Cryptogamie, Algologie, 2014, 35 (2): 117-156

An updated classification of brown algae (Ochrophyta, Phaeophyceae)

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Abstract – About three-hundred genera are currently recognized in the brown algae (SAR lineage, sub-regnum Stramenopiles or Heterokonta, divisio Ochrophyta, class Phaeophyceae). Since the first morphology-based pre-cladistic classifications, the advent of the concepts and methods of molecular phylogenies has resulted in countless new insights within the field of brown algal supra-generic systematics. Unfortunately, subsequent taxonomic changes have not always been performed; and after over twenty years of brown algal molecular systematics, it has become difficult to assign a given genus to its correct family and order. The aim of this review article is to update the generic and suprageneric classification of the Phaeophyceae, by taking into account the latest insights produced in the field of brown algal molecular systematics, in order to provide a clarified taxonomic framework whose uncertainties would result only either from absence of molecular data or phylogenetic irresolution rather than taxonomic vagueness due to misinterpretation of morphological characters.

Brown algae / Discosporangiophycidae subclass. nov. / Dictyotophycidae subclass. nov. / Fucophycidae subclass. nov. / Ishigeophycidae subclass. nov. / Petrodermataceae fam. nov. / Phaeosiphoniellales ord. nov. / phylogenetic classification / Splachnidiaceae / systematics / taxonomy

Résumé – **Mise à jour de la classification des algues brunes (Ochrophyta, Phaeophyceae).** Environ trois cents genres d'algues brunes (Lignée SAR, sous-règne Stramenopiles ou Heterokonta, embranchement Ochrophyta, classe Phaeophyceae) sont actuellement recensés. Depuis les premières classifications phénétiques basées sur les caractères morphologiques, l'avènement des concepts et méthodes des phylogénies moléculaires a résulté en d'innombrables apports dans le domaine de leur classification supragénérique. Malheureusement, les modifications taxinomiques subséquentes n'ont pas toujours été effectuées et après presque vingt ans de travaux visant à améliorer cette classification, il est parfois devenu difficile d'assigner correctement un genre à une famille et un ordre. L'objectif de cet article de synthèse est de mettre à jour la classification générique et supragénérique des Phaeophyceae, prenant en compte les résultats systématiques les plus récents, afin de mettre à disposition un cadre taxinomique clair dont les quelques incertitudes restantes résultent d'une absence de données moléculaires ou d'un manque de résolution phylogénétique plutôt que d'une position taxinomique incertaine liée à l'interprétation erronée de caractères morphologiques.

Algues brunes / classification phylogénétique / Discosporangiophycidae subclass. nov. / Dictyotophycidae subclass. nov. / Fucophycidae subclass. nov. / Ishigeophycidae subclass. nov. / Petrodermataceae fam. nov. / Phaeosiphoniellales ord. nov. / Splachnidiaceae / systématique / taxinomie

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doi/10.7872/crya.v35.iss2.2014.117

INTRODUCTION

The systematics of brown algae (Heterokonta, Ochrophyta, Phaeophyceae) has had a complex history. The first evolutionary classifications of brown algae (Kylin, 1933; Papenfuss, 1951a, 1951b; Scagel, 1966; Wynne & Loiseaux, 1976) reflected the gradualist views of their authors and resulted from the analysis of a small number of morpho-anatomical and reproductive features, such as the mode of growth, the thallus architecture, and the types of gamy and life history (Reviers & Rousseau, 1999). The advent of molecular systematics, however, brought new insights that thoroughly reshaped the evolutionary concepts of brown algae. The reviews of Reviers & Rousseau (1999) and Reviers *et al*. (2007) have provided detailed syntheses of the evolution of classificatory concepts within brown algae. The recent molecular works by Phillips *et al*. (2008) and Silberfeld *et al*. (2010, 2011) have resulted in an improved knowledge of the phylogenetic relationships within the brown algae, and particularly within the so-called "brown algal crown radiation". Yet, one must also acknowledge that twenty years of molecular brown algal studies have failed to provide phycologists with a clear classification of the Phaeophyceae. Indeed, the accumulation of contradictory and surprising results due to high levels of morphological homoplasy in brown algae (Silberfeld *et al*., 2010) seems only to have occluded brown algal classification above the genus level. As a result, it has become more and more difficult to assign accurately a genus to its proper family and order. These difficulties have led us to propose an updated generic and supra-generic classification of the class Phaeophyceae that would summarize the latest breakthroughs in the field of brown algal molecular systematics (*e.g*. Phillips *et al*., 2008; Silberfeld *et al*., 2010 & 2011).

To support the phaeophycean classification and provide a comprehensive picture of the evolutionary history at the brown algal class level, a multi-marker phylogenetic tree was produced. Phylogenetic analyses were based on the dataset of Silberfeld *et al.* (2011) including seven markers (*cox*1, *nad*1, *cox*3, *rbc*L, *psa*A, *psb*A and *atp*B, for a total of 6804 nt) and 70 phaeophycean taxa. Moreover, in order to include representatives of all phaeophycean orders, additional taxa from Discosporangiales, Ishigeales, Onslowiales, Sphacelariales and Syringodermatales were thus selected from the Genbank database (http://www.ncbi.nlm.nih.gov/genbank/) and included in our data set. Although we favoured taxa represented by more than one sequenced marker, some key taxa were included although they were represented by *rbc*L sequences only (Table 1). Moreover, *Schizocladia*, belonging to Schizocladiophyceae, the sister class of Phaeophyceae (Kawai *et al.*, 2003; Yang *et al.*, 2012), was included as the outgroup. The resulting dataset comprised 91 taxa (Table 1). Bayesian inference was performed using MrBayes v. 3.2.2 (Ronquist *et al.*, 2012) provided by Cipres portal (Miller *et al.*, 2010) with the same parameters as in Silberfeld *et al.* (2011).

FORMAT OF THE CHECKLIST

In the following checklist 18 names of orders (one being newly described in this study) and 54 names of families are listed as valid. Ordinal and familial names are provided with the authorities who described them along with the year of publication for those taxa. Authors for ordinal names follow Silva & Reviers (2000).

Table 1. Taxonomical list of the 91 taxa included in the phylogenetic tree, with indication of the systematic position and Genbank accession numbers for sequences of the seven markers included in our data set. Missing sequences are indicated by a dash.

Taxa	*GenbankID*						
	*cox*1	*cox*3	*nad*1	*rbc*L	*psa*A	*psb*A	*atp*B
Subclass Discosporangiophycidae							
Discosporangiales							
Discosporangiaceae							
Discosporangium mesarthrocarpum (Meneghini) Hauck	–	–	–	AB252654	–	–	–
Choristocarpaceae							
Choristocarpus tenellus Zanardini	–	–	–	AJ287862	HQ710674	HQ710729	–
Subclass Ishigeophycidae							
Ishigeales							
Ishigeaceae							
Ishige foliacea Okamura	–	FJ427588	–	FJ427693	–	–	–
Ishige okamurae Yendo	EU579869	FJ427578	–	AY372975	AY372945	AY528830	–
Ishige sinicola (Setchell *et* N.L. Gardner) Chihara	–	FJ427624	–	AY372947	AY528832	AY528832	–
Petrodermataceae							
Petroderma maculiforme (Wollny) Kuckuck	–	–	–	EU579934	KJ175246	KJ175248	–
***Incertae sedis* at familial rank**							
*Diplura sp.*Hollenberg	–	–	–	AB250087	–	–	–
Subclass Dictyotophycidae							
Dictyotales							
Dictyotaceae							
Dictyopteris polypodioides (de Candolle) J.V. Lamouroux	EU681404	EU681445	–	DQ472042	EU579899	EU681639	EU681681
Dictyota dichotoma (Hudson) J.V. Lamouroux	AY500368	AY500368	AY500368	DQ472051	AY422578	AY748321	X66939
Padina pavonica (Linnaeus) Thivy	–	EU681454	EU681498	EU579961	EU579919	EU681649	EU681690
Onslowiales							
Onslowiaceae							
Onslowia endophytica Searles	EU579870	–	–	AJ287864	EU579892	–	–
Sphacelariales							
Sphacelariaceae							
Phaeostrophion irregulare Setchell *et* N.L. Gardner	–	–	–	AB117948	–	–	–
Sphacelariaceae							
Cladostephus spongiosus (Hudson) C. Agardh	EU681396	–	–	AJ287863	EU579889	–	EU681672
Sphacelaria divaricata Montagne	–	–	–	AY372985	AY372970	AY528855	–
Stypocaulaceae							
Halopteris filicina (Grateloup) Kützing	KJ175241	KJ175242	–	AJ287894	KJ175245	AY528854	KJ175249

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Taxa	*GenbankID*						
	*cox*1	*cox*3	*nad*1	*rbc*L	*psa*A	*psb*A	*atp*B
***Incertae sedis* at familial rank**							
Bodanella lauterborni Zimmermann	–	KJ175243	–	KJ175244	KJ175247	–	KJ175250
Syringodermatales							
Syringodermataceae							
Syringoderma phinneyi E.C. Henry *et* D.G. Müller	EU681429	EU681467	EU681512	AJ287868	AY528862	AY528858	–
Subclass Fucophycidae							
Ascoseirales							
Ascoseiraceae							
Ascoseira mirabilis Skottsberg	EU681391	–	EU681474	EF990237	EU681604	EU681627	EU681667
Asterocladales							
Asterocladaceae							
Asterocladon interjectum Uwai, Nagasato, Motomura *et* Kogame	–	–	–	AB102866	–	–	–
Asterocladon lobatum D.G. Müller, E.R. Parodi *et* A.F. Peters	–	–	–	AJ295824	–	–	–
Desmarestiales							
Desmarestiaceae							
Desmarestia ligulata (Lightfoot) J.V.Lamouroux	EU681403	EU681444	EU681487	AJ287848	EU681610	EU681637	EU681679
Desmarestia menziesii J. Agardh	GQ368260	GQ368276	GQ368290	GQ368318	GQ368333	GQ368347	GQ368359
Desmarestia viridis (O.F. Müller) J.V. Lamouroux	AY500367	AY500367	AY500367	AJ287849	EU681611	EU681638	EU681680
Himantothallus grandifolius (A. *et* E. Gepp) Zinova	GQ368262	GQ368278	GQ368292	GQ368320	GQ368335	GQ368349	GQ368361
Ectocarpales							
Acinetosporaceae							
Hincksia granulosa (J.E. Smith) P.C. Silva	EU681410	EU681451	EU681493	EU681596	EU681614	EU681645	EU681687
Pylaiella littoralis (Linnaeus) Kjellman	AJ277126	AJ277126	AJ277126	X55372	AY119724	AY119760	EU681695
Adenocystaceae							
Adenocystis utricularis (Bory) Skottsberg	–	JF796551	–	JF796580	JF796594	AY528824	–
Chordariopsis capensis (C. Agardh) Kylin	JF796537	–	JF796564	JF796581	JF796597	–	–
Utriculidium durvillei Skottsberg	JF796550	JF796561	–	JF796593	JF796611	JF796625	JF796640
Chordariaceae							
Asperococcus bullosus J.V. Lamouroux	EU681392	EU681434	EU681475	EU681590	EU681605	EU681628	EU681668
Chordaria flagelliformis (O.F. Müller) C. Agardh	JF796536	JF796553	JF796563	AF207798	JF796596	JF796612	–
Corynophlaea crispa (Harvey) Kuckuck	JF796538	–	JF796565	JF796582	JF796598	JF796613	JF796628
Dictyosiphon foeniculaceus (Hudson) Greville	JF796539	JF796554	JF796566	AF055397	JF796599	JF796614	JF796629
Elachista flaccida (Dillwyn) Areschoug	JF796541	JF796556	JF796568	JF796583	JF796601	JF796615	JF796631

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Taxa	*GenbankID*						
	*cox*1	*cox*3	*nad*1	*rbc*L	*psa*A	*psb*A	*atp*B
Elachista fucicola (Velley) Areschoug	EU681407	EU681448	EU681490	AF055398	EU681612	EU681641	EU681684
Elachista scutulata (Smith) Duby	JF796542	–	JF796569	JF796584	–	JF796616	JF796632
Herponema velutinum (Greville) J. Agardh	–	–	JF796570	JF796585	JF796602	JF796617	JF796633
Leathesia difformis (Linneaus) J.E. Areschoug	EU681412	EU681453	EU681495	AY996365	AY996371	EU681647	–
Litosiphon laminariae (Lyngbye) Harvey	–	–	JF796572	JF796586	JF796603	JF796618	–
Myriactula clandestina (Crouan *frat.*) J. Feldmann	–	–	JF796573	JF796587	JF796604	JF796619	JF796635
Myrionema papillosum Sauvageau	JF796544	–	JF796574	JF796588	JF796605	JF796620	JF796636
Myrionema strangulans Greville	JF796545	JF796558	JF796575	AF055407	–	JF796621	JF796637
Punctaria latifolia Greville	EU681418	EU681459	EU681504	AY095322	AY372948	EU681654	EU681694
Soranthera ulvoidea Postels *et* Ruprecht	FJ409217*	–	JF796576	JF796589	JF796606	–	–
Striaria attenuata (C. Agardh) Greville	JF796548	–	JF796578	AF055415	JF796609	JF796624	–
Ulonema rhizophorum Foslie	JF796549	–	JF796579	JF796592	JF796610	–	JF796639
Ectocarpaceae							
Ectocarpus siliculosus (Dillwyn) Lyngbye	EU681406	EU681447	EU681489	AY372978	AY372949	X56695	EU681683
Ectocarpus fasciculatus Harvey	JF796540	JF796555	JF796567	–	JF796600	–	JF796630
Kuckuckia sp.	JF796543	JF796557	JF796571	–	–	–	JF796634
Spongonema tomentosum (Hudson) Kützing	JF796546	JF796559	JF796577	JF796590	JF796607	JF796622	JF796638
Petrospongiaceae							
Petrospongium berkeleyi (Greville) Nägeli *ex* Kützing	EU681416	EU681457	EU681502	EU850275	EU850280	EU681652	EU681693
Petrospongium rugosum (Okamura) Setchell *et* N.L. Gardner	–	–	–	AY996364	AY996370	–	–
Scytosiphonaceae							
Chnoospora implexa J. Agardh	GQ368258	GQ368273	GQ368287	GQ368316	GQ368330	GQ368345	GQ368356
Colpomenia peregrina Sauvageau	EU681397	EU681439	EU681481	AB022235	DQ239776	EU681631	EU681673
Hydroclathrus clathratus (C. Agardh) M. Howe	GQ368263	–	–	GQ368321	GQ368336	GQ368350	GQ368362
Petalonia fascia (O.F. Müller) Kuntze	EU681415	EU681456	EU681501	AB022243	AY372953	EU681651	EU681692
Rosenvingea intricata (J. Agardh) Børgesen	GQ368265	GQ368280	GQ368294	GQ368323	GQ368338	GQ368352	GQ368364
Scytosiphon lomentaria (Lyngbye) Link	EU681424	EU681464	EU681509	AB022238	AY372954	EU681660	EU681701
Fucales							
Durvillaeaceae							
Durvillaea potatorum (Labillardière) Areschoug	EU681405	EU681446	EU681488	EF990242	DQ092453	EU681640	EU681682
Fucaceae							
Ascophyllum nodosum (Linnaeus) Le Jolis	EU681390	EU681433	EU681473	AJ287853	AY372959	EU681626	EU681666
Fucus vesiculosus Linnaeus	AY494079	AY494079	AY494079	DQ307680	AY372960	EU681642	DQ307681

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Taxa	*GenbankID*						
	*cox*1	*cox*3	*nad*1	*rbc*L	*psa*A	*psb*A	*atp*B
Himanthaliaceae							
Himanthalia elongata (Linnaeus) S.F. Gray	EU681409	EU681450	EU681492	EF990246	DQ092459	EU681644	EU681686
Sargassaceae							
Bifurcaria bifurcata R. Ross	EU681394	EU681436	EU681477	AY590500	DQ092448	EU681630	EU681670
Cystoseira tamariscifolia (Hudson) Papenfuss	EU681401	EU681443	EU681485	EU681594	EU681609	EU681635	EU681677
Sargassum muticum (Yendo) Fensholt	EU681423	EU681463	EU681508	AJ287854	DQ092463	EU681659	EU681700
Laminariales							
Akkesiphycaceae							
Akkesiphycus lubricum Yamada *et* Tanaka	AB775219	AB775236	–	AB775330	AB775267	AB775299	AB775251
Alariaceae							
Alaria esculenta (Linnaeus) Greville	EU681388	EU681431	EU681471	EU681587	EU681602	EU681624	EU681665
Undaria pinnatifida (Harvey) Suringar	GQ368267	GQ368282	GQ368296	GQ368325	GQ368340	GQ368354	GQ368366
Chordaceae							
Chorda filum (Linnaeus) Stackhouse	–	EU681438	EU681479	AY372983	AY372963	AY528848	EU681671
Costariaceae							
Agarum clathratum Dumortier	GQ368254	GQ368269	GQ368283	GQ368312	GQ368326	GQ368341	GQ368355
Laminariaceae							
Laminaria digitata (Hudson) J.V. Lamouroux	AJ344328	AJ344328	AJ344328	AY851559	AY372964	EU681646	EU681688
Lessoniaceae							
Ecklonia radiata (C. Agardh) J. Agardh	GQ368261	GQ368277	GQ368291	GQ368319	GQ368334	GQ368348	GQ368360
Pseudochordaceae							
Pseudochorda nagaii (Tokida) Inagaki	AF037992	AB775248	–	AB035789	AB775280	AB775312	AB775264
Nemodermatales							
Nemodermataceae							
Nemoderma tingitanum Shousboe *ex* Bornet	–	–	EU681496	EF990253*	DQ094835*	–	EU681689
Phaeosiphoniellales							
Phaeosiphoniellaceae							
Phaeosiphoniella cryophila R.G. Hooper, E.C. Henry *et* R. Kuhlenkamp	–	–	–	EF990254	–	–	–
Ralfsiales							
Ralfsiaceae							
Analipus japonicus (Harvey) M.J. Wynne	EU681389	EU681432	EU681472	–	AY372966*	EU681625	–
Ralfsia fungiformis (Gunnerus) Setchell *et N.L.* Gardner	EU681419	EU681460	–	EU579936	EU579885	EU681655	EU681696

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Taxa	*GenbankID*						
	*cox*1	*cox*3	*nad*1	*rbc*L	*psa*A	*psb*A	*atp*B
Scytothamnales							
Asteronemataceae							
Asteronema ferruginea (Harvey) Delépine *et* Asensi	JF796535	JF796552	JF796562	AJ295818	JF796595	–	JF796626
Bachelotiaceae							
Bachelotia antillarum (Grunow) Gerloff	EU681393	EU681435	EU681476	AF207797	EU579881	EU681629	EU681669
Splachnidiaceae							
Scytothamnus australis (J. Agardh) Hooker *et* Harvey	EU681425	–	–	AJ295833	AY372967	EU681661	EU681702
Stereocladon rugulosus (Bory de Saint-Vincent) Hariot	JF796547	JF796560	–	JF796591	JF796608	JF796623	–
Splachnidium rugosum (Linnaeus) Greville	EU681427	EU681465	–	AJ295834	AY372968	AY528853	EU681704
Sporochnales							
Sporochnaceae							
Bellotia eriophorum Harvey	GQ368255	GQ368270	GQ368284	GQ368313	GQ368327	GQ368342	–
Carpomitra costata (Stackhouse) Batters	–	EU681437	EU681478	EU681591	EU681606	–	JF796627
Sporochnus pedunculatus (Hudson) C. Agardh	EU681428	EU681466	EU681511	EU579937	EU681621	EU681663	EU681705
Tilopteridales							
Cutleriaceae							
Cutleria multifida (Turner) Greville	EU681398	EU681440	EU681482	AY157692	AY372955	EU681632	EU681674
Zanardinia typus (Nardo) P.C. Silva	–	EU681470	EU681514	EU681601	EU681623	EU681664	EU681708
Phyllariaceae							
Phyllariopsis brevipes (C. Agardh) Henry *et* South	GQ368264	GQ368279	GQ368293	GQ368322	GQ368337	GQ368351	GQ368363
Saccorhiza polyschides (Lightfoot) Batters	EU681422	EU681462	EU681507	AB045256	AY372965	EU681658	EU681699
Tilopteridaceae							
Tilopteris mertensii (Turner) Kützing	EU681430	EU681468	–	AB045260	EU681622	–	EU681706
Schizocladiophyceae (outgroup)							
Schizocladia ischiensis E.C. Henry, Okuda *et* H. Kawai	–	–	–	AB085615	AY528863	AY528859	–

The four subclasses are listed by order of divergence on the molecular topologies displayed in our tree. For each subclass, names of orders and families in each order are listed by alphabetical order (Fig. 1). The present checklist includes the 308 names of brown algal genera in use and validly published to date. All valid names of genera are provided with the authors who described them, and the year and page of the protologue. When necessary, synonyms are listed below the relevant valid genus name, with their authors and date of publication. Old generic names synonymized in De Toni's *Sylloge Algarum* (1895), as well as synonyms already listed in the *Index Nominum Genericorum* (Farr, 2014), were not quoted in the present list. The "References" section comprises all literature cited for names of genera (valid as well as synonyms), families and orders. In addition to the primary bibliographical sources, we also retrieved and compared information from online resources, such as *Index Nominum Algarum* (Silva, 2014), *Index Nominum Genericorum* (Farr, 2014) and *AlgaeBase* (Guiry & Guiry, 2014). Notes, further explanations and discussion points regarding the taxonomy of some genera, families and orders are provided as footnotes. The present work includes one new ordinal name (Phaeosiphoniellales *ord. nov. prop.*), an emended second ordinal name (Ishigeales), one new familial name (Petrodermataceae *fam. nov.*), three new subclass names (Discosporangiophycidae *subclass. nov. prop.*, Ishigeophycidae *subclass. nov. prop.*, Dictyotophycidae *subclass. nov. prop.*), and an emended fourth subclass name (Fucophycidae Cavalier-Smith). All these names are employed directly in the checklist, the taxonomic treatments with English diagnoses being gathered in a subsequent Section "Taxonomic treatments".

CLASSIFICATION OF THE PHAEOPHYCEAE

SUBCLASS DISCOSPORANGIOPHYCIDAE[1] Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Order Discosporangiales[2] O.C. Schmidt (1937) *emend.* H. Kawai, Hanyuda, Draisma *et* Müller (2007)

Family Choristocarpaceae Kjellman (1891a)
Choristocarpus Zanardini 1860: 45.

Family Discosporangiaceae[3] O.C. Schmidt (1937)
Discosporangium Falkenberg 1878: 60.

SUBCLASS ISHIGEOPHYCIDAE[4] Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Order Ishigeales[5] G.Y. Cho *et* S.M. Boo *in* Cho *et al.* (2004)

Family Ishigeaceae Okamura *in* Segawa (1935)
Ishige Yendo 1907: 154.

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1. See diagnosis in the "Taxonomic treatments" section (section IV).
2. Reinstatement of Discosporangiales and Discosporangiaceae, and inclusion of Choristocarpaceae in the order, were suggested but not taxonomically pursued in Kawai *et al.*, 2007.
3. See footnote 2.
4. See diagnosis in the "Taxonomic treatments" section (section IV).
5. See emended diagnosis in the "Taxonomic treatments" section (section IV).

Family Petrodermataceae[6] Silberfeld, F. Rousseau *et* Reviers, *fam. nov*.

Petroderma Kuckuck 1897: 382.

***Incertae sedis* at familial rank**

Diplura[7] Hollenberg 1969: 298.

SUBCLASS DICTYOTOPHYCIDAE[8] Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Order Dictyotales Bory de Saint-Vincent (1828)

Family Dictyotaceae[9] J.V. Lamouroux *ex* Dumortier (1822) [*incl.* **Scoresbyellaceae**[10] Womersley (1987)]

Canistrocarpus De Paula *et* De Clerck *in* De Clerck *et al*., 2006: 1285.

Chlanidophora J. Agardh 1894: 6, 16.

Dictyopteris J.V. Lamouroux 1809a: 332, *nom. cons*.

Dictyota J.V. Lamouroux 1809b: 38, *nom. cons*.

Synonyms: *Dilophus*[11] J. Agardh (1882); *Glossophora*[12] J. Agardh (1882); *Glossophorella*[12] Nizamuddin *et* Campbell (1995); *Pachydictyon*[12] J. Agardh (1894).

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6. Our global analyses recovered with good support a sister relationship between *Petroderma maculiforme* and the Ishigeales (Fig. 1). *P. maculiforme* is a crustose species, commonly found off the cold temperate coasts of the Atlantic and Pacific oceans (Wilce *et al.*, 1970). The heterotrichous thallus consists of a discoid, monostromatic base made of radially creeping filaments that give rise to laterally coherent filaments (Edelstein & MacLachlan, 1969; Wilce *et al.*, 1970; Fletcher, 1987). In terms of gross morphology, *P. maculiforme* is therefore radically different from the erect, ramified, pseudoparenchymatous thalli occurring in the three species of the genus *Ishige* (Cho *et al.*, 2004; Lee *et al.*, 2003; Lee *et al.*, 2009). However, the close relationship between *Petroderma* and the Ishigeales, unveiled on a molecular criterion, was supported by several structural features. Both *Petroderma* and *Ishige* display a haplostichous structure, apical growth, and elongate uni- and plurilocular zoidangia originating by enlargement of the terminal cells of the filaments (Edelstein & MacLachlan, 1969; Wilce *et al.*, 1970; Fletcher, 1987; Lee *et al.*, 2003; Lee *et al.*, 2009). Moreover, both exhibit sheathed, phaeophycean hairs, although originating from cryptostomata in *Ishige* species (Cho *et al.*, 2004; Lee *et al.*, 2003; Lee *et al.*, 2009), and from the cells of the erect filaments in *P. maculiforme* (Peters & Moe, 2001). Finally, in terms of cytology, it is worth noticing that small exserted pyrenoids have been reported in plastids of some Ishigeales as well as in *P. maculiforme* (Sanders *et al.*, 2004; Cho *et al.*, 2004). In terms of taxonomy, the genus *Petroderma* Kuckuck (1897) is still placed in the Ralfsiaceae within the Ralfsiales Nakamura (1972) *ex* Lim *et* Kawai (2007). The position of *P. maculiforme* as sister to the Ishigeales clearly requires the withdrawal of *Petroderma* from Ralfsiaceae. Because of its close morphological features to Ishigeales, we therefore propose a new family, Petrodermataceae fam. nov., to accommodate *Petroderma* in an emended concept of Ishigeales. See diagnosis in the "Taxonomic treatments" section (section IV).

7. Lim *et al.* (2007) suggested that the crustose genus *Diplura* should be separated from the Ralfsiales and placed in its own family within Ishigeales but did not pursue the treatment. Our phylogenetic analyses supported this proposition (Fig. 1). However, as *Diplura* was represented only by *rbc*L sequence data, we considered that further molecular analyses were needed to conclude on its family placement. In particular, an alternative to the creation of its own family was the possible merging of *Diplura* in the family Petrodermataceae, created to accommodate another crustose genus, *Petroderma*.

8. See diagnosis in the "Taxonomic treatments" section (section IV).

9. The traditional subdivision of the family Dictyotaceae into two tribes, Dictyoteae and Zonarieae, according to the number of meristematic cells at the frond apices, has been shown irrelevant since Bittner *et al.* (2008) recovered the latter two tribes as nonmonophyletic and merged together. We therefore choose to dissolve this unnecessary infra-familial division accordingly.

10. As clearly shown in Bittner *et al.* (2008).

11. Although Hörnig *et al.* (1992) recommended the merging of *Dilophus* with *Dictyota*, this recommendation is not accepted unanimously (see De Clerck *et al.*, 2006; Hwang *et al.*, 2009).

12. The merger of the three genera *Glossophora*, *Glossophorella* and *Pachydictyon* has been proposed by De Clerck *et al.* (2006) on the basis of molecular phylogenetic data.

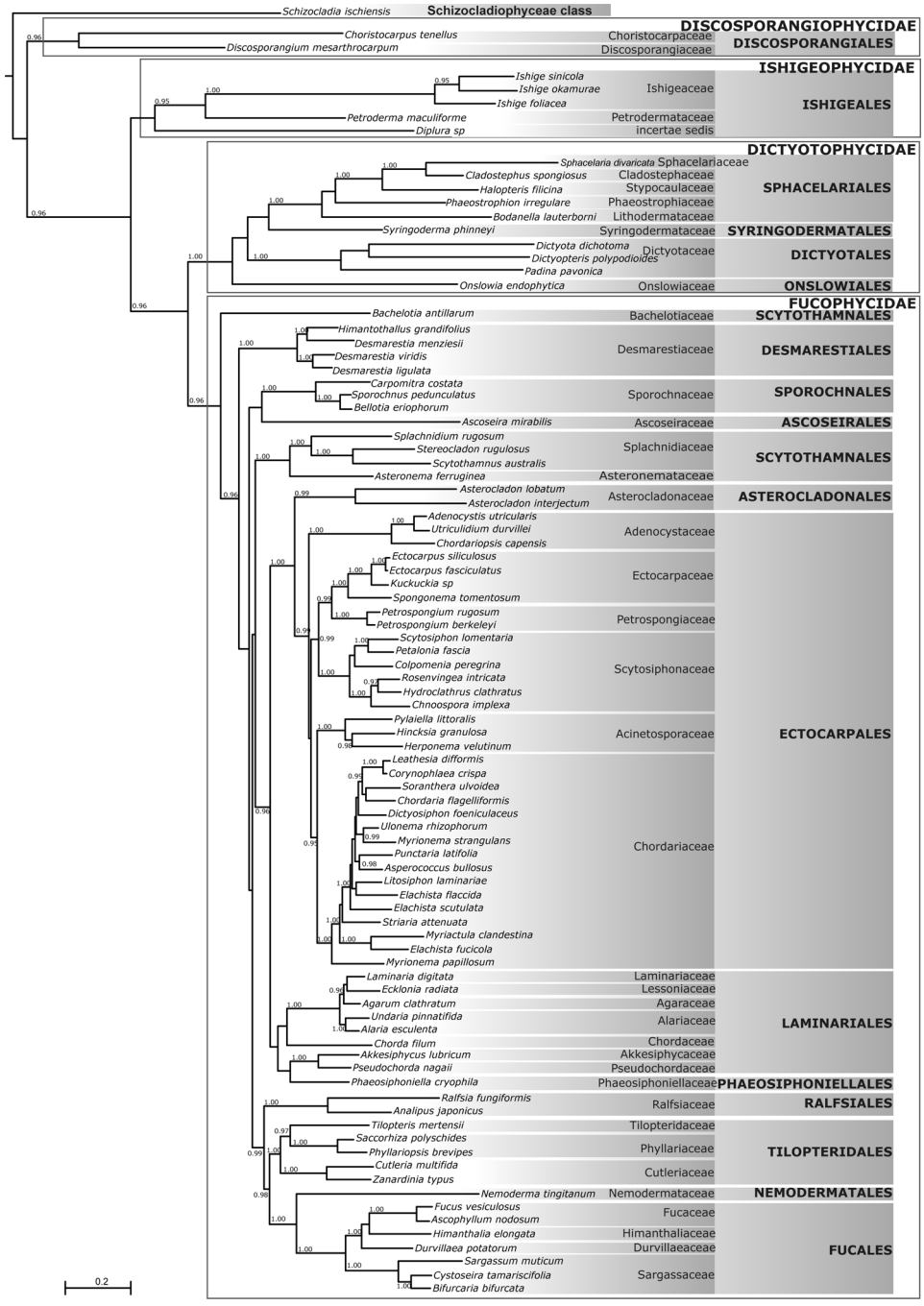

Fig. 1. Bayesian phylogeny inferred from the combined dataset (91 taxa, seven genes), using *Schizocladia ischiensis* (Schizocladiophyceae) as outgroup. BI posterior probability values are provided at branches for nodes whose values are above 0.94. The bar refers to the estimated number of substitutions per site.

Dictyotopsis[13] Troll 1931: 502.
Distromium Levring 1940: 3.
Exallosorus J.A. Phillips, 1997: 304.
Herringtonia Kraft, 2009: 205, 335.
Homoeostrichus[14] J. Agardh 1894: 6, 14.
Lobophora J. Agardh 1894: 21.
Synonym: *Pocockiella*[15] Papenfuss (1943).
Lobospira Areschoug 1854: 363.
Newhousia Kraft, G.W. Saunders, Abbott *et* Haroun 2004: 385.
Padina Adanson 1763: 13, 586, *nom. cons.*
Synonyms[16]: *Dictyerpa* Collins *et* Harvey *in* Collins (1901); *Vaughaniella* Børgesen (1950).
Padinopsis[17] Ercegovic 1955: 44.
Rugulopteryx De Clerck *et* Coppejans *in* De Clerck *et al*. 2006: 1286.
Scoresbyella[18] Womersley 1987: 257.
Spatoglossum Kützing 1843: 339.
Stoechospermum Kützing 1843: 339.
Stypopodium Kützing 1843: 341.
Taonia J. Agardh 1848: 101.
Zonaria C. Agardh 1817: xx.

Order Onslowiales Draisma *et* Prud'homme van Reine *in* Phillips *et al*. (2008)

Family Onslowiaceae Draisma *et* Prud'homme van Reine (2001)
Onslowia Searles *in* Searles *et* Leister 1980: 37.
Verosphacela E.C. Henry 1987: 183.

Order Sphacelariales Migula (1909)

Family Cladostephaceae[19] Oltmanns (1922)
Cladostephus C. Agardh 1817: XXV.

Family Lithodermataceae[20] Hauck (1883)
Bodanella Zimmermann 1927: 23.
Heribaudiella Gomont 1896: 391.
Lithoderma Areschoug 1875: 22.
Pseudolithoderma Svedelius *in* Kjellman *et* Svedelius 1910: 175.

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13. Although the genus *Dictyotopsis* is currently placed in a family of its own, Dictyotopsidaceae Allender (1980), we tentatively transfer it into the Dictyotaceae on the basis of unpublished preliminary molecular results (De Clerck *in* Bittner *et al*., 2008), with the Dictyotaceae thereby becoming the only family recognized within the order Dictyotales.
14. *H. sinclairii* (Hooker *et* Harvey) J.Agardh (1894), the type species of the genus *Homoeostrichus* according Womersley (1987), appeared as a separate lineage at the genus level among other representatives genera of Dictyotales in molecular phylogenies (Bittner *et al.*, 2008).
15. Source of synonymy: Womersley (1967).
16. The generic name *Vaughaniella* has been used to describe the prostrate, filamentous initial stage of several species of *Padina* (Cribb, 1951). *Dictyerpa* has also been shown to refer to a growth stage in the life history of *Padina* (Taylor, 1960; Ni-Ni-Win, 2010).
17. Specimens of *Padinopsis* have never been collected nor studied since the description of the genus.
18. The genus *Scoresbyella* was previously placed in a monotypic family of its own, Scoresbyellaceae Womersley (1987), but subsequently shown to be merged within the Dictyotaceae (Bittner *et al*., 2008).
19. Draisma *et al.* (2010b) finally supported recognition of the family Cladostephaceae, although an earlier study (Draisma *et al*., 2002) tended to show that the latter family should be merged within Sphacelariaceae.
20. The family Lithodermataceae, previously placed in Ralfsiales, currently encompasses four crustose genera *Heribaudiella*, *Lithoderma*, *Pseudolithoderma* and *Bodanella*, for which a close relationship with Sphacelariales has been shown (McCauley & Wehr, 2007).

Family Phaeostrophiaceae[21] H. Kawai, Sasaki, Maeba *et* E.C. Henry (2005)
Phaeostrophion Setchell *et* N.L. Gardner 1924: 10.

Family Sphacelariaceae Decaisne (1842)
Battersia[22] Reinke *ex* Batters 1890: 59 *emend.* Draisma, Prud'homme *et* H. Kawai, 2010b.
Chaetopteris[23] Kützing 1843: 293.
Herpodiscus[24] G.R. South 1974: 456, *emend*. Draisma, Prud'homme *et* H. Kawai (2010b).
Sphacelaria[25] Lyngbye *in* Hornemann 1818: 8.
Sphacella Reinke 1890: 206.
Sphacelorbus[26] Draisma, Prud'homme *et* H. Kawai 2010b: 322.

Family Sphacelodermaceae Draisma, Prud'homme *et* H. Kawai (2010b)
Sphaceloderma[27] Kuckuck 1894: 232.

Family Stypocaulaceae Oltmanns (1922)
Halopteris Kützing 1843: 292.
Synonym: *Stypocaulon*[28] Kützing (1843).
Phloiocaulon Geyler 1866: 527, 530.
Protohalopteris[29] Draisma, Prud'homme Van Reine *et* H. Kawai 2010b: 321.
Ptilopogon Reinke 1890: 214.

Order Syringodermatales E.C. Henry (1984)

Family Syringodermataceae E.C. Henry (1984)
Microzonia[30] J. Agardh 1894: 7, 18.
Syringoderma Levring 1940: 6.

SUBCLASS FUCOPHYCIDAE[31] Cavalier-Smith (1986)

Order Ascoseirales Yu.E. Petrov (1964) *emend*. Moe *et* E.C. Henry (1982)

Family Ascoseiraceae Skottsberg (1907)
Ascoseira Skottsberg 1907: 148.

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21. Kawai *et al*. (2005) established the family Phaeostrophiaceae but did not proceed with the ordinal treatment of the family. However, they recover a close relationship between *Phaeostrophion* and Sphacelariales.
22. See footnote 25.
23. See footnote 25.
24. On a molecular basis, Heesch *et al*. (2008) suggested that *Herpodiscus* should be merged within the order Sphacelariales, but they did not perform any taxonomic treatment. Later on Draisma *et al*. (2010b) confirmed this result, *Herpodiscus* merging within the family Sphacelariaceae and now encompassing several taxa previously placed in the genus *Sphacelaria* (Draisma *et al*., 2010b); see footnote 25.
25. Draisma *et al*. (2010b) molecularly showed that the genus *Sphacelaria* was polyphyletic within Sphacelariales and split it into monophyletic lineages, of which species were placed as *comb*. *nov*. either under newly created genera (*Sphacelorbus*, *Sphaceloderma*, *Protohalopteris*), reinstated genera (*Battersia*, *Chaetopteris*), or broadened genera (*Herpodiscus*).
26. See footnote 25.
27. See footnote 25.
28. As discussed in Draisma *et al*. (2010b).
29. See footnote 25.
30. Burrowes *et al*. (2003) showed that the monotypic genus *Microzonia*, previously placed in the family Cutleriaceae, should actually be included in Syringodermatales.
31. See emended diagnosis in the "Taxonomic treatments" section (section IV). As described here, the subclass Fucophycidae encompasses members of the former "brown algal crown radiation", as defined in Reviers & Rousseau (1999) and reassessed in Draisma *et al*. (2001), Rousseau *et al*. (2001), Phillips *et al*. (2008) and Silberfeld *et al*. (2010).

Order Asterocladales Silberfeld, Racault, R.L. Fletcher, A.F. Peters, F. Rousseau *et* Reviers (2011)
Family Asterocladaceae Silberfeld, Racault, R.L. Fletcher, A.F. Peters, F. Rousseau *et* Reviers (2011)
Asterocladon D.G. Müller, E.R. Parodi *et* A.F. Peters 1998: 430.

Order Desmarestiales Setchell *et* N.L. Gardner (1925)
Family Arthrocladiaceae Chauvin (1842)
Arthrocladia Duby 1830: 971.
Family Desmarestiaceae (Thuret *in* Le Jolis) Kjellman (1880)
Desmarestia J.V. Lamouroux 1813: 24, *nom. cons.*
Himantothallus[32] Skottsberg 1907: 143.
Synonyms[33]: *Phaeoglossum* Skottsberg (1907); *Phyllogigas* Skottsberg (1907).
Phaeurus Skottsberg 1907: 24.

Order Ectocarpales[34] Bessey (1907) *emend*. F. Rousseau *et* Reviers (1999a) [*incl*. **Chordariales** Setchell *et* N.L. Gardner (1925), **Dictyosiphonales** Setchell *et* N.L. Gardner (1925), **Scytosiphonales** Feldmann (1949)][35]
Family Acinetosporaceae[36] G. Hamel *ex* Feldmann (1937)
Acinetospora Bornet 1891: 370.
Feldmannia Hamel 1939a: 67.
Geminocarpus Skottsberg 1907: 12.
Herponema[37] J. Agardh 1882: 55.
Hincksia J.E. Gray 1864: 12.
Synonym: *Giffordia*[38] Batters (1893).
Internoretia[39] Setchell *et* N.L. Gardner 1920: 294.
Pogotrichum Reinke 1892: 61.
***Pylaiella* (‘*Pilayella*’)** Bory de Saint-Vincent 1823: 393.
Family Adenocystaceae Rousseau, Reviers, Leclerc, Asensi *et* Delépine (2000) *emend*. Silberfeld, Racault, R.L. Fletcher, A.F. Peters, F. Rousseau *et* Reviers (2011)
Adenocystis Hooker *et* Harvey *in* Harvey *et* Hooker 1845: 179.
Caepidium J. Agardh 1882: 58.
Chordariopsis[40] Kylin 1940: 54.
Utriculidium Skottsberg 1907: 36.

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32. Peters *et al.* (1997) showed that *Himantothallus* should likely be merged in *Desmarestia*.
33. The generic names *Phaeoglossum* and *Phyllogigas* both refer to juvenile stages of *Himantothallus*, as shown in Moe & Silva (1981).
34. Silva & Reviers (2000) indicate that Mesogloiales Nägeli (1847) is an earlier available synonym of Ectocarpales Bessey (1907), and therefore should be preferred over the latter name. However, we followed the proposition of Wynne (2005) to conserve the commonly used name “Ectocarpales” over Mesogloiales with a view to stabilizing nomenclature.
35. Rousseau & Reviers (1999a) suggested the merger of Chordariales, Dictyosiphonales and Scytosiphonales within a broadened concept of Ectocarpales, encompassing all taxa whose plastids display a stalked, protruding pyrenoid.
36. *Sensu* Peters & Ramírez (2001).
37. *Herponema* previously placed in Chordariaceae, was shown to belong to the family Acinetosporaceae based on molecular data (Silberfeld *et al.*, 2011).
38. Source of synonymy: Silva *et al*. (1987).
39. *I. fryeana* Setchell *et* N.L. Gardner (1920) was removed from the Chaetophoraceae (green algae) by O’Kelly (1983). Its placement in Acinetosporaceae needs confirmation with molecular tools.
40. The monospecific genus *Chordariopsis* [*C. capensis* (C. Agardh) Kylin] is currently placed in the monotypic family Chordariopsidaceae Kylin (1940); its placement in the family Adenocystaceae, previously assumed in several studies (Clayton, 1985; Asensi *et al*., 2004), has been molecularly shown and validated in Silberfeld *et al*. (2011).

Family Chordariaceae[41] Greville (1830) *emend.* A.F. Peters *et* Ramírez (2001)

Acrocytis Rosenvinge, 1933: 10.
Acrospongium Schiffner 1916: 157.
Acrothrix Kylin 1907: 93.
Acrotrichium Womersley *et* Skinner *in* Womersley 1987: 88.
Actinema Reinsch 1874-1875: 13.
Adriogloia Ercegovic 1955: 30.
Ascoseirophila A.F. Peters 2003: 301.
Asperococcus J.V. Lamouroux 1813: 277.
Asterotrichia Zanardini 1843: 63.
Australofilum A.F. Peters 2003: 301.
Botrytella Bory de Saint-Vincent 1822: 425.
Synonym: *Polytretus*[42] Sauvageau (1900).
Buffhamia Batters 1895: 168.
Chilionema Sauvageau 1898 ('1897'): 263.
Chordaria C. Agardh 1817: xii, *nom. cons.*
Chukchia R.T. Wilce, P.M. Pedersen *et* Sekida 2009: 272.
Cladochroa Skottsberg 1921: 42.
Cladosiphon Kützing 1843: 329.
Synonyms: *Bactrophora*[43] J. Agardh (1882); *Gontrania*[44] Sauvageau (1936).
Cladothele Hooker *et* Harvey 1845a: 293.
Clathrodiscus Hamel 1935: 87.
Climacosorus Sauvageau 1933: 196.
Coelocladia Rosenvinge 1893: 866.
Coilodesme Strømfelt 1886: 173.
Compsonema[45] Kuckuck 1899: 58.
Corycus Kjellman 1889: 17.
Corynophlaea Kützing 1843: 331.
Cylindrocarpus P. Crouan *et* H. Crouan 1851: 359.
Dalmatogloia Ercegovic 1955: 39.
Delamarea Hariot 1889: 156.
Dermatocelis Rosenvinge 1898: 93.
Dictyosiphon Greville 1830: xliii, 55, *nom. cons.*
Ectocarpidium Sperk 1869: 20.

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41. Peters & Ramírez (2001) reduced the number of ectocarpalean families from more than twenty to five and defined the family Chordariaceae negatively with respect to the other remaining valid families. As a consequence, the Chordariaceae encompass a particularly large number of genera, the majority of which having never been tested in a molecular phylogenetic framework. Many of these genera are suspected to be polyphyletic.
42. Source of synonymy: Kornmann & Sahling (1988).
43. Source of synonymy: Kylin (1940).
44. Source of synonymy: Kylin (1940).
45. *Compsonema saxicolum* (Kuckuck) Kuckuck has been shown to refer to the sporophytic generation of both scytosiphonacean genera *Petalonia* and *Scytosiphon* (Fletcher, 1987). The remaining species of *Compsonema* have not been included in any molecular phylogenies to date, but the genus is suspected to be polyphyletic.

Elachista[46] Duby 1830: 972 (‘*Elachistea*’), *nom. et orth. cons.*
Synonyms: *Portphillipia*[47] P.C. Silva (1970); *Symphoricoccus*[48] Reinke (1888).
Elachistiella Cassano, Yoneshigue-Valentin *et* M.J. Wynne 2004: 335.
Endodictyon Gran 1897: 47.
Entonema Reinsch 1874-1875: 1.
“Epinema”[49] P.J.L.Dangeard 1962: 976.
Eudesme J. Agardh 1882: 29.
Flabellonema Skinner *et* Womersley 1984: 174.
Fosliea Reinke 1891: 45.
Giraudya[50] (‘*Giraudia*’) Derbès *et* Solier *in* Castagne 1851: 100.
Gononema Kuckuck *et* Skottsberg *in* Skottsberg 1921: 9.
Halonema Jaasund 1951: 138.
Halorhipis D.A. Saunders 1898: 160.
Halorhiza Kützing 1843: 335.
Halothrix Reinke 1888: 19.
Hamelella Børgesen 1942: 46.
Haplogloia Levring 1939: 48.
Hecatonema Sauvageau 1898 (‘1897’): 248.
Heterophycus Trevisan 1848: 101.
Heterosaundersella Tokida 1942: 83.
Hummia J. Fiore 1975: 498.
Isthmoplea Kjellman 1877: 31.
Kuetzingiella (‘*Kützingiella*’) Kornmann *in* Kuckuck *et* Kornmann 1956: 293, 314.
Kurogiella H. Kawai 1993: 462.
Laminariocolax Kylin 1947: 6.
Laminarionema H. Kawai *et* Tokuyama 1995: 188.
Leathesia Gray 1821: 279, 301.
Leblondiella Hamel 1939a: xl.
Leptonematella P.C. Silva 1959: 63.
Levringia Kylin 1940: 15.
Liebmannia J. Agardh 1842: 34.
Litosiphon Harvey 1849: 43.
Melastictis[51] Reinsch 1890: 406.
Mesogloia C. Agardh 1817: xxxvii.
Mesogloiopsis Womersley *et* Bailey *in* Womersley 1987: 114.
Microcoryne Strømfelt 1888: 382.

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46. The genus *Elachista* is recovered nonmonophyletic with only three species included in the taxon sampling of Silberfeld *et al.* (2011). However, a taxonomic revision of the genus would require a more comprehensive specific sampling.
47. Source of synonymy: Womersley (1987).
48. Source of synonymy of *Symphoricoccus*: Fletcher (1987).
49. The status of *Epinema*, as well as dozens of names proposed by Dangeard (1962, 1968, 1970), is discussed in Wynne & Furnari (2014). Dangeard’s names are all invalid for lack of his giving Latin diagnoses or his not citing types; thus their validation is still pending.
50. Sauvageau (1927) recommended to spell *Giraudya* instead of Derbès & Solier’s *Giraudia* because the genus was dedicated to the phycologist ‘Giraudy’ and not ‘Giraud’ (p. 3 adnot.).
51. Status of this monotypic genus is considered as uncertain by some authors (Papenfuss, 1964; John *et al.*, 1994).

"Microspongium" [52] Reinke 1888: 20.
Mikrosyphar ('*Microsyphar*') Kuckuck 1895: 177.
Monosiphon L. Volkov 1916: 169.
Myriactula Kuntze 1898: 415.
Synonym: *Gonodia*[53] Nieuwland (1917).
Myriocladia J. Agardh 1841: 48.
Myriogloea Kuckuck *ex* Oltmanns 1922: 19.
Myrionema[54] Greville 1827: pl. 300.
Synonym: *Ascocyclus*[55] Magnus (1874).
Myrionemopsis[56] P.J.L. Dangeard 1968: 1945.
Myriotrichia Harvey 1834: 299.
Nemacystus Derbès *et* Solier 1850: 269.
Neoleptonema E.-Y.Lee *et* I.K. Lee 2002: 243.
Omphalophyllum Rosenvinge 1893: 872.
Papenfussiella Kylin 1940: 17.
Phaearthron P.M. Pedersen 1984: 52.
Phaeophysema A. Tanaka, S. Uwai *et* H. Kawai, 2010: 116.
Phaeostroma Kuckuck *in* Reinbold 1893: 43.
Synonym: *Phaeocladia*[57] Gran (1893).
Phaeostromatella[58] P.J.L. Dangeard 1970: 1680.
Pilinia Kützing 1843: 273.
Synonym: *Waerniella*[59] Kylin (1947).
Pilocladus Kornmann *in* Kuckuck *et* Kornmann 1954: 112.
Platysiphon R.T. Wilce 1962: 35.
Polycerea J. Agardh 1882: 46.
Proselachista Y.P. Lee *et* Garbary 1999: 214.
Protasperococcus[60] Sauvageau 1931: 1621.
Protectocarpus Kornmann 1955: 119.
Punctaria Greville 1830: 52.
Synonyms: *Desmotrichum*[61] Kützing (1845); *Homoeostroma*[62] J. Agardh (1896); *Rhadinocladia*[63] Schuh (1900).
Saundersella Kylin 1940: 41.
Sauvageaugloia Hamel *ex* Kylin 1940: 32.
Soranthera Postels *et* Ruprecht 1840: 19.
Spermatochnus Kützing 1843: 334, *nom. cons.*

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52. *Microspongium gelatinosum* Reinke has actually been applied to the ralfsioid sporophytes of the Scytosiphonaceae (Fletcher, 1987). Because *M. gelatinosum* is the type species of the chordariacean genus *Microspongium,* the latter genus is no longer recognized. The six other currently species belonging to *Microspongium* need to be reinvestigated to clarify their taxonomy.
53. Source of synonymy: Feldmann (1954).
54. Preliminary results in Silberfeld *et al.* (2011) show that *Myrionema* is polyphyletic. However, further taxonomic treatment of the genus would require a broader taxon sampling.
55. The type species, *Ascocyclus magnusii* Sauvageau (1927), is presently considered as a *Myrionema* species, and most of the species were transferred in *Myrionema* or *Chilioniema* genera, but 3 are still in need of reinvestigation: *A. dichotomus* Ohta (1973), *A. hypneae* Børgesen (1920), *A. stenonemus* Takamatsu in Noda (1987).
56. Invalid generic name whose status is discussed in Wynne & Furnari (2014). See footnote 49.
57. Source of synonymy: Kuckuck (1895).
58. Invalid generic name whose status is discussed in Wynne & Furnari (2014). See footnote 49.
59. Source of synonymy: Hooper *et al.* (1987).
60. Considered to be merged in *Myriotrichia* by Pedersen (1984).
61. Source of synonymy: Fletcher (1987).
62. Source of synonymy: Yoshida (1998).
63. Source of synonymy: Fletcher (1987).

Sphaerotrichia Kylin 1940: 38.
Stictyosiphon Kützing 1843: 301.
Synonym: Kjellmania[64] Reinke (1889).
Stilophora J. Agardh, 1841: 6, *nom. cons.*
Stilopsis Kuckuck 1929: 11, 70.
Streblonema Derbès *et* Solier *in* Castagne 1851: 100.
Streblonemopsis Valiante 1883: 492.
Strepsithalia Bornet *ex* Sauvageau 1896: 64.
Striaria Greville 1828: (synop.) 44.
Suringariella Womersley *et* Bailey *in* Womersley 1987: 110.
Tinocladia Kylin 1940: 33.
Trachynema P.M. Pedersen 1985: 498.
Ulonema Foslie 1894: 131.
? ***Vimineoleathesia***[65] A. Tanaka, S. Uwai *et* H. Kawai, 2010: 116.
Xanthosiphonia J. Agardh, 1894: 112.
Zeacarpa R.J. Anderson, Simons *et* J.J. Bolton, 1988: 320.

Family Ectocarpaceae C. Agardh (1828) *emend.* Silberfeld, Racault, R.L. Fletcher, A.F. Peters, F. Rousseau *et* Reviers (2011)
Ectocarpus Lyngbye 1819: 130, *nom. cons*.
Kuckuckia Hamel 1939b: 67.
Pleurocladia[66] A. Braun, 1855: 80.
Synonym: *Rhizocladia*[67] Reinsch (1876); *Kolderupia*[68] S. Lund (1959).
Spongonema[69] Kützing 1849: 461.

Family Petrospongiaceae Racault, R.L. Fletcher, Reviers, G.Y. Cho, S.M. Boo, Parente *et* F. Rousseau (2009)
Petrospongium Nägeli *ex* Kützing 1858: 2.

Family Scytosiphonaceae[70] Ardissone *et* Straforello (1877) [*incl.* **Chnoosporaceae** Setchell *et* N.L. Gardner (1925)]
Chnoospora J. Agardh 1847: 7.
Colpomenia (Endlicher) Derbès *et* Solier *in* Castagne, 1851: 95.
Hydroclathrus Bory de Saint-Vincent 1825: 419.
Iyengaria Børgesen 1939: 91.
Jolyna S.M. Guimarães *in* Guimarães *et al*. 1986: 100.
Melanosiphon M.J. Wynne 1969: 45.
Myelophycus Kjellman 1891b: 202.
Petalonia Derbès *et* Solier 1850: 265, *nom. cons.*
Synonym: *Endarachne*[71] J. Agardh (1896).

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64. Source of synonymy: Rosenvinge & Lund (1935).
65. Tanaka *et al*. (2010) established the new genus *Vimineoleathesia* to accommodate *Leathesia japonica* Inagaki. However their molecular topology clearly shows *L. japonica* nested within the genus *Botrytella* Bory de Saint-Vincent.
66. A sister relationship between *Pleurocladia lacustris* and Ectocarpaceae is retrieved in McCauley & Wehr (2007).
67. Source of synonymy: Bourrelly (1981).
68. Source of synonymy: Wilce (1966).
69. As shown in Silberfeld *et al*. (2011).
70. The generic name *Stragularia* Strömfelt (1886) and the specific names *Compsonema saxicolum* (Kuckuck) Kuckuck and *Microspongium gelatinosum* Reinke have actually been applied to the ralfsioid sporophytes of the Scytosiphonaceae (Fletcher, 1987). Because *M. gelatinosum* Reinke is the type species of the chordariacean genus *Microspongium* Reinke, the latter genus is not recognized anymore.
71. Source of synonymy: Vinogradova (1973).

Rosenvingea Børgesen 1914: 22.
Scytosiphon C. Agardh 1820: 160, *nom. cons.*
Synonym: *Hapterophycus*[72] Setchell *et* N.L. Gardner *in* Setchell (1912).
Symphyocarpus Rosenvinge 1893: 896.

Order Fucales Bory de Saint-Vincent (1827)
[*incl.* **Notheiales** Womersley (1987) and **Durvillaeales** Yu.E. Petrov (1965)][73]

Family Bifurcariopsidaceae[74] G.Y. Cho, F. Rousseau, Reviers *et* S.M. Boo (2006)
Bifurcariopsis Papenfuss 1940: 211.

Family Durvillaeaceae (Oltmanns) De Toni (1891)
Durvillaea Bory de Saint-Vincent 1826: 192.

Family Fucaceae Adanson (1763)
Ascophyllum Stackhouse 1809: 54, 66, *nom. et orth. cons.*
Fucus Linnaeus 1753: 1158, *nom. cons.*, *emend.* Decaisne *et* Thuret (1845).
Hesperophycus Setchell *et* N.L. Gardner *in* N.L. Gardner 1910: 127.
Pelvetia Decaisne *et* Thuret 1845: 12.
Pelvetiopsis N.L. Gardner 1910: 127.
Silvetia E.A. Serrão, T.O. Cho, S.M. Boo *et* S.H. Brawley *in* E.A. Serrão, L.A. Alice *et* S.H. Brawley 1999: 392.

Family Himanthaliaceae (Kjellman) De Toni (1891)
Himanthalia Lyngbye 1819: 36.

Family Hormosiraceae Fritsch (1945)
Hormosira (Endlicher) Meneghini 1838: 368, *nom. cons.*

Family Notheiaceae O.C. Schmidt (1938)
Notheia Harvey *et* Bailey 1851: 371.

Family Sargassaceae Kützing (1843) [*incl.* **Cystoseiraceae** De Toni (1891)][75]
Acrocarpia Areschoug 1854: 335.
Anthophycus Kützing 1849: 605.
Axillariella P.C. Silva 1959: 63.
Bifurcaria Stackhouse 1809: 59-90.
Brassicophycus[76] Draisma, Ballesteros, F. Rousseau *et* Thibaut 2010a: 11.
Carpoglossum Kützing 1843: 14-16.
Carpophyllum Greville 1830: 32.
Caulocystis Areschoug 1854: 334.
Cladophyllum Bula-Meyer 1980: 23.
Coccophora Greville 1830: xxxiv.

72. Source of synonymy: Kogame (1996).
73. As molecularly shown in Rousseau & Reviers (1999b).
74. Family created after withdrawal of *Bifurcariopsis* from Cystoseiraceae by Cho *et al.* (2006b).
75. Following Rousseau & Reviers (1999b), who have shown the Cystoseiraceae paraphyletic with respect to the Sargassaceae.
76. The new genus *Brassicophycus* has been established by Draisma *et al.* (2010a) to accommodate the southern African species *Bifurcaria brassicaeformis* (Kützing) Barton.

Cystophora J. Agardh 1841: 3, *nom. cons.*
Cystoseira[77] C. Agardh 1820: 50., *nom. cons.*
Synonyms: *Cystophyllum*[78] J. Agardh (1848) *pro parte*.
Halidrys Lyngbye 1819: 37, *nom. cons.*
Hormophysa Kützing 1843: 359.
Landsburgia Harvey *in* Hooker 1855: 213.
Myagropsis Kützing 1843: 57.
Synonym: *Cystophyllum*[79] J. Agardh (1848) *pro parte.*
Myriodesma Decaisne 1841: 148.
Nizamuddinia P.C. Silva *in* Silva, Basson *et* Moe 1996: 655.
Oerstedtia Trevisan 1848: 108.
Phyllotricha Areschoug 1854: 331.
Platythalia Sonder 1845: 51.
Polycladia Montagne *in* Orbigny 1847: 378.
Synonyms[80]: *Acystis* Schiffner (1934); *Stokeyia* Thivy *et* Doshi (1966).
Sargassopsis[81] Trevisan 1843: 332.
Sargassum C. Agardh 1820: 1, *nom. cons.*
Synonym: *Hizikia*[82] Okamura (1932).
Scaberia Greville 1830: 36.
Sirophysalis[83] Kützing 1843: 14.
Stephanocystis[84] Trevisan 1843: 332.
Stolonophora Nizamuddin 1969: 3.
Turbinaria J.V. Lamouroux 1825: 71.

Family Seirococcaceae Nizamuddin (1987)
Cystosphaera Skottsberg 1907: 146.
Marginariella Tandy 1936: 210.
Phyllospora C. Agardh 1839: 311.
Scytothalia Greville 1830: xxxiv.
Seirococcus Greville 1830: xxxiv.

Family Xiphophoraceae[85] G.Y. Cho, F. Rousseau, Reviers *et* S.M. Boo (2006b)
Xiphophora Montagne 1842: 12.

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77. Draisma *et al*. (2010a) have recently shown that the genus *Cystoseira* was strongly polyphyletic within the Sargassaceae.
78. All previous species of *Cystophyllum*, except one (see footnote 79), have been transferred to the genus *Cystoseira* (source of synonymy: Papenfuss & Jensen, 1967).
79. The specific name *Cystophyllum sisymbroides* (Turner) J.C. Agardh is currently regarded as a synonym of *Myagropsis myagroides* (Mertens *ex* Turner) Fensholt (Yoshida & Kawai, 1987).
80. *Polycladia* was recently reinstated by Draisma *et al*. (2010a) to accommodate *Cystoseira myrica* (Gmelin) C. Agardh, *Acystis heinii* Schiffner, and *Cystoseira indica* (Thivy *et* Doshi) Mairh (a new combination proposed by Mairh (1968) to accommodate *Stokeyia indica* Thivy *et* Doshi). *Acystis heinii* and *Stokeyia indica* being the type and only species of genera *Acystis* and *Stokeyia*, both were considered as synonyms of the newly reinstated genus *Polycladia* (Draisma *et al*., 2010a).
81. Formerly placed as a synonym of *Sargassum* by Silva *et al*. (1987), the genus *Sargassopsis* has recently been reinstated by Draisma *et al*. (2010a) to accommodate *Sargassum decurrens* (R.Brown *ex* Turner) C.Agardh.
82. Source of synonymy: Papenfuss (1951a), and subsequently confirmed with molecular evidence by Stiger *et al*. (2003).
83. *Sirophysalis* has recently been reinstated by Draisma *et al*. (2010a) to accommodate *Cystoseira trinodis* (Forsskål) C. Agardh.
84. *Stephanocystis* has been reinstated by Draisma *et al*. (2010a) to accommodate all northern Pacific *Cystoseira* and *Halidrys* species.
85. Family created after the genus *Xiphophora* was withdrawn from Fucaceae by Cho *et al*. (2006b).

Order Laminariales Migula (1909)
" ALL clade "[86] (Yoon *et al*., 2001).

Family Agaraceae*[87] Postels *et* Ruprecht (1840) (*'Agaroideae'*)
Agarum Dumortier 1822: 102.
Synonym: *Thalassiophyllum*[88] Postels *et* Ruprecht (1840).
Costaria Greville 1830: xxxix.
Dictyoneurum Ruprecht 1852: 80.
Synonym: *Dictyoneuropsis*[89] G.M. Smith (1942).

Family Akkesiphycaceae H. Kawai *et* H. Sasaki (2000)
Akkesiphycus Yamada *et* Tanaka 1944: 61.

Family Alariaceae[90]* Setchell *et* N.L. Gardner (1925)
Alaria Greville 1830: xxxix, 25, *nom. cons.*
Synonym: *Pleuropterum*[91] Miyabe *et* Nagai (1932).
Eualaria[92] Areschoug 1884: 16.
Synonym: *Druehlia* C.E. Lane *et* G.W. Saunders *in* Lane *et al.* (2007).
Lessoniopsis Reinke 1903: 25.
Pleurophycus Setchell *et* D.A. Saunders *ex* Tilden 1900: 346.
Pterygophora Ruprecht 1852: 73.
Undaria Suringar 1873: 77.
Synonyms: *Hirome*[93] Yendo (1903); *Undariopsis*[94] Miyabe *et* Okamura *in* Okamura (1902).
Undariella Yu.E. Petrov *et* O.G. Kusakin 1997: 81.

Family Aureophycaceae[95]* H. Kawai *et* L.M. Ridgway *in* Kawai *et al.* (2013)
Aureophycus H. Kawai, T. Hanyuda, Lindeberg *et* S.C. Lindstrom 2008: 1019.

Family Chordaceae Dumortier (1822)
Chorda Stackhouse 1797: xxiv.

Family Laminariaceae[96]* Bory de Saint-Vincent (1827) [*incl.* **Arthrothamnaceae** Yu.E. Petrov (1974)]
Arthrothamnus Ruprecht 1848: 67.
Cymathaere J. Agardh 1868b: 29. ('*Cymathere*')

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86. The "ALL" (Alariaceae-Laminariaceae-Lessoniaceae) clade has not been contradicted since the study of Yoon *et al.* (2001). Lane *et al.* (2006) created the new family Costariaceae (currently Agaraceae), and highlighted the fact that familial boundaries within and among Agaraceae-ALL (AALL) taxa are still not entirely clear. Whether this clade should be considered as one family rather than four is questionable. Because families are listed below by alphabetical order, the families belonging to this clade (and families subsequently created within it) are signaled with an asterisk.
87. Agaraceae Postels *et* Ruprecht (1840) is available, legitimate and has priority over Costariaceae C.E. Lane, C. Mayes, Druehl *et* G.W. Saunders (2006), which consequently becomes a synonym of the former. Member of the ALL clade.
88. Source of synonymy: Boo *et al.* (2011).
89. Source of synonymy: Lane *et al.* (2006), on the basis of molecular evidence.
90. Member of the ALL clade.
91. Source of synonymy: Widdowson (1971).
92. Areschoug (1884) initially validated the generic name *Eualaria,* based on the type (and only) species *Alaria fistulosa*, but did not make that combination. Wynne (2009) reinstated that generic name and made the *comb. nov.* of *Eualaria fistulosa.*
93. Source of synonymy: Okamura (1915).
94. Source of synonymy: Yoshida (1998).
95. Member of the ALL clade.
96. Member of the ALL clade.

Laminaria J.V. Lamouroux 1813: 40, *nom. cons.*
Synonym: *Renfrewia*[97] R.F. Griggs (1906).
Macrocystis C. Agardh 1820: 46.
Nereocystis Postels *et* Ruprecht 1840: 9.
Pelagophycus Areschoug 1881: 49.
Postelsia Ruprecht 1852: 75.
Pseudolessonia G.Y. Cho, N.G. Klochkova, T.N. Krupnova *et* S.M. Boo 2006a: 1292.
Saccharina[98] Stackhouse 1809: 53, 65.
Synonyms: *Hedophyllum* Setchell (1901); *Kjellmaniella* Miyabe (1902) (‘*Kjellmanniella*’).
Streptophyllopsis Kajimura 1981: 77.

Family Lessoniaceae[99]* Setchell *et* N.L. Gardner (1925)
Ecklonia Hornemann 1828: 388.
Eckloniopsis Okamura 1927: 143, 155.
Egregia Areschoug 1876: 66.
Eisenia Areschoug 1876: 68.
Lessonia Bory de Saint-Vincent *in* Dumont d’Urville 1825: 17, 22.

Family Pseudochordaceae H. Kawai *et* Kurogi (1985)
Pseudochorda Yamada, Tokida *et* Inagaki *in* Inagaki 1958: 174, 189.

Incertae sedis **at family rank**[100]
Costulariella N.G. Klochkova *et* T.A. Klochkova 2010: 184.
Feditia Yu.E. Petrov *et* Gusarova *in* Gusarova *et* Yu.E. Petrov 1972: 39.
Phyllariella Yu.E. Petrov *et* Vozzhinskaya 1966: 100.
Tauya N.G. Klochkova *et* T.N. Krupnova 2004: 89.

Order Nemodermatales Parente, R.L. Fletcher, F. Rousseau *et* N. Phillips *in* Phillips *et al.* (2008)

Family Nemodermataceae Kuckuck *ex* Feldmann (1937)
Nemoderma Schousboe *ex* Bornet 1892: 241.

Order Phaeosiphoniellales[101] **Silberfeld, F. Rousseau *et* Reviers, *ord. nov. prop.***

Family Phaeosiphoniellaceae N. Phillips, Burrowes, F. Rousseau, Reviers *et* G.W. Saunders (2008)
Phaeosiphoniella R.G. Hooper, E.C. Henry *et* Kuhlenkamp 1988: 395.

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97. Source of synonymy: Setchell & Gardner (1925).
98. Source of synonymy: species of the genera *Hedophyllum*, *Kjellmaniella*, as well as 18 species of *Laminaria* were all transferred into the reinstated genus *Saccharina* by Lane *et al.* (2006). Selivanova *et al.* (2007) also transferred two *Laminaria* species and twelve infraspecific taxa into *Saccharina*.
99. Member of the ALL clade.
100. As pointed out by Selivanova *et al.* (2007), most of the taxa described by Russian scientists from the Far-Eastern Russian Pacific, such as the genera *Costularia*, *Feditia*, *Phyllariella* and *Tauya*, remain unknown to the majority of the phycologists outside Russia and consequently are still in need of reexamination.
101. Initially placed in Tilopteridales (Hooper *et al*., 1988), *Phaeosiphoniella cryophila* R. Hooper, E.C. Henry *et* Kuhlenkamp was recently shown to be sister to Laminariales on molecular arguments (Phillips *et al*., 2008), despite its polystichous, filamentous architecture reminiscent of Tilopteridaceae. Given the highly divergent morphoanatomical features between *Phaeosiphoniella* and Laminariales, as well as the genetic distance between them (Phillips *et al*., 2008), we establish a new order, Phaeosiphoniellales *ord. nov*., to accommodate the genus *Phaeosiphoniella* and its monotypic family Phaeosiphoniellaceae N. Phillips, R. Burrowes, Rousseau, Reviers *et* G.W. Saunders (2008). See Section IV for taxonomic treatment of the new order.

Order Ralfsiales Nakamura (1972) *ex* Lim *et* H. Kawai *in* Lim *et al.* (2007)[102]

Family Mesosporaceae J. Tanaka *et* Chihara (1982)
Basispora D.M. John *et* G.W. Lawson 1974: 285.
Hapalospongidion (*'Hapalospongidium'*) D.A. Saunders 1899: 37.
Mesospora Weber-van Bosse 1911: 27.

Family Neoralfsiaceae Lim *et* H. Kawai *in* Lim *et al.* (2007)
Neoralfsia Lim *et* H. Kawai *in* Lim *et al.* 2007: 464.

Family Ralfsiaceae Farlow (1881) [incl. **Heterochordariaceae** Setchell *et* N.L. Gardner (1925)]
Analipus[103] Kjellman 1889: 48.
Heterochordaria[104] Setchell *et* N.L.Gardner (1924).
Endoplura Hollenberg 1969: 298.
Heteroralfsia H. Kawai 1989: 250.
Ralfsia Berkeley *in* Smith *et* Sowerby 1843: 2866.

Order Scytothamnales[105] A.F. Peters *et* M.N. Clayton (1998) *emend*. Silberfeld, Racault, R.L. Fletcher, A.F. Peters, F. Rousseau *et* Reviers (2011)

Family Asteronemataceae Silberfeld, Racault, R.L. Fletcher, F. Rousseau *et* Reviers (2011)
Asteronema Delépine *et* Asensi 1975: 296.

Family Bachelotiaceae Silberfeld, Racault, R.L. Fletcher, F. Rousseau *et* Reviers (2011)
Bachelotia (Bornet) Kuckuck *ex* Hamel 1939b: 66.

Family Splachnidiaceae Mitchell *et* Whitting (1892) [*incl.* **Scytothamnaceae**[106] Womersley (1987)]
Scytothamnus Hooker *et* Harvey 1845b: 531.
Splachnidium Greville 1830: xxxvi.
Stereocladon Hooker *et* Harvey 1845a: 250.

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102. Lim *et al.* (2007) have validated with a Latin diagnosis the name Ralfsiales Nakamura (1972) which had remained a *nomen nudum* until then since Nakamura (1972) had failed to provide a Latin diagnosis for the order.
103. As first shown in Tan & Druehl (1994).
104. Source of synonymy: Wynne (1971).
105. The family Bachelotiaceae was created by Silberfeld *et al.* (2011) in order to accommodate the placement of *Bachelotia* in the Scytothamnales. This placement was supported by molecular analyses and the sharing of morphological features as a stellate configuration of their plastids. Curiously, *Bachelotia* appeared as a separate lineage, distant from the other representatives of Scytothamnales, in our phylogenetic analyses (Fig. 1). Actually, its position was obtained when taxa outside Phaeophyceae were included as outgroup (see also Phillips *et al.*, 2008). Too distant outgroups could increase saturation in the data set and contribute to a phylogenetic reconstruction artifact. Further molecular analyses are therefore instead of thus needed to conclude on the reasons of this instability in the placement of *Bachelotia*.
106. *Splachnidium rugosum* (L.) Greville displays the same features as *Scytothamnus* and *Stereocladon*: haplostichous, pseudoparenchymatous, occurrence of cryptostomata, terminal growth by an apical meristem, a single lobate, focal plastid, and a central, embedded pyrenoid with tubular invaginations (Clayton, 1985; Peters & Clayton, 1998; Tanaka *et al*., 2007). Because *Splachnidium* is recovered monophyletic with Scytothamnaceae in all molecular studies (Rousseau *et al*., 2001; Phillips *et al*., 2008; Silberfeld *et al*., 2010), and given that Splachnidiaceae Mitchell *et* Whitting (1892) has priority over Scytothamnaceae Womersley (1987), we propose the merger of the three genera *Scytothamnus*, *Stereocladon* and *Splachnidium* into a single family, the Splachnidiaceae.

Order Sporochnales Sauvageau (1926)

Family Sporochnaceae Greville (1830)
Austronereia Womersley 1987: 272.
Bellotia Harvey 1855: 332.
Carpomitra Kützing 1843: 343, *nom. cons.*
Encyothalia Harvey 1859: pl. 62.
Lucasia Yee *et* A.J. K. Millar *in* Kraft (2009)
Nereia Zanardini 1846: 899.
Perisporochnus Chapman 1954: 201.
Perithalia J. Agardh 1890: 1.
Sporochnema Womersley 1987: 273.
Sporochnus C. Agardh 1817: xii.
Tomaculopsis A.B. Cribb 1960: 18.

Order Tilopteridales[107, 108] Bessey (1907) *emend.* Phillips *et al*. (2008) [or Cutleriales Bessey (1907)]

Family Cutleriaceae Griffith *et* Henfrey (1856)
Cutleria Greville 1830: 59.
Synonym: *Aglaozonia*[109] Zanardini (1843).
Zanardinia Zanardini 1841: 236.

Family Halosiphonaceae[110] H. Kawai *et* H. Sasaki (2000)
Halosiphon Jaasund 1957: 211.

Family Phyllariaceae Tilden 1935: 260
Saccorhiza Bachelot de la Pylaie 1830 ('1829'): 23, *nom. cons.*
Phyllariopsis E.C. Henry *et* G.R. South 1987: 10.
Synonym: *Phyllaria*[111] (Le Jolis) Rostafinski (1877).

Family Stschapoviaceae H. Kawai *in* Kawai *et* Sasaki (2004)[112]
Stschapovia A.D. Zinova 1954: 241.

Family Tilopteridaceae Kjellman (1890)
Haplospora Kjellman 1872: 3.
Tilopteris Kützing 1849: 462.

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107. The family Cutleriaceae Griffith *et* Henfrey is still formally placed in an order of its own, Cutleriales Bessey (1907), although it has long been shown on molecular arguments that the family Cutleriaceae is nested within Tilopteridales *emend*. Kawai & Sasaki (2004) (see for instance Phillips *et al*., 2008; Silberfeld *et al*., 2010). With a view to stabilizing nomenclature, we place Cutleriales (1907) as a synonym of Tilopteridales Bessey (1907), although Cutleriales appears prior to Tilopteridales in the same work by Bessey (1907) and should therefore have priority over Tiloteridales.
108. Kuhlenkamp & Müller (1985) discussed the elimination of two other genera, *Masonophycus* Setchell *et* N.L. Gardner (1930) and *Krobylopteris* P. Schmidt (1942), currently placed in Tilopteridales. As for the genus *Masonophycus*, Kuhlenkamp & Müller (1985) suggested its rejection, as well as the family Masonophycaceae O.C. Schmidt (1937), after examination of the type specimen which they unambiguously identified as a *Feldmannia*. They also suggested the rejection of the genus *Krobylopteris*, because the examination of the iconography available in the work of P. Schmidt (1942) strongly suggests that he based his description on a co-culture of *Tilopteris mertensii* and *Desmarestia viridis*, which both occur in Helgoland.
109. The generic name *Aglaozonia* was used for the crustose sporophyte of all *Cutleria* species (Fletcher, 1987).
110. Peters (1998) reinstated the generic name *Halosiphon* Jaasund to accommodate *Chorda tomentosa* Lyngbye. Kawai & Sasaki (2000) then created the new family Halosiphonaceae within the Laminariales. Later on Kawai & Sasaki (2004) showed its close relationship to Phyllariaceae and Tilopteridaceae, and thus suggested its inclusion in Tilopteridales, as later confirmed in Phillips *et al*. (2008).
111. Source of synonymy: J.G. Agardh (1868a).
112. Like Halosiphonaceae, the family Stschapoviaceae was transferred from Laminariales into Tilopteridales as suggested in Kawai & Sasaki (2004).

***Incertae sedis* at ordinal rank**

Jonssonia S. Lund 1959: 85.
Porterinema[113] Waern 1952: 136.
Sorapion[114] Kuckuck 1894: 236.
Zosterocarpus[115] Bornet 1890: 146.
Synonym: *Prototilopteris*[116] Funk (1927).

TAXONOMIC TREATMENTS

DISCOSPORANGIOPHYCIDAE Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Diagnosis – New subclass of Phaeophyceae. Characters and diagnosis as Discosporangiales O.C. Schmidt (1937), *Hedwigia* 77: 3.
Currently recognized order – Discosporangiales O.C. Schmidt 1937: 3.

ISHIGEOPHYCIDAE Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Diagnosis – New subclass of Phaeophyceae. Characters and diagnosis as Ishigeales G.Y. Cho, S.H. Lee *et* S.M. Boo (2004) *emend.* Silberfeld, A.F. Peters, F. Rousseau *et* Reviers (2010).
Currently recognized order – Ishigeales G.Y. Cho, S.H. Lee *et* S.M. Boo 2004: 934 *emend.* Silberfeld, A.F. Peters, F. Rousseau *et* Reviers (2010).

DICTYOTOPHYCIDAE Silberfeld, F. Rousseau *et* Reviers, *subclass. nov. prop.*

Diagnosis – New subclass of Phaeophyceae. Thalli filamentous or pseudoparenchymatous, never parenchymatous. Terminal growth by one or more large apical cells. Regular polystichous structure, except in a single genus within Sphacelariales (*Sphacella*), of secondary haplostichous structure. Cells containing several discoid plastids without pyrenoids. Life history isomorphic (Dictyotales, Sphacelariales, Onslowiales) or heteromorphic with reduced gametophytes (Syringodermatales).

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113. McCauley & Wehr (2007) included *Porterinema fluviatile* in their taxon sampling for molecular analyses, which failed to resolve the ordinal status of the genus. Pedersen (1981) linked *Porterinema fluviatile* and *Sorapion kjellmanii* (Wille) Rosenvinge, the latter being suspected to be a phase in the life history of the former. Consequently this would support a close relationship of *Porterinema* with the Scytosiphonaceae (Fletcher, 1987). Alternatively, Waern (1952) placed *Porterinema* within the family Lithodermataceae, which would support a close relationship with Sphacelariales.
114. According to Fletcher (1987), *Sorapion simulans* Kuckuck might be conspecific with *Stragularia spongiocarpa* (Batters) Hamel, the genus *Stragularia* being used to designate the encrusting sporophytes of several scytosiphonacean taxa (Ectocarpales). However, Fletcher (1987) also noted that the pyrenoid of *Sorapion* is not pedunculate, which would tend to support a close relationship with *Petroderma* (Ishigeales).
115. Generally accommodated in Ectocarpales, although cells contain numerous small discoid plastids without pyrenoids and plurilocular organs formed through outward segmentation of cells of lateral branches, resulting in corticating annular zoidangia. These features and the more or less localized intercalary growth in scattered areas led Funk (1955) to treat *Zosterocarpus* as a member of the Tilopteridales. Molecular analyses are needed to determine the ordinal placement of this genus.
116. Source of synonymy: Funk (1955).

Currently recognized orders – Dictyotales Bory de Saint-Vincent 1828: 142, **Onslowiales** Draisma *et* Prud'homme van Reine *in* Phillips *et al.*, 2008: 403; **Sphacelariales** Migula 1908: 237; **Syringodermatales** E.C. Henry 1984: 425.

PHAEOSIPHONIELLALES Silberfeld, F. Rousseau *et* Reviers, *ord. nov. prop.*

Diagnosis – New order of Phaeophyceae. Characters and diagnosis as Phaeosiphoniellaceae N. Phillips, Burrowes, F. Rousseau, Reviers *et* G.W. Saunders (2008), *J. Phycol.* 44: 403.
Type family – Phaeosiphoniellaceae N. Phillips, Burrowes, F. Rousseau, Reviers *et* G.W. Saunders (2008).

PETRODERMATACEAE Silberfeld, A.F. Peters, F. Rousseau *et* Reviers, *fam. nov.*

Diagnosis – Encrusting brown algae (Phaeophyceae) with spongy thalli firmly adherent to substratum. Monostromatic discoid base giving rise to erect, haplostichous filaments, loosely associated by mucilaginous material. Cells with a few parietal plastids, occasionally bearing small protruding pyrenoids. Phaeophycean hairs originating from cells of erect filaments. Plurilocular and unilocular sporangia terminal on erect filaments without paraphyses. Plurilocular elongate, often uniseriate.
Typus genus – *Petroderma* Kuckuck 1897: 382.

ISHIGEALES G.Y. Cho *et* S.M. Boo

Emended diagnosis – Modified from Cho *et al*. (2004). Plants epiphytic or epilithic. Growth from apical cells. Thalli either branched, terete, or foliose, pseudoparenchymatous with medulla and cortex, or heterotrichous and crustose. Cells containing several discoid plastids with a few occasional small, protruding pyrenoids. Phaeophycean hairs either clustered, growing from cryptostomata, or isolated, originating from cells of the erect filaments. Unilocular sporangia terminal, either transformed from cortical cells in pseudoparenchymatous taxa, or developing from the apex of erect filaments of crustose forms. Plurilocular sporangia transformed from assimilatory filaments, terminal, often uniseriate. Life history isomorphic.
Currently recognized further families – Ishigeaceae Okamura *in* Segawa (1935), **Petrodermataceae** Silberfeld, A.F. Peters, F. Rousseau *et* Reviers, *fam. nov.* (this study).

FUCOPHYCIDAE Cavalier-Smith

Emended diagnosis – Thalli of various structures and morphologies. Growth ancestrally intercalary. Life history basically heteromorphic, possibly secondarily iso- or subisomorphic.
Currently recognized orders – Desmarestiales Setchell *et* N.L. Gardner 1925: 554; **Ascoseirales** Yu.E. Petrov 1964: 148; **Asterocladales** D.G. Müller, Parodi *et* A.F. Peters *ex* Silberfeld, F. Rousseau *et* Reviers 2010; **Ectocarpales** Bessey 1907 *emend.* F. Rousseau *et* Reviers 1999; **Fucales** Bory de Saint-Vincent 1827: 62; **Laminariales** Migula 1908: 173; **Nemodermatales** M. Parente, R.L. Fletcher,

F. Rousseau *et* N. Phillips *in* Phillips *et al.*, 2008: 403; **Phaeosiphoniellales** Silberfeld, F. Rousseau *et* Reviers (this study); **Ralfsiales** Nakamura 1972: 152 *ex* Lim *et* Kawai in Lim *et al.* 2007: 464; **Scytothamnales** A.F. Peters *et* M.N. Clayton 1998: 111; **Sporochnales** 1926: 364; **Tilopteridales** Bessey 1907: 290 *emend.* H. Kawai *et* Sasaki 2004.

Acknowledgements. We are grateful to M.J. Wynne (University of Michigan) for providing us with invaluable advice and comments on an earlier version of the manuscript. The molecular work was undertaken at the "Service de Systématique Moléculaire" of the Muséum National d'Histoire Naturelle (UMS 2700). This work was supported by the "Consortium National de Recherche en Génomique" and the "Action Transversale du Muséum" (ATM) "Barcode". It is part of the agreement n° 2005/67 between the Genoscope and the Muséum National d'Histoire Naturelle on the project "Macrophylogeny of life" directed by Prof. Guillaume Lecointre.

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