, 343–350. [CrossRef]
81. Copp, G.H.; Vilizzi, L.; Wei, H.; Li, S.; Piria, M.; Al-Faisal, A.J.; Almeida, D.; Atique, U.; Al-Wazzan, Z.; Bakiu, R.; et al. Speaking Their Language—Development of a Multilingual Decision-Support Tool for Communicating Invasive Species Risks to Decision Makers and Stakeholders. *Environ. Model. Softw.* **2021**, *135*, 104900. [CrossRef]