Diversity of Marine and Brackish Macrophytes in the Port-Cros National Park (Provence, France, Mediterranean Sea): Taxa and Research Effort over Space and Time

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Abstract: The terrestrial and marine Port-Cros National (PCNP) was established in 1963; it was then made up only of the Archipelago of Port-Cros. Since 2012, it has been extended to include a vast land and sea area, including not only islands but also part of the mainland, the new PCNP (N-PCNP); the marine core area and the adjacent marine area cover approximately 120,000 ha and extend over 63 km as the crow flies, from east to west. Taxon richness is just one descriptor of biodiversity among others (e.g., functional and ecosystem diversity), and is far from being the most reliable one; however, it deserves to be taken into consideration, provided that certain prerequisites are met, because it constitutes a convenient measure of, e.g., the research effort and the diversity of habitats. The number of reported macrophyte taxa amounts to 502: 73 green algae, 316 red algae, 104 brown algae and 9 magnoliophyta and other taxa. Two new combinations are proposed: *Ericaria brachycarpa* var. *claudiae* and *Gongolaria montagnei* var. *compressa*. This gamma species diversity is far from being exceptionally high, but rather is within the norm for the Mediterranean, if we take into account the size of the area considered. The number of reported taxa per site is highly heterogeneous throughout the N-PCNP area; it is, as expected, correlated with the number of studies per site. The research effort peaked in the 1970–1980s, and then irregularly declined, which may seem surprising in this era of biodiversity launched at the 1992 Rio Summit. The exceptionally extensive database available, covering more than a century, provides the basis for a critical analysis of the concept of biodiversity, as proclaimed by the general public and the ‘greens’, which can be naive or biased, and of the concept of ‘heritage value species’, which the authors of this article consider to be a ‘toxic concept’, as opposed to ‘ordinary biodiversity’, which enables ecosystem functioning. However, this database, straddling both areas highly impacted by humans (coastal development, tourist resorts) and areas that are effectively protected, does not highlight obvious changes over time.

Keywords: brown algae; *Ericaria brachycarpa* var. *claudiae*; *Gongolaria montagnei* var. *compressa*; green algae; macrophytes; national park; Provence; red algae; research effort; seagrasses

1. Introduction

A checklist of benthic macroalgae of the Gulf of Hyères and Hyères Islands (Porquerolles Island, Port-Cros Archipelago and Le Levant Island; Provence, France, Mediterranean Sea) was published by Belsher et al. [1]. Since then, considerable changes have taken place in the taxonomy of macroalgae, and numerous works have led to the discovery of hitherto unreported taxa.

We define macrophytes as multicellular photosynthetic organisms (MPOs). Here, we include within macrophytes non-cellular taxa, with millions of nuclei within a common cytoplasm, such as *Caulerpa*, and unicellular species forming large colonies, such as *Palmophyllum* and *Chrysoreinhardia*. 
Macrophytes do not constitute a taxon but a customary, polyphyletic ensemble. They include some ‘green algae’ (Chlorobionta), Charophyta, some Magnoliophyta (seagrasses) (Viridiplantae), red algae (Rhodobionta) and brown algae (Phaeophyceae). Green algae, Charophyta, seagrasses and red algae belong to the kingdom Archaeplastida, while brown algae (Phaeophyceae) belong to the kingdom Stramenopiles [2,3].

The Port-Cros National Park (PCNP) (Provence, France, Mediterranean Sea) was established in 1963. It originally encompassed the island of Port-Cros and the nearby island and islets (Bagaud Island, La Gabinière Islet and Le Rascas Islet), i.e., the Port-Cros Archipelago, situated about 8 km off the mainland coast of eastern Provence. In addition to the land areas of the island and islets, the PCNP included a 600 m wide belt of sea, corresponding to ~1300 ha in surface area, surrounding the archipelago. The PCNP is one of the oldest terrestrial and marine national parks in the Mediterranean area [4,5].

Following the reconfiguration of the national parks by the French legislation of 2006, the PCNP engaged, between 2012 and 2016, in a major redefinition and extension of its territory; the new Port-Cros National Park (N-PCNP), established in 2016 (Figure 1), includes the Port-Cros Archipelago and Porquerolles Island as core areas (both terrestrial and marine), a vast adjacent marine area (AMA) including the gulfs of Giens and Hyères and extending seawards to the edge of the continental shelf (118,600 ha), and a discontinuous continental area, the adhesion area (AA) including five municipalities (communes in French; Figure 1). The municipalities of the AA have voluntarily joined the N-PCNP through the signing of a charter which defines the objectives of the national park regarding the conservation of the natural and cultural heritage and sustainable development [5,6]. Some other municipalities of the possible adhesion area (PAA) chose not to join the N-PCNP. Only part of the surface area of the municipalities, both those joining and those not joining the N-PCNP, belongs to the PAA (green limits, Figure 1). It is important to note that, whether or not a municipality has joined the park, the marine area located off its coastline does indeed belong to the AMA of the N-PCNP: the AA is therefore discontinuous, while the AMA is continuous. According to French law, the marine area located off the coast of a municipality is not part of the territory of this municipality.

Figure 1. The new Port-Cros National Park (N-PNPC), with terrestrial and marine core areas, the adjacent marine area, the adhesion Area and the abbreviations used (in orange) for the localities and sites taken into consideration.
Some protected areas in the Mediterranean, especially marine protected areas (MPAs), are no more than ‘paper parks’, i.e., fictitious protected areas, or ‘mist parks’, i.e., protected areas intended to fulfill the international commitments of states, often immense, having a real existence (director, premises, officials), but not implementing any real management measures involving, where necessary, constraints for some of the users [7–12]. In contrast with paper parks and mist parks, the PCNP, then the N-PNPC, are true protected areas [5,13]: in particular, since their creation, they have had a scientific council, a scientific strategy, a management plan, a strong scientific research effort based on the close collaboration between park staff and independent academic scientists, and of course the strict application of management measures which constitute constraints for some users whenever necessary [12–16].

2. Materials and Methods

We follow Boudouresque [2] for the taxonomy of higher taxa, Cormaci et al. [17] for Chlorobionta, Cormaci et al. [18–20] and Guiry and Guiry [21] for Rhodobionta and Cormaci et al. [22] for Phaeophyceae. In the few cases where we do not follow the treatment of these authors, we indicate it; we have also taken into account some subsequent articles (e.g., [23]). For each taxon, after the currently accepted name and the order (in parentheses), the names used by the cited authors, if different, are mentioned (in square brackets); such names are followed by correct authorities which could not correspond to those published by authors in the respective articles.

We have examined all of the literature dealing with marine macrophytes of the N-PCNP that we are aware of. This literature has been published in scientific journals (including the PCNP journal, Scientific Reports of Port-Cros National Park, 35 volumes of which have been published since its launch in 1975); it also includes unpublished reports (grey literature), kept at the PCNP headquarters (in Hyères-les-Palmiers) and in various libraries, including that of the Macrophyte platform of the MIO (Mediterranean Institute of Oceanography), at Aix-Marseille University [5,16]. Whenever publications clearly constitute duplicates (e.g., a report, a communication at a congress and the corresponding scientific article, or two articles strictly based on the same dataset), for example [24,25], or [26,27], we considered only one of them. Similarly, we did not consider checklists that simply repeat articles cited elsewhere (e.g., [28]). Of course, some duplicates may have escaped our attention, but their effect on the interpretation of the dataset is probably negligible.

Gut contents of herbivorous sea urchins (Arbacia lixula (Linnaeus, 1758), Centrostephanus longispinus (Philippi, 1845), Paracentrotus lividus (Lamarck, 1816) and Psammechinus microtuberculatus (Blainville, 1825)) have constituted a valuable source of information [29–32]. Some species were only or mainly recorded through the study of gut contents (e.g., the red alga Taenioma nanum).

The starting point of our literature research is 1900. Older records may exist. However, eastern Provence was little frequented by botanists in the 18th and 19th centuries. Moreover, when they exist, records were not accurately localized. In the case of Fucales (brown algae), Aurélie Blanfuné and Thierry Thibaut have explored (as far as N-PCNP is concerned) the literature and the herbaria prior to 1900 [33–35]: the rare records concern the zone outside the N-PNPC, with the exception of Ericaria crinita (Porquerolles Island). The oldest records are therefore those of Mouret in 1911 [36]. Marcellin Mouret (1881–1915) was a French soldier and botanist; he was posted to Martinique (French West Indies), Morocco and French Indochina and managed to assemble herbaria completed with notes and drawings, despite his military duties; during World War I, Lieutenant Mouret was wounded in August 1914, then was killed in March 1915 while launching an assault at the head of his company [37].

For each taxon, we have indicated the localities where it was observed from west to east, first for the mainland (La Garde LG through Ramatuelle R), then for the islands (Grand Ribaud Island GRI through Le Levant Island LLI). Magaud bank MB is a former island submerged towards the end of the Holocene transgression (Figure 1). Most localities correspond to a municipality (in French commune, the smallest administrative division
in France), with the exception of Hyères (H), a very large commune, where a number of particular sites have been distinguished: EP, GP, SH, VSSM and the islands GRI, PI, PCA and LLI (Figure 1). A few records, without indication of locality, have been labelled ‘NPCNP’.

In order to assess the variations in research effort over space and time, we have considered the number of ‘items’. An item is a record, at a given locality or site (see Figure 1), of a given taxon, by a given author in a given reference (year): item = taxon × locality (or site) × author (reference). Within each group, taxa are listed in alphabetical order.

3. Results
3.1. Green Algae (Chlorobionta)

*Acetabularia acetabulum* (Linnaeus) P.C. Silva (Dasycladales) [Acetabularia mediterranea J.V. Lamouroux nom. illeg.]. GP [38–41], SPH [42], EP [43,44], SH [45], CM [40], CV [40], PI [38,46,47], PCA [1,32,38,48–56], LLI [38].

*Anadyomene stellata* (Wulfen in Jacquin) C. Agardh (Cladophorales). CV [40], R [40], PI [46,57], PCA [1,49,51,58,59].

*Blastophysa rhizopus* Reinke (incertae sedis) [Blastophysa polymorpha Kjellman]. PCA [1,31,48,50].

*Blydia chadefaudii* (J. Feldmann) Bliding (Ulvales). CM [40], PI [46], PCA [1].

*Bryopsis corymbosa* J. Agardh (Bryopsidales). SPH [60], PCA [49,51].

*Bryopsis cupressina* J.V. Lamouroux var. *adriatica* (J. Agardh) M.J. Wynne (Bryopsidales) [Bryopsis adriatica (J. Agardh) Frauenfeld]. PCA [1,49,61].

*Bryopsis duplex* De Notaris (Bryopsidales) [as *B. balbisiana* J.V. Lamouroux in [1]]. GP [39], PCA [1,61]. According to Cormaci et al. [17], *B. balbisiana* is a taxon inquirendum.

*Bryopsis feldmannii* Gallardo et G. Furnari (Bryopsidales) [Bryopsis cupressoides Kützing non J.V. Lamouroux]. PCA [52], LLI [36,38].

*Bryopsis hypnoides* J.V. Lamouroux (Bryopsidales) [Bryopsis monoica Funk]. GP [41], PCA [1,49,51,61].

*Bryopsis muscosa* J.V. Lamouroux (Bryopsidales). SPH [42], SH [45,62], PCA [1].

*Bryopsis plumosa* (Hudson) C. Agardh (Bryopsidales). C [36], LL [36].

*Caulerpa cylindracea* Sonder (Bryopsidales) [Caulerpa racemosa (Forsskål) J. Agardh var. cylindracea (Sonder) Verlaque et al. Misidentified as Caulerpa racemosa]. GG [64], GP [41,64], GH [65,66], CM [67], CV [68], R [67,68], PI [47,65,69], PCA [54–56,59,70], LLI [71,72], NPCNP [73].

*Caulerpa prolifera* (Forsskål) J.V. Lamouroux (Bryopsidales). GH [65], PI [59,65,69,74,75], PCA [75].

*Caulerpa taxifolia* (Vahl) C. Agardh (Bryopsidales). LG [65,76], LP [65,77–79], GP [41,80], GH [65], LLM [79], CV [68], R [79], PI [47,65,69,79,81], PCA [70,79,82–88], LLI [72,89]. Successfully eradicated from the Port-Cros Archipelago [79,90].

*Chaetomorpha ligustica* (Kützing) Kützing (Cladophorales) [Chaetomorpha capillaris var. crispa Feldmann, C. tortuosa Kützing nom. illeg.]. LP [36], C [36], GP [36,39], CV [40], PCA [1].

*Chaetomorpha linum* (O.F. Müller) Kützing (Cladophorales) [Chaetomorpha aerea (Dillwyn) Kützing]. C [63], GG [38], EP [36,38,43,44], GP [39,41], SPH [42], SH [45], VSSM [43,44], CV [40], R [40], PI [36,38,46], PCA [1,49,51,52].

*Cladophora albida* (Nees) Kützing (Cladophorales) [Cladophora refracta Kützing]. GP [39], BLM [36].

*Cladophora coelothrix* Kützing (Cladophorales) [Cladophora repens Harvey]. GP [39,41], GH [38], PCA [1,49,52].

*Cladophora dalmatica* Kützing (Cladophorales). GP [39], SPH [60], BLM [36], PCA [49,51].

*Cladophora fracta* (O.F. Müller ex Vahl) Kützing. LP [36], EP [36,38], VSSM [36].
Cladophora hutchinsiae (Dillwyn) Kützing (Cladophorales). LP [36], C [36], GG [38], GP [36,38], SPH [42], PCA [1], LLI [36,38].

Cladophora laetevirens (Dillwyn) Kützing (Cladophorales). LP [36], C [36], GG [38], SPH [42], PCA [1], LLI [36,38].

Cladophora lehmanniana (Lindenberg) Kützing (Cladophorales). GP [36,38], SPH [42], PCA [1], LLI [36,38].

Cladophora prolifera (Roth) Kützing (Cladophorales). LP [36], C [63], GP [36,38,39,41], SPH [42,60,62], SH [45], PCA [1].

Cladophora rupestris (Linnaeus) Kützing (Cladophorales). GP [39,41].

Cladophora sericea (Hudson) Kützing (Cladophorales). C [36], SPH [42], BLM [36], PI [46].

Cladophora vagabunda (Linnaeus) Hoek (Cladophorales). PCA [1].

Cladophoropsis membranacea (Hofman Bang ex C. Agardh) Børgesen (Cladophorales). PCA [49]. See Cormaci et al. [17] for the confusion with Cladophoropsis modonensis (Kützing) Reinbold.

Codium bursa (Linnaeus) C. Agardh. LP [91], C [40], GG [39,92], GP [36,38–41], GH [93], CM [40], CV [40], R [40,94], PI [46,95,96], PCA [1,32,49,51,52,59,97,98], LLI [36,38,72].

Codium coralloides (Kützing) P. C. Silva (Bryopsidales). PCA [1,48].

Codium effusum (Rafinesque) Delle Chiaje (Bryopsidales). GP [40], CV [40], R [94], PI [46,96], PCA [1,49,54–56].

Codium fragile (Suringar) Hariot (Bryopsidales). CV [40], PI [46,99], PCA [1,98].

Codium vermilara (Olivi) Delle Chiaje (Bryopsidales). C [40], GP [40], CV [40], PI [46], PCA [1].

Dasycladus vermicularis (Scopoli) Krasser (Dasycladales). LP [36], GP [36,38,39,41], LL [100], CM [40], CV [40,68], PI [46,57], PCA [1,49,51,58].

Epicladia flustrae Reinke (Ulvales) \[Entocladia flustrae\] (Reinke) W.R. Taylor. PCA [61].

Flabellia petiolata (Turra) Nizamuddin (Bryopsidales) \[Udotea desfontainii\] (J.V. Lamouroux) Decaisne, \[U. petiolata\] (Turra) Børgesen. LP [36], C [40,63], GG [39,92], GP [36,39–41], GH [93], SPH [60], CM [40], CV [40], R [40,94,101], PI [46,47,57,59,95,96], PCA [1,29,30,39,48,49,52,54–56,59,61,97,102,103].

Gomontia polyrhiza (Lagerheim) Bornet et Flahault (Ulotrichales). PCA [61].

Halicystis parvula Schmitz ex Murray (Bryopsidales). As Derbesia tenuissima (Moris et De Notaris) P.L. Crouan et H.M. Crouan: GP [39], SPH [42], SH [45,62], CM [40], CV [40], R [40,94,101], PI [46,47,57,59,95,96], PCA [1,29,30,39,48,49,52,54–56,59,61,97,102,103].

Halimeda tuna (Ellis et Solander) J.V. Lamouroux (Bryopsidales). LP [91], C [40], GP [36,38–40], GH [93], LL [36], CM [40], CV [40], R [94,101], PI [46,47,57,59,96], PCA [1,48,49,54,55,59,97,117,118,72].

Lichaete pellucida (Hudson) M.J. Wynne (Cladophorales) \[Cladophora pellucida\] Hoek. PCA [52].

Lichaete echinus (Biaasoletto) M.J. Wynne (Cladophorales) \[Cladophora echinus\] (Biaasoletto) Kützing. GP [41], PCA [1,49,97].

Lichaete battersii (Hoek) M.J. Wynne (Cladophorales) \[Cladophora battersii\] (Hudson) Kützing. GP [36,38,39,41,104], BLM [36], PI [46], PCA [1,48,49,59].

Microdictyon umbilicatum (Velley) Zanardini (Cladophorales). PCA [Marc Verlaque, unpublished record, October 2019].

Ochlochaete hystrix Thwaites (Ulvales) \[Ochlochaete ferox\] Huber. PCA [31,52,61].

Ostreobium quettii Bornet et Flahault (Bryopsidales). PCA [61], MB [105].

Palmophyllum crassum (Naccari) Rabenhorst (Palmophyllales). GP [39,40,104], CV [40], R [40], PI [59,96], PCA [1,48,54–56,97,102], MB [106].

Pedobesia simplex (Meneghini ex Kützing) M.J. Wynne et F. Leliaert (Bryopsidales) \[Derbesia lamourouxii\] (J. Agardh) Solier, Pedobesia lamourouxii (J. Agardh) Feldmann et al. \[C\] [36], GG [38], PI [46], PCA [1,30,32,61], LLI [36,38].
**Phaeophila dendroides** (P.L. Crouan et H.M. Crouan) Batters (Ulvales). GP [41], PCA [1,29,31,49,50,52,61,107].

**Pseudobryopsis myura** (J. Agardh) Berthold ex Oltmanns (Bryopsidales). PCA [1].

**Pseudochlorodesmis furcellata** (Zanardini) Børgesen (Bryopsidales). GG [39], GP [39,41], PI [46,96], PCA [1,29,30,48–52,54–56,61,107].

**Rhizoclonium riparium** (Roth) Harvey, sensu Leliaert et Boedeker (Cladophorales) [Lola implexa (Dillwyn) Hamel, Rhizoclonium kerneri Stockmayer, R. kochianum Kützing]. PCA [29,30,49,61,97].

**Siphonocladius pusillus** (C. Agardh ex Kützing) Hauck (Cladophorales). PCA [49,52].

**Ulothrix flacca** (Dillwyn) Thuret (Ulotrichales). GP [39].

**Ulva clathrata** (Roth) C. Agardh (Ulvales) [Enteromorpha clathrata (Roth) Greville, E. ramulosa (J.E. Smith) Carmichael]. GP [36,38], SPH [42,62], LL [36], LLI [36,38].

**Ulva compressa** Linnaeus (Ulvales) [Enteromorpha compressa (Linnaeus) Nees]. C [63], GP [39], SPH [42,62], SH [62], PI [46], PCA [1,53,61].

**Ulva intestinalis** Linnaeus (Ulvales) [Enteromorpha intestinalis (Linnaeus) Nees]. EP [38], SPH [42,62], SH [62], PI [46], LLI [38].

**Ulvella inflata** (Ercegović) R. Nielsen, C.J. O'Kelly et B. Wysor (Ulvales) [Pseudodictyon inflatum Ercegović, Acrochaete inflata (Ercegović) Gallardo et al.]. GP [41], PCA [29,52].

**Ulvella major** (J. Feldmann) Cormaci, Furnari et Alongi (Ulvales) [Endoderma majus J. Feldmann]. PCA [1,49,97]. According to Guiry and Guiry [21], this taxon requires further investigation.

**Ulvella scutata** (Reinke) R. Nielsen, C.J. O’Kelly et B. Wyso (Ulvales) [Pringsheimiella scutata (Reinke) Marchewianka]. GP [41], PCA [1,29,30,48,52,107].

**Valonia macrophysa** Kützing (Cladophorales). GH [93], R [94], PCA [1,39,48,61,97,102,107], NPCNP [73].

**Valonia utricularis** (Roth) C. Agardh (Cladophorales). GG [39], GP [36,38,39,41,104], CM [40], CV [40], R [40], PI [46], PCA [1,49,52,107], LLI [36,38].

3.2. Charophyta, Streptobionta

**Lamprothamnium papulosum** (K. Wallroth) J. Groves. EP [43,44].
3.3. Seagrasses (Magnoliophyta, Streptobionta)

Althenia filiformis Petit. VSSM [109].

Cymodocea nodosa (Ucria) Ascherson. C [40], GG [39,40,64,80,109], GH [109], BLM [109], LL [100,109], CM [111], CV [40,68,109], R [101], PI [57,80,95,109], PCA [53,58,64,100,109,112–116], LLI [71,72,89]. The near disappearance of C. nodosa in the lagoon located behind the barrier reef of Posidonia oceanica in the Bay of Port-Cros was noted in 1997 by Meinesz et al. [116]; in 2002, they transplanted cuttings from another site at Port-Cros Island, the Bay of Port-Man; the operation was not successful [116].

Posidonia oceanica (Linnaeus) Delile. LG [27,117], LP [27,91,117,118], C [27,40,117,118], GG [27,39,92,100,110,117–119], GP [39,40,64,80,104,117,120], SPH [60], SH [64], GH [27,66,117,118,120], LLM [27,117,120], BLM [27,64,117,120], LL [27,64,100,117], RCM [27,117], CM [27,40,111,121], CV [27,40,64,68,94,117], R [27,68,94,101,111,117], GRI [117], PI [27,47,57,80,95,100,117,118,122,123], PCA [27,30–32,53,58,64,98,100,113,115,117,124–130], LLI [27,71,72,89,100,117].

Ruppia maritima Linnaeus [Ruppia cirrhosa (Petagna) Grande, as R. spiralis Linnaeus ex Dumortier (a misidentification for R. cirrhosa)]]. EP [43,44,109,131], VSSM (43,44,109,131].

Stuckenia pectinata (Linnaeus) Börner [Potamogeton pectinatus Linnaeus]. EP [109], VSSM [109].

Zostera noltei Hornemann [Nanozostera noltei (Hornemann) Tomlinson et Posluszny]. GG [100,109], GP [109], VSSM [109], LLM [109], BLM [109], CV [109], PI [80,109], PCA [58,61,98,100,112,113,115], LLI [89]; not found by [72]. The disappearance of Z. noltei in the lagoon located behind the barrier reef of Posidonia oceanica in the Bay of Port-Cros was noted in 1997 by Meinesz et al. [116]. It also disappeared from the Port-Man Bay [53].

3.4. Red Algae (Rhodobionta, Kingdom Archaeplastida)

Acrochaetium microscopicum (Nägeli ex Kützing) Nägeli (Acrochaetiales) [Acrochaetium crassipes Børgesen]. GP [39], PCA [1,49,51,61].

Acrochaetium molinieri Coppejans et Boudouresque (Acrochaetiales). PCA [58,61,132].

Acrochaetium subpinnatum Bornet ex Hamel (Acrochaetiales). GP [39]. We follow Guiry and Guiry [21] in distinguishing this taxon.

Acrodiscus vidovichii (Meneghini) Zanardini (Halymeniales). CV [32,48,49,135], NPCNP [73].

Acrosorium ciliolatum (Harvey) Kylin (Ceramiales) [Acrosorium venulosum (Zanardini) Kylin]. R [101], PCA [1,29,48,49,51,97].

Acrosorium ciliolatum (Harvey) Kylin (Ceramiales) [Acrosorium venulosum (Zanardini) Kylin]. R [101], PCA [1,29,48,49,51,97].

Acrosorium ciliolatum (Harvey) Kylin (Ceramiales) [Acrosorium venulosum (Zanardini) Kylin]. R [101], PCA [1,29,48,49,51,97].

Acrosorium ciliolatum (Harvey) Kylin (Ceramiales) [Acrosorium venulosum (Zanardini) Kylin]. R [101], PCA [1,29,48,49,51,97].

Acrosorium ciliolatum (Harvey) Kylin (Ceramiales) [Acrosorium venulosum (Zanardini) Kylin]. R [101], PCA [1,29,48,49,51,97].

Aglaothamnion caudatum (J. Agardh) G. Feldmann (Ceramiales) [Callithamnion caudatum (J. Agardh)]. PCA [1], LLI [36,38].

Aglaothamnion cordatum (Børsges) Feldmann-Mazoyer (Ceramiales) [Aglaothamnion neglectum Feldmann-Mazoyer]. PCA [49].

Aglaothamnion tenuissimum (Bonnemaison) Feldmann-Mazoyer (Ceramiales) [Aglaothamnion furcellariae (J. Agardh) Feldmann-Mazoyer]. GG [39], GP [39,41], CV [40], PCA [1,48,49,51,107].
Aglaothamnion tripinnatum (C. Agardh) Feldmann Mazoyer (Ceramiales). GP [39], PCA [1,48].

Alsidium helminthochorton (Schwendimann) Kützing (Ceramiales). GP [39].

Amphiroa beauviosii J.V. Lamouroux (Corallinales). PCA [1].

Amphiroa cryptarthrodia Zanardini (Corallinales). GP [39], CM [40], CV [40], PI [46], PCA [1,31,32,39,48,49].

Amphiroa rigida J.V. Lamouroux (Corallinales). C [40], GG [38], GP [39–41], BLM [36], CM [40], CV [40], R [40], PI [46,95], PCA [1,32,49,136], LLI [36,38].

Anotrichium barbatum (C. Agardh) Nägeli (Ceramiales) [Griffithsia barbata C. Agardh]. GG [39], GP [39], PCA [1,49,51,137].

Anotrichium furcellatum (J. Agardh) Baldock (Ceramiales) [Griffithsia furcellata J. Agardh, Neomonospora furcellata (J. Agardh) Feldmann-Mazoyer et Meslin]. C [63], GP [41], SPH [42,62], SH [45], PCA [1,61]. According to Verlaque et al. [138], possible confusion with the non-native Anotrichium okamurae Baldock.

Anotrichium tenue (C. Agardh) Nägeli (Ceramiales) [Griffithsia tenuis C. Agardh]. PCA [49,51,52,137]. According to Verlaque et al. [138], possible confusion with the non-native Anotrichium okamurae, they suggest to maintain as a distinct species from A. tenue notwithstanding the opposite opinion of Kim and Lee [139].

Antithamnion amphigeneum A.J.K. Millar (Ceramiales). PCA [133].

Antithamnion cruciatum (C. Agardh) Nägeli (Ceramiales) [var. cruciatum, var. profundum Feldmann-Mazoyer and f. radicans Feldmann Mazoyer nom. illeg.]. C [63], GG [39], GP [36,38,39], SH [45], BLM [36], CM [40], CV [40], R [40], PI [46], PCA [1,29,39,51,58,61,97,107,140].

Antithamnion heterocladum Funk (Ceramiales). GP [39,141], PCA [1,29,49,51,58,61,107,140].

Antithamnion piliferum Cormaci et G. Furnari (Ceramiales). PCA [133].

Antithamnion tenuissimum (Hauck) Schifflner (Ceramiales). PCA [1,29,39,48,52,61,97].

Antithamnionella elegans (Berthold) J.H. Price et D.M. John (Ceramiales). PCA [1].

Apoglossum ruscifolium (Turner) J. Agardh (Ceramiales). GG [39], GP [36,38,39], PI [46], PCA [1,29,39,48,49,51,52,97,107,136], LLI [36,38].

Asparagopsis armata Harvey (Bonnemaisoniales). As Asparagopsis armata: GP [39], CV [40]. As Falkenbergia rufolanosa (Harvey) F. Schmitz: LP [91], C [40,63], GG [39], GP [39–41], SPH [42,60], CM [40], R [40], PI [46,142], PCA [1,29–31,39,48,49,52,61,97,107,136]. F. rufolanosa is the sporogene of A. armata (gametogene).

Balliella cladoderma (Zanardini) Athanasiadis (Ceramiales) [Antithamnion cladodermum (Zanardini) Hauck]. PCA [1,48,58].

Bangia fuscopurpurea (Dillwyn) Lyngbye (Bangiales) [Bangia lutea J. Agardh]. LP [36], C [36], GP [36], SPH [42,62], LL [36]. This ‘species’ seems to constitute a complex of cryptic species pending taxonomic reassessment [18,143].

Bonnemaisonia asparagoides (Woodward) C. Agardh (Bonnemaisoniales). As B. asparagoides: GP [39], PCA [1,49,59]. As Hymenoclonium serpens (P.L. Crouan et H.M. Crouan) Batters: PCA [1,48,49,51]. H. serpens is the sporogene of B. asparagoides (gametogene).

Bornetia secundiflora (J. Agarh) Thuret (Ceramiales). GP [36,38], CV [40], PCA [1,49].

Botryocladia botryoides (Wulfen) Feldmann (Rhodymeniales) [Chrysymenia varia J. Agardh]. GP [36,38,39,104], BLM [36], PI [46], PCA [1,48,49,51,97], LLI [36,38].

Calliblepharis ciliata (Hudson) Kützing (Gigartinales). PCA [97].

Calliblepharis jubata (Goodenough et Woodward) Kützing (Gigartinales). PCA [133].

Callithamnion tingitana (Schousboe ex Bornet) Feldmann-Mazoyer (Ceramiales). PCA [1,58,61].

Callithamnion corymbosum (I.E. Smith) Lyngbye (Ceramiales). GP [39], PCA [29,49,51,52].

Callithamnion granulatum (Ducluzeau) C. Agardh (Ceramiales) [Callithamnion grande J. Agardh]. GP [39], SPH [42], CM [40], CV [40], PI [36,38,46], PCA [1,36,38], LLI [36,38].

Callithamnion tetragonum (Stackhouse) S.F. Gray (Ceramiales). SPH [42], SH [45], PCA [1].

Calosiphonia vermicularis (J. Agardh) F. Schmitz (Gigartinales). PCA [1,48].
Carradoriella elongata (Hudson) Savoie et G.W. Saunders (Ceramiales) [Polysiphonia elongata (Hudson) Sprengel]. PCA [1,29,49,51,52].

Ceramium bertholdii Funk (Ceramiales). R [101], PCA [1,29,48].

Ceramium ciliatum (Ellis) Ducluzeau var. ciliatum (Ceramiales). C [63], GP [39,41], SPH [42,60], SH [45,62], CV [40], R [40], PI [46], PCA [1,30–32,49,50,52,61,107].

Ceramium ciliatum var. robustum (J. Agardh) Mazoyer (Ceramiales). GP [39], PCA [1,49,51].

Ceramium circinatum (Kützing) J. Agardh (Ceramiales). GP [39,41], SPH [60], LL [36], CV [40], R [40], PI [46], PCA [1,29,32,49,51,52,61,107].

Ceramium comptum Børgesen (Ceramiales). PCA [107].

Ceramium diaphanum (Lightfoot) Roth (Ceramiales) [incl. Ceramium tenuissimum Roth]. GG [39], GP [39,41], SPH [60], LL [36], CV [40], R [40], PI [46], PCA [1,29,32,49–52,61,107].

Ceramium echionotum J. Agardh (Ceramiales). LP [36], C [63], GP [39,41], SPH [42,60], SH [45], BLM [36], CV [40], PCA [1,38,59,61], LLI [36,38].

Ceramium giacconei Cormaci et G. Furnari (Ceramiales) [misidentified as Ceramium cingulatum Weber van Bosse]. PCA [49,51,52,144].

Ceramium siliquosum (Kützing) Maggs et Hommersand var. lophophorum (Feldmann-Mazoyer) Serio (Ceramiales) [Ceramium diaphanum var. lophophorum Feldmann-Mazoyer]. PCA [1,39,48].

Champia parvula (C. Agardh) Harvey (Rhodymeniales). GP [39,41], SPH [60], LL [36], CV [40], R [40], PI [46], PCA [1,49].

Chondractanthus acicularis (Roth) Fredericq (Gigartinales) [Gigartina acicularis (Roth) J.V. Lamouroux]. C [63], GP [39,41], SH [45], PI [38,46], PCA [1,38,59,61], LLI [38].

Chondria curvilineata F.S. Collins et Hervey (Ceramiales). GP [39], PCA [1,29,48–52].

Chondrymenia lobata (Meneghini) Zanardini (Gigartinales). PCA [1,39,48,51,52,147].

Choreonema thuretii (Bornet) F. Schmitz (Hapalidiales). GP [39].

Chrysymenia ventricosa (J.V. Lamouroux) J. Agardh (Rhodymeniales). GP [39], SPH [60], LL [36], CV [40], R [40], PI [46], PCA [1,49,51,58,146].

Chylocladia verticillata (Lightfoot) Bliding (Rhodymeniales) [Chyllocladia bistratosa (Goodenough et Woodward) Ercegović, C. kaliformis Harvey, C. squarrosa (Kützing) Thuret]. LP [36], C [63], GG [39], SPH [42,62], SH [45], PCA [49]. We follow the taxonomic treatment of Wynne [146].

Colaconema codicola (Børgesen) Stegenga, J.J. Bolton et R.J. Anderson (Colaconematales) [misidentified as Rhodothamniella codii (Hamel) J. Feldmann = Colaconema caespitosum (J. Agardh) Jackelman, Stegenga et J.J. Bolton]. CV [40], PI [46], PCA [1].

Colaconema corymbiferum (Thuret) Alongi, Cormaci et G. Furnari (Colaconematales) [Acrochaetium corymbiferum (Thuret) Batters]. GP [36,38], PCA [1].
Colaconema daviesii (Dillwyn) Stegenga (Colaconematales) [Acrochaetium daviesii (Dillwyn) Nägeli]. GG [39], GP [39], PCA [1,29,49,51,52,61].

Colaconema nemalii (De Notaris ex Dufour) Stegenga (Colaconematales) [Acrochaetium nemalii ‘nemalionis’ (De Notaris ex Dufour) Børgesen]. GP [39], PCA [1].

Contarinia peyssonneliiformis (Meneghini) R. Nielsen (Colaconematales) [Rhizophyllis codii Feldmann]. GP [39,41], PCA [1,49,97].

Cryptonemia palmetta (S.G. Gmelin) Woelkerling, G. Furnari, Cormaci et McNeill (Halymeniales) [Cryptonemia lomation (Bertoloni) J. Agardh]. GP [39,41], PI [59], PCA [1,49,59,97], NPCNP [73].

Cryptopleura ramosa (Hudson) L. Newton (Ceramiales) [Acrosorium uncinatum (Turner) Kylin, Nitophyllum laceratum (S.G. Gmelin) Greville]. GG [39], GP [36,39], SPH [42], CV [40], PI [38], PCA [1,29,38,48], LLI [38].

Dasya rigidula (Kützing) Ardissone (Ceramiales). GP [39,41], R [40], PCA [52,61], LLI [36,38].

Dermocorynus dichotomus (J. Agardh) Gargiulo, Morabito et Manghisi (Halymeniales) [Grateloupia dichotoma (J. Agardh) C. Agardh]. GP [39], PCA [1,49–51,97].

Dermocorynus horridus (J. Agardh) Gargiulo, Morabito et Manghisi (Halymeniales) [Grateloupia filicina f. horrida (Kützing) Børgesen]. C [36], GG [38], SH [45], CM [40], PI [59], PCA [1,59], LLI [36,38].

Digenea simplex (Wulfen) C. Agardh (Ceramiales). C [40], GP [40], CM [40], CV [40,68].

Dipterosiphonia rigens (C. Agardh) Falkenberg (Ceramiales). GG [39], GP [39], PCA [1,32,48,49,51,52,107].

Duorresnaya verticillata (Withering) Le Jolis (Gigartinales). R [101], PCA [49,59,97].

Ellisolandia elongata (Ellis et Solander) K. Hind et G.W. Saunders (Corallinales) [Coralina elongata Ellis et Solander, C. mediterranea Areschoug]. LP [91], C [36,40,63], GG [38], GP [36,38–41], SPH [60], SH [45], BLM [36], CM [40], CV [40], R [40], PI [46,99], PCA [1,31,32,48–51,53,136].

Erythrocladia polystromatica P.J.L. Dangeard (Erythropeltales). PCA [1,49].

Erythroglossum balearicum J. Agardh ex Kylin (Ceramiales). PCA [1,48].
Erythroglossum sandrianum (Kützing) Kylin (Ceramiales). GP [39], SPH [60], PCA [1,48,49,51,97].

Erythrotrichia carnea (Dillwyn) J. Agardh (Erythropeltales) [Erythrotrichia ceramicola (Lyngbye) Kützing]. GP [36,38,41], PCA [1,29,49–52,107]. This ‘species’ probably constitutes a complex of cryptic species and genera, not yet formally proposed, pending further molecular studies [18,149].

Erythrotrichia rosea P.J.L. Dangeard (Erythropeltales). PCA [52]. According to Cormaci et al. [18], nomen invalidum.

Erythrotrichia simplex P.J.L. Dangeard (Erythropeltales). GP [41]. According to Cormaci et al. [18], this is an invalid name.

Eupogodon planus (J. Agardh) Kützing (Ceramiales) [Dasyopsis plana (C. Agardh) Zanardini ex Falkenberg]. GG [39], PCA [1,39,48,49,51,52,97,148], NPCNP [73].

Eupogodon spinellus (C. Agardh) Kützing (Ceramiales) [Dasyopsis cervicornis (J. Agardh) Schmitz]. PCA [1,39,48,49,51,52,97]. We follow Jong [150] in maintaining the distinction between E. spinellus and E. planus.

Feldmannophycus rayssiae (J. Feldmann et G. Feldmann) H. Augier et Boudouresque (Gigartinales). GP [39,41], PCA [1,39,48,49,58,97,151].

Felicinia marginata (Roussel) Manghisi, Le Gall, Ribera, Gargiulo et Morabito (Halymeniales) [Aeodes marginata (Roussel) F. Schmitz]. PCA [148].

Felicinia spathulata (J. Agardh) Le Gall et Vergès (Gigartinales) [Kallymenia spathulata (J. Agardh) Codomier ex P.G. Parkinson]. CV [40], PCA [97].

Furcellaria lumbricalis (Hudson) J.V. Lamouroux (Gigartinales). PCA [59].

Gaillona hookeri (Dillwyn) Athanasiadis (Ceramiales) [Aglaothamnion brodiei (Harvey) Feldmann-Mazoyer]. GP [39].

Gaillona scopulorum (C. Agardh) Athanasiadis (Ceramiales) [Aglaothamnion scopulorum (C. Agardh) Feldmann-Mazoyer; misidentified as Callithamnion roseum (Roth) Lyngbye = Gaillona rosa (Roth) Athanasiadis]. GP [36,38], SPH [60], LLI [38].

Gastroclonium clavatum (Roth) Ardissone (Rhodymeniales) [Chylocladia mediterranea J. Agardh]. GP [36,38,39], SPH [42], SH [45,62], BLM [36], CV [40], PI [46], PCA [1,61].

Gayliella mazoyerae T.O. Cho, Fredericq et Hommersand (Ceramiales) [Ceramium byssodeum Harvey nom illeg., C. gracillimum var. byssodeum Mazoyer]. C [63], GP [39], SPH [42], SH [45,62], CV [40], PCA [1,31,48–52,61,107].

Gayliella taylorii (E.Y. Dawson) T.P. Choo et S.M. Boo (Ceramiales) [Ceramium taylorii E.Y. Dawson]. PCA [49].

Gelidiella lubrica (Kützing) J. Feldmann et G. Hamel (Gelidiales). GP [39,41], SPH [60].

Gelidium crinale (Turner) Gaillon (Gelidiales). GP [39,41], SPH [42,60], SH [45], CV [40], PCA [1,32,49,50].

Gelidium minusculum (Weber van Bosse) R.E. Norris (Gelidiales) [Gelidium pusillum var. minusculum Weber van Bosse]. PCA [49].

Gelidium pulchellum (Turner) Kützing (Gelidiales). PCA [1,32,49].

Gelidium pusillum (Stackhouse) Le Jolis (Gelidiales). C [36], GP [39], PCA [52,61].

Gelidium spathulatum (Kützing) Bornet (Gelidiales). C [63], SPH [42,62], SH [45].

Gelidium spinosum (S.G. Gmelin) P.C. Silva var. spinosum (Gelidiales) [Gelidium latifolium var. latifolium (Greville) Bornet and var. luxurians (P.L. Crouan et H.M. Crouan) J. Feldmann et Hamel comb. inval.]. SPH [42], CV [40], PCA [1,49,51].

Gelidium spinosum var. hystrix (J. Agardh) G. Furnari (Gelidiales) [Gelidium latifolium var. hystrix (J. Agardh) J. Feldmann et Hamel comb. inval. and nom. illeg.]. CV [40], PCA [1].

Gloiocladia furcata (C. Agardh) J. Agardh (Rhodophyceae). PCA [1,29,30,48,49,59,97,107].

Gloiocladia repens (C. Agardh) N. Sánchez et Rodriguez-Prieto (Rhodophyceae) [Fauchea repens (C. Agardh) Montagne et Bory]. PI [96], PCA [54–56,59], LLI [72], MB [106].

Goniotrichopsis sublittoralis G.M. Smith (Stylonematales). GP [41,133].

Gracilaria bursa-pastoris (S.G. Gmelin) P.C. Silva (Gracilariales). GP [41], PCA [97].

Gracilaria coralllicola Zanardini (Gelidiales). R [101], MB [106].

Gracilaria dura (C. Agardh) J. Agardh (Gracilariales). PCA [102], NPCNP [73].
Gracilariopsis longissima (S.G. Gmelin) Steentoft, L.M. Irvine et Farnham (Graciariales) [Gracilaria confervoides Greville, G. verrucosa (Hudson) Papenfuss nom. rej.]. EP [38].

Griffithsia genovae J. Feldmann (Ceramiales). PCA [1,97].
Griffithsia opuntioides J. Agardh (Ceramiales). PCA [1,52].
Griffithsia phyllamphora J. Agardh (Ceramiales). CV [40], PCA [1].
Griffithsia schousboei Montagne (Ceramiales). PCA [1,48,49,51,61,107].

Gulsonia nodulosa (Ercegović) Feldmann et G. Feldmann (Ceramiales). PI [96], PCA [49].
Gymnogongrus crenulatus (Turner) J. Agardh (Gigartinales) [Gymnogongrus norvegicus (Gunnerus) J. Agardh]. PCA [1,58,152]. The conspecificity of G. norvegicus with G. crenulatus is questionable: see Cormaci et al. [19].
Gymnogongrus griffithsiae (Turner) Martius (Gigartinales). GP [39], SH [45,62], LLI [36,38].

Gymnothamnion elegans (Schousboe ex C. Agardh) J. Agardh (Ceramiales). GP [39], PCA [1,58].

Halopithys incurva (Hudson) Batters (Ceramiales) [Halopithys pinastroides (Stackhouse) Kützing]. GG [38,39], GP [36,38,39,41], CM [40], CV [40], R [40].

Halurus flosculosus (J. Ellis) Maggs et Hommersand var. flosculosus (Ceramiales) [Griffithsia flosculosa (J. Ellis) Batters; possibly misidentified as G. sphaerica Schousboe ex C. Agardh = H. flosculosus var. sphaericus (Schousboe ex C. Agardh) Gomez Garreta et al.,]. GG [39], GP [39], CV [40], PCA [1,107], LLI [36,38].

Hildenbrandia prototypus Nardo (Hildenbrandiales) [Hildenbrandta rosea Kützing]. GP [39], PI [36,38]. In the opinion of Cormaci et al. [18], this species should be considered as a taxon inquirendum.

Hydrolithon boreale (Foslie) Y.M. Chamberlain (Corallinales) [Fosliella farinosa var. solmsiana (Falkenberg) Foslie, F. ischiensis Coppejans nom nudum]. GP [154], PCA [1,48–51]. See Cormaci et al. [18] for taxonomic treatment of Fosliella ischiensis.

Hydrolithon farinosum (J.V. Lamouroux) Penrose et Y.M. Chamberlain var. farinosum (Corallinales) [Fosliella farinosa (J.V. Lamouroux) Howe, Melobesia farinosa J.V. Lamouroux]. GG [38,39], GP [36,38,39], CV [40], R [40], PCA [1,29–32,48–52,61,97,107].

Hypnea musciformis (Wulfen) J.V. Lamouroux (Gigartinales). C [63], GP [39], SPH [42], SH [45,62], CV [40], R [40], PCA [1,31,49,50,61].

Hypoglossum hypoglossoides (Stackhouse) Collins et Hervey (Ceramiales) [Delesseria hypoglossum (Woodward) J.V. Lamouroux, Hypoglossum woodwardii Kützing]. LP [36], GG [39], GP [36,38,39], LL [36], PI [46], PCA [1,29,39,48,49,51,52].

Irvinea boergesenii (Feldmann) R.J. Wilkes, L.M. McIvor et M.D. Guiry (Rhodymeniales) [Botryocladia boergesenii Feldmann]. GG [39], GP [39], CV [40], PI [59], PCA [1,29,39,48,49,51,52,59,61,97].

Janczewskaia verruciformis Solms-Laubach (Corallinales). PCA [49].

Jania longifurca Zanadini ex Zanadini (Corallinales). GP [39].
Jania pedunculata J.V. Lamouroux var. adhaerens (J.V. Lamouroux) A.S. Harvey, Woelkerling et Reivers (Corallinales). GP [41], PCA [52], NPCNP [73].

Jania rubens (Linnaeus) J.V. Lamouroux var. rubens (Corallinales). C [40,63], GG [38,39], GP [36,38–40,104], SPH [42], CM [40], CV [40], R [40], GRI [38,155], PI [38,46,95], PCA [1,31,32,48,49,52,59,97].

Jania rubens var. corniculata (Linnaeus) Yendo (Corallinales) [Jania corniculata (Linnaeus) J.V. Lamouroux]. C [36,63], GG [38,39], GP [38,39,41], SPH [42,60], SH [45], PCA [1,49,51].

Jania virgata (Zanardini) Montagne (Corallinales) [Corallina granifera J. Ellis et Solander]. C [40,63], GG [38,39], GP [38,39,41], SPH [42,60], SH [45], PCA [1,49,51].

Kallymenia feldmannii Codomier in Woelkerling et al., (Gigartinales). PI [47], PCA [59].

Kallymenia patens (J. Agardh) Codomier (Gigartinales). CV [40], PI [59], PCA [59].

Kallymenia reniformis (Turner) J. Agardh (Gigartinales) [Neurocaulon reniforme (Turner) J. Agardh]. C [36],GG [38,39], GP [38,39,41], SPH [42,60], SH [45], PCA [1,49,51].

Laurencia chondrioides Børgesen (Ceramiales). PI [133,156].

Laurencia microcladia Kützing (Ceramiales). GP [41], CV [40], R [40], PCA [29,31,32,50,52].

Laurencia obtusa (Hudson) J.V. Lamouroux (Ceramiales). GG [38,39], GP [36,39,104], CM [40], CV [40], R [40], GRI [38,155], PI [46,95], PCA [1,39,48–50,52,61,97,136], LLI [36,38].

Lejolisia mediterranea Bornet (Ceramiales). GP [39], PCA [1,48,49,51,52,138].

Leptofauchea coralligena Rodríguez-Prieto et De Clerck (Rhodymeniales). NPCNP [73].

Liagora distenta (Mertens ex Roth) J.V. Lamouroux (Nemaliales). CM [40], CV [40], PI [38], PCA [1,39,48,49,51,52,106].

Liagora viscida (Forsskål) C. Agardh (Nemaliales). C [36], GG [38], GP [39], BLM [36], CM [40], CV [40], R [40], PI [46,47,95], PCA [1,32,49,50,59], LLI [36,38].

Lithophyllum byssoides (Lamarck) Foslie (Corallinales) [Lithophyllum tortuosum (Esper) Hamel et Lemoine, L. lichenoides Philippi, erroneously as Tenarea tortuosa (Esper) Me. Lemoine]. GP [38–40,154,157,158], CM [40], CV [40], R [40,68,101,159], GRI [155,160], PI [46,47,123,160–162], PCA [1,53,59,61,97,161–169], LLI [72,158,161,162].

Lithophyllum corallinae (P.L. Crouan et H.M. Crouan) Heydrich (Corallinales) [Derma
tolithon pustulatum var. corallinae (P.L. Crouan et H.M. Crouan) Foslie ex Ercegović comb. inval.]. PCA [1]. See Cormaci et al. [18].

Lithophyllum cystoseirae (Hauck) Heydrich (Corallinales) [Dermatolithon cystoseirae (Hauck) Huvé]. PCA [1,48,148].

Lithophyllum racemus (Lamarck) Foslie (Corallinales). C [40], GP [39,40,157], CM [40], CV [40], R [40], PI [46,47,95], PCA [1,32,49,50,59], LLI [36,38].

Lomentaria articulata (Hudson) Lyngbye var. articulata (Rhodymeniales). GH [93], PCA [102].

Lomentaria stictiforme (Areschoug) Hauck (Corallinales) [Lithophyllum cabiochiae Boudouresque et Verlaque] Athanasiadis, Pseudolithophyllum expansum (Philippi) Me. Lemoine sensu Hamel et Lemoine]. GP [38,104], CM [40], CV [40], R [40,94], PI [96,154], PCA [35,54–56,154], LLI [154], NPCNP [73].

Lithothamnion coralliioides (P.L. Crouan et H.M. Crouan) P.L. Crouan et H.M. Crouan (Corallinales) [Lithothamnion solutum (Foslie) Foslie, Mesophyllum corallioides (P.L. Crouan et H.M. Crouan) Me. Lemoine comb inval.]. GG [110], GH [93], CV [68], R [68,94,101], PI [96], PCA [97,102], LLI [72], MB [105], NPCNP [73].

Lithothamnion minerarum Basso (Corallinales). PI [96], NPCNP [73].

Lithothamnion valens Foslie (Corallinales). R [94], PI [96], MB [106].

Lomentaria articulata (Hudson) Lyngbye var. articulata (Rhodymeniales). PCA [1,58,59], LLI [36,38].
Lomentaria articulata var. linearis Zanardini (Rhodymeniales) [Lomentaria linearis Zanardini]. PCA [97].
Lomentaria chylocladiella Funk (Rhodymeniales). GP [41], PCA [29,49,51,52].
Lomentaria clavelllosa (Lightfoot ex Turner) Gaillon var. clavellosa (Rhodymeniales). GP [41], SPH [42], PCA [1,30,61,148].
Lomentaria claviformis Ercegović (Rhodymeniales). PCA [107].
Lomentaria pennata Coppejans nomen nudum (Rhodymeniales). PCA [49]. Name invalidly published.
Lomentaria verticillata Funk (Rhodymeniales). PCA [29,49,58,61].
Lophocladia lallemandii (Montagne) F. Schmitz (Ceramiales). PCA [170].
Lophosiphonia cristata Falkenberg (Ceramiales). GP [41], PCA [31,49–52,58,132].
Lophosiphonia obscura (C. Agardh) Falkenberg (Ceramiales) [Lophosiphonia subadunca (Kützing) Falkenberg, Polysiphonia obscura (C. Agardh) J. Agardh, P. subtilis De Notaris]. GP [36,38,41], VSSM [43,44], PCA [31,49–52], LLI [36]. Guiry and Guiry [21] consider P. subtilis as a distinct species.
Melanothamnus harveyi (J.W. Bailey) Díaz-Tapia et Maggs (Ceramiales) [Neosiphonia harveyi (J. Bailey) M.S. Kim, H.G. Choi, Guiry et G.W. Sanders, Polysiphonia harveyi J.W. Bailey, P. mottei Lauret]. GP [41].
Melobesia membranacea (Esper) J.V. Lamouroux (Corallinales) [Epilithon membranaceum (Esper) Heydrich, Lithothamnium membranaceum (Esper) Foslie]. GP [36,38,154], PCA [1,56,61].
Meredithia microphylla (J. Agardh) J. Agardh (Gigartinales) [Kallymenia microphylla J. Agardh]. As M. microphylla: GP [38,39], PCA [1,48,49,59,97]. As Rhodochorton hauckii (Schifffner) Hamel: PCA [30,52]. R. hauckii could be a stage in the life history of M. microphylla (gametogene) (see Cormaci et al. [18]).
Mesophyllum alternans (Foslie) Cabioch et M.L. Mendoza (Corallinales). R [101], PI [96], PCA [54–56].
Mesophyllum expansum (Philippi) Cabioch et M.L. Mendoza (Corallinales). R [68], PI [47], PCA [55,56].
Mesophyllum lichenoides (J. Ellis) Me. Lemoine (Corallinales) [Lithothamnium lichenoides (J. Ellis) Foslie]. GP [36,38–40,104,154], GH [93], CM [40], CV [40], R [94], PCA [1,39,48,49], MB [106].
Mesophyllum philippii (Foslie) W.H. Adey (Corallinales) [Lithothamnium philippii Foslie]. PCA [1,48], MB [106]. See Cormaci et al. [18] for discussion regarding the identity of this species.
Metacallophyllis laciniata (Hudson) A. Vergès et Le Gall (Gigartinales) [Callophyllis laciniata (Hudson) Kützing]. PCA [59].
Metapeyssonnelia fendmarnii (Hudson) A. Vergès et Le Gall (Gigartinales) [Callophyllis laciniata (Hudson) Kützing]. PCA [39,172,173], PCA [49,51,52,61].
Microcladia glandulosa (Solander ex Turner) Greville (Ceramiales). C [63], PCA [1].
Müllerella albertanae (A. Bottalico, G.H. Boo, C. Russo, S.M. Boo et C. Perrone) G.H. Boo et A. Bottalico (Gelidiales) [erroneously as Gelidiella ramellosa (Kützing) Feldmann et Hamel]. GP [39,141], PCA [1]. Gelidiella ramellosa (= Huismanella ramellosa (Kützing) G.H. Boo et S.M. Boo) does not occur in the Mediterranean Sea [19].
Müllerella pannosa (J. Feldmann) G.H. Boo et L. Le Gall (Gelidiales) [Gelidiella pannosa (J. Feldmann) J. Feldmann et Hamel, G. tenuissima J. Feldmann et Hamel nom. illeg.]. GP [39,172,173], PCA [49,51,52,61].
Monosporus pedicellatus (J.E. Smith) Solier var. pedicellatus (Ceramiales) [Corynospora pedicellata (J.E. Smith) J. Agardh, Neomonospora pedicellata (J.E. Smith) Feldmann-Mazoyer et Meslin]. GP [39,41], PCA [1,29,49,51,52,107].
Monosporus pedicellatus var. tenuis (Feldmann-Mazoyer) Huisman et Kraft (Ceramiales) [Corynospora pedicellata var. tenuis Feldmann-Mazoyer]. PCA [49,51].
Myriogramme distromatica Rodriguez ex Boudouresque (Ceramiales). CV [40], PCA [1,49]. See Boudouresque [174] for taxonomy.

Myriogramme minuta Kylin (Ceramiales) [Drachiella minuta (Kylin) Maggs et Hommersand, Myriogramme giaoiae (Funk) Funk]. GP [39], PCA [1,48,52,61].

Myriogramme unistromatica Coppejans nomen nudum (Ceramiales). Name invalidly published.

Naccaria wiggii (Turner) Endlicher ex J. Agardh (Atractophorales). GP [59].

Nitophyllum micropunctatum Funk (Ceramiales). PCA [49].

Nitophyllum punctatum (Stackhouse) Greville (Ceramiales). GG [39], GP [39], PI [46], PCA [1,29,39,48,51,52,61,107,156].

Nitophyllum tristromaticum J.J. Rodriguez y Feminias ex Mazza (Ceramiales). PCA [1].
**Peyssonnelia rosa-marina** Boudouresque et Denizot (Peyssonneliales). GP [41], GH [93]-misidentified as *P. polymorpha*, CV [40,68,94]-misidentified as *P. polymorpha*, PI [46], PCA [1,49,58,97,135,148,177,181], NPCNP [73].

**Peyssonnelia rubra** (Greville) J. Agardh (Peyssonneliales). GG [92], GP [39,41], CV [40], R [94], PCA [1,39,48,51,97,106,107,148], NPCNP [73].

**Peyssonnelia squamaria** (S.G. Gmelin) Decaisne ex J. Agardh (Peyssonneliales). LP [36], GG [39], GP [36,38–40,104], CM [40], CV [40,68], R [40,68], PI [46,59,96], PCA [1,48,49,49,51,61,97], NPCNP [73].

**Phrix spatulata** (E.Y. Dawson) M.J. Wynne, M. Kamiya et J.A. West (Ceramiales) [Apoglossum gregarium (E.Y. Dawson) M.J. Wynne]. GP [41].

**Phyllophora crispa** (Hudson) P. S. Dixon (Gigartinales) [Phyllophora nervosa (A.P. de Candolle) Greville]. LP [36], GP [36,38–40,104], CM [40], CV [40,68], R [40,68], PI [46,59,96], PCA [1,48,49,49,59,97], LLI [72].

**Phyllophora sicula** (Kützing) Guiry et L.M. Irvine (Gigartinales) [Phyllophora palmettoides J. Agardh]. PI [38], PCA [38], LLI [38].

**Phymatolithon calcareum** (Pallas) W.H. Adey et McKibbin ex Woelkerling et L.M. Irvine (Corallinales) [Lithothamnium calcareum (Pallas) Areschoug]. LP [36], GP [36,38,154], GH [93], R [94], PCA [97,102], MB [105].

**Phymatolithon lenormandii** (Areschoug) W.H. Adey (Corallinales) [Lithothamnion lenormandii (Areschoug) Foslie]. GP [39], R [94], PCA [1].

**Platoma cyclocolpum** (Montagne) Schmitz (Nemastomatales). PCA [59].

**Pleonosporium borreri** (J.E. Smith) Nägeli (Ceramiales). GG [39], GP [39,41], PCA [1,29,107].

**Plocamium cartilagineum** (Linnaeus) P. S. Dixon (Plocamiales) [Plocamium coccineum Lyngbye nom. illeg., P. vulgare J.V. Lamouroux nom. illeg., P. cartilagineum var. uncinatum (C. Agardh) Guiry ex Benhissoune et al.]. GG [39,92], GP [39,104], H [36], GH [38], SPH [42,60], SH [45], BLM [36], R [40], PI [46], PCA [1,29,31,39,48,49,51,52,61,97,107].

**Pneophyllum confervicola** (Kützing) Y.M. Chamberlain (Corallinales) [Fosliella minutula (Foslie) Ganesan]. PCA [29,49–52,61].

**Pneophyllum fragile** Kützing (Corallinales) [Fosliella lejolisii (Rosanoff) Howe]. GG [39], GP [39], CV [40], R [40,94], PCA [29,49,52,61,107].

**Polysiphonia atlantica** Kapraun et J.N. Morris (Ceramiales) [Polysiphonia macrocarpa Harvey nom. illeg.]. GP [41].

**Polysiphonia biformis** Zanardini (Ceramiales). PCA [97].

**Polysiphonia deusta** (Roth) Sprengel (Ceramiales). GP [36], GH [38], BLM [36], CM [36].

**Polysiphonia flexella** (C. Agardh) J. Agardh (Ceramiales). GP [39].

**Polysiphonia flocculosa** (C. Agardh) Endlicher (Ceramiales). R [40], PI [46].

**Polysiphonia opaca** (C. Agardh) Moris et De Notaris (Ceramiales). GG [39], GP [39,41], SPH [42], R [40], PI [38], PCA [1,38,49–52], LLI [38].

**Polysiphonia pulvinata** (Roth) Sprengel (Ceramiales). EP [36,38].

**Polysiphonia sanguinea** (C. Agardh) Zanardini (Ceramiales). EP [38].

**Polysiphonia scopulorum** Harvey (Ceramiales) [Lophosiphonia scopulorum (Harvey) Womersley]. GP [41], SPH [60], PCA [31,52]. Some records of *P. scopulorum* may represent misidentification for *Polysiphonia atlantica* [138].

**Polysiphonia sertularioides** (Grateloup) J. Agardh (Ceramiales) [Neosiphonia sertularioides (Grateloup) K.W. Nam et P.J. Kang]. GP [39,104], PCA [1,50]. According to Díaz-Tapia et al. [182] it is doubtful if the genus *Neosiphonia* is a distinct genus; the correct name of *P. sertularioides* is currently unclear.

**Predaea ollivieri** J. Feldmann (Nemastomatales). PCA [1,59].

**Pterocladiella capillacea** (S.G. Gmelin) Santelices et Hommersand (Gelidiales) [Pterocladia pinnata (Hudson) Papenfuss, *P. capillacea* (S.G. Gmelin) Bornet]. C [63], SH [45], CV [40], PCA [1].

**Pterocladiella melanoidea** (Schousboe ex Bornet) Santelices et Hommersand (Gelidiales) [Gelidium melanoideum Schousboe ex Bornet]. SPH [60], PCA [1].

**Pterothamnion crispum** (Duclouzeau) Nägeli (Ceramiales) [Antithamnion plumula var. bebbii (Reinsch) J. Feldmann and var. crispum (Duclouzeau) Hauck, Platythamnion plumula var.
Diversity 2022, 14, 329

bebbii (Reinsch) J. Feldmann]. GP [39,41], SPH [42,62], SH [45], PCA [1,39,48,49,51,61,97,148], NPCNP [73].

Pterothamnion plumula (I. Ellis) Nägeli (Ceramiales) [Antithamnion plumula (I. Ellis) Thuoret, Platythamnion plumula (I. Ellis) Boudouresque, Belsher et Marcot-Coqueugnot comb. invol.]. C [63], R [40], PCA [1,29,30,39,48,49,52,61,107].

Ptilothamnion pluma (I. Ellis) Nägeli (Ceramiales) [Pterothamnion plumula (I. Ellis) Thuret, Platythamnion plumula (I. Ellis) Boudouresque, Belsher et Marcot-Coqueugnot comb. invol.]. C [63], R [40], PCA [1,29,30,39,48,49,52,61,107].

Ptilothamnion plumula (I. Ellis) Nägeli (Ceramiales) [Pterothamnion plumula (I. Ellis) Thuret, Platythamnion plumula (I. Ellis) Boudouresque, Belsher et Marcot-Coqueugnot comb. invol.]. C [63], R [40], PCA [1,29,30,39,48,49,52,61,107].

Pyropia elongata (Kylin) Neefus et J. Brodie (Bangiales) [misidentified as Porphyra leucosticta Thuret]. C [63], SPH [42]. See Cormaci et al. [18] for nomenclatural comments.

Radicilingua reptans (Kylin) Papenfuss (Ceramiales). PCA [1,48,52,183].

Radicilingua thysanorhizans (Holmes) Papenfuss (Ceramiales). PCA [1,48,97].

Rhodophyllis bifida (J.V. Lamouroux) Kützing (Gigartinales) [misidentified as R. divaricata (Stackhouse) Papenfuss, R. appendiculata J. Agardh]. GP [39,41], SPH [60], SH [45], CV [40], PCA [1,29,30,39,48,49,51,52,61,107]. See Woelkerling et al. [184] for taxonomic treatment.

Rhodophyllis strafforelloi Ardissone (Gigartinales). PCA [1,48].

Rhodymenia ardissonei (Kuntze) Feldmann (Rhodymeniales). C [63], GG [39], GP [39,41], SH [45,62], PI [46], PCA [1,32,39,48,52,61,97,136].

Risseola verruculosa (A. Bertoloni) J. Agardh (Gigartinales). LP [91], C [63], GG [39,104,157], CM [40], CV [40,68], R [40,68], PI [38,46,47], PCA [1,38,59,102,163,166–169,185]. LLI [38,72].

Scinaia complanata (Collins) Cotton (Nemaliales). PI [59].

Scinaia furcellata (Turner) J. Agardh (Nemaliales). PI [59].

Scinaia interrupta (A.P. De Candolle) Wynne (Nemaliales). PI [59].

Scinaia rhizophylloides (J.J. Rodriguez y Feminias) J. Feldmann. PI [59], PCA [1,49,59].

Sebdenia dichotoma (Berthold) J. Agardh (Sebdeniales). R [101], PI [47,59,96], PCA [59,97].

Sebdenia interrupta (A. P. De Candolle) Wynne (Nemaliales). PI [59].

Spermothamnion flabellatum Bornet f. disporum Feldmann-Mazoyer (Ceramiales). GP [39,41], PCA [1,49,59].

Spermothamnion johannis G. Feldmann-Mazoyer (Ceramiales). PCA [1,48,49,51,97,140].

Spermothamnion repens (Dillwyn) Magnus var. repens (Ceramiales). GP [39,41], PCA [1,29,30,48,49,51,52,61,107].

Spermothamnion repens var. variabile (C. Agardh) Feldmann-Mazoyer (Ceramiales). PCA [51].

Sphaerococcus coronopifolius Stackhouse (Gigartinales). As Haematocelis fissurata P.L. Crouan et H.M. Crouan [Ethelia fissurata (P.L. Crouan et H.M. Crouan) Denizot]: PCA [1,48,58]. As S. coronopifolius: C [40], GP [36,38–41], CM [40], CV [40], R [40], GRI [38], PI [59,96], PCA [1,49,56,59,97,102]. Haematocelis is the sporogene of Sphaerococcus (gametogene).

Sphaerococcus rhizophylloides J.J. Rodriguez y Feminias (Gigartinales). PCA [102,186], LLI [186].
Sphondylothamnion multifidum (Hudson) Nägeli f. multifidum (Ceramiales). GP [36,38,41], BLM [36], PCA [49].
Sphondylothamnion multifidum f. distichum G. Feldmann-Mazoyer (Ceramiales). GP [39], PCA [1,48,49].
Spongites fruticulosus Kützing (Corallinales) [Lithothamnium fruticulosum (Kützing) Foslie]. GH [93], R [94], PCA [102], NPCNP [73].
Sphondylothamnion multifidum f. distichum G. Feldmann-Mazoyer (Ceramiales). GP [39], PCA [1,48,49].
Stylonema alsidii (Zanardini) K.M. Drew (Stylonematales) [Goniotrichum alsidii (Zanardini) Howe]. GP [39,41], PCA [1,29,31,49,50,52,97,107].
Stylonema cornu-cervi Reinsch (Stylonematales) [Goniotrichum cornu-cervi (Reinsch) Hauck]. GP [41], PCA [1,29,48,49,51,52].
Symphyocladiella parasitica (Hudson) D. Bustamante, B.Y. Won, S.C. Lindstrom et T.O. Cho (Ceramiales) [Pterosiphonia parasitica (Hudson) Falkenberg]. SPH [60].
Symphyocladiella spinifera (Kützing) Bustamante, B.Y. Won, S.C. Lindstrom et T.O. Cho (Ceramiales) [Pterosiphonia spinifera (Kützing) Ardré]. PCA [61].
Taenioma nanum (Kützing) Papenfuss (Ceramiales). PCA [31,50].
Tricleocarpa fragilis (Linnaeus) Huisman et R.A. Townsend (Nemaliales) [Galaxaura oblongata (J. Ellis et Solander) J.V. Lamouroux]. CV [40,68], R [68], PI [96], PCA [1,59], NPCNP [73].
Verlaquea lacerata (Feldmann) L. Le Gall et Vergès (Gigartinales) [Kallymenia lacerata Feldmann]. PI [96], PCA [1,59].
Vertebrata byssoides (Goodenough et Woodward) Kuntze (Ceramiales) [Brongniartella byssoides (Goodenough et Woodward) F. Schmitz]. PCA [97,148], NPCNP [73].
Vertebrata furcellata (C. Agardh) Kuntze (Ceramiales) [Polysiphonia furcellata (C. Agardh) Harvey]. GP [41], SPH [60], PCA [49,51,52].
Vertebrata reptabunda (Suhr) Díaz-Tapia et Maggs (Ceramiales) [Polysiphonia reptabunda Suhr]. GP [39].
Vertebrata subulifera (C. Agardh) Kuntze (Ceramiales) [Polysiphonia subulifera (C. Agardh) Harvey]. PCA [1,48,49,51,52,97], NPCNP [73].
Vertebrata tripinnata (J. Agardh) Kuntze (Ceramiales) [Polysiphonia tripinnata (J. Agardh). R [40], PCA [50,52].
Vickersia baccata (J. Agardh) Karsakoff (Ceramiales). GP [39], PCA [1,51].
Womersleyella setacea (Hollenberg) R.E. Norris (Ceramiales). GG [92], GP [41], CV [68], R [68,101], PI [47,96], PCA [54–56], LLI [72], NPCNP [73].
Xiphosiphonia ardreana (Maggs Kuntze et Hamel) Savoie et G.W. Saunders (Ceramiales) [Pterosiphonia ardreana Maggs et Hommersand] GP [41].
Xiphosiphonia pennata (C. Agardh) Savoie et G.W. Saunders (Ceramiales) [Pterosiphonia pennata (C. Agardh) Sauvageau]. GG [39], SPH [42], SH [45].
Xiphosiphonia pinnulata (Kützing) Savoie et G.W. Saunders (Ceramiales) [Pterosiphonia pinnulata (Kützing) Maggs et Hommersand]. GP [41].

3.5. Brown Algae (Phaeophyceae, Kingdom Stramenopiles)

Acinetospora crinita (Carmichael) Sauvageau (Ectocarpales). GP [41], SPH [60], PCA [50,52].
Arthrocladia villosa (Hudson) Duby (Desmarestiales). R [101], PI [96], PCA [1,59,97], NPCNP [73].
Asperococcus bullosus J.V. Lamouroux (Ectocarpales) [including f. profundus Feldmann]. GP [36,38], R [101], BLM [36], PI [59], PCA [1,48,49,59,97], LLI [36,38].
Asperococcus ensiformis (Delle Chiaje) M.J. Wynne (Ectocarpales) [Asperococcus compressus Griffiths ex W.J. Hooker, Haloglossum compressum (Griffiths ex W.J. Hooker) Hamel]. GP [36,38], PCA [49].

Carpomitra costata (Stackhouse) Batters var. costata (Sporochnales). PI [59], PCA [59,97].

Choristocarpus tenellus Zanardini (Discosporangiales). PCA [49,51,58,187].

Cladosiphon ciliatus (Sauvageau) Kylin (Ectocarpales) [Castagnea ciliata Sauvageau]. GP [39], PCA [1,29,49,51,107].

Cladosiphon irregularis (Sauvageau) Kylin (Ectocarpales) [Castagnea irregularis Sauvageau]. GP [39], PCA [1,48,49,51,107].

Cladosiphon mediterraneus Kützing (Ectocarpales) [Castagnea mediterranea (Kützing) Hauck]. GP [39].

Cladosiphon zosterae (J. Agardh) Kylin (Ectocarpales) [Myriocladia zosterae J. Agardh]. GP [36], BLM [36]. Regarded as introduced from the Atlantic Ocean in coastal lagoons harbouring shellfish aquaculture [138].

Cladostephus hirsutus (Linnaeus) Boudouresque et Perret-Boudouresque ex Heesch, Rindi, Guiry et Nelson. (Sphacelariales) [Misidentified as Cladostephus spongiosus (Hudson) C. Agardh and C. verticillatus (Lightfoot) Lyngbye nom. illeg.]. C [40], GP [36,38,39,41], SPH [60], SH [45], BLM [36], CM [40], CV [40], R [40], PI [46,96], PCA [1,49,51,53,59]. For taxonomic treatment, see Heesch et al. [188].

Colpomenia peregrina Sauvageau (Ectocarpales). PCA [49,51,59,61].

Colpomenia sinuosa (Mertens ex Roth) Derbes et Solier (Ectocarpales). C [63], GP [36,38,39], SPH [42,60], CM [40], CV [40], PI [46,59], PCA [1,32,49,50,53,59,61].

Cutleria adspersa (Roth) De Notaris (Tilopteridales). As C. adspersa: PI [46], PCA [1,49,51]. As Aglaozonia melanoidea: PCA [1]. A. melanoidea is the sporogene of C. adspersa (gametogene).

Cutleria chilosa (Falkenberg) P.C. Silva (Tilopteridales) [Cutleria monoica Ollivier]. As C. monoica: PCA [49,51]. As Aglaozonia chilosa: PCA [1,48,49,51,97,107], NPCNP [73]. Aglaozonia chilosa is the sporogene of Cutleria chilosa (gametogene).

Cutleria multifida (Turner) Greville (Tilopteridales). As C. multifida: PI [46], PCA [49,51,59,61]. As Aglaozonia parvula (Greville) Zanardini: GP [39,41], SPH [60], PCA [31,49,50,52,61]. A. parvula is the sporogene of C. multifida (gametogene).

Cystoseira compressa (Esper) Gerloff et Nizamuddin var. compressa (Fucales) [Cystoseira abrotanifolia (Linnaeaeus) C. Agardh, C. fimbriata Bory]. C [63], GP [39,104], SPH [42,62], SH [45,62], CM [40], CV [40,68,159], R [40,68,159], PI [38,46,47], PCA [1,24,31,32,49,53,59,136,166–169,189], LLI [72].

Cystoseira compressa var. pustulata (Ercegovi´c) Verlaque (Fucales) [Cystoseira compressa var. pustulata (Ercegovi´c ex Verlaque nom. inval.). CV [159], R [159], PCA [24,189].

Cystoseira foeniculacea (Linnaeus) Greville f. foeniculacea (Fucales) [Cystoseira discors (Linnaeus) C. Agardh, C. ercegovicii Giaccone]. LP [36], GP [39], GH [38], SH [45,62], CV [68,159], R [68,159], PI [38,46], PCA [1,24,189].

Cystoseira foeniculacea f. latiramosa (Ercegovi´c) Gómez Garreta, Barceló, Ribera et Rull Lluch (Fucales). LLI [72].

Desmotrichum tenuissimum (C. Agardh) Athanasiadis (Ectocarpales) [Desmotrichum undulatum (J. Agardh) Reinke]. PCA [61].

Dictyopteris polypodioides (A.P. De Candolle) J.V. Lamouroux (Dictyotales) [Dictyopteris membranacea Batters]. LP [91], C [40,63], GG [38,39], GP [36,38,39,41,104], SH [45], BLM [36], CM [40], CV [40], R [40,101], PI [46,59,96], PCA [1,39,48,49,52,59,61,97], LLI [72].

Dictyota dichotoma (Hudson) J.V. Lamouroux var. dichotoma (Dictyotales). LP [91], C [63], GG [39], GP [36,38,39], BLM [36], GRI [38], SH [45,62], PI [46], PCA [1,39,48–50,52,61,97,98], NPCNP [73].

Dictyota dichotoma var. intricata (C. Agardh) Greville (Dictyotales) [Dictyota dichotoma var. implexa (Desfontaines) S.F. Gray, D. implexa (Desfontaines) J.V. Lamouroux]. C [63], GP [39], PI [46], PCA [1,61], NPCNP [73].
Dictyota fasciola (Roth) J.V. Lamouroux var. fasciola (Dictyotales) [Dilophus fasciola (Roth) Howe]. C [40], GG [39,41], GP [39,40,104], SPH [60], CM [40], CV [40], PI [46], PCA [1,48–50,53,61].

Dictyota fasciola var. repens (J. Agardh) Ardissone (Dictyotales) [Dilophus repens (J. Agardh) J. Agardh]. GP [39], CV [40], R [40], PCA [1,49,50,136].

Dictyota linearis (C. Agardh) Greville (Dictyotales). GP [36,41], BLM [36], CV [40], PCA [1,29,31,48,49,51,97,107]. We follow the taxonomic treatment of Cormaci et al. [22] in recognizing D. linearis as a distinct species.

Dictyota mediterranea (Schiffner) G. Furnari (Dictyotales) [Dilophus mediterraneus]. PCA [51,52].

Dictyota spiralis Montagne (Dictyotales) [Dilophus ligulatus (Kützing) Feldmann, D. spiralis (Montagne) Hamel]. C [63], PI [46].

Dilophus linearis Coppejans nomen nudum (Dictyotales). PCA [49]. Name invalidly published.

Discosporangium mesarthrocarpum (Meneghini) Hauck (Discosporangiales). CV [40], PCA [1,49,51,58,97].

Ectocarpus siliculosus (Dillwyn) Lyngbye (Ectocarpales) [Ectocarpus confervoides Le Jolis]. GG [39], PCA [52].

Elachista intermedia P.L. Crouan et H.M. Crouan (Ectocarpales). PCA [1,49,51].

Elachista stellaris J.E. Areschoug (Ectocarpales). PCA [1,48].

Ericaria amentacea (C. Agardh) Molinari Novoa et Guiry (Fucales) [Cystoseira amentacea var. stricta Montagne, C. stricta (Montagne) Sauvageau]. LP [33,91], C [33,36,63], GG [38,92], GP [33,36,39,40,104,157], LLM [33], LL [33], RCM [33], CM [33,40], CV [33,40,68], R [33,40,68,101], GRI [38], PI [33,46,47,123], PCA [1,24,32,33,59,136,166–169,189], LLI [33,72].

Ericaria brachycarpa (J. Agardh) Molinari Novoa et Guiry var. brachycarpa (Fucales) [Cystoseira balearica Sauvageau, C. brachycarpa J. Agardh, C. caespitosa Sauvageau]. CM [40], CV [40,68,159], R [68,159], PCA [1,24,31,32,49,50,53,189,190].

Ericaria brachycarpa var. claudiae (Giaccone) comb. nov. (Fucales) [Cystoseira balearica Sauvageau var. claudiae Giaccone]. CV [159], R [159]. We propose here the new combination, to date not proposed; basyonym Cystoseira balearica Sauvageau var. claudiae Giaccone in Amico et al. [191] (1986: 906; Figures 22–23; Bol. Acc. Gioenia Sci. Nat., 18(326), 887–986; dated ‘1985’); Latin diagnosis in Cinelli et al. [192] (1976: 161; Mem. Biol. Mar. Oceanogr., N.S., 6(5), 141–174).

Ericaria crinita (Duby) Molinari Novoa et Guiry (Fucales) [Cystoseira crinita Duby]. LP [34,91], C [34], GP [34,39,104], BLM [34], LL [34], RCM [34], CM [34], CV [68,159], R [34,68,159], PI [38,46], PCA [1,24,32,33,59,136,166–169,189], LLI [33,72], MB [106].

Eudesme virescens (Carmichael ex Berkeley) J. Agardh (Chordariales). PCA [59].

Feldmannia irregularis (Kützing) Hamel (Ectocarpales). GP [39], PCA [49,51].

Feldmannia michelii (Harvey) H.S. Kim (Ectocarpales) [Giffordia michelii (Harvey) Hamel, Hinckia michelii (Harvey) P.C. Silva]. GP [39], PCA [61].

Feldmannia padinae (Buffham) Hamel (Ectocarpales). PCA [49,52].

Feldmannia paradoxa (Montagne) Hamel var. paradoxa (Ectocarpales) [Feldmannia globifera (Kützing) Hamel]. GP [39], CV [40], PCA [49,52].

Feldmannia paradoxa (Montagne) Hamel var. donatiae (Ercegović) M.J. Wynne (Ectocarpales) [Ectocarpus caespitulus J. Agardh, Feldmannia caespitula (J. Agardh) Knoepfle-Péguy]. GP [36,38], PI [46], PCA [1,31,49,51,194].

Giraudya sphaelarioides Derbès et Solier (Ectocarpales). GG [39], GP [39], CV [40], PCA [1,29,32,48,49,51,52,61,107].
Gongolaria barbata (Stackhouse) Kuntze (Fucales) [Cystoseira barbata (Stackhouse) C. Agardh, incl. var. barbata and var. hoppei (C. Agardh) J. Agardh]. LP [36], CV [159], R [159], PI [38], PCA [24, 189], LLI [36].

Gongolaria elegans (Sauvageau) Molinari Novoa et Guiry (Fucales) [Cystoseira elegans Sauvageau]. GP [104], CV [159], R [101], PI [96], PCA [24, 189].

Gongolaria montagnei (C. Agardh) Kuntze var. montagnei (Fucales) [Cystoseira spinosa Sauvageau]. GP [104], CV [159], R [101], PI [47], PCA [1, 24, 48, 97, 102, 189].

Gongolaria montagnei var. tenuior (Ercegović) Molinari Novoa et Guiry (Fucales) [Cystoseira jabukae Ercegović, C. spinosa var. tenuior (Ercegović) Cormaci, G. Furnari, Giaccone, Scammacca et Serio]. CV [68], R [68], PCA [24, 189], LLI [72]. We propose here the new combination, to date not proposed; basyonym Cystoseira adriatica Sauvageau var. compressa Ercegović (Ercegović, 1952 [195]. ‘Jadranske Cistozire. Njihova morfologija, ekologija i razvitak’. Sur les cystoseira adriatiques. Leur morphologie, écologie et evolution. Flora et flora adriatica, volumen II. Institut za Oceanografiju i Ribartsvo FNR Jugoslavije, Split), diagnosis page 107, figure plate 9.

Gongolaria montagnei var. tenuior (Ercegović) Molinari Novoa et Guiry (Fucales) [Cystoseira jabukae Ercegović, C. spinosa var. tenuior (Ercegović) Cormaci, G. Furnari, Giaccone, Scammacca et Serio]. CV [159], R [159], PI [96], PCA [24, 189], LLI [72].

Gongolaria sauvageauana (Hamel) Molinari Novoa et Guiry (Fucales) [Cystoseira sauvageauana Hamel]. GRI [38], PCA [24, 189].

Halopteris filicina (Grateloup) Kützing (Sphacelariales). C [36], GG [38], GP [36, 38, 39, 41], SPH [60], BLM [36], CV [40], R [40], PI [96], PCA [1, 29, 30, 39, 48, 49, 51, 59, 61, 97, 102, 107], MB [106, 175], NPCNP [73].

Halopteris scoparia (Linnaeus) Sauvageau (Sphacelariales) [Stypocaulon scoparium (Linnaeus) Kützing]. C [40, 63], GP [39–41, 104], SPH [42, 60, 62], SH [45, 62], CM [40], CV [40], R [40], GRI [38], PI [46, 59, 99], PCA [1, 31, 32, 49, 51–53, 59, 61, 98].

Hapalospongidion macrocarpum (Feldmann) Léon-Álvarez et González-González (Ralfsiales) [Mesospora macrocarpa (J. Feldmann) Hartog, M. mediterranea Feldmann]. GP [39, 104], PCA [31, 50].

Herponema valiantei (Bornet) Hamel (Ectocarpales). GP [39].

Hincksia granulosa (J.E. Smith) P. C. Silva (Ectocarpales) [Ectocarpus granulosus (J.E. Smith) C. Agardh]. C [36].

Hincksia ovata (Kjellman) P.C. Silva (Ectocarpales) [Giffordia intermedia (Rosenvinge) Lund]. PCA [49].

Hincksia sandriana (Zanardini) P.C. Silva (Ectocarpales) [Giffordia sandriana (Zanardini) Hamel]. PCA [1, 48, 49].

Hydroclathrus clathratus (Bory ex C. Agardh) M. Howe (Ectocarpales). PCA [59].

Kuckuckia spinosa (Kützing) Kornmann (Ectocarpales). GP [41], PCA [30, 49, 51, 52, 61].

Kuetzingiella battersii (Bornet) Kornmann (Ectocarpales). PCA [52].

Laminaria rodriguezii Bornet (Laminariales). R [101, 196], PCA [106], LLI [175], MB [106, 175, 196].

Leathesia mucosa J. Feldmann var. condensata J. Feldmann (Ectocarpales). PI [59], PCA [1, 59].

Lobophora variegata (J.V. Lamouroux) Womersley ex E.C. Oliveira (Dictyotales) [Pocockiella variegata (J.V. Lamouroux) Papenfuss]. PCA [1, 49, 51].

Mesogloia leveillei (J. Agardh) Meneghini (Ectocarpales) [Liebmannia leveillei J. Agardh]. GP [39], PCA [32].

Mesogloia vermiculata (J.E. Smith) S.F. Gray (Ectocarpales). PCA [49].

Myriactula gracilis van der Ben (Ectocarpales). PCA [1, 29, 48].

Myriactula stellulata (Harvey) Levring (Ectocarpales). PCA [49, 51, 52], NPCNP [73].

Myrionema conchicola (J. Feldmann) Boudouresque (Ectocarpales) [misidentified as Myrionema magnusii Sauvageau Loiseaux nom. inval.]. CV [40], PCA [52]. See Cormaci et al. [22] for taxonomic features.

Myrionema hemisphaericum Sauvageau (Ectocarpales). PCA [49, 51].
Myrionema liechtensternii Hauck (Ectocarpales). PCA [49,51,58,197].

Myrionema orbiculare J. Agardh (Ectocarpales) [Ascocystus orbicularis (J. Agardh) Kjellman]. GG [39], GP [39,41], PCA [1,29,30,32,48,61,107].

Myrionema strangulans Greville (Ectocarpales). GP [39], PCA [61].

Myriotrichia claviformis ‘clavaeformis’ Harvey (Ectocarpales). PCA [32,52].

Nemacystus flexuosus (J. Agardh) Kylin var. giraudyi (J. Agardh) Y.S.D.M. De Jong (Ectocarpales) [Nemacystus ramulosus Derbes et Solier]. GP [41]. PCA [1,2,49,51].

Nemoderma tingitanum Schousboe ex Bornet (Nemodermatales). GP [39], CM [40], PCA [31,32].

Nereia filiformis (J. Agardh) Zanardini (Sporochnales). GP [36,38,39,41], CV [68], R [68], PI [96], PCA [1,48,49,50,51,97,106], LLI [72].

Padina pavonica (Linnaeus) J.V. Lamouroux (Dictyotales) [Padina pavonia (J.V. Lamouroux)]. LP [91], GG [38,39], GP [38,39,41,104], SPH [42], SH [45], CM [40], CV [40], R [40,94,101], PI [38,46,47,50,96], PCA [1,2,49,50,61,98], LLI [38].

Phyllariopsis brevipes (C. Agardh) E.C. Henry et G.R. South (Tilopteridales) [Phyllaria reniformis (J.V. Lamouroux ex J. Agardh) Rostafinsky ex Bornet]. R [68,101], PI [47,50,61], PCA [1,59].

Sargassum acinarium (Linnaeus) Setchell (Fucales). C [35], GP [35], PI [35], PCA [Feldmann 1929 in [24,35,189]], LLI [35].

Sargassum vulgare f. diversifolium Grunow (Fucales). PI [47,96].

Sphacelaria cirrosa (Roth) C. Agardh (Sphacelariales) [incl. f. mediterranea Sauvageau; S. hystrix Suhr ex Reineke]. GG [39], GP [39,41,198], SPH [60], R [40], PI [46], PCA [1,29–32,39,48–52,51,97,107,136], NPCNP [73].

Sphacelaria fusca (Hudson) S.F. Gray (Sphacelariales). CV [40], PCA [1,49,51,52].

Sphacelaria plumula Zanardini (Sphacelariales). GP [41], PCA [1,48,49,51], NPCNP [73].

Sphacelaria rigidula Kützing (Sphacelariales) [Sphacelaria furcigera Kützing]. GP [39,41], SPH [2,60], PCA [49,51].

Sphacelaria tribuloides Meneghini (Sphacelariales). GP [39,41,198], SPH [42], SH [45], PCA [31,32,49,50].

Sporochnus pedunculatus (Hudson) C. Agardh (Sporochnales). GG [110], PCA [1,59], NPCNP [73].

Sphacelaria fusca (Hudson) S.F. Gray (Sphacelariales). CV [40], PCA [1,49,51,52].

Stictysiphon soriferus (Reineke) Rosenvinge (Ectocarpales). PCA [50].

Stilophora tenella (Esper) P.C. Silva (Ectocarpales) [Stilophora rhizodes (Turner) J. Agardh nom. illeg., incl. var. Adriatica J. Agardh]. GP [41], PCA [1,49,51,52].

Strepsithalia laiagorae Sauvageau (Ectocarpales). PCA [49].

Taonia atomaria (Woodward) J. Agardh (Dicyotales). GG [39], GP [36,38,39], CM [40], CV [40], PI [46], PCA [1,49].
Diversity 2022, 14, 329

3.6. Pelagophyceae (Kingdom Stramenopiles)

Nematochrysopsis marina (J. Feldmann) C. Billard [Tribonema marinum Feldmann]. GP [41].

3.7. Prymnesophyceae (Kingdom Haptobionta)

Chrysoreinhardia giraudyi (Derbès et Solier) C. Billard [Phaeocystis giraudyi Derbès et Solier]. GP [41], PCA [29,50].

3.8. Taxa Inquirenda

Acrochaetium mediterraneum (Levring) Athanasiadis (Acrochaetales). GP [39], PCA [61]. See Cormaci et al. [18].

Ectocarpus brachiatus (C. Agardh) J. Agardh (Ectocarpales). VSSM [36].

Fosliella zonalis (P.L. Crouan et H.M. Crouan) J. Feldmann (Corallinales). PCA [50]. See Cormaci et al. [18] for taxonomic discussion.

Lithophyllum lobatum Lemoine (Corallinales). PCA [1,48]. See Cormaci et al. [18] for taxonomic discussion.

Polysiphonia havanensis Montagne (Ceramiales). PCA [52]. P. havanensis Montagne, a taxon of uncertain status, is different from P. havanensis sensu Børgesen, which is known from eastern Atlantic (Azores, Madeira, Canary Islands) and Mediterranean Morocco [199].

Polysiphonia spinella C. Agardh (Ceramiales). PI [38], PCA [38], LLI [38].

Porphyra laciniata auctorum (Bangiales). GP [36,38], LL [36]. The type specimen of Porphyra laciniata (Lightfoot) C. Agardh actually belongs to the genus Erythroglossum (in [18]); it is difficult to resituate in the current taxonomy the old records of P. laciniata.

Sargassum flavifolium Kützing (Fucales). LLI [35]. According to Aouissi et al. [200], the presence of this species in the Mediterranean requires confirmation.

3.9. Taxa Excludenda

Acrochaetium lenormandii (Suhr ex Kützing) Nägeli (Acrochaetales). PCA [49]. See Cormaci et al. [18] for taxonomic treatment.

Atractophora hypnoides P.L. Crouan et H.M. Crouan (Atractophorales). PCA [59]. The occurrence of this Atlantic species at Port-Cros is doubtful.

Ceramium rosenvingei Petersen (Ceramiales) [Ceramium rubrum var. decurrens J. Agardh]. C [36], GP [36], LLI [36].

Codium adhaerens C. Agardh (Codiiales). GP [36]. See Cormaci et al. [17] for nomenclatural comments.

Cordylecladia erecta (Greville) J. Agardh (Graclariales). GP [39], SPH [60]. A possible confusion with C. guiryi described from Sicily by Gargiulo et al. [201] and recorded at Marseilles by Klein and Verlaque [133].

Derbesia marina (Lyngbye) Solier (Bryopsidales). GP [36,38], LLI [36,38]. D. marina is the sporogene of Halicystis ovalis (Lyngbye) Areschoug (the gametogene). According to Gallardo et al. [202], all Mediterranean records of this species are misidentifications for D. tenuissima (Moris et De Notaris) P.L. Crouan et H.M. Crouan and H. parvula F. Schmitz.

Dictyosiphon foeniculaceus (Hudson) Greville (Ectocarpales). PCA [48].

Gayliella flaccida (Harvey ex Kützing) T.O. Cho et L. Melvior (Ceramiales) [Ceramium flaccidum (Harvey ex Kützing) Ardissone]. GP [41], PCA [32]. Occurrence in the Mediterranean should be confirmed.
Leptosiphonia fibrata (C. Agardh) A.M. Savoie et G.W. Saunders (Ceramiales) [Polysiphonia fibrata (Dillwyn) Harvey]. LL [36].
Porphyra umbilicalis Kützing (Bangiales). GP [39]. We follow Cormaci et al. [18].
Tricleocarpa cylindrica (J. Ellis et Solander) Huisman et Borowitzka (Nemaliales). PI [59].
According to Cormaci et al. [18], the occurrence of this pantropical species in the Mediterranean Sea should be confirmed.

4. Discussion

4.1. How Many Taxa?

In 1976, Belsher et al. [1] listed 335 taxa and stadia (life stages) of green, red and brown macroalgae for the Gulf of Hyères and Hyères islands, including the Port-Cros Archipelago, the latter then constituting the Port-Cros National Park (PCNP). The present updated checklist identifies 502 taxa, on a slightly different scale, that of the N-PCNP, from La Garde to Ramatuelle (eastern Provence) (Figure 1), and a slightly different taxonomic format, macrophytes (including seagrasses) instead of macroalgae. As far as the Port-Cros Archipelago is concerned, the number of recorded taxa was 285 in 1976 [1], 284 in 1981 [58], 353 in 1985 [28] and 441 (present study).

According to Cormaci et al. [18], the occurrence of this pantropical species in the Mediterranean Sea should be confirmed.

Such gamma species diversity (see [203] for the concept of diversity) is not low, but far from particularly high: it falls just within the norm for a size-diversity relationship in the Mediterranean (Table 1). In addition, the research effort in the AMA of the N-PCNP has been particularly strong (see Section 4.3), which would imply that exceptionally high numbers of taxa might be expected. This may disappoint those who, on the basis of an old conception of biodiversity (see e.g., [5] for criticism), believe that a national park necessarily harbours high gamma species diversity, and that only high species diversity deserves to be protected. For the tiny Isole dei Ciclopi (Sicily) and the Principality of Monaco (French Riviera), 380 and 365 taxa and stages have been reported, respectively (Table 1). Overall, the number of taxa reported from the N-PCNP represents 40 to 55% of the Mediterranean epsilon diversity (Table 2).

Table 1. Epsilon taxon diversity of macrophytes in a number of Mediterranean areas. The maximum distance (as the crow flies) between the outer limits of the area was used as a proxy for its size. Note that the research effort differs between areas.

| Area                                  | Size                          | Number of Taxa | Reference                  |
|---------------------------------------|-------------------------------|----------------|----------------------------|
| Thau Lagoon (Occitania, France)       | SW–NE: ~20 km                 | 222 a          | Boudouresque et al. [204]  |
| Maltese Islands                       | W–E: ~41 km                   | 179 b          | Cormaci et al. [205]       |
| Maddalena Peninsula (Sicily)          | ~9 km                         | 223 c          | Cormaci and Furnari [206]  |
| Venice Lagoon (northern Adriatic, Italy) | SW–NE: ~50 km             | 229 c          | Sfriso and Curiel [207]    |
| Isole dei Ciclopi (Catania, Sicily)   | W–E: ~0.1 km                  | 277 c          | Giacone and Pizzuto [208]  |
| Principality of Monaco (French Riviera) | SW–NE: ~3 km               | 380 c,d        | Verlaque and Bernard [209] |
| Balearic Islands                      | SW–NE: 290 km                 | 381            | Ribera Siguan and Gómez-Garreta [210] |
| Aeolian Islands (Tyrrenian Sea, Italy)| W–E: ~80 km                   | 420 c          | Giacone et al. [211]       |
| Scandula Nature Reserve area (Galeria-Ghjurulu, Corsica) | NW–SE and W–E: ~18 km | 441 d | Verlaque [212] |
| Study area: AMA of the N-PCNP         | W–E: ~63 km                   | 454            | This study                 |
| French Catalonia                      | N–S: ~46 km                   | 502            | Boudouresque et al. [213]  |
| Iblea area (SE Sicily)                | N–S and W–E: ~170 km          | 573 d          | Giacone and Di Martino [214] |

a Cumulative census dating back to the 19th century. b Thorough exploration of the lagoon since 1994. c Magnoliophyta not taken into account by the authors. d Cyanobacteria removed.
Table 2. Number of taxa at the scale of the study area and of the whole Mediterranean Sea. Note that the accepted taxa generally follow the treatment of Cormaci et al. (2012, 2014, 2017, 2020, 2021), but sometimes other authors, such as Guiry and Guiry (2022), are followed: see text in Section 3 for details.

| Taxa                                           | Number of Taxa in the N-PCNP | Number of Taxa in the Mediterranean Sea (Reference) |
|------------------------------------------------|------------------------------|---------------------------------------------------|
| Green algae (Chlorobionta, kingdom Archaeplastida) | 73                           | 214 (Gallardo et al. [202])                       |
|                                                 |                              | 176 (Cormaci et al. [17])                         |
| Red algae (Rhodobionta other than Ceramiales, kingdom Archaeplastida) | 166                          | 352 (Cormaci et al. [18–20])                      |
| Red algae (Ceramiales, Rhodobionta, kingdom Archaeplastida) | 150                          | 271 (Gómez Garreta et al. [215])                  |
| Brown algae (Phaeophyceae, kingdom Stramenopiles) | 104                          | 265 (Ribera et al. [216])                         |
|                                                 |                              | 270 (Cormaci et al. [22])                         |

A higher number of species was reported from Giens Peninsula, Porquerolles Island and the Port-Cros Archipelago than in other, less explored (see below) localities and sites. Some large species, easy to identify and therefore unlikely to be missed, have been only found at mainland localities and sites, but not at Porquerolles Island, Port-Cros Archipelago and Le Levant Island: *Alsidium helminthochorton*, *Digenea simplex*, *Halopithys incurva* and the gametogene of *Asparagopsis armata*; a lower mean sea surface temperature, at offshore islands than at mainland areas, may account for these observations. Other large species, some of them of cold affinities, such as *Calliblepharis ciliata*, *C. jubata*, *Gymnogongrus crenulatus*, *Lomentaria articulata* and *Spatoglossum solieri*, were only reported from offshore islands.

The increase over time in the cumulative number of taxa presents two major phases: the foundational work of Mouret [36] in 1911 and the bulk of taxonomic and ecological studies of the 1970–1980s (e.g., [1,39,49,51]) (Figure 2).

It is worth underlining that such a cumulative checklist, although useful and even essential for management purposes, must be handled with caution. For some civil servants of state agencies (e.g., in France the Ministry of the Environment and the Service Patrimoine of the Muséum National d’Histoire Naturelle), the production of these inventories sometimes constitutes in a way a goal in itself, and the paradigm of biodiversity, whereas it is rather a caricature of the concept of biodiversity, and the opposite of an ecosystem-based approach to biodiversity. Biodiversity is a multidimensional concept, encompassing levels of complexity from within species to across ecosystems: evolutionary scale (from genes to species and kingdoms); functional scale; organizational scale (from patches to landscapes/seascapes); spatial scale; and heterogeneity scale [203,217–219]. This naive approach to biodiversity, this race for the maximum number of species (‘my list of species is longer than yours!’) can have several perverse effects: (i) It can divert a disproportionate amount of human and financial resources for the production of lists of species whose value is more arithmetical than ecological, although they are obviously necessary. (ii) It helps to ‘deify’ the number of species, whereas it is just one descriptor of biodiversity among others, and this descriptor is far from being the most relevant, in contrast with functional diversity and ecosystem diversity. (iii) It contributes to the general public’s belief that the greater the number of species in an area, the more this area deserves protection. (iv) It equates species that are important because of their rarity, or the role they play in ecosystems, or which are abundant, with species that occur incidentally, are sometimes observed only once, and are therefore without ecological and biogeographical significance. (v) It underestimates ‘ordinary biodiversity’, which might be seen as ‘the biodiversity of the people’, that ensures the functioning of ecosystems throughout the year, in favor of biodiversity that is in a way ‘aristocratic’, qualified as ‘heritage value species’. The term ‘heritage value species’ is very vague and even fuzzy: it covers truly rare and/or threatened species, attractive and human-friendly species, species supported by taxonomic lobbies (e.g., bird, bat and...
sea mammal lobbies), and legitimately protected species together with not legitimately protected species, species that are just protected thanks to taxonomic lobbies.

Figure 2. Cumulative number of reported taxa of macrophytes over time, in the N-PNPC, since the early 20th century.

Of course, the species gamma diversity may be underestimated in the framework of the present study. On the one hand, taxonomic expertise and research effort have declined over time (see below). On the other hand, partly following from the first point, species newly described elsewhere in the Mediterranean were not searched for in the N-PCNP. For example, *Dictyopteris lucida* M.A. Ríbera Siguán, A. Gómez Garreta, Pérez Ruzafa, Barceló Martí et Rull Lluch, previously confused with *D. poly podioides* [220], *Lithophyllum pseudoracemus* Caragnano, Rodondi et Říndi, previously confused with *L. racemus* [221] and the cryptic species hitherto confused as *Padina pavonica* [222].

4.2. How Many Introduced Species?

Introduced species are recognized worldwide as a major threat to biodiversity [223–225]. The Mediterranean Sea is the area most hit worldwide by introduced species [138,226–228].

In the N-PCNP area, the number of introduced macrophyte species is relatively low: only 18 species, namely *Caulerpa cylindracea*, *C. taxifolia*, *Codium fragile* (Chlorobionta), *Acrothamnion preissii*, *Antithamnion amphigeneum*, *Antithamnionella elegans*, *Asparagopsis armata*, *Chondria curvilineata*, *Colaconema codicola*, *Goniotrichopsis sublittoralis*, *Lophocladia lallemandii*, *Malanothamnus harveyi*, *Phrix spatulata*, *Poly sphonia atlantica*, *Womersleyella setacea* (Rhodobionta), *Colpomenia peregrina*, *Cutleria multifida* and *Desmotrichum tenuissima* (Phaeophyceae). These 18 species are to be compared with the 117 non-indigenous species recorded in the Mediterranean Sea [138].

In the middle of the 20th century, Elton (ecological resistance theory—ERT) [229] claimed that low species diversity and disturbance favored biological invasions. As a matter of fact, ERT is today widely challenged. At least in the marine realm, species richness usually enhances biological invasions (ecological acceptance hypothesis—EAH) [230–232]. In fact, the probability of introduction does not depend upon species richness and disturbances, but on the presence of a vector, e.g., a harbour or aquaculture facilities; for
Diversity 2022, 14, x FOR PEER REVIEW 29 of 43

this reason, the N-PCNP is less affected by introduced species than, e.g., the Calanques National Park (western Provence), adjacent to the port of Marseilles, and Thau Lagoon in Occitania, a major shellfish aquaculture area [40,204,233]. As already pointed out by a host of authors (e.g., [234–238]), invasive species do not respect the boundaries of marine protected areas (MPAs).

Four introduced species are invasive in the N-PCNP: Caulerpa taxifolia, C. cylindracea, Acrothamnion preissii and WOMERSLEYELLA SETACEA [55,239]. Caulerpa taxifolia, present at Port-Cros Island since 1994 [82–84], has been successfully eradicated [90].

4.3. The Research Effort over Space and Time

The different parts of the adjacent marine area (AMA) of the N-PCNP have been studied very heterogeneously: from 3 to 94 documents per site (Figure 3). The fact that the size of the sites (surface area, length of coastline) is very heterogeneous does not in itself explain the differences in the number of taxa per site (from 2–La Garde to 441–Port-Cros Archipelago). As intuitively expected, there is a significant correlation ($r = 0.69$, $p < 0.001$) between the number of references (a clue for research effort) and the cumulative number of reported taxa (Figure 4).

![Number of reported taxa per locality](image)

**Figure 3.** Number of reported taxa (in blue) and literature documents (in green) per locality and site (in red).

The fact that the archipelago of Port-Cros (PCA) has been, by far, the site which benefited from the most important research effort, is unsurprising: it was the initial site of the Port-Cros National Park (PCNP) and, since 2012, is one of the two core areas of the N-PCNP. It is widely accepted that we only effectively protect what we know well [6,14,16,240]. Unfortunately, the other side of the coin is that ‘ordinary biodiversity’, as pointed out above, has been neglected. We are witnessing a kind of opposition between the biodiversity of most of the territory, poorly known and which would not interest scientists and managers (which of course is not really the case), and the biodiversity of the core area of
the PCNP, supposedly more central and worthy of interest: plebeian versus aristocratic, deluxe, biodiversity?

![Figure 4. Log-Log correlation between the number of reported taxa and the number of references per site.](image)

The number of items (i.e., reporting of a taxon, at a given site, by a given reference) peaked in the 1970–1980s, then declined in the 1990s, before a partial recovery in the 2000s (Figure 5). The extinction of taxonomists, in the age of biodiversity, is a recurring topic in the literature (e.g., [241,242]). This extinction of taxonomists constitutes a paradox, insofar as the general public believes that, since 1992 and the Rio summit, taxonomy has won acclaim and has expanded in a significant way. In fact, according to many authors, the biodiversity concept has been stolen by molecular biologists, by taxonomic lobbies, by ‘green’ activists with no real interest in scientific ecology and by often whimsical database manipulators [243–245]. The result is that there are fewer and fewer taxonomists able to put a name to a taxon, and more and more ‘parasitic researchers’, unable to distinguish a mouse from an elephant (in the absence of a genetic analysis; of course an exaggeration!), but experts in modelling, based upon doubtful databases and interpretations dating back to the prehistory of ecology [242]. In the study area, the decline in the taxonomic research effort, from the 1970–1980s, is obvious (Figure 5).

The heterogeneity of scientific exploration also concerns habitats. Intertidal habitats have long been favored by scientists. Since the advent of scuba diving, the opposite has happened. The relative scarcity of reports of intertidal species, probably present everywhere, such as *Pyropia elongata*, *Nemoderma tingitanum* and *Pseudoralfsia verrucosa*, can be explained in this way.

The scientific strategy of the Port-Cros National Park [14] explicitly involved plans to explore the new territories of the N-PCNP, those of its vast AMA. For the moment, this is far from being achieved (Figure 3). In the 2000s, as part of the establishment of Natura 2000 areas programmed by the European ‘Habitat Directive’ of 1992, studies were carried out [47,68,72]. However, they were unfortunately based on minimalist lists of protected species, on the ‘toxic’ concept of heritage value species and on the doctrine of the French Ministry of the Environment [10,246,247].
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Figure 5. A clue to research efforts: number of items (i.e., reporting of a taxon, in a given site, by a given reference) per 5-year interval.

4.4. Are Some Taxa Locally Extinct?

The year of the last sighting of a taxon in the study area can date back from a few years to more than a century (Table 3). Overall, 50% of the taxa have not been reported for 30 years and almost 10% for more than 50 years (Table 3). Could we consider that the latter are locally extinct? In some cases, we can suspect errors of identification, e.g., Polysiphonia deusta and Phyllophora sicula, only reported by Mouret in 1911 [36], and Corallina officinalis, only reported by Fredj in 1964 [94], who was not known as a phycologist. However, this is not the case with, e.g., Alsidium helminthochorton, Gelidum spathulatum, Gymnogongrus griffithsiae, Hildenbrandia prototypus, Lithophyllum racemus, Pyropia elongata, Sphaerococcus rhizophylloides and Petalonia fascia, large and well-characterized species which are not prone to misidentification.

For a number of ‘missing’ species, the lack of recent investigations, perhaps also the decline in the taxonomic expertise, may account for the absence of sightings. This is not the case with some Fucales of the genera Cystoseira, Ericaria, Gongolaria and Sargassum, for which the identification expertise is fortunately not lost (e.g., [25,33–35,189]).

4.5. Are There Clues to Climate Warming?

Species, on the basis of their presence or absence, and the spread of their range area, are the best biological indicators of the current warming [248–251]. This contrasts with inter-annual fluctuations of physical parameters, so sharply that contemporaries of the Late Bronze Age (LBA; ~1000 BCE), the Dark Age Cold Period and the Fall of the Roman Empire (DACP; ~500 CE) and the Little Ice Age (LIA; ~1800 CE) never perceived that civilization was sinking into a climatic episode rather than into changes triggered by the decadence of morals or the errors of the politicians of the time [252–255].
Table 3. Year of the last record for the 502 taxa reported from the N-PCNP.

| Year | Number of Taxa | Cumulated Number of Taxa | Cumulated Percentage |
|------|----------------|--------------------------|----------------------|
| 2022 | 4              | 4                        | <1%                  |
| 2021 | 6              | 10                       | 2%                   |
| 2020 | 4              | 14                       | 3%                   |
| 2019 | 31             | 45                       | 9%                   |
| 2017 | 1              | 46                       | 9%                   |
| 2016 | 18             | 64                       | 13%                  |
| 2011 | 23             | 87                       | 17%                  |
| 2009 | 56             | 143                      | 28%                  |
| 2007 | 8              | 151                      | 30%                  |
| 2005 | 82             | 233                      | 46%                  |
| 2001 | 2              | 235                      | 47%                  |
| 1992 | 9              | 244                      | 49%                  |
| 1988 | 11             | 255                      | 51%                  |
| 1987 | 11             | 266                      | 53%                  |
| 1986 | 35             | 301                      | 60%                  |
| 1985 | 28             | 329                      | 66%                  |
| 1984 | 8              | 337                      | 67%                  |
| 1983 | 32             | 369                      | 74%                  |
| 1981 | 17             | 386                      | 77%                  |
| 1980 | 3              | 389                      | 77%                  |
| 1978 | 13             | 402                      | 80%                  |
| 1977 | 33             | 435                      | 87%                  |
| 1976 | 30             | 465                      | 93%                  |
| 1971 | 18             | 483                      | 96%                  |
| 1970 | 1              | 484                      | 96%                  |
| 1968 | 4              | 488                      | 97%                  |
| 1966 | 2              | 490                      | 98%                  |
| 1964 | 1              | 491                      | 98%                  |
| 1963 | 1              | 492                      | 98%                  |
| 1953 | 1              | 493                      | 98%                  |
| 1914 | 6              | 499                      | 99%                  |
| 1911 | 3              | 502                      | 100%                 |

A number of macrophyte species are regarded as thermophilous. As a result, they are expected to spread northwards in the Mediterranean Sea. In the N-PCNP area, the year of first report of thermophilous macrophytes is 1911 (*Dasycladus vermicularis*, *Hypnea musciformis* and *Rytiphlaea tinctoria*), 1953 (*Caulerpa prolifera*), 1971 (*Spyridia filamentosa*), 1976 (*Anadyomene stellata* and *Lobophora variegata*), 1977 (*Cladophoropsis membranacea*), 1987 (*Taenioma nanum*), 2009 (*Hydrochlathrus clathratus*), 2019 (*Microdictyon umbilicatum*) and 2022 (*Lophocladia lallemandii*).

It is worth noting that two invasive species, initially regarded as of tropical origin, *Caulerpa taxifolia* and *C. cylindracea*, subsequently proved to originate from temperate southern Australia [256–260].

Overall, the increase in the presence of thermophilous species is not obvious. The possible increase in their abundance would be of more significance, but no data are available. This reinforces the perception of a stronger impact of global warming on the human target than on the biodiversity target (see, e.g., [11,225]).

At the same time, have species of cold affinity disappeared? The only species which seems to offer an affirmative answer to this question is the brown alga *Scytosiphon lomentaria*, never sighted since the years 1960–1970.

5. Conclusions

The diversity of macrophytes within the new Port-Cros National Park (N-PCNP) is not exceptionally high. However, this observation must be put in the light of the very patchy knowledge of the territory: the research effort has mainly focused on the Port-Cros...
Archipelago, the original area of the Port-Cros National Park (PCNP), founded in 1963. This diversity is known through two highpoints of research effort: the early 20th century and the 1960–1970s. Since then, the research effort has declined: contrary to popular belief, in the midst of the current so-called era of biodiversity launched by the 1992 Rio Summit, knowledge of biodiversity has not increased and may even have declined.

It should also be stressed that species diversity (how many species?), often idolized by political ecologists (successors of the prehistory of ecology), taxonomic lobbies, the general public and managers, is a very poor indicator of biodiversity. The concept of biodiversity is actually very different from, and much broader than, species richness.

Heritage value species, sometimes regarded as the paradigm of biodiversity, constitute a vague and fuzzy concept, a kind of aristocratic concept as opposed to the ordinary diversity that keeps the ecosystems of the real world functioning.

However, although the inventory of species is a poor descriptor of biodiversity, it is an essential prerequisite for the study of human impact, global change and in particular the impact of climate change.

The database that we present here is unique because it concerns an area (i) in part strongly impacted by humans, mainland Provence, strongly urbanized and with world-famous tourist resorts, and (ii) in part efficiently protected since the middle of the 20th century, the offshore islands bordering the Gulf of Hyères. However, it does not offer the means to highlight an obvious change in the flora over time, in relation with, e.g., urbanization, tourism and warming, either because it is not suited to a study of that kind, or because the change is (for the moment) more tenuous than is generally thought.

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