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Checklist of benthic marine algae and cyanobacteria of northern Portugal

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Abstract

The northern Portuguese coast is a biogeographic transition zone where many macroalgal species have their distribution limits; it is thus a particularly interesting region for investigating species distribution shifts. An updated and complete list of species for this region is not available in spite of its baseline importance for comparative studies with past and present data. Based on new records, literature references, and herbarium data, we provide an updated checklist of the benthic marine algae of the northern Portuguese coast. This checklist includes 346 species: 26 Cyanobacteria, 200 Rhodophyta, 70 Ochrophyta, and 50 Chlorophyta. From these, 21 species are new records for the Portuguese coast (*Lyngbya aestuarii*, *Lyngbya semiplena*, *Microcoleus acutirostris*, *Myxosarcina gloeocapsoides*, *Aiolocolax pulchella*, *Antithamnion densum*, *Antithamnion villosum*, *Antithamnionella spirographidis*, *Dasya sessilis*, *Furcellaria lumbricalis*, *Neosiphonia harveyi*, *Porphyrostromium boryanum*, *Chorda filum*, *Dictyopteris ambigua*, *Sphacelaria rigidula*, *Undaria pinnatifida*, *Vaucheria coronata*, *Vaucheria velutina*, *Ulothrix implexa*, *Ulva scandinavica*, and *Umbraulva olivascens*) and 33 were recorded for the first time in the north of Portugal. Alien species have increased in number and extended their distribution range over the last 10 years in the study area. Distribution shifts of northern cold water species with southern distribution limit in the north of Portugal were not consistent among species.

Keywords: alien species; biogeography; checklist; macroalgae; northern Portugal.

Introduction

Temperature is a dominant factor structuring the distribution of taxa (Angilletta et al. 2006, Helmuth et al. 2006, Parmesan 2006, Portner et al. 2006); global warming therefore affects the distribution and performance of organisms (Walther et al. 2002, Jonzén et al. 2006). Such effects are likely to be magnified at species' geographic boundaries, where organisms are at their ecophysiological tolerance limits (Helmuth et al. 2006). In response to global warming, many species are presently changing their distribution ranges, with poleward shifts in distributional patterns (Thomas et al. 2001, Walther et al. 2002, Parmesan and Yohe 2003, Helmuth et al. 2006, Hickling et al. 2006). Non-native species (aliens) may expand their distributional ranges and occupy new habitats (Walther et al. 2002). These changes in geographical distribution modify the structure of local communities (Walther et al. 2002, Sax and Gaines 2003). The most effective and informative method of predicting species' declines or disappearances and/or non-natives' expansion is by monitoring boundary conditions and/or marginal populations (Guo et al. 2005).

The continental Portuguese coast constitutes the southernmost limit for nearly 40 macroalgal species (Ardré 1970, 1971) and approximately half of them have their distributional limit off the northern shores of the country. The Portuguese coast is subject to particular biogeographic circumstances, receiving climatic influences from the Atlantic Ocean and Mediterranean Sea, which determine unique combinations of species forming macroalgal communities. Despite its biogeographic importance, the macroalgal flora of this region has not been thoroughly studied.

The first phycological study of the Portuguese coast was published by Correa da Serra (1796). In the following years, other studies were carried out by Welwitsch (1850), Hauck (1889), Palminha (1951, 1953, 1954, 1961), Mesquita Rodrigues (1958, 1963), Póvoa dos Reis (1977, 1981a,b), Melo and Santos (1979), and Santos and Melo (1986). The most complete study on the Portuguese phycological flora was carried out by Ardré (1961, 1970, 1971) and Ginsburg-Ardré (1966). Although few studies were recently conducted off the north coast of Portugal by Araújo et al. (2003), López-Rodríguez et al. (2003), Cremades et al. (2002, 2007), Díaz-Tapia and Bárbara (2005), Bárbara and Cremades (2004), and Bárbara et al. (2003, 2006a,b), since the 1970s, phycological knowledge of this region has not improved substantially.

The temporal gap in phycological studies of the Portuguese coast is an important deficiency in basic information on composition and distribution of species; this deficiency precludes the possibility of closely monitoring distributional shifts.

The general aim of this work is to update the benthic marine macroalgal checklist of the north coast of Portugal. To investigate species distributional shifts and alien introductions, data obtained in this study were compared with previously available records.

Materials and methods

Study area

This study was conducted on the northern coast of continental Portugal, which extends approximately 250 km from Insua de Caminha to Cabo Mondego (Figure 1). The area studied was divided into three regions [Minho (Mi), Douro Litoral (DL), and Beira Litoral (BL)] (Figure 1). In this area, seawater surface temperature ranges annually from 13°C to 20°C. The coastline studied faces westwards and is exposed to the prevailing northwest oceanic swell, which can be higher than 5 m in winter. The tidal regime is semidiurnal, with an extreme range of approximately 3.5–4 m during spring tides. The northern Portuguese coast is granitic in the regions of Minho and Douro Litoral and sandy with sparse rocky areas in Beira Litoral.

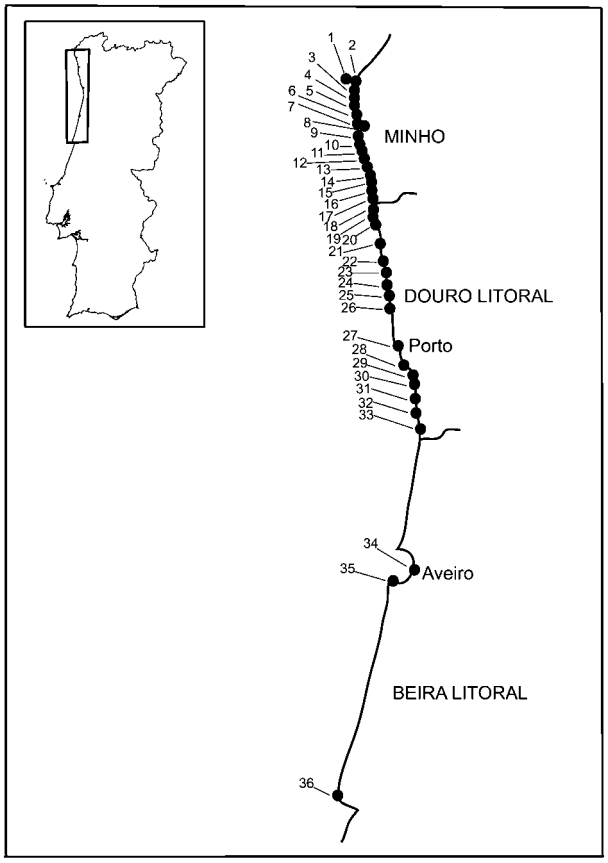

Figure 1 Study area with the sampling localities marked with numbers. **1** – Insua de Caminha (41°51′32″ N; 8°52′33″ W); **2** – Moledo (41°50′33″ N; 8°52′28″ W); **3** – Vila Praia de Âncora (41°49′12″ N; 8°52′26″ W); **4** – Forte do Cão (41°47′52″ N; 8°52′28″ W); **5** – Montedor (41°45′01″ N; 8°52′48″ W); **6** – Areosa (41°43′20″ N; 8°52′07″ W); **7** – Viana do Castelo (41°41′49″ N; 8°51′08″ W); **8** – Lima's saltmarsh (41°40′59″ N; 8°49′43″ W); **9** – Amorosa (41°38′26″ N; 8°49′22″ W); **10** – Castelo do Neiva (41°37′47″ N; 8°49′19″ W); **11** – Belinho (41°35′03″ N; 8°48′19″ W); **12** – S. Bartolomeu do Mar (41°34′24″ N; 8°47′57″ W); **13** – Rio de Moinhos (41°34′02″ N; 8°47′52″ W); **14** – Cepães (41°33′24″ N; 8°47′43″ W); **15** – Esposende (41°31′29″ N; 8°47′35″ W); **16** – Cávado's saltmarsh (41°31′30″ N; 8°47′09″ W); **17** – Apúlia (41°29′16″ N; 8°47′03″ W); **18** – Aguçadoura (41°26′40″ N; 8°46′47″ W); **19** – Quião (41°24′44″ N; 8°47′15″ W); **20** – Póvoa do Varzim (41°22′21″ N; 8°46′13″ W); **21** – Vila do Conde (41°21′42″ N; 8°45′41″ W); **22** – Mindelo (41°18′37″ N; 8°44′32″ W); **23** – Praia dos Eléctricos (41°17′49″ N; 8°44′14″ W); **24** – Angeiras (41°16′03″ N; 8°43′41″ W); **25** – Cabo do Mundo (41°13′30″ N; 8°43′02″ W); **26** – Leça da Palmeira (41°12′18″ N; 8°42′59″ W); **27** – Foz do Douro (41°09′58″ N; 8°41′22″ W); **28** – Lavadores (41°07′49″ N; 8°40′10″ W); **29** – Valadares (41°07′18″ N; 8°40′04″ W); **30** – S. Félix da Marinha (41°05′06″ N; 8°39′26″ W); **31** – Miramar (41°04′07″ N; 8°39′32″ W); **32** – Aguda (41°03′25″ N; 8°39′24″ W); **33** – Espinho (40°59′54″ N; 8°39′00″ W); **34** – Ria de Aveiro (40°40′26″ N; 8°43′16″ W); **35** – Barra de Aveiro (40°38′28″ N; 8°45′16″ W); **36** – Buarcos (40°10′44″ N; 8°54′23″ W).

Anthropogenic activities along the northern coast include recreational activities during summer months and harvesting activities for shellfish and other species throughout the year. Aquaculture industries and fishing/recreational harbors are also frequent along the coast.

Sampling methods and systematic arrangement

From 1999 until 2007, 36 localities within the study area were repeatedly sampled: 17 in the Minho region, 16 in the Douro Litoral region and 3 in the Beira Litoral region (Figure 1). Samples were collected in intertidal and subtidal areas. Macroalgal specimens were collected and preserved at 4°C in 4% formalin seawater in darkness. Species were identified using taxonomic monographs, guides, and identification keys covering neighboring areas. Selected material was preserved as voucher herbarium specimens. More than 3600 herbarium specimens were stored in the herbaria of Jardim Botânico of Porto (PO), University of Algarve (ALGU), and Santiago de Compostela (SANT-Algae).

The checklist of benthic marine algae of northern Portugal is based on a compilation of data collected in this study, literature references, and herbarium data. Systematic arrangement of Cyanobacteria follows Komárek and Anagnostidis (1986, 1989 1999) and Anagnostidis and Komárek (1985, 1988, 1990). Systematic arrangement of Rhodophyta, Ochrophyta, and Chlorophyta follows Silva et al. (1996), Cavalier-Smith and Chao (1996), Reviers and Rousseau (1999), Rousseau and Reviers (1999), Rousseau et al. (2001), Friedl and O'Kelly (2002), and O'Kelly et al. (2004a,b). Families, genera, and species are alphabetically arranged. This catalog includes the synonyms used in the literature on Portugal, especially when there were heterotypes. For each species, infraspecific taxa and life history stage are given, along with presence in Minho, Douro Litoral, and Beira Litoral regions. Main literature and details of localities are provided only for species poorly known in Portugal, for those present in a unique province or for those recently introduced in northern Portugal. Taxa excludenda and taxa inquirenda are also included for several species (Appendix, below, p. 43).

A comparison with similar catalogs from Britain and Ireland (Hardy and Guiry 2003), Atlantic coast of France (Dizerbo and Herpe 2007), Basque coast (Gorostiaga et al. 2004), Galicia (Bárbara et al. 2005), southern Portugal (Ardré 1970), Andalucía (Flores Moya et al. 1995a,b, Conde et al. 1996), Canary Islands (Haroun et al. 2002), and Atlantic coast of Morocco (Benhissoune et al. 2001, 2002a,b, 2003) is provided to support biogeographic analysis. Feldmann's (Rhodophyta/Phaeophyta; Feldmann 1937) and Cheney's (Rhodophyta+Chlorophyta/

Table 1 Checklist of marine macroalgae collected on the northern coast of Portugal.

CYANOBACTERIA
CHROOCOCCALES
CHAMAESIPHONACEAE
Chamaecalyx Komárek *et* Anagnostidis
Chamaecalyx leibleiniae (Reinsch) Komárek *et* Anagnostidis (Mi)[1]
CHROOCOCCACEAE
Gloeocapsopsis Geitler *ex* Komárek
Gloeocapsopsis crepidinum (Thuret) Komárek (Mi)[2]
DERMOCARPELLACEAE
Dermocarpella Lemmermann
Dermocarpella prasina (Reinsch) Komárek *et* Anagnostidis (Mi, *DL, *BL)[3]
ENTOPHYSALIDACEAE
Entophysalis Kützing
Entophysalis deusta (Meneghini) Drouet *et* Daily (Mi)[1]
Entophysalis granulosa Kützing (Mi)[4]
HYDROCOCCACEAE
Hydrococcus Kützing
Hydrococcus rivularis Kützing (Mi)[2]
HYELLACEAE
Hyella Bornet *et* Flahault
Hyella caespitosa Bornet *et* Flahault (Mi)[4]
XENOCOCCACEAE
Myxosarcina Printz
**Myxosarcina gloeocapsoides* (Setchell *et* N.L. Gardner) Komárek *et* Anagnostidis (Mi)[5]
Xenococcus Thuret in Bornet *et* Thuret
Xenococcus schousboei Thuret (Mi)[4]
OSCILLATORIALES
OSCILLATORIACEAE
Lyngbya C. Agardh, nom. cons.
**Lyngbya aestuarii* (Mertens) Liebman *ex* Gomont) (BL)[6]
Lyngbya confervoides C. Agardh (Mi, DL)[7]
Lyngbya martensiana Meneghini *ex* Gomont (Mi)[1]
**Lyngbya semiplena* (C. Agardh) J. Agardh *ex* Gomont (DL)[8]
PHORMIDIACEAE
Microccoleus Desmazières *ex* Gomont
**Microcoleus acutirostris* Gomont (BL)[9]
Microcoleus chthonoplastes Thuret *ex* Gomont *(BL)[10]
Trichocoleus Anagnostidis
Trichocoleus tenerrimus (Gomont) Anagnostidis (Mi)[4]
Porphyrosiphon Kützing *ex* Gomont
Porphyrosiphon luteus (Gomont *ex* Gomont) Anagnostidis *et* Komárek (Mi)[4]
Phormidium Kützing *ex* Gomont
Phormidium nigro-viride (Thornwaites *ex* Gomont) Anagnostidis *et* Komárek (Mi)[1]
Phormidium valderianum (Delponte) Gomont (Mi)[1]
Sirocoleum Kützing *ex* Gomont
Sirocoleum kurzii (Zeller) Gomont (Mi)[11]
Spirulina Turpin *emend*. N.L. Gardner *ex* Gomont
Spirulina subsalsa Gomont (Mi)[1]
SCHIZOTRICHACEAE
PSEUDOANABAENACEAE
Spirocoleus Möbius
Spirocoleus fragilis (Meneghini) P.C. Silva (Mi)[4]
Pseudophormidium (Forti) Anagnostidis
Pseudophormidium battersii (Gomont) Anagnostidis (Mi)[4]
Pseudophormidium golenkinianum (Gomont) Anagnostidis (Mi)[2]
NOSTOCALES
RIVULARIACEAE
Calothrix C. Agardh *ex* Bornet *et* Flahault
Calothrix crustacea Thuret (Mi, DL)[12]
Calothrix scopulorum (F.F. Weber *et* Morh) C. Agardh (Mi)[4]

RHODOPHYTA
BANGIOPHYCEAE
PORPHYRIDIALES
GONIOTRICHACEAE
Stylonema Reinsch
Stylonema alsidii (Zanardini) K. Drew *(Mi, DL, BL)[13]
ERYTHROPELTIDALES
ERYTHROPELTIDACEAE
Erythrotrichia J.E. Areschoug
Erythrotrichia bertholdii Batters (Mi, *BL)[14]

(Table 1 *continued*)

Erythrotrichia carnea (Dillwyn) J. Agardh (Mi, *DL, *BL)[15]
Erythrotrichia welwitschii (Ruprecht) Batters (Mi, *DL)[16]
Porphyrostromium Trevisan
**Porphyrostromium boryanum* (Montagne) P.C. Silva (Mi, DL, BL)[17]
Porphyrostromium ciliare (Carmichael) M.J. Wynne (Mi, *DL)[18]
Sahlingia Kornmann
Sahlingia subintegra (Rosenvinge) Kornmann *(Mi)[19]
BANGIALES
BANGIACEAE
Bangia Lyngbye
Bangia fuscopurpurea (Dillwyn) Lyngbye (Mi, DL, BL)
Porphyra C. Agardh
Porphyra dioica J. Brodiet *et* L.M. Irvine (*Mi, DL, *BL)[20]
Porphyra leucosticta Thuret (Mi, DL, BL)[21]
Porphyra linearis Greville (Mi, DL, *BL)[22]
Porphyra purpurea (Roth) C. Agardh (Mi, DL, *BL)[23]
Porphyra umbilicalis (Linnaeus) Kützing (Mi, DL, BL)[24]
FLORIDEOPHYCEAE
ACROCHAETIALES
ACROCHAETIACEAE
Rhodochorton Nägeli
Rhodocorton purpureum (Lightfoot) Rosenvinge (Mi, DL)[25]
COLACONEMATALES
COLACONEMATACEAE
Colaconema Batters *emend.* J.T. Harper *et* G.W. Saunders
Colaconema daviesii (Dillwyn) Stegenga (Mi, *DL, *BL)[26]
PALMARIALES
PALMARIACEAE
Palmaria Stackhouse
Palmaria palmata (Linnaeus) Kuntze (Mi, DL, BL)
RHODOTHAMNIELLACEAE
Rhodothamniella J. Feldmann *emend.* Bidoux *et* Magne
Rhodothamniella floridula (Dillwyn) Feldmann (Mi, DL, BL)
AHNFELTIALES
AHNFELTIACEAE
Ahnfeltia Fries
Ahnfeltia plicata (Hudson) Fries (Mi, DL, BL)
NEMALIALES
GALAXAURACEAE
Scinaia Bivona-Bernardi
Scinaia furcellata (Turner) J. Agardh (Mi, DL, BL)
Scinaia interrupta (A.P. de Candolle) M.J. Wynne (Mi)[27]
LIAGORACEAE
Helminthocladia J. Agardh
Helminthocladia calvadosii (J.V. Lamouroux *ex* Duby) Setchell (*Mi, DL)[28]
Nemalion Duby
Nemalion helminthoides (Velley) Batters (Mi, DL, BL)
GELIDIALES
GELIDIACEAE
Gelidium J.V. Lamouroux
Gelidium corneum (Hudson) J.V. Lamouroux (Mi, DL, BL)
Gelidium crinale (Hare *ex* Turner) Gaillon (Mi, DL, *BL)[29]
Gelidium fasciculatum G. Hamel (Mi)[30]
Gelidium pulchellum (Turner) Kützing (Mi, DL, BL)
Gelidium pusillum (Stackhouse) Le Jolis (Mi, DL, *BL)[31]
Gelidium spathulatum (Kützing) Bornet (Mi)[32]
Gelidium spinosum (S.G. Gmelin) P.C. Silva (Mi, DL, BL)
Parviphycus Santelices
Parviphycus tenuissimus (Feldmann *et* G. Hamel) Santelices *(Mi, BL)[33]
Pterocladiella Santelices *et* Hommersand
Pterocladiella capillaceae (S.G. Gmelin) Santelices *et* Hommersand (Mi, DL, BL)
Pterocladiella melanoidea (Schousboe *ex* Bornet) Santelices *et* Hommersand (Mi, DL, BL)[34]
GRACILARIALES
GRACILARIACEAE
Gracilaria Greville
Gracilaria bursa-pastoris (S.G. Gmelin) P.C. Silva (BL)[11]
Gracilaria gracilis (Stackhouse) Steentoft, L.M. Irvine *et* Farnham (Mi, DL, BL)
Gracilaria multipartita (Clemente) Harvey (Mi, DL, BL)
PTEROCLADIOPHILLACEAE
Gelidiocolax N.L. Gardner
Gelidiocolax margaritoides (Martin *et* Pocock) Fan *et* Papenfuss (Mi, *DL)[35]

(Table 1 *continued*)

BONNEMAISONIALES
BONNEMAISONIACEAE
Asparagopsis Montagne
Asparagopsis armata Harvey (Mi, *BL)[36]
"*Falkenbergia rufolanosa*" (Harvey) F. Schmitz [stage] (Mi)
Bonnemaisonia C. Agardh
Bonnemaisonia asparagoides (Woodward) C. Agardh (Mi)[27]
CRYPTONEMIALES
DUMONTIACEAE
Dilsea Stackhouse
Dilsea carnosa (Schmidel) Kuntze (Mi, DL)
Dumontia J.V. Lamouroux
Dumontia contorta (S.G. Gmelin) Ruprecht (Mi, DL, *BL)[37]
GLOIOSIPHONIACEAE
Gloiosiphonia Carmichael
Gloisiphonia capillaris (Hudson) Carmichael (Mi)[2]
HALYMENIACEAE
Cryptonemia J. Agardh
Cryptonemia lomation (Bertoloni) J. Agardh (Mi, DL, BL)[38]
Grateloupia C. Agardh
Grateloupia dichotoma J. Agardh (Mi, *DL)[39]
Grateloupia filicina (J.V. Lamouroux) C. Agardh (Mi, DL, BL)
Grateloupia turuturu Yamada (DL, BL)[40]
KALLYMENIACEAE
Callocolax F. Schmitz *ex* Batters
Callocolax neglectus F. Schmitz *ex* Batters *(Mi)[41]
Callophyllis Kützing
Callophyllis laciniata (Hudson) Kützing (Mi, DL, BL)
Kallymenia C. Agardh
Kallymenia reniformis (Turner) J. Agardh (Mi, DL, BL)
HILDENBRANDIALES
PEYSSONNELIACEAE
Peyssonnelia Decaisne
Peyssonelia atropurpurea P. Crouan *et* H. Crouan (Mi, *DL, *BL)[42]
Peyssonelia dubyi P. Crouan *et* H. Crouan (Mi)[1]
Peyssonelia harveyana P. Crouan *et* H. Crouan *in* J. Agardh (Mi)[1]
HILDENBRANDIACEAE
Hildenbrandia Nardo
Hildenbrandia rubra (Sommerfelt) Meneghini (Mi, BL)
Hildenbrandia crouaniorum J. Agardh (Mi)[43]
CORALLINALES
CORALLINACEAE
Choreonema F. Schmitz
Choreonema thuretii (Bornet) F. Schmitz (Mi, *DL)[44]
Corallina Linnaeus
Corallina elongata J. Ellis *et* Solander (Mi, DL, BL)
Corallina officinalis Linnaeus (Mi, DL, BL)
Hydrolithon (Foslie) Foslie
Hydrolithon farinosum (J.V. Lamouroux) D. Penrose *et* Y.M. Chamberlain (Mi, DL, BL)[1]
Jania J.V. Lamouroux
Jania longifurca Zanardini (Mi, DL, BL)
Jania rubens (Linnaeus) J.V. Lamouroux (Mi, DL, BL)
Jania squamata (Linnaeus) J.H. Kim, Guiry *et* H.-G. Choi (Mi, DL, BL)
Lithophyllum Philippi
Lithophyllum byssoides (Lamarck) Foslie (Mi, DL, BL)
Lithophyllum incrustans Philippi (Mi, DL, BL)
Lithophyllum orbiculatum (Foslie) Foslie (Mi)[45]
Lithophyllum vickersiae Lemoine (Mi)[46]
Melobesia J.V. Lamouroux
Melobesia membranacea (Esper) Lamouroux (Mi, DL, BL)
Mesophyllum Lemoine
Mesophyllum lichenoides (J. Ellis) M. Lemoine (Mi, DL, BL)
Phymatholithon Foslie
Phymatolithon lenormandii (J.E. Areschoug) W.H. Adey (Mi, BL)[1]
Titanoderma Nägeli
Titanoderma pustullatum (Lamouroux) Nägeli (Mi, DL, BL)
GIGARTINALES
CAULACANTHACEAE
Catenella Greville
Catenella caespitosa (Withering) L.M. Irvine (Mi, DL, BL)
Caulacanthus Kützing

(Table 1 *continued*)

Caulacanthus ustulatus (Mertens *ex* Turner) Kützing (Mi, DL, *BL)[47]
CHOREOCOLACACEAE
Choreocolax Reinsch
Choreocolax polysiphoniae Reinsch (Mi)[48]
CRUORIACEAE
Cruoria Fries
Cruoria pellita (Lyngbye) Fries (Mi)[49]
CYSTOCLONIACEAE
Calliblepharis Kützing
Calliblepharis ciliata (Hudson) Kützing (*Mi, DL, BL)[50]
Calliblepharis jubata (Goodenough *et* Woodward) Kützing (Mi, DL, BL)
Rhodophyllis Kützing
Rhodophyllis divaricata (Stackhouse) Papenfuss (Mi, DL, BL)
FURCELLARIACEAE
Furcellaria J.V. Lamouroux
**Furcellaria lumbricalis* (Hudson) J.V. Lamouroux (Mi)[51]
GIGARTINACEAE
Chondracanthus Kützing
Chondracanthus acicularis (Roth) Fredericq (Mi, DL, BL)
Chondracanthus teedei (Roth) Kützing (Mi, DL, BL)[52]
Chondrus Stackhouse
Chondrus crispus Stackhouse (Mi, DL, BL)
Gigartina Stackhouse
Gigartina pistillata (S.G. Gmelin) Stackhouse (Mi, DL, BL)
HYPNEACEAE
Hypnea J.V. Lamouroux
Hypnea musciformis (Wulfen) J.V. Lamouroux (Mi, DL, BL)[53]
PETROCELIDACEAE
Mastocarpus Kützing
Mastocarpus stellatus (Stackhouse) Guiry (Mi, DL, BL)
"*Petrocelis cruenta*" J. Agardh [stage] (Mi, BL)
PHYLLOPHORACEAE
Ahnfeltiopsis P.C. Silva *et* DeCew
Ahnfeltiopsis devoniensis (Greville) P.C. Silva *et* DeCew (Mi, DL, BL)[11]
Gymnogongrus Martius
Gymnogongrus crenulatus (Turner) J. Agardh (Mi, DL, BL)
Gymnogongrus griffithsiae (Turner) Martius (Mi, DL, BL)
Phyllophora Greville
Phyllophora crispa (Hudson) P.S. Dixon (Mi, DL)
Phyllophora sicula (Kützing) Guiry *et* L.M. Irvine (Mi)[30]
Schottera Guiry *et* Hollenberg
Schottera nicaeensis (J.V. Lamouroux *ex* Duby) Guiry *et* Hollenberg (Mi, DL)[54]
Stenogramme Harvey
Stenogramme interrupta (C. Agardh) Montagne *ex* Harvey *(Mi)[55]
SCHIZMENIACEAE
Schizymenia J. Agardh
Schizymenia dubyi (Chauvin *ex* Duby) J. Agardh (Mi, DL, BL)
"*Haematocelis rubens*" J. Agardh [stage] (Mi, *DL)[56]
SPHAEROCOCCACEAE
Sphaerococcus Stackhouse
Sphaerococcus coronopifolius Stackhouse (Mi)[1]
PLOCAMIALES
PLOCAMIACEAE
Plocamium J.V. Lamouroux
Plocamium cartilagineum (Linnaeus) P.S. Dixon (Mi, DL, BL)
Plocamium raphelisianum P.J.L. Dangeard (DL)[57]
RHODYMENIALES
CHAMPIACEAE
Champia Desvaux
Champia parvula (C. Agardh) Harvey (Mi, DL)[58]
Chylocladia Greville *ex* W.J. Hooker
Chylocladia verticillata (Lightfoot) Bliding (Mi, DL, BL)
Gastroclonium Kützing
Gastroclonium ovatum (Hudson) Papenfuss (Mi, DL, BL)
Gastroclonium reflexum (Chauvin) Kützing (Mi, *DL, *BL)[59]
LOMENTARIACEAE
Lomentaria Lyngbye
Lomentaria articulata (Hudson) Lyngbye (Mi, DL, BL)
Lomentaria orcadensis (Harvey) F.S. Collins *ex* W.R. Taylor (Mi, DL, BL)[60]
Lomentaria clavellosa (Turner) Gaillon (Mi, DL, BL)

(Table 1 *continued*)

RHODYMENIACEAE
Cordylecladia J. Agardh
Cordylecladia erecta (Greville) J. Agardh (*Mi, DL)[61]
Rhodymenia Greville
Rhodymenia holmesii Ardissone (Mi, DL, *BL)[62]
Rhodymenia pseudopalmata (J.V. Lamouroux) P.C. Silva (Mi, DL, BL)
CERAMIALES
CERAMIACEAE
Aglaothamnion Feldmann-Mazoyer
Aglaothamnion gallicum (Nägeli) L'Hardy-Halos *et* Ardré (Mi)
Aglaothamnion hookeri (Dillwyn) Maggs *et* Hommersand (Mi, DL, *BL)[63]
Aglaothamnium roseum (Roth) Maggs *et* L'Hardy-Halos (Mi, DL, BL)[64]
Aglaothamnion sepositum (Gunnerus) Maggs *et* Hommersand (Mi, DL)[65]
Aglaothamnion tenuissimum (Bonnemaison) Feldmann-Mazoyer (DL)[1]
Aglaothamnion pseudobyssoides (P.L. Crouan *et* H.M. Crouan) L'Hardy-Halos
Anotrichium Nägeli
Anotrichium furcellatum (J. Agardh) Baldock (BL)[60]
Antithamnion Nägeli
Antithamnion cruciatum (C. Agardh) Nägeli *(Mi, DL, BL)[66]
**Antithamnion densum* (Suhr) M.A. Howe (DL)[67]
**Antithamnion villosum* (Kützing) Athanasiadis (BL)[68]
Antithamnionella Lyle
Antithamnionella ternifolia (J.D. Hooker *et* Harvey) Lyle *(Mi, DL)[69]
**Antithamnionella spirographidis* (Schiffner) E.M. Wollaston (DL, BL)[70]
Bornetia Thuret
Bornetia secundiflora (J. Agardh) Thuret (Mi, *DL, BL)[71]
Callithamnion Lyngbye
Callithamnion corymbosum (J.E. Smith) Lyngbye *(BL)[72]
Callithamnion granulatum (Ducluzeau) C. Agardh (Mi, *DL, BL)[73]
Callithamnion tetragonum (Withering) S.F. Gray (Mi, DL, BL)
Callihamnion tetricum (Dillwyn) S.F. Gray (Mi, DL, BL)
Ceramium Roth
Ceramium botryocarpum A.W. Griffiths *ex* Harvey (Mi, DL, *BL)[74]
Ceramium ciliatum (J. Ellis) Ducluzeau (Mi, DL, *BL)[75]
Ceramium diaphanum (Lightfoot) Roth (Mi, DL, BL)
Ceramium echionotum J. Agardh (Mi, DL, BL)
Ceramium gaditanum (Clemente y Rubio) Cremades (Mi, BL, DL)
Ceramium pallidum (Nägeli *ex* Kützing) Maggs *et* Hommersand (Mi, DL, BL)
Ceramium secundatum Lyngbye (Mi, DL, BL)
Ceramium shuttleworthianum (Kützing) Rabenhorst (Mi, DL)
Ceramium tenuicorne Kützing (Waern) (Mi, DL)
Ceramium virgatum Roth (Mi, DL, BL)
Compsothamnion (Nägeli) F. Schmitz
Compsothamnion decompositum (J. Agardh) Maggs *et* L'Hardy-Halos *(Mi)[76]
Compsothamnion thuyoides (J.E. Smith) Nägeli *(BL)[77]
Crouania J. Agardh
Crouania attenuata (C. Agardh) J. Agardh *(Mi)[78]
Gayliella Cho, McIvor *et* Boo
Gayliella flaccida (Kützing) T.O. Cho *et* L. McIvor (Mi, *DL, *BL)[79]
Griffithsia C. Agardh
Griffithsia schousboei Montagne *(BL)[80]
Halurus Kützing
Halurus equisetifolius (Lightfoot) Kützing (Mi, DL, BL)
Halurus flosculosus (J. Ellis) Maggs *et* Hommersand *(Mi)[81]
Monosporus Solier
Monosporus pedicellatus (J.E. Smith) Solier *(DL)[82]
Pleonosporium Nägeli *nom. cons.*
Pleonosporium borreri (Smith) Nägeli *ex* Hauck (Mi, DL, BL)
Pleonosporium flexuosum (C. Agardh) Bornet (*Mi, DL, BL)[83]
Plumaria F. Schmitz
Plumaria plumosa (Hudson) Kuntze (Mi)
Pterothamnion Nägeli *in* Nägeli *et* C.E. Cramer
Pterothamnion crispum (Ducluzeau) Nägeli (Mi, DL, *BL)[84]
Pterothamnion plumula (J. Ellis) Nägelli (Mi, *DL)[85]
Ptilothamnion Thuret
Ptilothamnium pluma (Dillwyn) Thuret (Mi)[1]
Ptilothamnion sphaericum (P. Crouan *et* H. Crouan) Maggs *et* Hommersand (Mi, DL, BL)[86]
Spermothamnion J.E. Areschoug
Spermothamnion repens (Dillwyn) Rosenvinge (*Mi, DL)[87]
Sphondylothamnion Nägeli
Sphondylothamnion multifidum (Hudson) Nägeli (DL)[88]

(Table 1 *continued*)

Tiffaniella Doty *et* Meñez
Tiffaniella capitata (Schousboe *ex* Bornet) Doty *et* Meñez (DL, *BL)[89]
DASYACEAE
Dasya C. Agardh
Dasya hutchinsiae Harvey (Mi)[27]
Dasya ocellata (Grateloup) Harvey *(Mi, BL)[90]
**Dasya sessilis* Yamada (BL)[91]
Heterosiphonia Montagne
Heterosiphonia plumosa (J. Ellis) Batters (Mi, DL, *BL)[92]
DELESSERIACEAE
Acrosorium Zanardini *ex* Kützing
Acrosorium ciliolatum (Harvey) Kylin (Mi, DL, BL)
Apoglossum J. Agardh
Apoglossum ruscifolium (Turner) J. Agardh (Mi, DL, BL)[7]
Cryptopleura Kützing
Cryptopleura ramosa (Hudson) Kylin *ex* Lily Newton (Mi, DL, BL)
Delesseria J.V. Lamouroux
Delesseria sanguinea (Hudson) J.V. Lamouroux (Mi, DL, BL)
Drachiella J. Ernst *et* J. Feldmann
Drachiella spectabilis J. Ernst *et* Feldmann (Mi)[27]
Erythroglossum J. Agardh
Erythroglossum laciniatum (Lightfoot) Maggs *et* Hommersand (Mi, DL, BL)[93]
Erythroglossum lusitanicum Ardré (Mi, DL, BL)[94]
Haraldiophyllum A.D. Zinova
Haraldiophyllum bonnemaisonii (Kylin) A.D. Zinova (Mi)[95]
Hypoglossum Kützing
Hypoglossum hypoglossoides (Stackouse) F.S. Collins *et* Hervey (Mi, DL, BL)
Nitophyllum Greville
Nitophyllum punctatum (Stackhouse) Greville (Mi, DL)
RHODOMELACEAE
Aphanocladia Falkenberg
Aphanocladia stichidiosa (Funk) Ardré *(Mi)[96]
Boergeseniella Kylin
Boergeseniella fruticulosa (Wulfen) Kylin (Mi, DL, *BL)[97]
Boergeseniella thuyoides (Harvey) Kylin (Mi, DL, BL)
Bostrychia Montagne
Bostrychia scorpioides (Huds.) Mont. *ex* Kützing (Mi, DL, BL)
Brongniartella Bory de Saint-Vincent
Brongniartella byssoides (Goodenough *et* Woodward) F. Schmitz (DL)[98]
Chondria C. Agardh
Chondria coerulescens (J. Agardh) Falkenberg (Mi, DL, BL)
Chondria dasyphylla (Woodward) C. Agardh (Mi, DL, BL)
Chondria scintillans G. Feldmann (Mi, DL, BL)
Ctenosiphonia Falkenberg
Ctenosiphonia hypnoides (Welwitsch *ex* J. Agardh) Falkenberg *(DL)[99]
Herposiphonia Nägeli
Herposiphonia secunda (C. Agardh) Ambronn (Mi)[60]
Laurencia Nägeli
Laurencia obtusa (Hudson) J.V. Lamouroux (Mi, DL, BL)[100]
Laurencia pyramidalis Bory de Saint-Vincent *ex* Kützing (Mi)[27]
Leptosiphonia Kylin
Leptosiphonia schousboei (Thuret) Kylin (Mi, DL, BL)
Lophosiphonia Falkenberg
Lophosiphonia reptabunda (Suhr) Kylin (Mi, DL)[38]
Neosiphonia M.S. Kim *et* I.K. Lee
**Neosiphonia harveyi* (J. Bailey) M.S. Kim, H.G. Choi, Guiry *et* G.W. Saunders (Mi, DL, BL)[101]
Ophidocladus Falkenberg
Ophidocladus simpliciusculus (P.L. Crouan *et* H.M. Crouan) Falkenberg (Mi, DL, BL)
Osmundea Stackhouse
Osmundea hybrida (A.P. de Candolle) K.W. Nam (Mi, DL, BL)[102]
Osmundea osmunda (S.G. Gmelin) K.W. Nam *et* Maggs (Mi, DL, *BL)[103]
Osmundea pinnatifida (Hudson) Stackhouse (Mi, DL, BL)
Polysiphonia Greville
Polysiphonia atlantica Kapraun *et* J.N. Norris (Mi, DL, *BL)[104]
Polysiphonia brodiei (Dillwyn) Sprengel (Mi, DL, *BL)[105]
Polysiphonia denudata (Dillwyn) Greville *ex* Harvey (Mi, DL, BL)[106]
Polysiphonia elongata (Hudson) Sprengel (Mi, DL, BL)[1]
Polysiphonia fucoides (Hudson) Greville (Mi, *DL, *BL)[107]
Polysiphonia furcellata (C. Agardh) Harvey *in* W.J. Hooker (DL)[108]
Polysiphonia lanosa (Linnaeus) Tandy (Mi)
Polysiphonia nigra (Hudson) Batters (Mi, DL, BL)[109]

(Table 1 *continued*)

Polysiphonia polyspora (C. Agardh) Montagne (Mi, *DL, *BL)[110]
Polysiphonia scopulorum Harvey (Mi, DL, BL)[111]
Polysiphonia stricta (Dillwyn) Greville (Mi, DL, *BL)[112]
Pterosiphonia Falkenberg *in* F. Schmitz *et* Falkenberg
Pterosiphonia ardreana Maggs *et* Hommersand (Mi, *DL, BL)[113]
Pterosiphonia complanata (Clemente) Falkenberg (Mi, DL, BL)
Pterosiphonia parasitica (Hudson) Falkenberg *(Mi)[114]
Pterosiphonia pennata (C. Agardh) Sauvageau (Mi, DL, *BL)[115]
Rhodomela C. Agardh
Rhodomela confervoides (Hudson) P.C. Silva (Mi)[116]
Streblocladia F. Schmitz *in* Engler *et* Prantl
Streblocladia collabens (C. Agardh) Falkenberg (Mi, DL, BL)
Aiolocolax Pocock
**Aiolocolax pulchella* Pocock (Mi, DL, BL)[117]

OCHROPHYTA
XANTHOPHYCEAE
VAUCHERIALES
VAUCHERIACEAE
Vaucheria A.P. De Candolle
**Vaucheria coronata* Nordstedt (Mi)[118]
**Vaucheria velutina* C. Agardh (Mi, BL)[119]
PHAEOPHYCEAE
SPHACELARIALES
CLADOSTEPHACEAE
Cladostephus C. Agardh
Cladostephus spongiosus (Hudson) C. Agardh (Mi, DL, BL)
SPHACELARIACEAE
Sphacelaria Lyngbye
Sphacelaria cirrosa (Roth) C. Agardh (Mi, DL, *BL)[120]
Sphacelaria fusca (Hudson) S.F. Gray *(Mi)[121]
**Sphacelaria rigidula* Kützing (Mi)[122]
STYPOCAULACEAE
Halopteris Kützing
Halopteris filicina (Grateloup) Kützing (Mi, DL)[123]
Stypocaulon Kützing
Stypocaulon scoparium (Linnaeus) Kützing (Mi, DL, BL)
DICTYOTALES
DICTYOTACEAE
Dictyopteris J.V. Lamouroux
**Dictyopteris ambigua* (Clemente) Cremades (Mi, DL, BL)[124]
Dictyopteris polypodioides (A.P. de Candolle) J.V. Lamouroux (Mi, DL, BL)
Dictyota J.V. Lamouroux
Dictyota dichotoma (Hudson) J.V. Lamouroux (Mi, DL, BL)
Dictyota spiralis Montagne (Mi)[1]
Padina Adanson
Padina pavonica (Linnaeus) Thivy (DL)[98]
Taonia J. Agardh
Taonia atomaria (Woodward) J. Agardh (*Mi, BL)[125]
ECTOCARPALES
ACINETOSPORACEAE
Feldmannia G. Hamel
Feldmannia irregularis (Kützing) G. Hamel *(Mi)[126]
Feldmannia paradoxa (Montagne) G. Hamel (Mi)[1]
Hincksia E. Gray
Hincksia granulosa (J.E. Smith) P.C. Silva (Mi, DL, BL)
Hincksia hincksiae (Harvey) P.C. Silva (Mi, DL, BL)
Hincksia mitchelliae (Harvey) P.C. Silva *(DL, BL)[127]
Hincksia sandriana (Zanardini) P.C. Silva *(Mi, DL, BL)[128]
Hincksia secunda (Kützing) P.C. Silva (Mi, DL)[95]
Pylaiella Bory de Sant-Vincent
Pylaiella littoralis (Linnaeus) Kjellman (*Mi, DL)[129]
CHORDARIACEAE
Asperococcus J.V. Lamouroux
Asperococcus bullosus J.V. Lamouroux (DL)[88]
Asperococcus ensiformis (Delle Chiaje) M.J. Wynne (DL)[98]
Asperococcus fistulosus (Hudson) W.J. Hooker (DL)[98]
Elachista Duby
Elachista flaccida (Dillwyn) Fries (Mi, *DL)[130]
Elachista fucicola (Velley) Areschoug (Mi, *DL)[131]
Elachista scutulata (J.E. Smith) Duby (Mi)[1]

(Table 1 *continued*)

Hecatonema J. Agardh
Hecatonema terminale (Kützing) Kylin (DL)[98]
Herponema J. Agardh
Herponema velutinum (Greville) J. Agardh (Mi, BL)[132]
Leathesia S.F. Gray
Leathesia difformis (Linnaeus) Areschoug (Mi, *DL, *BL)[133]
Litosiphon Harvey
Litosiphon laminariae (Lyngbye) Harvey *(Mi)[134]
Myrionema Greville
Myrionema corunnae Sauvageau (Mi)[1]
Myrionema strangulans Greville (Mi, *DL)[135]
Pilocladus Kuckuck *emend*. Kormann
Pilocladus codicola (Setchell *et* N.L. Gardner) Ardré (Mi)[27]
Sauvageaugloia G. Hamel *ex* Kylin
Sauvageaugloia griffithsiana (A.W. Griffiths *ex* Harvey) G. Hamel *ex* Kylin (Mi)[1]
Spongonema Kützing
Spongonema tomentosum (Hudson) Kützing (Mi)[1]
ECTOCARPACEAE
Ectocarpus Lyngbye
Ectocarpus fasciculatus Harvey (Mi, DL, BL)
Ectocarpus siliculosus (Dillwyn) Lyngbye (Mi, DL)[1]
SCYTOSIPHONACEAE
Colpomenia (Endlicher) Derbès *et* Solier
Colpomenia peregrina Sauvageau (Mi)[136]
Petalonia Derbès *et* Solier
Petalonia fascia (O.F. Müller) Kuntze (*Mi, *DL, BL)[137]
Petalonia zosterifolia (Reinke) Kuntze (DL)[49]
Scytosiphon C. Agardh
Scytosiphon lomentaria (Lyngnbye) Link *(BL)[138]
RALFSIALES[139]
RALFSIACEAE
Ralfsia Berkeley
Ralfsia verrucosa (Areschoug) Areschoug (Mi, DL, BL)
CUTLERIALES
CUTLERIACEAE
Cutleria Greville
Cutleria adspersa (Mertens *ex* Roth) De Notarsi *(Mi)[140]
Zanardinia Zanardini
Zanardinia typus (Nardo) G. Furnari (Mi)[1]
DESMARESTIALES
DESMARESTIACEAE
Desmarestia J.V. Lamouroux
Desmarestia aculeata (Linnaeus) J.V. Lamouroux (Mi, DL)
Desmarestia ligulata (Stackhouse) J.V. Lamouroux (Mi, DL, BL)
LAMINARIALES
ALARIACEAE
Undaria Suringar
**Undaria pinnatifida* (Harvey) Suringar (DL, BL)[141]
CHORDACEAE
Chorda Stackhouse
**Chorda filum* (Linnaeus) Stackhouse (Mi)[142]
LAMINARIACEAE
Laminaria J.V. Lamouroux
Laminaria hyperborea (Gunnerus) Foslie (Mi, DL, BL)
Laminaria ochroleuca Bachelot de la Pylaie (Mi, DL, BL)
Saccharina Stackhouse
Saccharina latissima (Linnaeus) C.E. Lane, C. Mayes, Druehl *et* G.W. Saunders (Mi, DL)
PHYLLARIACEAE
Phyllariopsis Henry *et* South
Phyllariopsis brevipes (C. Agardh) E.C. Henry *et* South subsp. *pseudopurpurascens* Pérez-Cirera, Cremades, Bárbara *et* López-Rodríguez (Mi)[27]
Saccorhiza De La Pylaie
Saccorhiza polyschides (Lightfoot) Batters (Mi, DL, BL)
FUCALES
CYSTOSEIRACEAE
Bifurcaria Stackhouse
Bifurcaria bifurcata R. Ross (Mi, DL, BL)
Cystoseira C. Agardh
Cystoseira baccata (S.G. Gmelin) P.C. Silva (Mi, DL, BL)
Cystoseira humilis Kützing var. *myriophylloides* (Sauvageau) J.H. Price *et* D.M. John (Mi, *DL)[143]
Cystoseira nodicaulis (Withering) M. Roberts (Mi, *DL)[144]

(Table 1 *continued*)

Cystoseira tamariscifolia (Hudson) Papenfuss (Mi, DL, BL)
Halidrys Lyngbye
Halidrys siliquosa (Linnaeus) Lyngbye (Mi)
FUCACEAE
Ascophyllum Stackhouse
Ascophyllum nodosum (Linnaeus) Le Jolis (Mi, DL)
Fucus Linnaeus
Fucus ceranoides Linnaeus (Mi, DL, BL)
Fucus serratus Linnaeus (Mi, DL)
Fucus spiralis Linnaeus (Mi, DL, BL)[145]
Fucus vesiculosus Linnaeus (Mi, DL, BL)[146]
Pelvetia Decaisne *et* Thuret
Pelvetia canaliculata (Linnaeus) Decaisne *et* Thuret (Mi, DL)
HIMANTHALIACEAE
Himanthalia Lyngbye
Himanthalia elongata (Linnaeus) S.F. Gray (Mi, DL, BL)
SARGASSACEAE
Sargassum C. Agardh
Sargassum muticum (Yendo) Fensholt (Mi, DL, BL)
INCERTAE SEDIS
Bachelotia (Bornet) Kuckuck *ex* G. Hamel
Bachelotia antillarum (Grunow) Gerloff (Mi)[1]

CHLOROPHYTA
ULVOPHYCEAE
ULVALES
GAYRALIACEAE
Gayralia K.L. Vinogradova
Gayralia oxysperma (Kützing) K.L. Vinogradova *ex* Scagel et al. (Mi, DL, BL)
GOMONTIACEAE
Gomontia Bornet *et* Flahault
Gomonthia polyrhiza (Lagerheim) Bornet *et* Flahault (Mi)[1]
KORNMANNIACEAE
Pseudendoclonium Wille
Pseudendoclonium submarinum Wille (Mi)[1]
ULVACEAE
Blidingia Kylin
Blidingia marginata (J. Agardh) P.J.L. Dang. (Mi, DL, BL)[147]
Blidingia minima (Nägeli *ex* Kützing) Kylin (Mi, DL, BL)
Ulva Linnaeus
Ulva bifrons Ardré *(DL)[148]
Ulva clathrata (Roth) C. Agardh (Mi, DL, BL)
Ulva compressa Linnaeus (Mi, DL, BL)
Ulva curvata (Kützing) de Toni (Mi, BL)
Ulva flexuosa Wulfen (Mi, DL, BL)[149]
Ulva intestinalis Linnaeus (Mi, DL, BL)
Ulva lactuca Linnaeus (Mi, DL, BL)[1]
Ulva linza Linnaeus (*Mi, DL, BL)[150]
Ulva prolifera O.F. Müller (Mi, DL, BL)
Ulva pseudocurvata Koeman *et* Hoek (Mi, *DL, *BL)[151]
Ulva pseudolinza (R.P.T. Koeman *et* Hoek) Hayden, Blomster, Maggs, P.C. Silva, M.J. Stanhope *et* J.R. Waaland (Mi)[49]
Ulva rhacodes (Holmes) Papenfuss (Mi)[152]
Ulva rigida C. Agardh (Mi, DL, BL)[153]
**Ulva scandinavica* Bliding (Mi)[154]
Ulva simplex (K.L. Vinogradova) H.S. Hayden et al. (Mi)[27]
Ulvaria Ruprecht
Ulvaria obscura (Kützing) Gayral (Mi, DL, BL)
Umbraulva E.H. Bae *et* I.K. Lee
**Umbraulva olivascens* (P.J.L. Dangeard) E.H. Bae *et* I.K. Lee (Mi, BL)[155]
ULVELLACEAE
Entocladia Reinke
Entocladia viridis Reinke (Mi, DL, BL)[1]
Ulvella P.L. Crouan *et* H.M. Crouan
Ulvella lens P.L. Crouan *et* H.M. Crouan (Mi, DL)[93]
CLADOPHOROPHYCEAE
CLADOPHORALES
CLADOPHORACEAE
Chaetomorpha Kützing
Chaetomorpha aerea (Dillwyn) Kützing (*Mi, DL, BL)[156]
Chaetomorpha linum (O.F. Muller) Kützing (Mi, *DL)[157]
Chaetomorpha ligustica (Kützing) Kützing (Mi, *DL, *BL)[158]

(Table 1 *continued*)

Cladophora Kützing
Cladophora albida (Nees) Kützing (Mi, DL, BL)
Cladophora hutchinsiae (Dillwyn) Kützing (Mi, DL, *BL)[159]
Cladophora laetevirens (Dillwyn) Kützing (Mi, DL, *BL)[160]
Cladophora lehmanniana (Lindenberg) Kützing *(Mi, DL)[161]
Cladophora pellucida (Hudson) Kützing *(Mi, BL)[162]
Cladophora rupestris (Linnaeus) Kützing (Mi,DL, BL)
Cladophora sericea (Hudson) Kützing *(Mi)[163]
Rhizoclonium Kützing
Rhizoclonium riparium (Roth) Harvey (DL)[108]
Rhizoclonium tortuosum (Dilwyn) Kützing (Mi, DL, *BL)[164]
Rhizoclonium implexum (Dillwyn) Kützing (Mi)[1]
BRYOPSIDOPHYCEAE
ACROSIPHONIALES
ACROSIPHONIACEAE
Acrosiphonia J. Agardh
Acrosiphonia arcta (Dillwyn) Gain (Mi, *DL, *BL)[165]
Urospora J.E. Areschoug
Urospora penicilliformis (Roth) Areschoug (Mi)[166]
BRYOPSIDALES
BRYOPSIDACEAE
Bryopsis J.V. Lamouroux
Bryopsis duplex De Notaris *(Mi, BL)[167]
Bryopsis hypnoides J.V. Lamouroux (*DL, BL)[168]
Bryopsis plumosa (Hudson) C. Agardh (Mi, *DL, BL)[169]
CODIACEAE
Codium Stackhouse
Codium tomentosum Stackhouse (Mi, DL, BL)[170]
Codium vermilara (Olivi) Delle Chiaje (Mi)[1]
DERBESIACEAE
Derbesia Solier
Derbesia marina (Lyngbye) Solier *(DL, BL)[171]
Derbesia tenuissima (Moris *et* De Notaris) P.L. Crouan *et* H.M. Crouan *(DL,BL)[172]
ULOTRICHALES
ULOTRICHACEAE
Ulothrix Kützing
Ulothrix flacca (Dillwyn) Thuret (Mi, DL)[173]
**Ulothrix implexa* (Kützing) Kützing (Mi)[174]
Ulothrix subflaccida Wille (Mi)43

Geographical occurrence by region is marked for each species. New records are marked by * (before the species name in the case of new records for Portugal, before the regional distribution in the case of new records for the north of Portugal, and before each regional abbreviation in the case of new records for regions).
[1]Ardré (1970).
[2]Ginsburg-Ardré (1966).
[3]Ardré (1970). New record for Douro Litoral, collected in Mindelo in 2007 and for Beira Litoral, collected in Buarcos in 2004.
[4]Ardré (1961).
[5]New record for Portugal, collected in Vila Praia de Âncora in 2002.
[6]New record for Portugal, collected in Barra de Aveiro in 2007.
[7]Ardré (1970) and Bárbara et al. (2006b).
[8]New record for Portugal, collected in Vila Chã in 2006.
[9]New record for Portugal, collected in Buarcos in 2004.
[10]New record for northern Portugal, collected in Beira Litoral at Buarcos in 2005.
[11]Cremades et al. (2002) and Araújo et al. (2003).
[12]Ardré (1961) and Bárbara et al. (2006b).
[13]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003, Montedor in 2003, in Douro Litoral at Póvoa de Varzim in 2007 and in Beira Litoral at Barra de Aveiro in 2007 and Buarcos in 2003.
[14]New record for Beira Litoral, collected in Barra de Aveiro in 2007.
[15]New record for Douro Litoral, collected in Leça da Palmeira in 2004 and Lavadores in 2004 and in Beira Litoral, collected at Barra de Aveiro in 2007.
[16]New record for Douro Litoral, collected in Foz do Douro in 2004 and Aguda in 2006.
[17]New record for Portugal, collected for Minho in Moledo in 2003, Vila Praia de Âncora in 2003 and Apúlia in 2003, for Douro Litoral in Póvoa de Varzim in 2007, Vila do Conde in 2004 and Cabo do Mundo in 2004 and for Beira Litoral in Buarcos in 2003.
[18]New record for Douro Litoral, collected in Leça da Palmeira in 2004.
[19]New record for northern Portugal, collected for Minho in Apúlia in 2001.
[20]Pereira et al. (2004). New record for Minho, collected in Insua Caminha in 2002, Vila Praia de Âncora in 2002, Forte Cão in 2003, Montedor in 2003, Viana do Castelo in 2003, S. Bartolomeu do Mar in 2003, Rio de Moinhos in 2003, Cepães in 2003, Esposende in 2001 and Apúlia in 2002 and in Beira Litoral at Barra de Aveiro in 2000 and Buarcos in 2000.
[21]Hauck (1889), Ardré (1970) and Bárbara et al. (2006b).
[22]New record for Beira Litoral, collected in Barra de Aveiro in 1997 and Buarcos in 2003.
[23]New record for Beira Litoral, collected in Buarcos in 2006. Reported in Minho and Douro Litoral by Cremades et al. (2002).

(Table 1 *continued*)

[24]Includes *Porphyra laciniata* (Lightfoot) J. Agardh.
[25]Henriques (1881), Hauck (1889), Ardré (1970) and Araújo et al. (2003).
[26]New record for Douro Litoral, collected in Mindelo in 2003, Vila Chã in 2004, Leça de Palmeira in 2004, Lavadores in 2004, Valadares in 2004 and Aguda in 2004 and for Beira Litoral, collected in Buarcos in 2004.
[27]Araújo et al. (2003).
[28]Hauck (1889). New record for Minho, collected in Montedor in 2003.
[29]New record for Beira Litoral, collected in Buarcos in 2003.
[30]Cremades et al. (2000).
[31]New record for Beira Litoral, collected in Buarcos in 2003. Includes *Gelidium pusillum* var. *pulvinatum* (C. Agardh) J. Feldmann (Mi, DL).
[32]Ardré (1970). Collected in Vila Praia de Âncora in 1999.
[33]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003 and in Beira Litoral at Buarcos in 2003.
[34]Cremades et al. (1999), Bárbara et al. (2003, 2006b), Díaz-Tapia and Bárbara (2005).
[35]Cremades et al. (2002). New record for Douro Litoral, collected in Cabo Mundo in 2004.
[36]Araújo et al. (2003). New record for Beira Litoral, collected in Buarcos in 2003.
[37]New record for Beira Litoral, collected in Buarcos in 2003.
[38]Ardré (1970), Araújo et al. (2003), Bárbara et al. (2006b).
[39]New record for Douro Litoral, collected in Leça da Palmeira in 1997.
[40]Araújo et al. (2003) and Bárbara and Cremades (2004).
[41]New record for northern Portugal, collected in Minho at Amorosa in 2003.
[42]New record for Douro Litoral, collected in Angeiras in 2004 and for Beira Litoral, collected in Buarcos in 2004.
[43]Ardré (1961, 1970).
[44]Cremades et al. (2002). New record for Douro Litoral, collected in Vila Chã in 2004.
[45]Ginsburg-Ardré (1966).
[46]Lemoine (1963) and Ardré (1970).
[47]New record for Beira Litoral, collected in Ria de Aveiro in 1997 and Barra de Aveiro in 2007.
[48]López-Rodríguez et al. (2003).
[49]Cremades et al. (2002).
[50]New record for Minho, collected in Vila Praia de Âncora in 2003, Montedor in 2002 and Viana do Castelo in 2003.
[51]New record for Portugal, collected for Minho in Vila Praia de Âncora in 2003 and Viana do Castelo in 2004.
[52]Includes *Chondracanthus teedei* var. *lusitanicus* (Mesquita Rodrigues) Bárbara *et* Cremades (Mi, DL, BL).
[53]Cremades et al. (2002), Araújo et al. (2003) and Díaz-Tapia and Bárbara (2005).
[54]Cremades et al. (2002) and Bárbara et al. (2006b).
[55]New record for northern Portugal, collected in Minho at Viana do Castelo in 2003.
[56]Ardré (1970). New record for Douro Litoral, collected in Mindelo in 2005.
[57]Cremades et al. (2007).
[58]Hauck (1889), Cremades et al. (2002) and Bárbara et al. (2006b).
[59]Cremades et al. (2002) and Araújo et al. (2003). New record for Douro Litoral, collected in Vila do Conde in 2004, Angeiras in 2004, Cabo do Mundo in 2003, Leça da Palmeira in 2004, Valadares in 2004, Miramar in 2005 and Aguda in 2004 and for Beira Litoral, collected in Buarcos in 2004.
[60]Bárbara et al. (2006b).
[61]Hauck (1889). New record for Minho, collected in Viana do Castelo in 2003.
[62]Cremades et al. (2002), Araújo et al. (2003) and Bárbara et al. (2006b). New record for Beira Litoral, collected in Buarcos in 2003.
[63]Hauck (1889) and Ardré (1970). New record for Beira Litoral, collected in Buarcos in 2003.
[64]Henriques (1881), Hauck (1889), and Ardré (1970).
[65]Cremades et al. (2002), Araújo et al. (2003), and Bárbara et al. (2006b).
[66]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003, in Douro Litoral at Vila Chã in 2006 and Aguda in 2004 and in Beira Litoral at Buarcos in 2003.
[67]New record for Portugal, collected in Douro Litoral at Aguda in 2006.
[68]New record for Portugal, collected in Beira Litoral at Buarcos in 2003.
[69]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003, Montedor in 2003, Viana do Castelo in 2003 and Apulia in 2002 and in Douro Litoral at Quião in 2004, Vila Chã in 2006, Angeiras in 2004, Foz do Douro in 2004 and Aguda in 2004.
[70]New record for Portugal, collected in Douro Litoral at Póvoa de Varzim in 2007 and in Beira Litoral at Barra de Aveiro in 2007.
[71]New record for Douro Litoral, collected in Aguçadoura in 1997, Vila Chã in 2006, Angeiras in 2004, S. Félix da Marinha in 2005 and Aguda in 2004.
[72]New record for northern Portugal, collected in Beira Litoral at Buarcos in 2003.
[73]New record for Douro Litoral, collected in Quião in 2004, Vila do Conde in 2006, Mindelo in 2004, Vila Chã in 2006, Angeiras in 2004 and Aguda in 2006.
[74]New record for Beira Litoral, collected in Buarcos in 2004.
[75]New record for Beira Litoral, collected in Buarcos in 2003.
[76]New record for northern Portugal, collected in Minho at Viana do Castelo in 2003.
[77]New record for northern Portugal, collected in Beira Litoral at Buarcos in 2006.
[78]New record for northern Portugal, collected in Minho at Viana do Castelo in 2004.
[79]Cho et al. (2008) proposed *Gayliella* as gen. nov. including *Ceramium flaccidum* as synonymous of *Gayliella flaccida*. New record for Douro Litoral, collected in Vila do Conde in 2004, Vila Chã in 2006, Angeiras in 2004, Valadares in 2004, Miramar in 2005 and Aguda in 2004 and for Beira Litoral, collected in Barra de Aveiro in 2007 and Buarcos in 2003.
[80]New record for northern Portugal, collected in Beira Litoral at Buarcos in 2003.
[81]New record for northern Portugal, collected in Minho at Viana do Castelo in 2003.
[82]New record for northern Portugal, collected in Douro Litoral at Aguda in 2004.
[83]Henriques (1881) and Bárbara et al. (2006b). New record for Minho, collected in Vila Praia de Âncora in 2003.

(Table 1 *continued*)

[84]New record for Beira Litoral, collected in Buarcos in 2003.
[85]Araújo et al. (2003) and Bárbara et al. (2006b). New record for Douro Litoral, collected in Póvoa de Varzim in 2007.
[86]Díaz-Tapia and Bárbara (2005) and Bárbara et al. (2006a).
[87]Díaz-Tapia and Bárbara (2005), Bárbara et al. (2006b). New record for Minho, collected in Vila Praia de Âncora in 2003, Viana do Castelo in 2003 and Cepães in 2003.
[88]Hauck (1889) and Ardré (1970).
[89]Cremades et al. (2002). New record for Beira Litoral, collected in Barra de Aveiro in 2007.
[90]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003 and in Beira Litoral at Buarcos in 2003.
[91]New record for Portugal, collected in Beira Litoral at Ria de Aveiro in 2006 and Barra de Aveiro in 2007. Reported as new alien species for the European Atlantic coast by Peña and Bárbara (2006).
[92]New record for Beira Litoral, collected in Buarcos in 2003.
[93]Araújo et al. (2003) and Bárbara et al. (2006b).
[94]Ardré (1970), Araújo et al. (2003), Díaz-Tapia and Bárbara (2005) and Bárbara et al. (2006a).
[95]Hauck (1889) and Araújo et al. (2003).
[96]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003.
[97]New record for Beira Litoral, collected in Buarcos in 2003.
[98]Hauck (1889).
[99]New record for northern Portugal, collected in Douro Litoral at Quião in 2004.
[100]Henriques (1881), De Toni (1888), Hauck (1889), and Ardré (1970).
[101]New record for Portugal, collected in Minho at Vila Praia de Âncora in 2003 and Viana do Castelo in 2003, in Douro Litoral at Póvoa de Varzim in 2007 and Foz do Douro in 2007 and in Beira Litoral at Barra de Aveiro in 2007.
[102]Henriques (1881) and Ardré (1970).
[103]Cremades et al. (2002) and Araújo et al. (2003). New record for Beira Litoral, collected in Buarcos in 2003.
[104]New record for Beira Litoral, collected in Buarcos in 2003.
[105]New record for Beira Litoral, collected in Barra de Aveiro in 2005 and Buarcos in 2000.
[106]Henriques (1881), De Toni (1888), Hauck (1889), Ardré (1970), and Cremades et al. (2002).
[107]New record for Douro Litoral, collected in Aguçadoura in 1997, Quião in 2004 and Valadares in 2004 and in Beira litoral at Buarcos in 2003.
[108]Henriques (1881). Brodie et al. (2007) propose the use of *Rhizoclonium riparium* for all species in this complex. However, we have used the separate species to avoid the loss of information in the flora of the north of Portugal.
[109]Henriques (1881), Ardré (1970), and Araújo et al. (2003).
[110]New record for Douro Litoral, collected in Aguçadoura in 1997, Vila Chã in 2006, Angeiras in 2004 and Aguda in 2004 and for Beira Litoral, collected in Buarcos in 2003.
[111]Araújo et al. (2003), Díaz-Tapia and Bárbara (2005), and Bárbara et al. (2006b).
[112]Cremades et al. (2002) and Araújo et al. (2003). New record for Beira Litoral, collected in Buarcos in 2003 and Barra de Aveiro in 2007.
[113]New record for Douro Litoral, collected in Aguçadoura in 1997, Mindelo in 2004, Vila Chã in 2007, Leça da Palmeira in 2004, Valadares in 2004, Miramar in 2005, Aguda in 2004 and Espinho in 1997.
[114]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003, Montedor in 2003 and Viana do Castelo in 2003.
[115]New record for Beira Litoral, collected in Buarcos in 2003.
[116]Bárbara et al. (2003, 2006b).
[117]New record for Portugal, collected in Minho at Cepães in 2004, in Douro Litoral at Leça da Palmeira in 2004 and in Beira Litoral at Buarcos in 2004.
[118]New record for Portugal, collected in Cávado's saltmarsh in 2007.
[119]New record for Portugal, collected in Esposende in 2007 and Ria de Aveiro in 2007.
[120]Ardré (1970). New record for Beira Litoral, collected in Buarcos in 2003.
[121]New record for northern Portugal, collected in Minho at Viana do Castelo in 2003.
[122]New record for Portugal, collected for Minho in Viana do Castelo in 2004.
[123]Ardré (1970), Bárbara et al. (2006b), Lima et al. 2007.
[124]New record for Portugal, collected in Minho at Vila Praia de Âncora in 2003, Montedor in 2003, Viana do Castelo in 1999, in Douro Litoral at Vila Chã in 2006 and Aguda in 2004 and in Beira Litoral at Buarcos in 2003.
[125]New record for Minho, collected in Montedor in 2003 and Cepães in 2007.
[126]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003.
[127]New record for northern Portugal, collected in Minho at Vila Chã in 2006 and in Beira Litoral at Buarcos in 2003.
[128]New record for northern Portugal, collected in Minho at Montedor in 2003 and Viana do Castelo in 2003, in Douro Litoral at Vila do Conde in 2004 and in Beira Litoral at Buarcos in 2003.
[129]Hauck (1889). New record for Minho, collected in Lima's saltmarsh in 2005 and Cávado's saltmarsh in 2007.
[130]Bárbara et al. (2006b). New record for Douro Litoral, collected in Vila do Conde in 2004.
[131]New record for Douro Litoral, collected in Vila do Conde in 2006, Cabo do Mundo in 2005, Leça de Palmeira in 2005 and Foz do Douro in 2005.
[132]Ardré (1970) and Araújo et al. (2003).
[133]Lima et al. (2007). New record for Douro Litoral collected in Mindelo in 2004 and Vila Chã in 2007 and in Beira Litoral at Buarcos in 2005.
[134]New record for northern Portugal, collected in Minho at Amorosa in 2003.
[135]Ardré (1970). New record for Douro Litoral, collected in Vila do Conde in 2004 and Cabo do Mundo in 2004.
[136]Ardré (1970) and recently collected in Montedor in 2003.
[137]Cremades et al. (2002). New record for Minho, collected in Vila Praia de Âncora in 2003 and for Douro Litoral, collected in Aguçadoura in 1997, Mindelo in 2004 and Foz do Douro in 2007.
[138]New record for northern Portugal, collected in Beira Litoral at Barra de Aveiro in 2007.
[139]The new order Ralfsiales is validated by Lim et al. (2007).

(Table 1 *continued*)

[140]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2002.
[141]New record for Portugal, collected in Douro Litoral at Póvoa de Varzim in 2007 and in Beira Litoral at Barra de Aveiro in 2007.
[142]New record for Portugal, collected in Minho at Vila Praia de Âncora in 2003. Ardré (1970) reported this species for Leça de Palmeira, as drift plants.
[143]Ardré (1961) and Bárbara et al. (2006b). New record for Douro Litoral, collected in Valadares in 2004.
[144]Ginsburg-Ardré (1966). New record for Douro Litoral, collected in Póvoa de Varzim in 2007.
[145]Includes *Fucus spiralis* var. *platycarpus* Batters (Mi, DL).
[146]Includes *Fucus vesiculosus* var. *compressus* Kjellman (Mi, BL).
[147]Ardré (1970) and Cremades et al. (2002).
[148]New record for northern Portugal, collected in Douro Litoral at Vila Chã in 2007 and Foz do Douro in 2004.
[149]Includes *Ulva flexuosa* subsp. *paradoxa* (C. Agardh) M.J. Wynne reported by Ardré (1970) for Beira Litoral.
[150]Ardré (1970). New record for Minho, collected in Vila Praia de Âncora in 2003 and Montedor in 2003.
[151]Araújo et al. (2003). New record for Douro Litoral, collected in Mindelo in 2003, Cabo do Mundo in 2004 and Aguda in 2004 and in Beira Litoral at Buarcos in 2004.
[152]Lami (1967).
[153]Includes *Ulva rigida* var. *fimbriata* (Welwitsch) J. Agardh (Mi, DL).
[154]New record for Portugal, collected in Minho at Vila Praia de Âncora in 2003, Viana do Castelo in 2003 and S. Bartolomeu do Mar in 2003.
[155]New record for Portugal, collected in Minho at Montedor in 2003 and in Beira Litoral at Buarcos in 2003.
[156]New record for Minho, collected in Vila Praia de Âncora in 2003, Forte Cão in 2003 and Viana do Castelo in 2003.
[157]New record for Douro Litoral, collected in Mindelo in 2004.
[158]Araújo et al. (2003) and Bárbara et al. (2006b). New record for Douro Litoral, collected in Vila do Conde in 2004, Mindelo in 2004, Cabo do Mundo in 2003, Leça de Palmeira in 2004, Foz do Douro in 2004 and Aguda in 2004 and for Beira Litoral, collected in Buarcos in 2004.
[159]Hauck (1889), Araújo et al. (2003), and Bárbara et al. (2006b). New record for Beira Litoral, collected in Buarcos in 2003.
[160]Ardré (1970) and Bárbara et al. (2006b). New record for Beira Litoral, collected in Buarcos in 2003.
[161]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003 and Montedor in 2003 and in Douro Litoral at Cabo do Mundo in 2003.
[162]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003 and Montedor in 2003 and in Beira Litoral at Buarcos in 2003.
[163]New record for northern Portugal, collected in Minho at Montedor in 2003 and Cepães in 2007.
[164]New record for Beira Litoral, collected in Ria de Aveiro in 2007.
[165]Araújo et al. (2003). New record for Douro Litoral, collected in Quião in 2004 and Vila Chã in 2005 and for Beira Litoral, collected in Buarcos in 2004.
[166]Ardré (1970) and recently collected in Esposende in 2007.
[167]New record for northern Portugal, collected in Minho at Vila Praia de Âncora in 2003 and Viana do Castelo in 2003 and in Beira Litoral at Buarcos in 2003.
[168]Henriques (1881). New record for Douro Litoral, collected in Vila Chã in 2007.
[169]New record for Douro Litoral, collected in Cabo do Mundo in 2003.
[170]Includes *Codium tomentosum* var. *mucronatum* (G. Hamel) Ardré (Mi, DL, BL).
[171]New record for northern Portugal, collected in Douro Litoral at Leça de Palmeira in 2004 and in Beira Litoral at Buarcos in 2003.
[172]New record for northern Portugal, collected in Douro Litoral at Aguda in 2004 and in Beira Litoral at Buarcos in 2003.
[173]Hauck (1889) and Ardré (1961, 1970).
[174]New record for Portugal, collected in Minho at Viana do Castelo in 2005.

Ochrophyta; Cheney 1977) ratios were calculated to indicate the relative biogeographic position of the flora.

Shifts in the distribution range of native species and aliens were determined by comparison with previous literature and herbarium records.

Results

The checklist presented in this work includes 346 species: 26 Cyanobacteria, 200 Rhodophyta, 70 Ochrophyta, and 50 Chlorophyta (Table 1). Of these, 21 are new records for the continental Portuguese coast: *Lyngbya aestuarii*, *Lyngbya semiplena*, *Microcoleus acutirostris*, *Myxosarcina gloeocapsoides*, *Aiolocolax pulchella*, *Antithamnion densum*, *Antithamnion villosum*, *Antithamnionella spirographidis*, *Dasya sessilis*, *Furcellaria lumbricalis*, *Neosiphonia harveyi*, *Porphyrostromium boryanum*, *Chorda filum*, *Dictyopteris ambigua*, *Sphacelaria rigidula*, *Undaria pinnatifida*, *Vaucheria coronata*, *Vaucheria velutina*, *Ulothrix implexa*, *Ulva scandinavica*, and *Umbraulva olivascens* (Table 1) and 33 are new records for the north of Portugal: *Microcoleus chthonoplastes*, *Stylonema alsidii*, *Sahlingia subintegra*, *Parviphycus tenuissimus*, *Callocolax neglectus*, *Stenogramme interrupta*, *Antithamnion cruciatum*, *Antithamnionella ternifolia*, *Callithamnion corymbosum*, *Compsothamnion decompositum*, *Compsothamnion thuyoides*, *Crouania attenuata*, *Griffithsia schousboei*, *Halurus flosculosus*, *Monosporus pedicellatus*, *Dasya ocellata*, *Aphanocladia stichidiosa*, *Ctenosiphonia hypnoides*, *Pterosiphonia parasitica*, *Sphacelaria fusca*, *Feldmannia irregularis*, *Hincksia mitchelliae*, *Hincksia sandriana*, *Leathesia difformis*, *Litosiphon laminariae*, *Scytosiphon lomentaria*, *Cutleria adspersa*, *Ulva bifrons*, *Cladophora lehmanniana*, *Cladophora pellucida*, *Cladophora sericea*, *Bryopsis duplex*, *Derbesia marina*, and *Derbesia tenuissima* (Table 1). Furthermore, 78 species are new regional records: 10 were found for the first time in the Minho region, 29 in the Douro Litoral region and 37 in Beira Litoral (Table 1).

This checklist contains nearly twice the number of records provided in the most complete study carried out

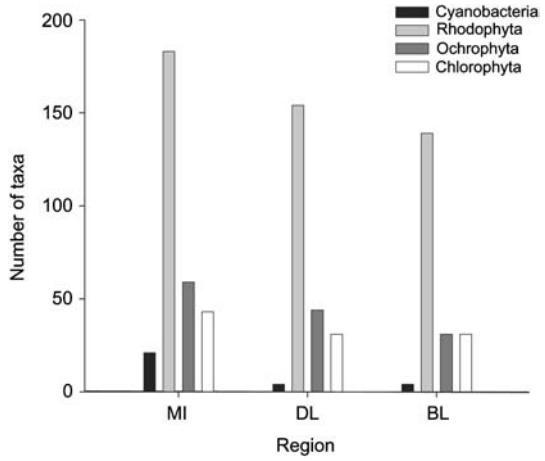

Figure 2 Number of species from each phylum by region of northern Portugal.
MI, Minho; DL, Douro Litoral; BL, Beira Litoral.

to date (Ardré 1970) for the northern coast of Portugal (26 vs. 20 Cyanobacteria, 200 vs. 115 Rhodophyta, 70 vs. 41 Ochrophyta, and 50 vs. 22 Chlorophyta). The percentage increase in species richness was similar for all phyla, except for Cyanobacteria which still remains poorly studied.

The species richness of northern Portugal decreased southwards for all phyla (Figure 2). The Minho region contains the highest number of taxa (306 species; 21 Cyanobacteria, 183 Rhodophyta, 59 Ochrophyta, and 43 Chlorophyta) (Figure 2), with 90% of the total number of species found occurred in this region. Douro Litoral has an intermediate species richness (233 species; 4 Cyanobacteria, 154 Rhodophyta, 44 Ochrophyta, and 31 Chlorophyta) (Figure 2), with 73% of the total number of species of the northern coast present in this region. Beira Litoral has the lowest number of species (202 species; 4 Cyanobacteria, 136 Rhodophyta, 31 Ochrophyta, and 31 Chlorophyta) (Figure 2), with 64% of northern coast species present in this region. In total, 170 species were recorded in the three regions, while 63 were found exclusively in the Minho region, 14 in Douro Litoral and 8 in Beira Litoral.

The number of species found off the northern coast of Portugal is lower than in surrounding and nearby regions (Table 2). The Feldmann and Cheney ratios were intermediate between values for northern regions (Britain and Ireland, Atlantic coast of France and Galicia) and southern regions (Andalucia, Canary Islands and the Atlantic coast of Morocco) (Table 2). Northern-cold species were better represented than southern-warm species (Table 3). Several northern cold-water species reach their southern distribution limit off the northern Portuguese coast (Figure 3). Northern cold-water species include a large number of brown algae, mainly Fucales and Laminariales and epiphytic and/or parasitic northern cold-water species growing on these species and tracking their distribution. Some fucoids and kelps, which are common on the North Atlantic European coast, reach their southern distribution limits off the Portuguese coast: *Ascophyllum nodosum*, *Himanthalia elongata*, *Fucus serratus*, *Laminaria hyperborea*, *Saccharina latissima*, and *Pelvetia canaliculata*, as well as the red algae *Furcellaria lumbricalis*, *Delesseria sanguinea*, *Dilsea carnosa*, and *Palmaria palmata*. Distribution ranges of species, such as *Ascophyllum nodosum*, *Delesseria sanguinea*, *Desmarestia aculeata*, *Dilsea carnosa*, *Elachista scutulata*, *Fucus serratus*, and *Gloisiphonia capilaris* have retracted northwards (Figure 3). However, several northern-cold species maintained their earlier southern boundary limit (e.g., *Callocolax neglectus* and *Petalonia zosterifolia*) or moved southward (e.g., *Dumontia contorta* and *Saccharina latissima*), and some of them (e.g., *Choreocolax polysiphoniae*, *Furcellaria lumbricalis*, *Rhodomela confervoides*, and *Chorda filum*) have been recorded only recently off the northern coast of Portugal (Figure 3).

The number of alien species found amounts to 3% of the total recorded for this area. *Antithamnion densum, Antithamnionella spirographidis, Dasya sessilis, Neosiphonia harveyi*, and *Undaria pinnatifida* are new records for Portugal. *Antithamnionella ternifolia* was recorded for the first time in northern Portugal, and *Asparagopsis armata* is a new record for Beira Litoral (Table 1). The number of records of alien species in the northern coast has greatly increased during the last decade, and for some species, such as *Antithamnionella ternifolia, Sargassum muticum*, and *Grateloupia turuturu*, there has been an expansion of geographical range (Figure 4).

The checklist compiled includes 18 species of Lusitanian endemics, including 10 Rhodophyta, 5 Ochrophyta, and 3 Chlorophyta (Table 3). In particular, *Cordylecladia erecta*, *Drachiella spectabilis*, *Erythroglossum lusitanicum*, *Ptilothamnion sphaericum*, *Ulva rigida* var. *fimbriata*, and *Ulva bifrons* are not well represented in the rest of the Iberian Peninsula coasts, except in Galicia.

Discussion

The checklist compiled represents an advance in understanding of the northern Portuguese algal flora, providing several new records for this area and increasing knowledge on the occurrence and distribution of alien, northern-cold, and southern-warm species.

Table 2 Number of species in each phylum, Feldmann and Cheney ratios by geographical region.

	Britain and Ireland	Atlantic coast, France	Basque Coast	Galicia (NW Spain)	North Portugal	South Portugal	Andalucia (SW Spain)	Canary Islands	Atlantic Coast, Morocco
Rhodophyta	341	423	215	296	200	215	348	385	314
Ochrophyta	182	225	65	127	70	75	108	125	107
Chlorophyta	120	153	51	77	50	46	86	117	83
Feldmann ratio	1.87	1.88	3.31	2.33	2.86	2.87	3.22	3.08	2.93
Cheney ratio	2.53	2.56	4.09	2.94	3.57	3.48	4.02	4.02	3.71

Table 3 List of northern-cold species, southern-warm species, species of Lusitanic endemics and alien species recorded off the northern coast of Portugal.

Rhodophyta	Ochrophyta	Chlorophyta
Northern-cold species		
Aglaothamnium roseum	*Ascophyllum nodosum*	*Acrosiphonia arcta*
Aglaothamnion sepositum	*Chorda filum*	*Urospora penicilliformis*
Brongniartella byssoides	*Desmarestia aculeata*	
Callocolax neglectus	*Desmarestia ligulata*	
Ceramium shuttleworthianum	*Ectocarpus fasciculatus*	
Chondrus crispus	*Elachista flaccida*	
Choreocolax polysiphoniae	*Elachista fucicola*	
Cruoria pellita	*Elachista scutulata*	
Delesseria sanguinea	*Herponema velutinum*	
Dilsea carnosa	*Fucus ceranoides*	
Dumontia contorta	*Fucus serratus*	
Furcellaria lumbricalis	*Himanthalia elongata*	
Gloiosiphonia capillaris	*Laminaria hyperborea*	
Heterosiphonia plumosa	*Litosiphon laminariae*	
Lomentaria orcadensis	*Pelvetia canaliculata*	
Mastocarpus stellatus	*Petalonia zosterifolia*	
Palmaria palmata	*Pylaiella littoralis*	
Plumaria plumosa	*Saccharina latissima*	
Polysiphonia fucoides	*Spongonema tomentosum*	
Polysiphonia lanosa	*Vaucheria velutina*	
Polysiphonia nigra	*Vaucheria coronata*	
Polysiphonia stricta		
Porphyra linearis		
Porphyra purpurea		
Rhodocorton purpureum		
Rhodomela confervoides		
Rhodothamniella floridula		
Southern-warm species		
Aiolocolax pulchella	*Cutleria adspersa*	
Aphanocladia stichidiosa	*Halopteris filicina*	
Ctenosiphonia hypnoides	*Padina pavonia*	
Griffithsia schousboei		
Herposiphonia secunda		
Leptosiphonia schousboei		
Plenosporium flexuosum		
Plocamium raphelisianum		
Polysiphonia polyspora		
Polysiphonia scopulorum		
Streblocladia collabens		
Tiffaniella capitata		
Species of Lusitanic endemics		
Callithamnion tetricum	*Bifurcaria bifurcata*	*Codium tomentosum* var.
Drachiella spectabilis	*Cystoseira baccata*	*mucronatum*
Cordylecladia erecta	*Cystoseira nodicaulis*	*Ulva bifrons*
Erythroglossum lusitanicum	*Laminaria ochroleuca*	*Ulva rigida* var. *fimbriata*
Haraldiophyllum bonnemaisonii	*Phyllariopsis brevipes* ssp.	
Laurencia pyramidalis	*pseudopurpurascens*	
Osmundea osmunda		
Pterosiphonia complanata		
Ptilothamnion sphaericum		
Rhodymenia holmesii		
Alien species		
Anotrichium furcellatum	*Colpomenia peregrina*	
Antithamnionella spirographidis	*Sargassum muticum*	
Antithamnionella ternifolia	*Undaria pinnatifida*	
Antithamnion densum		
Asparagopsis armata and		
"Falkenbergia rufolanosa" [stage]		
Dasya sessilis		
Grateloupia turuturu		
Neosiphonia harveyi		

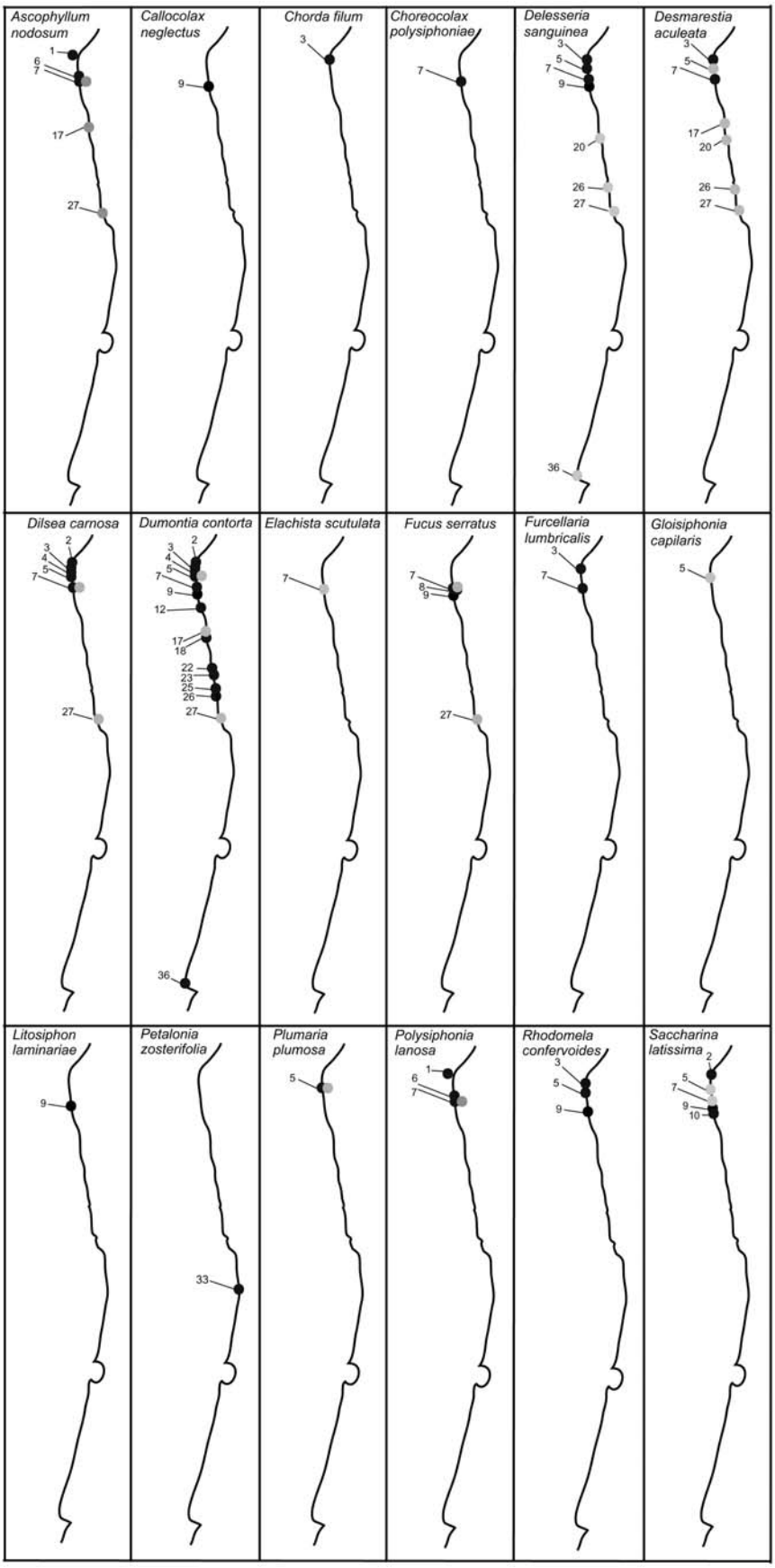

Figure 3 Geographical distribution of northern-cold water species whose southern distribution limits are presently in the north of Portugal.

Numbers indicate the localities where the species were recorded (for key to numbers, see legend to Figure 1). Gray circles refer to the species' geographical distribution known before 1970, and black circles refer to the geographical distribution recorded in the present work.

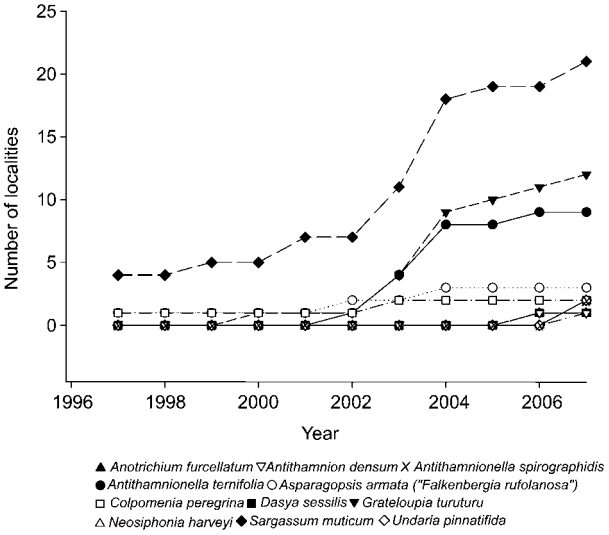

Figure 4 Number of localities on the northern Portuguese coast where each alien species was recorded between 1996 and 2006.

The increase in the number of species recorded is probably mainly related to the sampling effort. A larger sampling effort has been undertaken in recent years across many more localities than in previous works, with a consequent increase in the diversity of habitats surveyed. The majority of the species recorded for the first time off the Portuguese coast (with the exception of introduced species) are small, inconspicuous forms. Their presence may easily pass unnoticed unless a large-scale and spatially detailed sampling program is implemented. The appearance for the first time in some regions of medium and larger sized species, such as *Calliblepharis ciliata*, *Cystoseira humilis* var. *myriophylloides*, *Cystoseira nodicaulis*, *Dictyopteris ambigua*, *Dumontia contorta*, *Grateloupia dichotoma*, *Heterosiphonia plumosa*, *Osmundea osmunda*, *Porphyra dioica*, *Porphyra linearis*, *Rhodymenia holmesii*, and *Taonia atomaria*, demonstrates the incompleteness of previous floristic knowledge of this area. However, some newly recorded species, such as the aliens *Dasya sessilis*, *Neosiphonia harveyi*, and *Undaria pinnatifida*, have probably arrived only recently.

Despite the significant increase in phycological knowledge of northern Portugal, the number of species recorded for this region remains the lowest when compared with surrounding areas (e.g., Galicia, south of Portugal and Atlantic coast of France) (Ardré 1970, Flores Moya et al. 1995a,b, Conde et al. 1996, Benhissoune et al. 2001, 2002a,b, 2003, Haroun et al. 2002, Hardy and Guiry 2003, Gorostiaga et al. 2004, Bárbara et al. 2005). Latitudinal gradients of increasing species richness from polar to equatorial regions are well documented (Hawkins 2001). However, with few exceptions, studies of aquatic plants show that latitudinal gradient is not important in determining species richness (Willig et al. 2003). Some potential explanations for the low species richness found in northern Portugal are habitat characteristics and the scarcity of floristic studies. The coast is, in general, a homogeneous exposed shore with much lower habitat diversity than in other surrounding regions, such as the heterogeneous and indented coast of Galicia. Also, in spite of the large increase in the number of species found for this area in recent works, the lack of continued studies over the past years, especially in subtidal habitats, may be reflected in a deficient knowledge of diminutive, crustose, and/or subtidal taxa.

The ratios of Cheney (1977) and Feldmann (1937) confirm the biogeographic position of the northern Portuguese flora as intermediate between northern and southern surrounding regions. In general, ratio values are higher at lower latitudes, because the dominance of the Rhodophyta and Chlorophyta over Ochrophyta increases towards the equator (Feldmann 1937). Values of these indices in northern Portugal are lower than those of the Basque coast and higher than those in southern Portugal. High values found for the Basque coast can be explained by the meridional character of its flora (Gorostiaga et al. 2004). Here, the Bay of Biscay forms a thermal barrier that prevents survival of cold-adapted marine species in this area (Arrontes 1993). The low values of biogeographic indices recorded for southern Portugal are probably related to the scarcity of studies developed for this region.

The number of alien species recorded in northern Portugal has increased considerably during the last 10 years. Some of these species, such as *Grateloupia turuturu*, *Antithamnionella ternifolia*, and *Sargassum muticum*, have had range expansions since they were first recorded in this area. Others, such as *Dasya sessilis*, *Neosiphonia harveyi*, and *Undaria pinnatifida*, were found recently off the northern coast and probably are starting to colonize intertidal shores along the study area. This is of conservation importance because of the well-documented negative effects of introduced species, such as *Sargassum muticum* and *Undaria pinnatifida*, on the structure of native communities (Staehr et al. 2000, Casas et al. 2004). The effects of other species, such as *Grateloupia turuturu* and *Antithamnionella ternifolia* (which have large geographical ranges on the northern coast of Portugal), on native communities are not known. However, studies of *G. turuturu* demonstrate that this species is well adapted to a wide variation of environmental conditions and has high reproductive potential (multiplicity of recruitment strategies and extended reproductive period), which might be indicative of its potential invasive capability (Villalard-Bohnsack and Harlin 1997, Simon et al. 1999, 2001, Harlin and Villalard-Bohnsack 2001). These recent introductions to the Portuguese coast may be related to expansion of aquaculture activities over the last years, but may also be explained by short-distance dispersal of fertile blades from neighboring regions, such as the Galician coast where the number of introduced species is higher and longer established (Bárbara et al. 2005). Curiously, some non-native species that are common on the Galician coast, such as *Codium fragile* subsp. *fragile* (Suringar) Hariot (Pérez-Cirera et al. 1989, Bárbara et al. 2005), *Lomentaria hakodatensis* Yendo (Bárbara and Cremades 1996, Bárbara et al. 2005), *Heterosiphonia japonica* Yendo (Bárbara et al. 2003, 2005, Peña and Bárbara 2006), and *Ulva pertusa* Kjellman (Baamonde et al. 2007) were not found on the northern Portuguese coast.

In this work, distributional shifts were not consistent among northern-cold species. Only a minority of the species with southern distribution limits in the northern Portugal retracted their distributional ranges over a >30-year period. These results are in accordance with Lima et al. (2007), who studied the distributional shifts of conspicuous, large dimension, cold- and warm-water species on the Portuguese coast. Those authors concluded that, globally, cold-water species did not show a shifting trend. However, the study of Lima et al. (2007) did not consider diminutive, inconspicuous species that can behave differently. The same absence of distributional shifts of cold-water species was observed when examining the pool of species with distributional limits on the northern coast of Portugal. In fact, some of these species showed an extension of their geographical range southwards and 8 of the 19 northern-cold species considered were reported recently for the first time in this area (Cremades et al. 2002, Araújo et al. 2003, Bárbara et al. 2003, 2006b, López-Rodríguez et al. 2003, this work). Some species, such as *Acrosiphonia arcta* or *Rhodomela confervoides*, were found in several locations. Simultaneously, some southern-warm species, such as *Aphanocladia stichidiosa*, *Ctenosiphonia hypnoides*, *Griffithsia schousboei*, and *Cutleria adspersa*, showed an extension in distributional range northwards. Sea temperature has increased over recent years off the Portuguese coast (Lima et al. 2007) and several works suggest that recent climatic changes are affecting species distribution and abundance (Hughes 2000). One possible explanation for the results of this study is that the increase in sea temperature is affecting the distributions of some northern-cold and southern-warm species occurring on the northern Portuguese coast. However, many of the northern-cold species studied increased their known distributional range southwards. Also, some of the species studied showed an increase in distributional limits. This is perhaps not in agreement with a reaction of macroalgal distribution to environmental stress. Probably, the majority of the results of our work can be explained by the increase in the phycological knowledge of this region, which filled gaps in previous studies of species' distributions. Our results highlight the importance of developing long-term monitoring programs along the Portuguese coast, especially in the less surveyed subtidal habitats, to increase the phycological knowledge of this area. The most conclusive results for species' distributional shifts in relation to global warming have come from long-term studies where extensive monitoring has been developed (Hughes 2000, Hawkins et al. 2003). This work will be the basis for future global biogeographic comparative studies and for reaching clear conclusions about distributional shifts caused by global warming.

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Appendix

Taxa excludenda

Rhodophyta

Phycodrys rubens (Linnaeus) Batters reported by Ardré (1970) as drift plants probably corresponds to degradated specimens of *Delesseria sanguinea* (see Bárbara et al. 2005).

Chlorophyta

Cladophora fracta (Fl. Dan.) Kützing (BL) reported by Hauck (1889) is a freshwater species that was not recently collected.

Taxa inquirenda

Cyanobacteria

Radaisia gomontiana Sauvageau (Mi) reported by Ginsburg-Ardré (1966) requires confirmation.

Rhodophyta

Ceramium arborescens J. Agardh (BL) reported by Póvoa dos Reis (1981b) requires confirmation.

Compsopogon lusitanicus Reis (BL) reported by Póvoa dos Reis (1977) requires confirmation owing to its resemblance to *Compsopogon caeruleus* (Balbis *ex* C. Agardh) Montagne.

Gigartina falcata Kützing (DL) reported by Hauck (1889) requires confirmation owing to its resemblance to *Chondracanthus acicularis*.

Gracilaria vieirae Reis (BL) reported by Póvoa dos Reis (1977) requires confirmation owing to its resemblance to *Gracilaria vermiculophylla* (Ohmi) Papenfuss, an alien species found in Galicia (Bárbara et al. 2005).

Grateloupia cosentinii Kützing (DL) reported by Hauck (1889) requires confirmation.

Halopithys incurva (Hudson) Batters (DL) reported by Ardré (1970) requires confirmation because it was not reported in Galicia (see Bárbara et al. 2005).

Phyllophora membranifolia (Goodenough *et* Woodward) J. Agardh (Mi, DL) reported by Henriques (1881) and Colmeiro (1889) requires confirmation.

Phymatolithon calcareum (Pallas) Adey *et* D.L. McKibbin (DL) reported by Hauck (1889) as *Lithothamnion polymorphum* (Linnaeus) Areschoug requires confirmation.

Polysiphonia fernandesiana Reis (BL) reported by Póvoa dos Reis (1977) requires confirmation owing to its resemblance with other species of *Polysiphonia*.

Polysiphonia sertularioides (Grateloup) J. Agardh (DL) reported by Hauck (1889) requires confirmation.

Polysiphonia havanensis Montagne (BL) reported by Póvoa dos Reis (1981b) requires confirmation.

Spyridia filamentosa (Wulfen) Harvey (BL) reported by Póvoa dos Reis (1977) requires confirmation due to its resemblance to *Spyridia griffithsiana* (J.E. Smith) Zuccarello, Prud'homme van Reine *et* Stegenga.

Wurdemannia miniata (Sprengel) Feldmann *et* G. Hamel (DL) reported by Hauck (1889) as *Gelidium miniatum* Kützing requires confirmation.

Chlorophyta

Enteromorpha juergensii Kützing reported by Hauck (1889) requires confirmation.

Monostroma quaternarium (Kützing) Desmazières (DL) reported by Hauck (1889) requires confirmation.

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