ANALYSIS OF CHLOROPLAST GENOMES AND A SUPERMATRIX INFORM RECLASSIFICATION OF THE RHODOMELACEAE (RHODOPHYTA) [1]

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Abstract

With over a thousand species, the Rhodomelaceae is the most species-rich family of red algae. While its genera have been assigned to 14 tribes, the high-level classification of the family has never been evaluated with a molecular phylogeny. Here, we reassess its classification by integrating genome-scale phylogenetic analysis with observations of the morphological characters of clades. In order to resolve relationships among the main lineages of the family we constructed a phylogeny with 55 chloroplast genomes (52 newly determined). The majority of branches were resolved with full bootstrap support. We then added 266 *rbc*L, 125 18S rRNA gene and 143 *cox*1 sequences to construct a comprehensive phylogeny containing nearly half of all known species in the family (407 species in 89 genera). These analyses suggest the same subdivision into higher-level lineages, but included many branches with moderate or poor support. The circumscription for nine of the 13 previously described tribes was supported, but the Lophothalieae, Polysiphonieae, Pterosiphonieae and Herposiphonieae required revision, and five new tribes and one resurrected tribe were segregated from them. Rhizoid anatomy is highlighted as a key diagnostic character for the morphological delineation of several lineages. This work provides the most extensive phylogenetic analysis of the Rhodomelaceae to date and successfully resolves the relationships among major clades of the family. Our data show that organellar genomes obtained through high-throughput sequencing produce well-resolved phylogenies of difficult groups, and their more general application in algal systematics will likely permit deciphering questions about classification at many taxonomic levels.

Key words: chloroplast genome, classification, phylogenomics, red algae, Rhodomelaceae, Rhodophyta, tribes.

List of abbreviations: *cox*1, cytochrome oxidase subunit 1; e.g., *exempli gratia*; *rbc*L, ribulose 1,5-bisphosphate carboxylase/oxygenase large subunit; *vs*., *versus*; 18S, small subunit ribosomal RNA gene.

INTRODUCTION

The Rhodomelaceae is the largest family of the red algae, with 1,054 species and 149 genera recognized (Guiry and Guiry 2017). The number of species is probably underestimated as new taxa are often described when detailed studies using molecular data are performed (e.g. Sherwood et al. 2010, Savoie & Saunders 2016, Machín-Sánchez et al. 2016, Díaz-Tapia et al. 2017a). Moreover, there is a large number of synonyms and taxonomic entities of uncertain status, particularly in the most diverse genera such as *Polysiphonia* and *Laurencia* (Guiry and Guiry 2017). Most of these unknown entities correspond to species described in the 18th and 19th centuries and a proper reassessment may lead to the resurrection of some of these taxa. The enormous species count in the family is mirrored in high morphological diversity, particularly of vegetative organization. Thalli range from a wide variety of simple, filiform architectures to more complex pseudoparenchymatous structures, as well as diminutive parasites. The family is distinguished from other Ceramiales by a combination of vegetative and reproductive characters (Maggs and Hommersand 1993, Womersley 2003). The most significant trait is the polysiphonous structure (axial cell surrounded by several pericentral cells) with monopodially developed axes.

The Rhodomelaceae nom. cons. was established by Areschoug (1847) as a grouping of 10 genera of which only four are currently retained in the family. The first classification of the Rhodomelaceae into tribes was provided by Schmitz (1889) and later updated in Engler (1892) and in Schmitz and Falkenberg (1897). Subsequently, Falkenberg (1901) published a monumental monograph with a more extensive and detailed integrative study of the family. The 73 genera recognized by Falkenberg were classified into 12 “Familien” (equivalent to tribes) and two unnamed groups, while five remained unplaced (Tables S1 and S2). A major modification in Falkenberg´s classification was the resurrection of the family Dasyaceae Kützing (later supported by Rosenberg 1933) for a group that he considered a tribe (as "Familie") of the Rhodomelaceae. Kylin (1956), in his classification of the red algal genera, essentially followed Falkenberg´s treatise, but also proposed five new "Gruppen" (equivalent to tribes: *Levringiella*, *Picconiella*, *Placophora*, *Streblocladia* and *Pleurostichidium*).

The most recent comprehensive classification of the family (Hommersand 1963) recognized 13 tribes and maintained three genera in an uncertain position (Tables S1 and S2). Comparing Hommersand´s (1963) treatise with Falkenberg´s (1901) monograph, the circumscription of the tribes Amansieae, Rhodomeleae, Heterocladieae, Chondrieae, Laurencieae, Polyzonieae and Bostrychiae is the same. Although the Lophothalieae was recognized in both classifications, Hommersand (1963) included in it seven genera that Falkenberg had placed in other tribes or in the unnamed groups, as well as seven genera described after 1901. Likewise, the Pterosiphonieae was recognized by both authors, but two of its genera (*Aphanocladia* and *Pollexfenia*) were placed in the Polysiphonieae by Hommersand. A major difference between these monographs is that Hommersand merged the tribes Polysiphonieae and Herposiphonieae. Hommersand also maintained the separation of the tribes Pleurostichidieae and Streblocladieae proposed by Kylin (1956). In addition to the tribal classification, Hommersand (1963) proposed three subfamilies (Bostrychioideae, Rhodomeloideae and Polysiphonioideae), of which only the first two were maintained in a subsequent publication (Maggs and Hommersand 1993).

Later work on the Rhodomelaceae focused on particular taxa within the family and resulted in the recognition of 58 new or resurrected genera that were placed in previously established tribes or remain unplaced (Tables S1 and S2). Furthermore, the Brongniartelleae was segregated from the Lophothalieae (Parsons 1975); the tribe

Neotenophyceae was described for the parasitic genus *Neotenophycus* (Kraft and Abbott 2002); and the Sonderelleae was established for two genera previously assigned to the Delesseriaceae (Phillips 2001).

Since the introduction of molecular tools for macroalgal systematics, some taxa of the Rhodomelaceae have been studied in attempts to clarify relationships among genera within the Polysiphonieae (Choi et al. 2001, Bárbara et al. 2013, Díaz-Tapia et al. 2017b), Pterosiphonieae (Savoie and Saunders 2016), Bostrychieae (Zuccarello and West 2006), Laurencieae (Nam et al. 1994, Martin-Lescanne et al. 2010, Cassano et al. 2012, Metti et al. 2015, Machín-Sánchez et al. 2016, Rousseau et al. 2017), Amansieae (Phillips 2002a, b, Phillips and De Clerck 2005, Phillips 2006), Heterocladieae (Phillips et al. 2000) and Pleurostichidieae (Phillips 2000). Collectively, these studies have demonstrated that the traditionally employed molecular markers (18S rRNA and *rbc*L genes) are unable to fully resolve phylogenies, especially at the taxonomic levels of genera and tribes. This problem is particularly obvious in the Polysiphonieae (Díaz-Tapia et al. 2017b) and Bostrychieae (Zuccarello and West 2006). Other tribes (Chondrieae, Polyzonieae, Herposiphonieae, Lophothalieae) have been almost completely ignored in phylogenetic studies, and a molecular phylogeny of the whole family has never been attempted. Therefore, the current tribal classification of the family is still based almost entirely on morphological characters and the correlation between morphological and phylogenetic groups has not yet been tested.

Organellar phylogenomics is a valuable approach to resolving difficult phylogenies or deep level relationships in numerous groups of organisms (i.e. Ma et al. 2014, Lu et al. 2015, Leliaert et al. 2016). In the red algae, the chloroplast genome is very large (about 180 kb), with a highly conserved structure that includes the most diverse set of genes (about 200) known in the Archaeplastida (Janouškovec et al. 2013). However, red algae are still underrepresented in genome datasets, despite promising results whenever they have been applied to phylogenetic studies (Costa et al. 2016, Lee et al. 2016).

The objective of this work is to produce the first comprehensive molecular phylogeny of the Rhodomelaceae and use it to evaluate and update the high-level classification of the family. Our approach relied on resolving phylogenetic relationships among the major lineages of the Rhodomelaceae using phylogenomics based on 45 (42 newly sequenced) chloroplast genomes for selected representative taxa of the main clades of the family, as well as 11 chloroplast genomes of other Ceramiales (10 newly sequenced) to be used as outgroups. In order to get a better phylogenetic view on the rich species diversity of the family, we assembled a second dataset of 407 species in 89 genera based on more comprehensive sampling of the *rbc*L, 18S rRNA and *cox*1 genes, and constructed a phylogeny constrained using the genome-scale tree as a backbone. In order to re-evaluate the tribal classification of the Rhodomelaceae we interpreted both phylogenies along with morphological characters relevant to the delineation of tribes.

MATERIALS AND METHODS

Taxon sampling. To identify the main lineages of the family Rhodomelaceae we constructed an *rbc*L phylogenetic tree including the ca. 500 sequences available in GenBank, as well as ca. 1,000 new sequences generated in our study according to methods described in Saunders and McDevit (2012). In generating new sequences, we sampled extensively in Australia, where the diversity of the Rhodomelaceae is particularly high, with nearly all tribes represented, but from where very little molecular data were available. Using a preliminary tree from this densely sampled dataset, we selected one to four species of each major lineage for high throughput sequencing. For the highly diverse (300 spp.) yet very poorly resolved tribe Polysiphonieae, 14 species were sequenced. This resulted in a total of 52 selected species (42 Rhodomelaceae and 10 other Ceramiales as outgroup). Three previously recognized tribes (Pleurostichidieae, Heterocladieae and the parasitic Neotenophyceae) were excluded as we could not collect new material for them. These are small tribes, containing one, three and one species, respectively.

Data collection. Total DNA was isolated with an adapted cetyltrimethylammonium bromide (CTAB) protocol (Doyle and Doyle 1987). In summary, samples were incubated for an hour in CTAB buffer with proteinase K and extracted with 24:1 chloroform:isoamyl alcohol. DNA was precipitated using 80% isopropanol at 4°C for 1 h and eluted in 0.1 TE buffer.

Barcoded sequencing libraries (350 nt) of the 51 DNA extracts were prepared with the TruSeq Nano LT kit. Because the Verbruggen lab carries out organellar genome projects of both red and green algae, we pooled DNA extracts of red and green algae prior to library preparation, resulting in reduced costs, and the assembled genomes were separated using bioinformatics (e.g. Costa et al. 2016). Libraries were sequenced either on Illumina HiSeq 2000 at the Genome Center of the Cold Spring Harbor Marine Laboratory or Illumina NextSeq at Georgia Genomics Facility. Assembly and annotation of the genomes were performed as previously described (Verbruggen and Costa 2015, Marcelino et al. 2016). GenBank accession numbers for annotated genomes are provided in Table S3.

Sequence alignment and phylogenetic analyses. We assembled a dataset consisting of the 51 newly sequenced chloroplast genomes, an incomplete genome (*Polysiphonia teges*) for which we recovered 79 genes and the four genomes previously published for the order Ceramiales (Salomaki et al. 2015, Verbruggen and Costa 2015, Hughey and

Boo 2016). All protein-coding genes were aligned at the amino acid level using MAFFTv7.245 (Katoh and Standley 2013) using default settings and checked visually in Geneious 6.1.7. Nucleotide alignments were constructed based on the inferred amino acid alignments using TranslatorX (Abascal et al. 2010). Alignments were then concatenated and phylogenetic trees inferred with maximum likelihood (ML) in RAxML v8.0.26 (Stamatakis 2014) with GTR+Γ and CPREV+Γ+F models for the nucleotide and amino acid alignments, respectively, and using 100 traditional bootstrap replicates (Felsenstein 1985). Further analyses were carried out to assess the sensitivity of these analyses to model choice (LG, WAG) and partitioning of the data into codon positions.

While the chloroplast genome dataset serves to infer a solid backbone for the initial diversification of the family, it represents less than 5% of the species in the family. To obtain a tree with higher species diversity, we assembled a dataset containing 266 *rbc*L, 125 18S rRNA gene and 143 *cox*1 sequences for additional species, as well as 56 *rbc*L, 54 18S rRNA gene and 51 *cox*1 sequences for species included in the genome-scale phylogeny. Genbank accession numbers for these sequences are provided in Table S4. The total number of species in this tree was 418: 407 members of of the Rhodomelaceae and 11 representatives of related families as an outgroup. The three genes were available for 89 species, but there was a substantial amount of missing data in this matrix (45%). A binary constrained phylogeny was constructed using the RAxML chloroplast genome phylogeny based on the nucleotide alignment (constructed as explained above) as the backbone and adding the concatenated alignment with the *rbc*L, 18S rRNA gene and *cox*1 sequences. Data were analyzed using rapid bootstraping in RAxML and a GTR + CAT model (Stamatakis, 2014). Data were partitioned to allow the more densely sampled genes (*rbc*L, *cox*1 and 18S rRNA gene) to have different model parameters than the remaining genes from the chloroplast genome data. Furthermore, *cox*1 and *rbc*L genes were each divided into two partitions based on codon positions (1st + 2nd, 3rd).

RESULTS AND DISCUSSION

We determined 41 complete chloroplast genomes for the Rhodomelaceae, a partial genome for *Polysiphonia teges* (79 genes) and 10 complete genomes for other Ceramiales to be used as outgroups. The genomes were identical in structure to those previously reported for the group (Salomaki et al. 2015, Verbruggen & Costa 2015), and a detailed description of the new genomes will be provided elsewhere. For the purpose of this paper, we required only the gene data to build alignments, and from our 52 new genomes plus 4 downloaded from GenBank, a concatenated alignment of 56 taxa and 194 genes (146,187 nucleotides) was obtained.

Chloroplast phylogenomics resolved the relationships among the major lineages of Rhodomelaceae with full support for the vast majority of branches (Fig. 1). The topology was robust to analysing the data as nucleotides or amino acids (Fig. 1 *vs.* S1), different models of sequence evolution (WAG, LG; not shown) and partitioning strategies (genes, codon positions, both combined; not shown). The position of *Thaumatella adunca* is the only exception, as it was resolved with high support as sister to the Rhodomeleae in the nucleotide tree while its relationships within the family were unresolved in the amino acid tree (Fig. S1). These phylogenies include representative taxa for ten of the eleven tribes recognized in Falkenberg's (1901) classification, as well as for the Sonderelleae established by Phillips (2001). While a number of these tribes form well-supported clades in the genome-scale phylogenies, some split into different, unrelated lineages. For example, the genera *Digenea* and *Bryothamnion* are not closely related to other members of the Polysiphonieae where they are currently placed but form a separate, early-branching and well-supported lineage. Similarly, the genus *Thaumatella* is not grouped with the Lophothalieae but forms an early-branching lineage. We propose a new and the resurrection of an existing tribe for both of these early-branching lineages. The Polysiphonieae as traditionally defined forms a monophyletic clade with 96% bootstrap support in our tree, but it consists of two divergent lineages and we propose their recognition as tribes (Streblocladieae and Polysiphonieae). *Ophidocladus*, previously thought to be related to genera belonging to the Polysiphonieae, is resolved as an isolated taxon that should also be placed in its own tribe. *Herposiphonia* and *Dipterosiphonia*, two lineages currently in the Herposiphonieae, are grouped together in the trees but with poor support in the nucleotide phylogeny (66%, Fig. 1), and we propose to place them in separate tribes. The delineation of these four new tribes and the Alsidieae is further discussed below. The proposals to divide the family into three subfamilies (Bostrychioideae, for the tribe Bostrychieae; Rhodomeloideae, for the tribes Rhodomeleae, Lophothalieae, Heterocladieae and Polyzonieae; and Polysiphonioideae, for the tribes Amansieae, Chondrieae, Laurencieae, Lophosiphonieae nom. nud., Pleurostichidieae, Polysiphonieae, Pterosiphonieae and Streblocladieae nom. nud.; Hommersand 1963) or two subfamilies (Bostrychioideae for the tribe Bostrychieae, and Rhodomeloideae for the other tribes; Maggs and Hommersand 1993) are not supported in the genome-scale phylogeny.

With the aim of getting a more comprehensive phylogenetic view of this species-rich family, we constructed a constrained tree using the nucleotide genome-scale tree as backbone and adding 266 *rbc*L, 125 18S rRNA gene and 143 *cox*1 sequences corresponding to 407 species and 89 genera of the Rhodomelaceae (Fig. S2). A schematic representation of the tree (Fig. 2) shows that while it is congruent with the genome-scale tree, many branches were resolved with only moderate or low bootstrap support. In this tree we recognized the same tribes from the genome-scale tree except for Bostrychieae, which was paraphyletic with respect to Heterocladieae. In addition, there was a range of additional early-branching lineages without close relatives. These include the formerly recognized tribes Pleurostichidieae and Heterocladieae, the genus *Ophidocladus*, for which we propose the tribe Ophidocladeae, *Thaumatella*, for which we propose the Thaumatelleae and *Cladurus*, for which we propose the Cladureae. There were also three early-branching species (*Micropeuce strobiliferum*, *Heterodasya mucronata* and *Wilsonosiphonia howei*) whose tribal assignment requires further work. The Heterocladieae was resolved among taxa of the Bostrychieae, rendering the latter paraphyletic. However, support for this placement was very low, and it most probably resulted from missing data, because only 18S rRNA gene sequences were available for the Heterocladieae, and there were only five 18S rRNA gene sequences for the Bostrychieae (*Bostrychia simpliciuscula*, *B. tenella*, of the Peripherohapteron clade in Fig. S2; and *B. moritziana*, *Bostrychiocolax* and *Dawsoniocolax* of the Cladohapteron clade in Fig. S2).

Below we discuss in more detail the classification that emerged from our phylogenies. We will present the groups in the order they appear in Fig. 2, from the bottom upwards. Each tribe is morphologically defined by a combination of vegetative and reproductive characters and for detailed descriptions for previously established tribes we refer to Falkenberg (1901), Hommersand (1963), Womersley (2003) and for the Sonderelleae to Phillips (2001). The brief descriptions provided below for each tribe are intended to highlight easily recognizable characters, as well as propose new key characters needed to delineate some tribes. A summary of the key morphological characters delineating tribes is presented in Table S5. More detailed descriptions of the new tribes are provided in the “Formal taxonomy” section at the end of the paper.

The Sonderelleae is an endemic Australasian tribe that includes two monospecific genera (*Sonderella* and *Lembergia*). Thalli consist of linear blades with a dorsiventral structure formed by three or four pericentral cells, the two laterals producing the ecorticate blade, and one or two pseudopericentrals. They lack trichoblasts; procarps and spermatangia are formed on the blade surface; and there are two tetrasporangia per segment in stichidia. Before placement in their own tribe by Phillips (2001) based on an 18S rRNA gene phylogeny, *Sonderella* and *Lembergia* had been thought to be related respectively to the tribe Amansieae (Lindauer 1949, Harvey 1859, Womersley 1965, 2003) and the family Delesseriaceae (Schmitz 1889, Saenger et al. 1971). Both species of the Sonderelleae were represented in the taxon-rich tree and the tribe was resolved as monophyletic with high support (Figs. 2 and S2). The genome-scale tree included *Sonderella*, and evidenced its sister relationship with the tribe Polyzonieae. Phillips (2001) had already predicted this because these are the only two tribes of the family in which three pericentral cells can be observed in certain vegetative structures of some species.

The Polyzonieae includes 17 species in five genera (*Cliftonaea*, *Dasyclonium*, *Echinosporangium*, *Leveillea* and *Polyzonia*) with an Indo-Pacific distribution, characterized by an elaborate structure. Thalli are strongly dorsiventral and consist of indeterminate ecorticate or corticate axes with 6 or 7 pericentral cells, bearing determinate laterals in a regular pattern. The determinate laterals have 3 pericentral cells and are simple, branched or foliose. Trichoblasts are persistent and pigmented (*Cliftonaea* and *Echinothamnion*), deciduous and unpigmented (*Leveillea*) or absent

(*Dasyclonium* and *Polyzonia*). Spermatangial structures arise on determinate laterals with a sterile marginal flank, procarps and cystocarps are formed on branches or on the basal cell of a trichoblast, and the tetrasporangia are in stichidia. The genome-scale tree resolved *Cliftonaea pectinata* and *Dasyclonium flaccidum* in a strongly supported clade (Fig. 1). Likewise, our taxon-rich tree including representatives of four genera resolved the Polyzonieae as monophyletic, although with low support (Figs. 2 and S2). Our results are in line with the general agreement regarding the generic composition of the tribe (Falkenberg 1901, Scagel 1953, Hommersand 1963). Interestingly, our data revealed significant cryptic diversity in *Dasyclonium incisum* (three species from Australia and one from South Africa – *rbc*L sequence divergence > 2.7 %), as well as in *Leveillea jungermannioides* (two species from Australia differing from a Korean specimen – sequence divergence > 2.1 %; the type locality is in the Red Sea).

The Heterocladieae is an Australian tribe with three species in the single genus *Heterocladia*, the delineation of which has been widely accepted in all previous classifications (Falkenberg 1901, Hommersand 1963, Phillips et al. 2000). It is distinguished from other Rhodomelaceae by having four pericentral cells that divide longitudinally forming 7-8 cells around the axial cell, with cortical and rhizoidal cells giving rise to a pseudoparenchymatous thallus that bears pigmented trichoblasts. The procarps and spermatangial branches are formed on trichoblasts and one tetrasporangium per segment develops in stichidia. Our taxon-rich tree included 18S rRNA gene sequences for the three known species and, in agreement with Phillips et al. (2000), the tribe was resolved as monophyletic (Figs. 2 and S2). However, it was placed together with members of the Bostrychieae in an unsupported clade, which is probably an artifact resulting from missing data. Therefore, the relationship of this tribe to other members of the family should be considered unresolved.

All earlier classifications recognized the Bostrychieae for the genus *Bostrychia*, as it is clearly distinguished morphologically from other Rhodomelaceae (Falkenberg 1901, Hommersand 1963). It is distributed worldwide, often in brackish environments, and is mainly characterized by its filiform habit, consisting of axes with pericentral cells dividing transversely to form tiers, the basal cell of which remains pit-connected with the axial cell. *Bostrychia* lacks trichoblasts, but has monosiphonous branches. The spermatangia and procarps are formed on determinate branches, with a particular development of female structures, and tetrasporangia form in whorls in stichidia. Furthermore, the two parasitic genera *Dawsoniocolax* and *Bostrychiocolax* were included in the tribe based on their phylogenetic affinities (Zuccarello et al. 2004). The three *Bostrychia* species for which we obtained the complete chloroplast genome were resolved in a strongly supported clade (Fig. 1). In the taxon-rich tree (Figs. 2 and S2) all *Bostrychia* species were placed together in an unsupported clade, which in turn contains two major clades, a species without close relatives and the Heterocladieae. The first clade, which was poorly supported, was composed of 17 species of *Bostrychia* (Peripherohapteron-clade in Fig. S2), but the second one received high support, and contained eight *Bostrychia* species and the two monospecific parasitic genera *Dawsoniocolax* and *Bostrychiocolax* (Cladohapteron-clade in Fig. S2). These clades were named from and are in agreement with the two major groups delineated in the Bostrychieae based on the anatomy of attachment organs: peripherohapteron and cladohapteron (Zuccarello and West 2006). As discussed above, and considering the clear morphological differences, the positioning of the Heterocladieae among the Bostrychiae is very likely to be an artifact explained by the lack of overlapping markers from the two tribes in our dataset.

The tribe Lophothalieae included ten genera in Falkenberg´s (1901) classification. Subsequently, Hommersand (1963) added another 14, seven that had been placed in different tribes by Falkenberg and seven described since 1901. Later, five newly described genera were allocated to this tribe (Joly and Oliveira Filho 1966, Wynne and Norris 1982, Noble and Kraft 1983, Millar 2000a, Huisman 2001). More recently, the two *Brongniartella* species were transferred to *Vertebrata* in the Polysiphonieae (here Streblocladieae), based on phylogenetic studies (Díaz-Tapia et al. 2017b). Therefore, the Lophothalieae currently encompasses 28 genera, each containing only 1 to 7 species. The tribe is distributed worldwide and mainly characterized by thalli consisting of terete and radially branched axes that bear pigmented and persistent trichoblasts. Genera are delineated by characters such as the presence and degree of cortication, number of pericentral cells, trichoblast anatomy, number of sterile groups in procarps, tetrasporangial arrangement, and number and origin of cover cells (pre- or post-sporangial; Parsons 1975, Millar 2000a, Womersley 2003). On the other hand, nine genera are parasites and Hommersand (1963) placed them in this tribe mainly because they form tetrasporangia in stichidia. Our taxon-rich tree (Fig. S2) resolved with moderate support a clade including *Lophothalia hormoclados*, as well as species of *Doxodasya*, *Lophocladia*, *Murrayella*, *Spirocladia* and *Wrightiella*. This clade is represented in our genome-scale tree by *Lophocladia kuetzingii* and its phylogenetic relationships within the family are still unclear (Fig. 1). Furthermore, *Heterodasya mucronata* and *Micropeuce strobiliferum* are two rogue taxa in the taxon-rich tree placed as sisters to the Alsidieae and the Ophidocladeae with low support (Figs. 2 and S2). More gene sequences are needed to resolve the phylogenetic relationships of these two taxa and clarify whether they are in the Lophothalieae or if they should be placed in different tribes.

Our phylogenies showed that the tribe Lophothalieae is not monophyletic as currently circumscribed. In addition to the above-mentioned clade and these two rogue taxa, *Thaumatella* (*Veleroa) adunca* was placed as sister to the Rhodomeleae with strong support in the genome-scale tree (Fig. 1). These results, together with the placement of *Brongniartella* in *Vertebrata* (as *V. byssoides* and *V. australis* in Fig. S2, Díaz-Tapia et al. 2017b), demonstrate that pigmented and persistent trichoblasts have evolved independently in several lineages of the family and further morphological traits are needed to redefine the tribe. Two schemes for subdividing the Lophothalieae have been proposed, though not generally accepted. Parsons (1975) segregated the Brongniartelleae from the Lophothalieae based on the number of sterile groups in the procarps (2/1); the absence/presence of post-sporangial tetrasporangial cover cells; and trichoblasts branched in a single plane/spirally branched/unbranched. However, Womersley and Parsons (2003) merged them again into a single tribe, suggesting that a tribal character may be the formation of tetrasporangia in stichidia without trichoblasts (*Lophocladia*, *Haplodasya*) *vs.* tetrasporangia on normal branches. This second proposal is not supported in our phylogeny, as *Lophocladia* is closely related to *Spirocladia barodensis* which has tetrasporangial stichidia bearing trichoblasts. Interestingly, and despite the fact that the Brongniartelleae is not supported in our phylogeny as a monophyletic taxon, four genera (*Brongniartella*, *Micropeuce*, *Veleroa* and *Heterodasya,* among the five currently recognized) that Parsons attributed to this tribe, and are represented in our taxon-rich tree, were not placed in the Lophothalieae clade. Therefore, the morphological delineation proposed by Parsons (1975) for the Lophothalieae is consistent with our phylogenies. However, some of the key reproductive characters are poorly known in several species or genera, our analysis only included representatives of nine of 19 non-parasitic genera currently assigned to the tribe, and the phylogenetic relationships of *Micropeuce* and *Heterodasya* are unresolved. Therefore, it is not yet possible to provide an accurate delineation for the Lophothalieae and further morphological and molecular studies are needed to clarify the systematics of this group. The systematics of *Thaumatella (Veleroa) adunca*, a morphologically distinctive species with respect to other Lophothalieae, is discussed below.

The circumscription of the Amansieae is identical in Falkenberg (1901) and Hommersand (1963), who both assigned nine genera to this tribe. Four new genera have subsequently been included in the Amansieae (Wilson and Kraft 2000, Phillips 2002b, 2006). The tribe includes about 60 species, and is particularly diverse on Australian and South African shores. It is characterized by pseudoparenchymatous thalli, mostly complanate or leaf-like, with strong dorsiventrality involving trichoblasts arising adaxially at the apices and, in most species, the differentiation of pericentral cells into lateral, dorsal and ventral positions. The procarps and spermatangial branches are formed on modified trichoblasts and the tetrasporangia, two per segment, usually form in stichidia. Our genome-scale and taxon-rich trees (Figs. 1, 2 and S2), including representatives of two and 13 genera, respectively, resolved the Amansieae as monophyletic with strong support. Although relationships among species within the tribe in the taxon-rich tree are in general not well supported, our data suggest that a revision is needed at generic level, as *Amansia*, *Vidalia* and *Osmundaria* are apparently not monophyletic.

The monospecific genus *Cladurus*, endemic to Australia, was included in the tribe Chondrieae in earlier classifications (Falkenberg 1901, Hommersand 1963). However, Gordon-Mills and Womersley (1987) and Womersley (2003) considered that it did not belong to this tribe because spermatangial branches are cylindrical instead of plate-like, as is characteristic in the Chondrieae. Furthermore, this genus is distinguished from other Rhodomelaceae by its terete thalli with five pericentral cells, pseudoparenchymatous construction with light cortication so that the segments are conspicuous in surface view in branches, cystocarps arising on short axillary branches and tetrasporangia borne in stichidia. This species was only included in the taxon-rich tree, where it was placed as sister to the Alsidieae, but with low support. Considering the peculiar morphological characters of this genus and its ambiguous relationships with other members of the family, we propose the Cladureae trib. nov.

The small genera *Alsidium*, *Bryothamnion* and *Digenea* (8, 3 and 2 species respectively) were previously included in the Polysiphonieae (Falkenberg 1901, Hommersand 1963). The genome-scale tree (Fig. 1) placed *Bryothamnion* and *Digenea* in a single clade with strong support, sister to the clade formed by the Chondrieae and Laurencieae. The taxon-rich phylogeny (Fig. S2) resolved *Alsidium*, *Bryothamnion* and *Digenea* in a moderately supported clade. These three genera have pseudoparenchymatous thalli with 5-12 pericentral cells, forming axes of indeterminate growth usually clothed with short determinate branches. Furthermore, they differ from the Polysiphonieae by having plate-like spermatangial branches without sterile margins (Falkenberg 1901, Børgesen 1920, Norris 1994). These spermatangial branches resemble the typical ones of the Chondrieae, however, in the Chondrieae they have marginal sterile cells and all species have 5 pericentral cells. Therefore, based on the morphology and the phylogeny we propose the resurrection of the tribe Alsidieae for these three genera (discussed in the formal taxonomic treatment below). According to the taxon-rich tree, two main clades are resolved in the tribe and *Alsidium* is not monophyletic. Considering that *A. corallinum* from the Mediterranean is the type of the genus, *A. cymatophilum* from

Hawaii must be transferred to *Digenea*. Furthermore, the separation between *Bryothamnion* and *Alsidium* requires further investigation.

Generic composition of the Chondrieae was very similar in Falkenberg´s (1901) and Hommersand´s (1963) classifications. Falkenberg included six genera, one later transferred to the Lophothalieae by Hommersand (1963), who also added two newly described genera. Subsequently, *Waldoia* and the parasitic genera *Ululania*, *Benzaitenia* and *Jantinella* were included in this tribe (Taylor 1962, Morrill 1976, Apt and Schlech 1998, Kurihara et al. 2010). The genome-scale phylogeny (Fig. 1) includes three *Chondria* species that consitute a monophyletic clade. Similarly, the taxon-rich phylogeny (Fig. S2) includes representatives from nine of the 11 genera currently assigned to the tribe which, except for *Cladurus* (see above), are resolved in a monophyletic clade with moderate support. Our data also suggest that the tribe requires a revision at the genus level because neither *Chondria*, currently including 80 species, nor *Acanthophora* (7 species), is monophyletic.

The tribe Laurencieae was likewise very similar in generic composition in Falkenberg´s (1901) and Hommersand´s (1963) classifications, encompassing the large genus *Laurencia* (145 currently recognized species), *Rodriguezella* and the parasitic *Janczewskia*. Subsequently, six other genera were reinstated or segregated for groups of species previously assigned to *Laurencia* (Nam et al. 1994, Martin-Lescanne et al. 2010, Cassano et al. 2012, Nam 2007, Metti et al. 2015, Rousseau et al. 2017). The genome-scale and taxon-rich phylogenies (Figs. 1 and S2), with representatives of seven genera, resolved all members of the tribe as a single clade that respectively received high or moderate support.

A close relationship between the Chondrieae and Laurencieae was previously predicted in evolutionary reconstructions of the family based on morphological characters

(Falkenberg 1901, Hommersand 1963) and is strongly supported in our phylogenies (Figs. 1 and 2). Both tribes are distributed worldwide and characterized by pseudoparenchymatous thalli, such that the segments and pericentral cells are not distinguishable in surface view. They differ in the number of pericentral cells (5 in the Chondrieae and 2 or 4 in the Laurencieae) and the anatomy of the male structures (plate-like spermatangial branches with sterile marginal cells in the Chondrieae and modified trichoblasts or filaments immersed in apical depressions in the Laurencieae).

Ophidocladus simpliciusculus was included in Falkenberg´s (1901) classification in the "*Lophosiphonia* group" (Lophosiphonieae nom. nud. in Hommersand 1963), a group of genera with dorsiventral prostrate and erect ecorticate terete axes and exclusive production of endogenous branches. Although this group resembles various tribes in some of its characters, it could not be assigned to any of them (Falkenberg 1901). *O. simpliciusculus* is separated out in our genome-scale and taxon-rich phylogenies (Figs. 1 and 2) and it has numerous characters that make it unique within the family, such as a large axial cell surrounded by up to 28 pericentral cells, alternately arranged trichoblasts and spermatangial structures covering the two basal dichotomies of a trichoblast (Saenger 1971, Díaz-Tapia and Bárbara 2013). On the basis of its morphology and our molecular evidence we propose Ophidocladeae trib. nov. for this monospecific genus.

The genus *Veleroa* is currently placed in the tribe Lophothalieae (Dawson 1944, Hommersand 1963); *V. adunca* is the only one of the seven species in this genus included in our analysis (as *Thaumatella adunca*; see below). It was placed as a taxon without close relatives, sister to the Rhodomeleae, with high and moderate support in the genome-scale and taxon-rich trees (Figs. 1 and 2), respectively. The type species of *Veleroa* is *V. subulata* from California and the genus is characterized by ecorticate axes with four pericentral cells, pigmented unbranched trichoblasts and one tetrasporangium per segment on branches bearing trichoblasts (Dawson 1944). *Veleroa adunca*, by contrast, has branched trichoblasts (Womersley and Parsons 2003). Furthermore, the detailed description of *V. subulata* (Abbott and Ballantine 2012) based on topotype material reveals additional important differences between them. *V. adunca* has rhizoids cut off from a single pericentral cell as multicellular, but uniseriate, filaments that terminate in a multicellular discoid pad (Fig. 2H); rhizoids in *V. subulata* have multiseriate rhizoidal filaments formed from two adjoining pericentral cells (Abbott and Ballantine 2012, Fig. 2N). Also, the spermatangial organs differ in these species – they are ovoid, with a single basal sterile cell in *V. adunca*, while they are cylindrical with long basal and apical sterile filaments in *V. subulata*. When Womersley and Parsons (2003) transferred *Dasya adunca* to *Veleroa* they also placed *Thaumatella disticha*, the type of the genus, in synonymy. They argued that the characters used by Kylin (1956) to separate *Thaumatella* from *Veleroa*, i.e. branching patterns, were misinterpreted. However, differences in the anatomy of rhizoids and spermatangial organs suggest that *V. adunca* and *V. subulata* most probably belong to different genera. Therefore, we propose to resurrect the genus *Thaumatella* for *Veleroa adunca*. Furthermore, considering the position of this species in the phylogeny and its unique rhizoid anatomy [differing from other *Veleroa* – see also *V. mangeana* (Millar 2000b, Schneider et al. 2010) – and members of the Lophothalieae, when information is available], we propose the Thaumatelleae trib. nov.

The Rhodomeleae includes *Rhodomela* and *Odonthalia*, both placed in this tribe by Falkenberg (1901) and Hommersand (1963), as well as the subsequently described *Neorhodomela* (Masuda 1982) and *Beringiella* (Wynne 1980). Their distribution is restricted to cold shores of the Northern Hemisphere. They are characterized by having pseudoparenchymatous thalli, with 6-7 pericentral cells dividing transversely and the apical cell retaining the pit connection with the axial cell. The taxon-rich tree (Fig. 2), including representatives of three genera, resolves the tribe in a highly supported clade. Furthermore, three parasites (*Harveyella*, *Leachiella* and *Choreocolax*), whose placement in the Rhodomelaceae was clarified in Zuccarello et al. (2004), were also resolved in this tribe in our phylogeny. The tribe is represented in the genome-scale tree (Fig. 1) by *R. confervoides* and *C. polysiphoniae* and was placed as sister to *Thaumatella* and in turn to the Polysiphonieae.

The Pterosiphonieae was erected by Falkenberg (1901) for six genera that share a bilateral branching pattern, with the branches congenitally fused to the main axes to a varying extent, ranging from filiform to foliose thalli. They have procarps and spermatangia on modified trichoblasts and tetrasporangia on lateral branches. Hommersand (1963) pointed out that *Tayloriella*, *Rhodomelopsis* and *Carradoria* (as *Carradoriella*) of the Polysiphonieae, all erected after 1901, must be in this tribe although they lack congenital fusion of branches. Consequently, he redefined the tribe mainly by the alternate-distichous branching pattern and the absence of vegetative trichoblasts, and he transferred *Aphanocladia* and *Pollexfenia* to the Polysiphonieae. Only two genera have subsequently been placed in this tribe, *Xiphosiphonia*, recently segregated from *Pterosiphonia,* and *Heterostroma* (Kraft and Wynne 1992, Savoie and Saunders 2016).

The taxon-rich tree (Fig. S2), including 10 representatives of the 12 genera assigned to the tribe at one time, resolved a moderately supported clade comprising *Pterosiphonia* and seven other genera previously assigned to the Pterosiphonieae. However, *Pterochondria* and *Carradoria* (as *P. virgata*) were placed in the Polysiphonieae (here clade Streblocladieae) despite having the characters of the tribe Pterosiphonieae. Furthermore, the clade Pterosiphonieae included five additional genera, *Lophurella*, *Echinothamnion* and *Periphykon*, currently included in the Polysiphonieae, *Gredgaria* of the Herposiphonieae and *Womersleyella* currently lacking tribal assignment. Also, an unidentified species of Pterosiphonieae was resolved in this clade with high support, and three other *Polysiphonia*-like species were placed as sister to this clade with low support (their taxonomic identity at generic and species level requires further work).

This tribe is represented in the genome-scale tree (Fig. 1) by members of four genera (*Symphyocladia*, *Dictyomenia*, *Periphykon* and *Gredgaria*) that form a strongly supported clade, which in turn is sister with moderate support to the clade formed by two *"Polysiphonia"* spp. Among the genera placed for the first time in the Pterosiphonieae, *Gredgaria* is the only one that meets Falkenberg´s or Hommersand´s criteria for delineating the tribe, despite being included by Womersley (2003) in the Herposiphonieae. By contrast, the other genera or species have trichoblasts, and/or branches spirally arranged and not congenitally fused with the main axes (Hollenberg 1967, Womersley 2003, P. Díaz-Tapia, pers. obs.). Therefore, the morphological criteria used for distinguishing the Pterosiphoniae from the Polysiphonieae are not supported. While all genera with an alternate branching pattern and congenitally fused branches are in the Pterosiphonieae (except *Pterochondria*), the tribe also includes several members with spirally arranged branches not congenitally fused with the main axes. Also the presence/absence of trichoblasts varies among members of the tribe. However, a character that we found uniformly in all the species placed in this tribe in our phylogeny is that rhizoids are cut off from the distal (and proximal in *Gredgaria* and Pterosiphonieae sp.) ends of the pericentral cells, and the rhizoidal filament terminates in several cells forming a multicellular discoid pad (Fig. 2E-G). This character is distinctive with respect to the Polysiphonieae and Streblocladieae, in which the rhizoids are unicellular and are formed from the mid-proximal ends of the pericentral cells.

Lampisiphonia is the only known exception among the species placed in the Streblocladieae in our phylogeny, as it has multicellular rhizoids (some rhizoids of the thallus have multicellular filaments, and discoid pads are multicellular when mature). However, they are formed from the proximal ends of the pericentral cells (Fig. 2B, Bárbara et al. 2013, P. Díaz-Tapia, pers. obs.).

The Herposiphonieae is found worldwide and is characterized by a dorsiventral and filiform habit, thalli consisting of ecorticate axes with 4-16 pericentral cells and the exclusive production of endogenous branches with defined sequences of determinate and indeterminate branches. Procarps and spermatangia are formed on modified trichoblasts and tetrasporangia on determinate branches. The tribe was erected by Falkenberg (1901) for seven genera, but Hommersand (1963) merged it with the Polysiphonieae, distinguishing the genera of this tribe as "dorsiventral Polysiphonieae". *Streblocladia* and the parasite *Microcolax* were moved to a separate "Gruppe" by Kylin (1956), which was recognized as the tribe Streblocladieae nom. nud. by Hommersand (1963), as discussed below. On the other hand, four genera described since 1963 (*Herposiphoniella*, *Ditria*, *Gredgaria* and *Tiparria*) have been attributed to the Herposiphonieae (Hollenberg 1967, Womersley 2003). In summary, nine genera are currently assigned to the tribe Herposiphonieae, of which *Herposiphonia* contains 56 species, *Dipterosiphonia* seven and the other genera only one to three species. They are distinguished by distinct branching patterns. Three of them were included in our analysis, but *Gredgaria* was transferred to the Pterosiphonieae (see above). The other two, *Herposiphonia* and *Dipterosiphonia*, were placed together in a poorly supported clade, sister to the Pterosiphonieae in the genome-scale tree (Fig. 1). The taxon-rich tree placed them, with *Wilsonosiphonia* and *Pleurostichidium*, in a poorly supported clade (Fig. 2).

Pleurostichidium is a morphologically very distinctive monospecific genus placed in its own tribe, the Pleurostichidieae, for which Phillips (2000) provided a detailed characterization. Considering that the Dipterosiphonieae and Herposiphonieae clades are strongly supported, the early divergence of these two lineages as well as the Pleurostichidieae, and the extent to which *Pleurostichidium* differs morphologically from the Herposiphonieae, we propose the segregation of the tribe Dipterosiphonieae from the Herposiphonieae. The tribal assignment of *Wilsonosiphonia* requires a better understanding of its phylogenetic relationships and further studies using more gene data are needed. The Dipterosiphonieae and Herposiphonieae differ from the Polysiphonieae and share with the Pterosiphonieae rhizoids cut off from the distal end of pericentral cells. All have multicellular discoid pads, which have the same structure in the Dipterosiphonieae and Pterosiphonieae. By contrast, in the Herposiphonieae, discoid pads consist of a digitate structure formed by an extension of the rhizoidal filament that divides to form small apical cells (Fig. 2D). Furthermore, the Herposiphonieae is characterized by its distinctive regular pattern of the formation of determinate and indeterminate branches, often in a 3:1 sequence. The tribe Dipterosiphonieae, by contrast, is distinguished by producing alternate pairs of determinate branches. However, as only seven species are currently known, it remains to be determined whether this branching pattern applies more generally.

The Polysiphonieae is the largest tribe of the Rhodomelaceae and has a worldwide distribution. Falkenberg (1901) included 11 genera characterized by filiform thalli, heavily corticated in a few species, with branches radially organized and trichoblasts deciduous and unpigmented. Subsequently, another 11 newly described or resurrected genera, three of them parasitic, were included in this tribe. While some genera in this tribe (*Echinothamnion*, *Lophurella*, *Digenea*, *Alsidium*, *Bryothamnion*) are here transferred to other tribes (see discussion on Alsidieae and Pterosiphonieae), the vast majority are placed in a monophyletic clade that was resolved with high and moderate support in the genome-scale and taxon-rich phylogenies, respectively (Figs. 1, 2 and S2, Streblocladieae and Polysiphonieae clades). Two major lineages were resolved within this clade and we propose to segregate the tribe Streblocladieae from the Polysiphonieae. They are distinguished by the synapomorphic trait of having rhizoids cut off from the mid-proximal end of the pericentral cells (Streblocladieae, Fig. 2A) *vs.* rhizoids in open connection with the pericentral cells (Polysiphonieae, Fig. 2C; Kim and Lee 1999, Choi et al. 2001, Díaz-Tapia et al. 2017b).

The Polysiphonieae clade contains the type of the genus *Polysiphonia* (*P. stricta*) and it was termed *Polysiphonia sensu stricto* in previous phylogenetic studies of the tribe (Choi et al. 2001, Bárbara et al. 2013, Díaz-Tapia et al. 2017b). These studies emphasized the existence of two major clades within *Polysiphonia sensu stricto* (here named *Polysiphonia* and *Bryocladia*/*Falkenbergiella* in Fig. S2), and they were resolved as monophyletic or paraphyletic in previous works depending on the taxon selection and the molecular marker(s) considered. *Polysiphonia* and *Bryocladia*/*Falkenbergiella* are represented in our genome-scale tree by *P. stricta* and *P. scopulorum* Harvey and are definitively resolved as a monophyletic clade sister to Streblocladieae (Fig. 1). In the taxon-rich tree (Fig. S2) *Polysiphonia* and *Bryocladia*/*Falkenbergiella* contain eight and 10 species and are resolved as two highly supported clades. The clade containing *P. stricta* corresponds to the genus *Polysiphonia* and all the species have four pericentral cells, are decumbent or erect and have predominantly exogenous branches. The other clade is morphologically more variable and includes species with a dorsiventral or radial structure, with predominantly exogenous or endogenous branches, and with four or more (*Bryocladia*) pericentral cells. The generic assignment of this second clade requires further studies including analysis of material of *Falkenbergiella capensis* from South Africa (currently included in *Lophosiphonia*), with morphological traits (four pericentral cells, dorsiventral, with endogenous branches) that indicate it may be included in this clade, and the scarcely known *Bryocladia cervicornis* from Java. These two species are the types of their corresponding genera, *Bryocladia* pre-dating *Falkenbergiella*.

In addition to these two previously recognized groups in *Polysiphonia sensu stricto*, *P. teges* was also resolved in this clade (Fig. 1). In the taxon-rich phylogeny (Fig. S2), *P. teges* is closely related to *Lophosiphonia simplicissima* and *L. obscura* sensu Kylin (1956, with six pericentral cells; see Rueness 1971, Silva 1996, Díaz-Tapia and Bárbara 2013, for a further discussion on the taxonomic identity of this species), the type species of *Lophosiphonia*. We propose to maintain the generic attribution of this clade to *Lophosiphonia* and transfer *P. teges* to this genus. *Lophosiphonia* was erected by Falkenberg (in Schmitz and Falkenberg 1897) to group species with a secondary dorsiventral structure and predominantly endogenous branches. However, the validity of this circumscription has been discussed (Díaz-Tapia and Bárbara 2013 and references therein) and finally rejected on the basis of molecular and morphological evidence, as species meeting these criteria have very different affinities with other members of the Polysiphonieae (e.g. *L. reptabunda* is in *Vertebrata* and *L. scopulorum* in *Bryocladia/Falkenbergiella*). The main character distinguishing *Lophosiphonia sensu stricto* from the Streblocladieae is that rhizoids are in open connection with the pericentral cells (P. Díaz-Tapia & C.A. Maggs, pers. obs.). It differs from other Polysiphonieae by having more than four pericentral cells (*Bryocladia* is an exception). Furthermore, the characters proposed by Falkenberg to delineate this genus are shared by all members of the clade, and are also present in other genera. *Lophosiphonia* *prostrata* is also resolved as sister to this clade but with moderate support and it differs from other *Lophosiphonia* species because it is always epiphytic on brown algae in the Zonarieae, with the apices curled over the host, growing synchronously with it, and is completely prostrate except for the branches bearing reproductive structures (Womersley 2003, P. Díaz-Tapia, pers. obs.). We propose *Epizonaria* gen. nov. for this species. Our phylogenies reveal that Falkenberg´s "*Lophosiphonia* group" (equivalent to Hommersand´s tribe Lophosiphonieae nom. nud.) is not phylogenetically supported, as the type species of the genus *Lophosiphonia* is placed with high support in the Polysiphonieae. Among the genera included in the *Lophosiphonia* group by Falkenberg, *Ctenosiphonia* has been merged with *Vertebrata* (Díaz-Tapia et al. 2017b) and *Pleurostichidium* and *Ophidocladus* represent separate tribes (Hommersand 1963, present work). Finally, in addition to the three clades discussed above, three small unidentified *Polysiphonia*-like species collected on Australian coral reefs and at Rottnest Island (Western Australia) were resolved as sisters to the *Bryocladia*/*Falkenbergiella* clade with low support. They are very similar in morphology to other small Polysiphonieae, as they have four pericentral cells and unicellular rhizoids in open connection to pericentral cells. They may constitute new genera, but further studies are required.

The Streblocladieae clade includes eight genera, as well as a number of clades and taxa for which generic assignment needs further investigation. The parasite *Aiolocolax pulchellus* was placed in this clade but with low support. Previously this species was considered *incertae sedis*, even at family level (Pocock 1956). Here, we propose the tribe Streblocladieae for this clade. This name was used before by Kylin (1956, as *Streblocladia* "Gruppe") and by Hommersand (1963, Streblocladieae nom. nud.) but, as discussed above, we propose a different circumscription, defined by unicellular rhizoids cut off from the mid-proximal ends of pericentral cells. Kylin´s and Hommersand's concept was of a tribe containing species similar to *Polysiphonia* but with primary dorsiventrality, which is not supported in our phylogeny. The genus *Streblocladia*, including the type species *S. glomerulata*, is placed among radially branched species in phylogenetic analyses (Díaz-Tapia et al. 2017b, Fig. S2).

CONCLUSIONS

The phylogenies presented here are based on the most comprehensive molecular dataset analyzed to date for the family Rhodomelaceae, both in terms of number of genes (198 for the genome-scale phylogeny) and number of taxa (407 for the taxon-rich phylogeny). The relationships among the major clades of the family received very strong support in the genome-scale phylogeny including 44 species from 16 tribes (11 previously established and five proposed here), demonstrating the strength of chloroplast genome data to resolve challenging phylogenies in the red algae. Conversely, the taxon-rich phylogeny resolved the majority of branches with moderate to low support, suggesting that the chloroplast genomes of many more species are required to fully understand the phylogeny of the family. An integrative analysis of the two phylogenies and the morphological characters of the identified lineages have led us to thoroughly evaluate previous classification schemes and propose the first subdivision of the family Rhodomelaceae into tribes supported by molecular data.

The genome-scale and taxon-rich molecular phylogenies of the family Rhodomelaceae supported recognition of the 12 tribes previously proposed in Falkenberg´s (1901) and Hommersand´s (1963) classifications, as well as the tribe Sonderelleae (Phillips 2001). By contrast, the Lophosiphonieae and the division of the family into subfamilies proposed by Hommersand (1963) and Maggs and Hommersand (1993) were not supported. Our analysis, representing 89 genera of the Rhodomelaceae, corroborates the previously established circumscriptions of the tribes Sonderelleae, Polyzonieae, Heterocladieae, Bostrychieae, Amansieae, Rhodomeleae, Chondrieae (except *Cladurus*, as predicted by Womersley 2003), Laurencieae and Pleurostichidieae. A very different scenario emerged for the tribes Lophothalieae, Pterosiphonieae, Herposiphonieae and Polysiphonieae. Not surprisingly, these four tribes include most of the members of the family with terete ecorticate or slightly corticate filiform thalli (apart from the Bostrychieae and some Polyzonieae), the simplest morphological architecture in the Rhodomelaceae.

A tribe is resurrected (Alsidieae) and three new tribes are here proposed (Dipterosiphonieae, Thaumatelleae and Streblocladieae) to accommodate genera previously placed in the Lophothalieae, Herposiphonieae, Polysiphonieae and Pterosiphonieae. Furthermore, several genera are transferred from the Polysiphonieae (and Streblocladieae) to the Pterosiphonieae and *vice versa*. Therefore, the morphological delineation of these tribes requires reassessment and we propose rhizoid anatomy as a key diagnostic character. Free rhizoids are the attachment structures of most Rhodomelaceae, while basal discs have evolved in the largest species. Although rhizoids are small structures, they are morphologically very variable, as previously described (e.g. Hollenberg 1967, Womersley 2003, Zuccarello & West 2006, Bustamante et al. 2017; Fig. 2). However, their relevance in delineating tribes was not previously highlighted (but see McIvor 2000). Rhizoid anatomy is particularly useful in delineating the tribes Streblocladieae, Polysiphonieae, Herposiphonieae and Pterosiphonieae/Dipterosiphonieae (Table S5 and Fig. 2), as some of their species are very similar in other morphological characters. Furthermore, the Thaumatelleae, Polyzonieae and Bostrychieae also have distinctive rhizoids (Fig. 2), although there are many other key characters for delineating them at the tribal level.

The resurrected tribe Alsidieae is recognized as independent from the Polysiphonieae and is characterized by having corticate and radially branched indeterminate axes and plate-like spermatangial branches. The delineation of the tribe Lophothalieae is more problematic, as it is not monophyletic as originally conceived (*Brongniartella* was merged with *Vertebrata* and *Thaumatella* was segregated as a separate tribe). Furthermore, the relationships of *Micropeuce* and *Haplodasya* within the family are still unclear and further investigations, including more extensive taxon and gene sampling, are needed to clarify their tribal placement and determine the actual circumscription of the tribe Lophothalieae. Finally, the genus *Ophidocladus*, previously included in the Lophosiphonieae nom. nud., was also allocated to its own tribe. In addition to the tribal level results emerging from this work, our phylogenies showed that an integrative review at the genus level is especially needed in the tribes Chondrieae, Amansieae and Streblocladieae.

The family Rhodomelaceae includes 48 species of parasites in 26 genera separated from non-parasitic species. However, the few previous investigations on parasites involving molecular data and our phylogenies (including ten species and 9 genera) have all demonstrated that they are often closely related to non-parasitic species and their separation as independent genera is not always supported (Zuccarello et al. 2004, Kurihara et al. 2010, Preuss et al. 2017). The available molecular data suggest that species of *Janczewskia*, *Benzaitenia*, *Ululania*, *Dawsoniocolax* and *Bostrychiocolax* belong to genera with non-parasitic type species. We do not make nomenclatural proposals here, pending revisions of these genera. By contrast, our data support the recognition of *Leachiella*, *Harveyella, Choreocolax* and *Aiolocolax* as separate genera, but their phylogenetic relationships within the tribes are still not well resolved. These four genera previously lacked tribal attributions and our phylogenies revealed that the first three are in the Rhodomeleae, while *Aiolocolax* is in the Streblocladieae. In addition to the above-mentioned taxa, five parasitic genera are unclassified at a tribal level, one was placed in an independent tribe and 11 were included in five other tribes. Assigning parasitic genera to tribes based on morphological characters is not supported. For example, nine parasitic genera were included in the Lophothalieae mainly because they have tetrasporangia in whorls (Hommersand 1963), but several parasites with sporangia in whorls do not belong in the Lophothalieae (e.g. *Aiolocolax*, *Ululania*). The morphological characters of parasites, with very reduced vegetative structures, are markedly different from the non-parasitic members of their corresponding tribes and are always exceptions to the morphological delineations established for the tribes.

Besides the tribal classification of the Rhodomelaceae, Falkenberg (1901, p. 700) and Hommersand (1963, p. 343) reconstructed the phylogenetic relationships among tribes based on morphology. While use of the wide variety of morphological characters is reliable for delineating tribes, reconstructing their phylogenetic relationships on this basis it is much more difficult. Interpretations provided by Falkenberg (1901) and Hommersand (1963) agreed in recognizing the Bostrychieae on the basis of the phylogeny and considering the Laurencieae and the Chondrieae as closely related tribes, which were all supported in our molecular phylogeny (Fig. 1). Otherwise, their interpretations differed greatly and also are very different from our results (Fig. 1). For example, the Polyzonieae was considered related to the Rhodomeleae by Hommersand (1963), Falkenberg (1901) allied this tribe to the Herposiphonieae and our phylogeny resolved it as sister to the Sonderelleae and the Bostrychieae (Fig. 1). Differences between morphological and molecular phylogenies may result from the fact that characters classically used for establishing tribal relationships (e.g. dorsiventrality, pigmented trichoblasts, reproductive structures on specialized branches) evolved independently several times in the history of the family.

In addition to the 407 species and 89 genera represented in our phylogeny, there are currently 647 species and 60 genera in the family Rhodomelaceae for which molecular data are not available at present. Further investigations are needed to unravel their phylogenetic relationships and reassess their classification. Among them, some taxa, such as *Pachychaeta*, *Rhodolachne*, *Stichothamnion*, *Oligocladus*, and *"Lophosiphonia" mexicana*, have very unusual morphological characteristics (Weber-van Bosse 1911, Dawson 1944, Hommersand 1963, Vroman 1967, Wynne 1970, Womersley and Bailey 1970). This paper provides the first global phylogenetic study of the family Rhodomelaceae, but much work remains, especially at lower taxonomic levels, to fully understand the systematics of the most diverse family of the red algae.

FORMAL TAXONOMY

Taxonomic proposals at tribe level

Cladureae Díaz-Tapia & Maggs, trib. nov.

Diagnosis: Thalli erect, attached by a holdfast, radially branched, with a protruding apical cell surrounded by deciduous trichoblasts. Axes terete, with 5 (-6) pericentral cells, 1-3 layers of cortical cells developing close to the apices, but the segments remaining obvious throughout branches in surface view. Rhizoids cut off from pericentral cells, surrounding the axial and pericentral cells in older parts of the thallus. Spermatangial branches cylindrical, arising on branches of trichoblasts; cystocarps formed on axillary branchlets; one tetrasporangium per segment, cut off from the pericentral cells, formed in stichidia arising in axils of lateral branches.

Type and only genus: *Cladurus* Falkenberg in Schmitz and Falkenberg 1897: 435.

Dipterosiphonieae Díaz-Tapia & Maggs, trib. nov.

Diagnosis: Thalli entirely or largely prostrate, formed by axes of indeterminate growth bearing branches of determinate growth in alternate pairs. Rhizoids cut off from the distal ends of pericentral cells of prostrate axes, terminating in multicellular haptera. Axes with 4-10 pericentral cells, ecorticate. All branches exogenous. Trichoblasts, when present, only on determinate branches, deciduous. Spermatangial branches cylindrical, formed on modified trichoblasts; one tetrasporangium per segment in determinate branches. Cystocarps ovoid.

Type and only genus: *Dipterosiphonia* F.Schmitz & Falkenberg 1897: 463.

Ophidocladeae Díaz-Tapia & Maggs, trib. nov.

Diagnosis: Thalli dorsiventral, consisting of an extensive prostrate system bearing rhizoids ventrally and erect axes dorsally. Rhizoids cut off from the middle or proximal ends of pericentral cells, terminating in multicellular discoid pads. Axes ecorticate; erect axes composed of a large axial cell and 16-28 pericentrals. All branches endogenous. Trichoblasts deciduous, alternately arranged. Spermatangial structures formed on branched trichoblasts, each covering the two basal dichotomies, with a quadrifurcate appearance; procarps formed on trichoblasts, with two sterile groups, cystocarps ovoid; two tetrasporangia per segment in lateral branches with two cover cells.

Type and only genus: *Ophidocladus* Falkenberg in Schmitz and Falkenberg 1897: 461.

Streblocladieae Díaz-Tapia & Maggs, trib. nov.

Hommersand's (1963) proposal of the Streblocladieae was invalid because it lacked a formal description. Considering that we are proposing a very different concept for the tribe than that established by Hommersand (1963) and formerly by Kylin (1956, as *Streblocladia* "Gruppe"), here we propose a new tribe.

Diagnosis: Thalli predominantly erect, decumbent or dorsiventral (erect and prostrate axes). Axes with 4-24 pericentral cells, ecorticate or corticate. Rhizoids cut off from mid-proximal ends of pericentral cells, normally unicellular (multicellular in *Lampisiphonia*), occasionally absent in largest species and in the obligate epiphyte *Vertebrata lanosa*. Trichoblasts deciduous and unpigmented when mature (except *V. byssoides* and *V. australis*). Spermatangial branches cylindrical, borne on modified trichoblasts or on one or two branches of trichoblasts; procarps formed on modified trichoblasts, with 2 sterile groups; one tetrasporangium per segment (two in *Leptosiphonia* and *Ctenosiphonia*) on main axes or lateral branches.

Type genus: *Streblocladia* F.Schmitz in Schmitz and Falkenberg 1897: 457-458.

Other genera of this tribe included in our molecular analysis: *Aiolocolax* M.A.Pocock, 1956: 22, *Lampisiphonia* H.-G.Choi, Díaz-Tapia & Bárbara in Bárbara et al. 2013: 138, *Leptosiphonia* Kylin 1956: 509, *Melanothamnus* Bornet & Falkenberg in Falkenberg

1901: 684, *Pterochondria* Hollenberg 1942: 532-533, *Polyostea* Ruprecht 1850: 231, *Tolypiocladia* F.Schmitz in Schmitz and Falkenberg 1897: 441-442, *Vertebrata* S.F.Gray 1821: 338.

Thaumatelleae Díaz-Tapia & Maggs, trib. nov.

Diagnosis: Thalli predominantly prostrate, radially branched, with 4 ecorticate pericentral cells. Rhizoids cut off from pericentral cells, with a uniseriate multicellular filament terminating in multicellular haptera. Trichoblasts pigmented and persistent, branched 1-3 times. Spermatangial branches formed on trichoblasts, often several per trichoblast, ovoid, lacking basal and sterile apical cells; cystocarps stongly urceolate; one tetrasporangium per segment on lateral branches bearing trichoblasts.

Type and only genus: Thaumatella (Falkenberg) Kylin 1956: 511.

Amended descriptions of tribes

Alsidieae Ardissone 1883: 352.

Diagnosis: Thalli erect, attached by a holdfast or a basal crust, consisting of axes of indeterminate growth, radially branched, and clothed in some species with branches of determinate growth. Trichoblasts, if present, deciduous. Axes terete or complanate, with 5-12 pericentral cells, corticated from close to the apices with 1-2 layers of cortical cells. Spermatangial branches plate-like, lacking sterile marginal cells; one tetrasporangium per segment. Cystocarps globose.

Type: *Alsidium* C.Agardh 1827: 639.

Other genera of this tribe included in our molecular analysis: *Digenea* C.Agardh 1822: 388-389, *Bryothamnion* Kützing 1843: 433.

Nomenclatural note: although J.Agardh (1863) provided a diagnosis for the tribe Alsideae, he included this “tribus” and other tribes as sections of the Ordo Rhodomeleae so it is not valid under ICBN Art. 37.6-8 which states that names of taxa with misplaced rank are invalid. Therefore the first valid publication of the tribe Alsideae was by Ardissone (1883).

Herposiphonieae F.Schmitz & Falkenberg 1897: 457.

Description: Thalli formed by axes of indeterminate growth, prostrate or partially erect, which bear axes of determinate growth that are simple and erect. Rhizoids cut off from the distal ends of pericentral cells of prostrate axes, terminating in multicellular haptera that consist of the extension of the rhizoidal filament into a digitate structure that divides to form small terminal cells. Axes with 6-16 pericentral cells, ecorticate. All branches exogenous, formed on consecutive segments in a pattern that consists of one branch of indeterminate growth followed by three determinate branches. Some species have naked segments and more determinate branches separate indeterminate axes. Trichoblasts only on determinate branches, deciduous and unpigmented when mature. Spermatangial branches cylindrical, formed on modified trichoblasts; cystocarps terminal or subterminal on determinate branches; one tetrasporangium per segment on determinate branches.

Genus of this tribe included in our molecular analysis: *Herposiphonia* Nägeli 1846: 238.

Polysiphonieae F.Schmitz 1889: 447.

Description: Thalli predominantly erect, decumbent or dorsiventral (erect and prostrate axes). Axes with 4 (-7-11) pericentral cells, ecorticate. Rhizoids in open connection with pericentral cells, unicellular. Trichoblasts, when present, deciduous and unpigmented at maturity. Spermatangial branches cylindrical, formed on modified trichoblasts or on one or two branches of trichoblasts; procarps formed on modified trichoblasts, with two sterile groups; one tetrasporangium per segment on main axes or lateral branches with two or three cover cells. Cystocarps globose or ovoid.

Genera of this tribe included in our molecular analysis: *Bryocladia* F.Schmitz in Schmitz and Falkenberg 1897: 442, *Epizonaria* Díaz-Tapia & Maggs gen. nov., *Lophosiphonia* Falkenberg in Schmitz and Falkenberg 1897: 459-460, *Polysiphonia* Greville 1823: 210.

Pterosiphonieae Falkenberg 1901: 261.

Description: Thalli ranging from largely prostrate to erect, bilaterally or radially branched, usually with erect axes of determinate growth bearing determinate laterals that remain completely free, or are congenitally fused with the main axes to different degrees, forming foliose thalli in genera with branches fused along the whole length with the main axes. Attachment by holdfasts in the largest species or by rhizoids cut off from the distal ends of pericentral cells of prostrate axes (in some genera also from proximal ends in adjoining pericentral cells), terminating in multicellular haptera formed by cell divisions at the end of the rhizoidal filament. Axes with 4-14 pericentral cells, ecorticate to heavily corticate. Trichoblasts varying from rare and formed only on reproductive branches, to common in determinate branches, deciduous. Spermatangial branches cylindrical, formed on modified trichoblasts; one tetrasporangium per segment on determinate branches, with two pre-sporangial and one post-sporangial cover cells.

Genera of this tribe included in our molecular analysis: *Amplisiphonia* Hollenberg 1939: 380, *Aphanocladia* Falkenberg in Schmitz and Falkenberg 1897: 444, *Dictyomenia* Greville 1830: l, *Echinothamnion* Kylin 1956: 506, *Gredgaria* Womersley 2003: 314-315, *Lophurella* Schmitz in Schmitz and Falkenberg 1897: 440-441, *Periphykon* Weber-van Bosse 1929: 255, *Pollexfenia* Harvey 1844: 431, *Pterosiphonia* Falkenberg in Schmitz and Falkenberg 1897: 443, *Rhodomelopsis* M.A.Pocock 1953: 34, *Symphyocladia* Falkenberg in Schmitz and Falkenberg 1897: 443-444, *Womersleyella* Hollenberg 1967: 213, *Xiphosiphonia* Savoie & Saunders 2016: 933.

Taxonomic proposals at genus level

Epizonaria Díaz-Tapia & Maggs, gen. nov.

Diagnosis: Vegetative thalli entirely prostrate, attached by unicellular rhizoids in open connection with the pericentral cells. Axes with four pericentral cells, ecorticate. Reproductive structures on short erect axes. Trichoblasts, if present, on erect branches, deciduous. Spermatangial branches on modified trichoblasts; cystocarps terminal on erect branches, ovoid to slightly urceolate; one tetrasporangium per segment.

Type species: *Epizonaria prostrata* (Harvey) Díaz-Tapia & Maggs, comb. nov.

Basionym: *Polysiphonia prostrata* Harvey, 1855. Some account of the marine botany of the colony of western Australia. *Trans. R. I. Acad.* 22:525–66.

Synonyms: *Lophosiphonia prostrata* (Harvey) Falkenberg; *Falkenbergiella prostrata* (Harvey) Kylin.

Etymology: From the Greek prefix epi (on) and the genus name *Zonaria*, as the type species of the genus is epiphytic on members of the Zonarieae.

Amended descriptions of genera

Lophosiphonia Falkenberg in Schmitz and Falkenberg 1897: 459-460.

Description: Thalli consisting of prostrate and erect axes, endogenously branched. Axes ecorticate, with 6-7 pericentral cells. Rhizoids in open connection with pericentral cells, unicellular. Trichoblasts deciduous when present. Spermatangial branches cylindrical, formed on modified trichoblasts; cystocarps ovoid; one tetrasporangium per segment.

Type species: *Lophosiphonia obscura* (C.Agardh) Falkenberg in Schmitz and Falkenberg 1897: 460.

Species of this genus included in our molecular analysis: *L. simplicissima* Díaz-Tapia in Díaz-Tapia and Bárbara 2013: 356, *Lophosiphonia teges* (Womersley) Díaz-Tapia & Maggs, comb. nov.

Taxonomic proposals at species level

Digenea cymatophila (R.E.Norris) Díaz-Tapia & Maggs, comb. nov.

Basionym: *Alsidium cymatophilum* R.E.Norris 1994, p. 434: Some cumophytic Rhodomelaceae (Rhodophyta) occurring in Hawaiian surf. *Phycologia* 33:434–43.

Lophosiphonia teges (Womersley) Díaz-Tapia & Maggs, comb. nov.

Basionym: *Polysiphonia teges* Womersley 1979: 494, Southern Australian species of *Polysiphonia* Greville (Rhodophyta). *Aust. J. Bot.* 27:459–528.

Thaumatella adunca (J.Agardh) Díaz-Tapia & Maggs, comb. nov.

Basionym: *Dasya adunca* J.Agardh 1890: 112-113, Till algernes systematik. Nya bidrag. (Sjette afdelningen.). *Lunds Universitets Års-Skrift, Andra Afdelningen, Kongl. Fysiografiska Sällskapets i Lund Handlingar* 26:1–125.

Synonyms: *Brongniartella disticha* Falkenberg; *Thaumatella disticha* (Falkenberg) Kylin; *Veleroa adunca* (J.Agardh) Womersley & M.J.Parsons.

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Figure legends.

FIG. 1. Phylogeny of the family Rhodomelaceae indicating tribes with light or dark shaded areas; the unshaded area corresponds to the outgroup. Resurrected (Alsidieae) and new tribes are indicated with bold font. RAxML tree based on nucleotide alignment of the 198 concatenated genes from the chloroplast genome. All branches have full bootstrap support (*), except those where bootstrap values are indicated on branches.

FIG. 2. Compressed phylogeny of 16 clades and seven isolated taxa. The width of each triangle is proportional to the number of species from that clade included in the analysis. The RAxML tree used the genome-scale phylogeny based on nucleotides as a constraint and incorporated 322 *rbc*L, 179 18S rRNA gene and 194 *cox*1 sequences for a total of 418 species. Bootstrap values are indicated on branches when 100 (*) or > 50%. Black triangles and bold names represent resurrected (Alsidieae) and new tribes, while gray triangles represent previously recognized tribes. The complete phylogeny is presented in Figure S2. Schematic representations of the rhizoid anatomy and cladohapteron (Fig. K) are provided indicating their corresponding tribes with capital letters, when applicable (basal discs characterizes tribes without diagrams). Fig. N corresponds to *Veleroa subulata*, which was not included in our phylogeny and is currently placed in the Lophothalieae.

FIG. S1. Phylogeny of the family Rhodomelaceae indicating tribes with light or dark shaded areas, the unshaded area corresponds to the outgroup. Resurrected (Alsidieae) and new tribes are indicated with bold font. RAxML tree based on protein alignment of the 198 concatenated genes from the chloroplast genome. All branches have full bootstrap support (*), except those where bootstrap values are indicated on branches.

FIG. S2. Phylogeny of the family Rhodomelaceae. The RAxML tree used the genome-scale phylogeny based on nucleotides as a constraint and incorporated 322 *rbc*L, 179 18S rRNA gene and 194 *cox*1 sequences for a total of 418 species. Bootstrap values are indicated on branches 100 (*) or > 50%. Species names in bold correspond to type species of genera. Note: *Dasyclonium incisum, Leveillea jungermannioides, Dipterosiphonia dendritica* and *Herposiphonia tenella* are the type species of their corresponding genera, but considering the cryptic diversity found in these species, we are unable to determine at present which of them, if any, should be considered as the type.

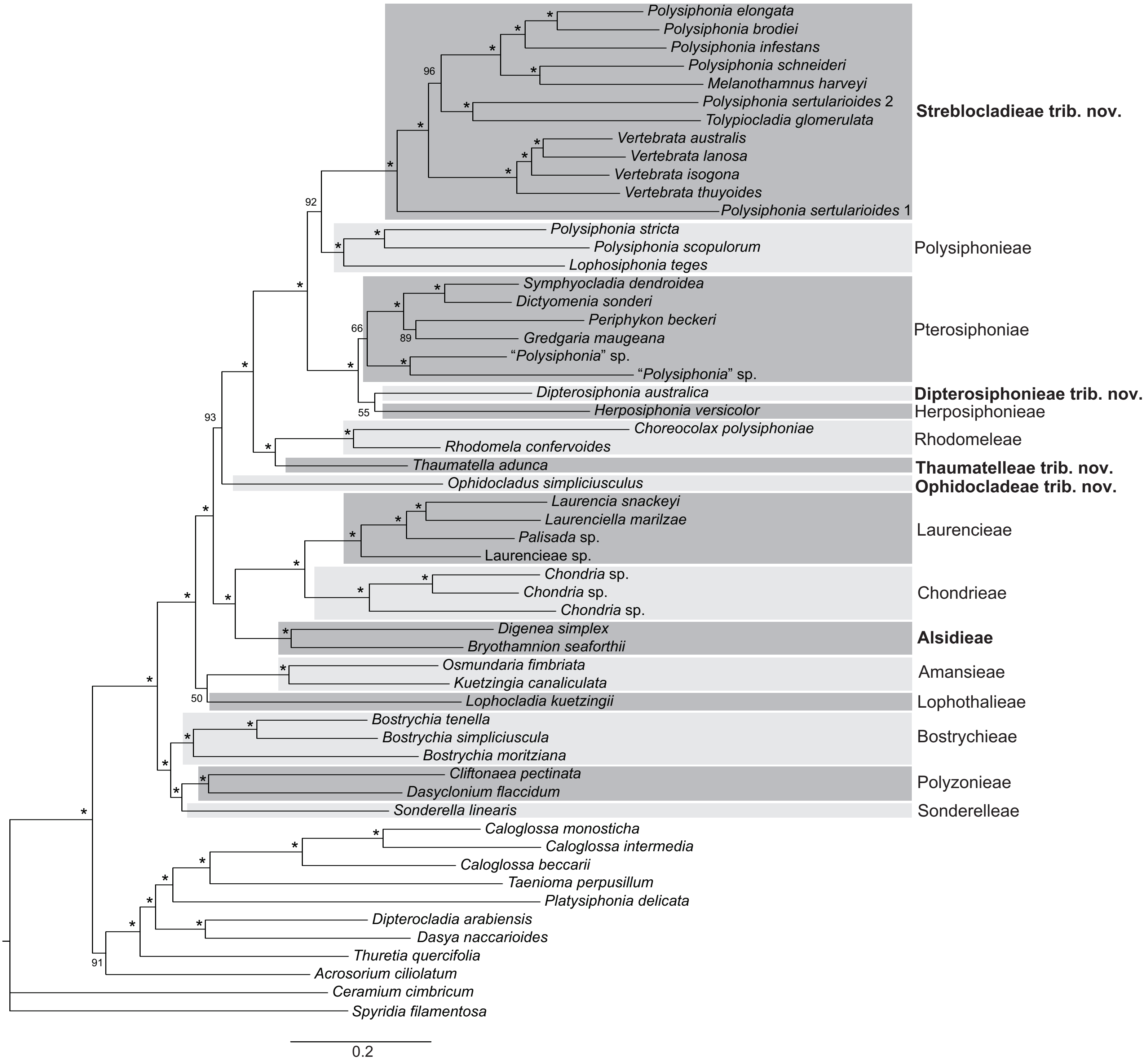
Table S1. Alphabetical list of genera currently recognized in the Rhodomelaceae indicating their tribal placement in Falkenberg´s (1901) and Hommersand´s (1963) classifications and the tribal assignment of genera described after 1963, as well as the positions resulting from this work.

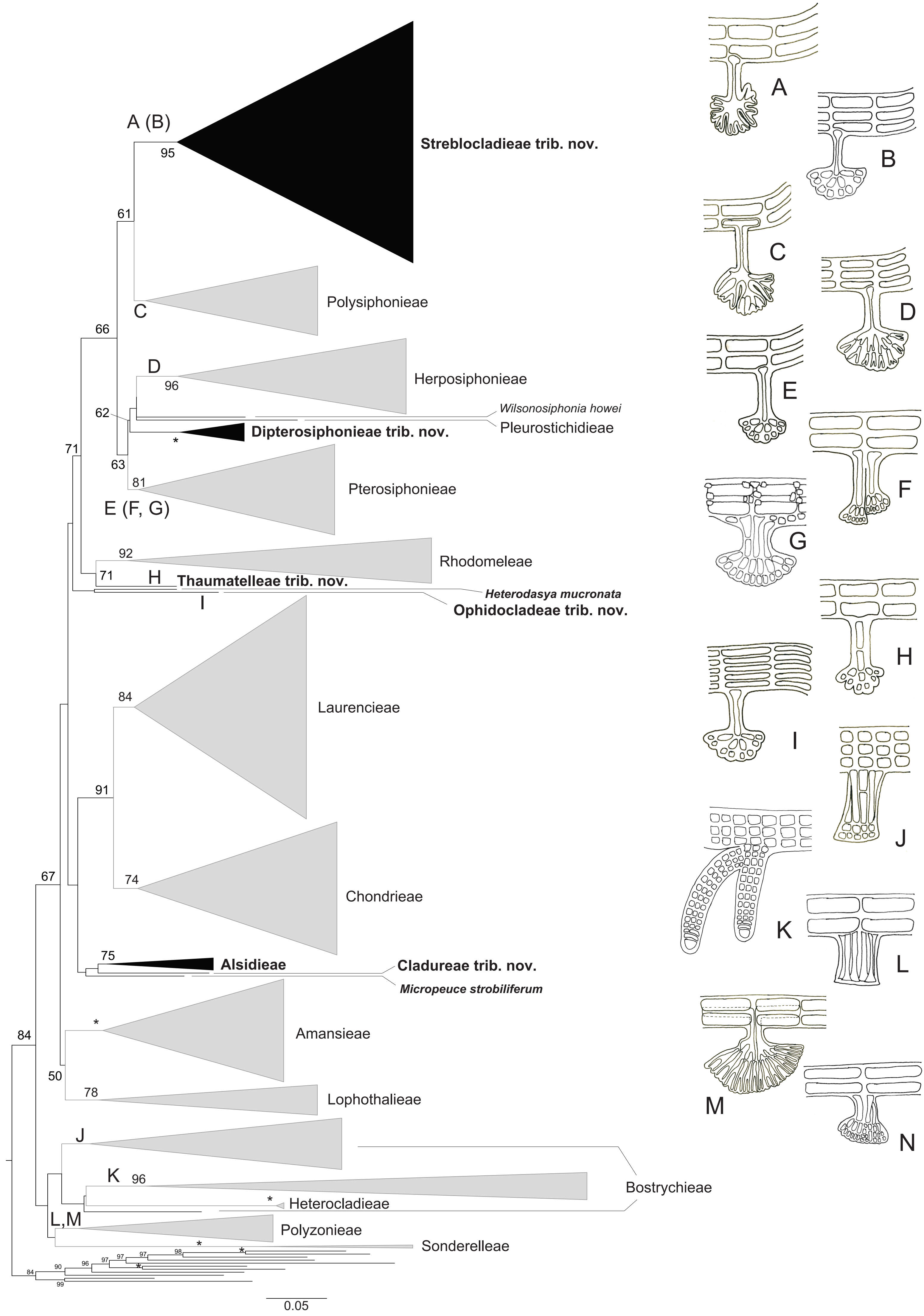
Table S2. Generic composition of the rhodomelacean tribes in Falkenberg´s (1901) and Hommersand´s (1963) classifications. The tribal placement of genera described after 1963 is also indicated, as well as the generic composition of tribes resulting from this work. N.d. = no data; d.p. = different position.

Table S3. GenBank accession numbers of the chloroplast genomes included in the phylogenetic analysis.

Table S4. GenBank accession numbers of the sequences included in the phylogenetic analysis. Numbers printed in bold correspond to newly determined sequences.

Table S5. Key morphological characters delineating the tribes of the Rhodomelaceae.


Polysiphonia elongata
Polysiphonia brodiei
Polysiphonia infestans
Polysiphonia schneideri
Melanothamnus harveyi
Polysiphonia sertularioides 2
Tolypiocladia glomerulata
Vertebrata australis
Vertebrata lanosa
Vertebrata isogona
Vertebrata thuyoides
Polysiphonia sertularioides 1
Streblocladieae trib. nov.
Polysiphonia stricta
Polysiphonia scopulorum
Lophosiphonia teges
Polysiphonieae
Symphyocladia dendroidea
Dictyomenia sonderi
Periphykon beckeri
Gredgaria maugeana
"Polysiphonia" sp.
"Polysiphonia" sp.
Pterosiphoniae
Dipterosiphonia australica
Dipterosiphonieae trib. nov.
Herposiphonia versicolor
Herposiphonieae
Choreocolax polysiphoniae
Rhodomela confervoides
Rhodomeleae
Thaumatella adunca
Thaumatelleae trib. nov.
Ophidocladus simpliciusculus
Ophidocladeae trib. nov.
Laurencia snackeyi
Laurenciella marilzae
Palisada sp.
Laurencieae sp.
Laurencieae
Chondria sp.
Chondria sp.
Chondria sp.
Chondrieae
Digenea simplex
Bryothamnion seaforthii
Alsidieae
Osmundaria fimbriata
Kuetzingia canaliculata
Amansieae
Lophocladia kuetzingii
Lophothalieae
Bostrychia tenella
Bostrychia simpliciuscula
Bostrychia moritziana
Bostrychieae
Cliftonaea pectinata
Dasyclonium flaccidum
Polyzonieae
Sonderella linearis
Sonderelleae
Caloglossa monosticha
Caloglossa intermedia
Caloglossa beccarii
Taenioma perpusillum
Platysiphonia delicata
Dipterocladia arabiensis
Dasya naccarioides
Thuretia quercifolia
Acrosorium ciliolatum
Ceramium cimbricum
Spyridia filamentosa
96
92
66
89
55
93
50
91
*
0.2


A (B)
95
Streblocladieae trib. nov.
61
C
Polysiphonieae
66
D
96
Herposiphonieae
62
Wilsonosiphonia howei
Pleurostichidieae
Dipterosiphonieae trib. nov.
*
71
63
81
Pterosiphonieae
E (F, G)
92
Rhodomeleae
71
H
Thaumatelleae trib. nov.
Heterodasya mucronata
I
Ophidocladeae trib. nov.
84
Laurencieae
91
74
Chondrieae
67
75
Alsidieae
Cladureae trib. nov.
Micropeuce strobiliferum
*
Amansieae
50
78
Lophothalieae
84
J
K
96
Bostrychieae
*
Heterocladieae
L,M
Polyzonieae
*
Sonderelleae
98
*
97
97
97
*
96
90
84
99
0.05
A
B
C
D
E
F
G
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J
K
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N

Table S1. Alphabetical list of genera currently recognized in the Rhodomelaceae indicating their tribal placement in Falkenberg´s (1901) and Hommersand´s (1963) classifications and the tribal assignment of genera described after 1963, as well as the positions resulting from this work.

	Falkenberg (1901)	Hommersand (1963)	Described after 1963	Present work
Abbottella Hollenberg 1967	-	-	Polyzonieae	-
Acanthophora J.V.Lamouroux 1813	Chondrieae	Chondrieae	-	Chondrieae
Acrocystis Zanardini 1872	-	Chondrieae	-	Chondrieae
Adamsiella L.E.Phillips & W.A.Nelson in Phillips 2002	-	-	Amansieae	Amansieae
Aiolocolax M.A.Pocock 1956	-	-	Incertae sedis	Polysiphonieae
Alleynea Womersley 2003	-	-	Polysiphonieae	-
Alsidium C.Agardh 1827	Polysiphonieae	Polysiphonieae	-	**Alsidieae**
Amansia J.V.Lamouroux 1809	Amansieae	Amansieae	-	Amansieae
Amplisiphonia Hollenberg 1939	-	Pterosiphonieae	-	Pterosiphonieae
Aneurianna L.E.Phillips 2006	-	-	Amansieae	Amansieae
Antarctocolax Skottsberg 1953	-	Lophothalieae	-	-
Aphanocladia Falkenberg in Schmitz and Falkenberg 1897	Pterosiphonieae	Polysiphonieae	-	Pterosiphonieae
Ardissonula J.De Toni 1936	-	Lophothalieae	-	-
Benzaitenia Yendo 1913	-	Lophothalieae	-	Chondrieae
Beringiella M.J.Wynne 1980	-	-	Rhodomeleae	-
Bostrychia Montagne 1842	Bostrychieae	Bostrychieae	-	Bostrychieae
Bostrychiocolax Zuccarello & J.A.West 1994	-	-	Bostrychieae	Bostrychieae
Bryocladia F.Schmitz in Schmitz and Falkenberg 1897	Polysiphonieae	Polysiphonieae	-	Polysiphonieae
Bryothamnion Kützing 1843	Polysiphonieae	Polysiphonieae	-	**Alsidieae**

Chamaethamnion Falkenberg in Schmitz and Falkenberg 1897	*Endosiphonia*, *Pachychaeta*, *Chamaethamnion* group	Lophothalieae	-	-
Chiracanthia Falkenberg in Schmitz and Falkenberg 1897	Polysiphonieae	Polysiphonieae	-	-
Chondria C.Agardh 1817	Chondrieae	Chondrieae	-	Chondrieae
Chondrophycus (Tokida & Saito) Garbary & Harper 1998	Laurencieae	Laurencieae	-	Laurencieae
Choreocolax Reinsch 1875	-	-	incertae sedis	Rhodomeleae
Cladhymenia Harvey in Hooker & Harvey 1845	Chondrieae	Chondrieae	-	Chondrieae
Cladurus Falkenberg in Schmitz and Falkenberg 1897	Chondrieae	Chondrieae	-	**Cladureae trib. nov.**
Cliftonaea (Harvey) Harvey 1863	Polyzonieae	Polyzonieae	-	Polyzonieae
Coeloclonium J.Agardh 1876	Chondrieae	Chondrieae	-	Chondrieae
Colacopsis De Toni 1903	Bostrychieae	Lophothalieae	-	-
Coronaphycus Metti 2015	-	-	Laurencieae	Laurencieae
Dasyclonium J.Agardh 1894	Polyzonieae (as *Euzoniella*)	Polyzonieae	-	Polyzonieae
Dawsoniella Hollenberg 1967	-	-	incertae sedis	-
Dawsoniocolax A.B.Joly & Yamaguishi-Tomita 1970	-	-	Bostrychieae	Bostrychieae
Dictyomenia Greville 1830	Pterosiphonieae	Pterosiphonieae	-	Pterosiphonieae
Digenea C.Agardh 1822	Polysiphonieae	Polysiphonieae	-	**Alsidieae**
Diplocladia Kylin 1956	-	Polysiphonieae	-	-
Dipterocolax J.Morrill 1977	-	-	incertae sedis	-
Dipterosiphonia Schmitz & Falkenberg 1897	Herposiphonieae	Polysiphonieae	-	**Dipterosiphonieae trib. nov.**
Ditria Hollenberg 1967	-	-	Herposiphonieae	-
Doxodasya (F.Schmitz) Falkenberg 1901	Lophothalieae	Lophothalieae	-	-

Echinophycus Huisman 2001	-	-	Lophothalieae	-
Echinosporangium Kylin 1956	Polyzonieae (as *Cliftonaea*)	Polyzonieae	-	-
Echinothamnion Kylin 1956	Polysiphonieae (as *Polysiphonia*)	Polysiphonieae	-	Pterosiphonieae
Enantiocladia Falkenberg in Schmitz and Falkenberg 1897	Amansieae	Amansieae	-	-
Endosiphonia Zanardini 1878	*Endosiphonia, Pachychaeta, Chamaethamnion* group	Lophothalieae	-	-
Epiglossum Kützing 1849	Amansieae (as *Lenormandia*)	-	Amansieae	Amansieae
Erythrocystis J.Agardh 1876	incertae sedis	Laurencieae	-	-
Erythrostachys J.Agardh ex Jean White in Ewart et al. 1912	Lophothalieae (as *Brongniartella*)	*Lophothalieae (as *Rhodolophia*)	Lophothalieae	-
Exophyllum Weber-van Bosse 1911	-	-	incertae sedis	-
Gonatogenia J.Agardh 1896	Chondrieae	Lophothalieae	-	-
Gredgaria Womersley 2003	-	-	Herposiphonieae	Pterosiphonieae
Halopithys Kützing 1843	Amansieae	Amansieae	-	Amansieae
Halydictyon Zanardini 1843	incertae sedis	incertae sedis	-	-
Haplodasya Falkenberg in Schmitz and Falkenberg 1897	Dasyaceae	-	Lophothalieae	-
Harveyella F.Schmitz & Reinke in Reinke 1889	-	-	incertae sedis	Rhodomeleae
Hawaiia Hollenberg 1967	-	-	incertae sedis	-
Herpopteros Falkenberg in Schmitz and Falkenberg 1897	Herposiphonieae	Polysiphonieae	-	-
Herposiphonia Nägeli 1846	Herposiphonieae	Polysiphonieae	-	Herposiphonieae
Herposiphoniella Womersley 2003	-	-	Herposiphonieae	-

Heterocladia Decaisne 1841	Heterocladieae	Heterocladieae	-	Heterocladieae
Heterodasya Joly & Oliveira 1966	Lophothalieae (as *Brongniartella*)	-	Lophothalieae	Incertae sedis
Heterostroma Kraft & M.J.Wynne 1992	-	-	Pterosiphonieae	-
Holotrichia F.Schmitz in Schmitz & Falkenberg 1897	Lophothalieae	Lophothalieae	-	-
Husseya J.Agardh 1901	-	Chondrieae	-	-
Janczewskia Solms-Laubach 1877	Laurencieae	Laurencieae	-	Laurencieae
Jantinella Kylin 1941	-	-	incertae sedis	-
Kentrophora S.M.Wilson & Kraft in Henderson et al. 2001	Amansieae (as *Kuetzingia*)	-	Amansieae	-
Kuetzingia Sonder 1845	Amansieae	Amansieae	-	Amansieae
Lampisiphonia H.-G.Choi, Diaz Tapia & Bárbara in Bárbara et al. 2013	-	-	Polysiphonieae	**Streblocladieae trib. nov.**
Laurencia J.V.Lamouroux 1813	Laurencieae	Laurencieae	-	Laurencieae
Laurenciella V.Cassano, Gil-Rodríguez, Sentíes, Díaz-Larrea, M.C.Oliveira & M.T.Fujii in Cassano et al. 2012	-	-	Laurencieae	Laurencieae
Laurenciocolax A.D.Zinova & Perestenko 1964	-	-	incertae sedis	-
Leachiella Kugrens 1982	-	-	incertae sedis	Rhodomeleae
Lembergia Saenger in Saenger et al. 1971	-	-	Sonderelleae	Sonderelleae
Lenormandia Sonder 1845	Amansieae	Amansieae	-	Amansieae
Leptosiphonia Kylin 1956	*Lophosiphonia* group (as ?*Ophidocladus*)	Polysiphonieae	-	**Streblocladieae trib. nov.**
Leveillea Decaisne 1839	Polyzonieae	Polyzonieae	-	Polyzonieae
Levringiella Kylin 1956	-	Polysiphonieae	-	-
Lophocladia (J.Agardh) F.Schmitz 1893	Lophothalieae	Lophothalieae	-	Lophothalieae
Lophosiphonia Falkenberg in Schmitz and Falkenberg 1897	*Lophosiphonia* group	*Lophosiphonia* group	-	Polysiphonieae

Lophothalia (Harvey) Kützing 1849	Lophothalieae	Lophothalieae	-	Lophothalieae
Lophurella F.Schmitz in Schmitz and Falkenberg 1897	Polysiphonieae	Polysiphonieae	-	Pterosiphonieae
Melanothamnus Bornet & Falkenberg in Falkenberg 1901	incertae sedis	incertae sedis	Polysiphonieae	**Streblocladieae trib. nov.**
Meridiocolax J.Morrill 1976	-	-	Polysiphonieae	-
Metamorphe Falkenberg in Schmitz and Falkenberg 1897	Herposiphonieae	Polysiphonieae	-	-
Microcolax F.Schmitz in Schmitz and Falkenberg 1897	Herposiphonieae	"Streblocladieae"	-	-
Micropeuce J.Agardh 1899	incertae sedis	Lophothalieae	-	incertae sedis
Murrayella F.Schmitz 1893	Lophothalieae	Lophothalieae	-	Lophothalieae
Nanopera S.M.Wilson & G.T.Kraft 2000	Amansieae (as *Enantiocladia*)	-	Amansieae	Amansieae
Neorhodomela Masuda 1982	Rhodomeleae (as *Rhodomela*)	-	Rhodomeleae	Rhodomeleae
Neotenophycus Kraft & I.A.Abbott 2002	-	-	Neotenophyceae	-
Neurymenia J.Agardh 1863	Amansieae	Amansieae	-	Amansieae
Odonthalia Lyngbye 1819	Rhodomeleae	Rhodomeleae	-	Rhodomeleae
Ohelopapa Martin-Lescanne, Payri & L.Le Gall 2017	-	-	Laurencieae	-
Oligocladella P.C.Silva 1996	-	*Lophosiphonia* group	-	-
Onychocolax M.A.Pocock 1956	-	Lophothalieae	-	-
Ophidocladus Falkenberg in Schmitz and Falkenberg 1897	*Lophosiphonia* group	*Lophosiphonia* group	-	**Ophidocladeae trib. nov.**
Osmundaria J.V.Lamouroux 1813	Amansieae	Amansieae	-	Amansieae
Osmundea Stackhouse 1809	Laurencieae (as *Laurencia*)	-	Laurencieae	Laurencieae

Pachychaeta Kützing 1862	*Endosiphonia*, *Pachychaeta*, *Chamaethamnion* group	Lophothalieae	-	-
Palisada K.W.Nam 2007	-	-	Laurencieae	Laurencieae
Periphykon Weber-van Bosse 1929	-	Polysiphonieae	-	Pterosiphonieae
Perrinia Womersley 2003	-	-	Polysiphonieae	-
Phaeocolax Hollenberg 1967	-	-	incertae sedis	-
Picconiella De Toni fil. 1936	Lophothalieae (as *Pteronia*)	Lophothalieae	-	-
Pityophykos Papenfus 1958	Polysiphonieae (as *Pithyopsis* Falkenberg nom. illeg.)	Polysiphonieae	-	-
Placophora J.Agardh 1863	Herposiphonieae	Polysiphonieae	-	Pterosiphonieae
Pleurostichidium Heydrich 1893	*Lophosiphonia* group	Pleurostichidieae	-	Pleurostichidieae
Pollexfenia Harvey 1844	Pterosiphonieae	Polysiphonieae (as *Jeannerettia*)		Pterosiphonieae
Polyostea Ruprecht 1850			Polysiphonieae	**Streblocladieae trib. nov.**
Polysiphonia Greville 1823	Polysiphonieae	Polysiphonieae	-	Polysiphonieae
Polyzonia Suhr 1834	Polyzonieae	Polyzonieae	-	Polyzonieae
Protokuetzingia Falkenberg in Schmitz and Falkenberg 1897	Amansieae	Amansieae	-	Amansieae
Pterochondria Hollenberg 1942	Pterosiphonieae (as *Pterosiphonia*)	Pterosiphonieae	-	Polysiphonieae
Pterosiphonia Falkenberg in Schmitz and Falkenberg 1897	Pterosiphonieae	Pterosiphonieae	-	Pterosiphonieae
Pterosiphoniella E.Y.Dawson 1963	-	-	incertae sedis	-
Pycnothamnion P.J.L.Dangeard 1953	-	-	incertae sedis	-
Rhodolachne M.J.Wynne 1970	-	-	Rhodolachneae nom. nud.	-

Rhodomela C.Agardh 1822	Rhodomeleae	Rhodomeleae	-	Rhodomeleae
Rhodomelopsis Pocock 1953	-	Pterosiphonieae	-	Pterosiphonieae
Rodriguezella F.Schmitz 1895	Laurencieae	Laurencieae	-	-
Rytiphlaea C.Agardh 1817	Amansieae	Amansieae	-	Amansieae
Schizochlaenion M.J.Wynne & R.E.Norris 1982	-	-	Lophothalieae	-
Sonderella Schmitz in Schmitz and Falkenberg 1897	-	-	Sonderelleae	Sonderelleae
Spirocladia Børgesen 1933	-	Lophothalieae	-	Lophothalieae
Spirophycus A.J.K.Millar 2000	-	-	Lophothalieae	-
Sporoglossum Kylin in Kylin & Skottsberg 1919	-	Lophothalieae	-	-
Stichothamnion Børgesen 1930	-	*Lophosiphonia* group	-	-
Streblocladia F.Schmitz in Schmitz and Falkenberg 1897	Herposiphonieae	"Streblocladieae"	Polysiphonieae	**Streblocladieae trib. nov.**
Stromatocarpus Fakenberg in Schmitz and Falkenberg 1897	Polysiphonieae	Lophothalieae	-	-
Symphyocladia Falkenberg in Schmitz and Falkenberg 1897	Pterosiphonieae	Pterosiphonieae	-	Pterosiphonieae
Symphyocolax M.-S.Kim in Kim and Cho 2010	-	-	Polysiphonieae	-
Tayloriella Kylin 1938	Herposiphonieae (as *Streblocladia*)	Pterosiphonieae	-	
Thaumatella (Falkenberg) Kylin 1956	-	-	-	**Thaumatelleae trib. nov.**
Tiparraria Womersley 2003	-	-	Herposiphonieae	-
Tolypiocladia F.Schmitz in Schmitz and Falkenberg 1897	Polysiphonieae	Polysiphonieae	-	Polysiphonieae
Trichidium J.M.Noble & Kraft 1984	-	-	Lophothalieae	-
Tylocolax F.Schmitz in Schmitz and Falkenberg 1897	incertae sedis	incertae sedis	-	-

Ululania K.E.Apt & K.E.Schlech 1998	-	-	Chondrieae	Chondrieae
Veleroa Dawson 1944	-	Lophothalieae	-	-
Vertebrata S.F.Gray 1821	*Polysiphonieae* (as part of *Polysiphonia*)	Polysiphonieae (as part of *Polysphonia*)	Polysiphonieae	**Streblocladieae trib. nov.**
Vidalia J.V.Lamouroux ex J.Agardh 1863	Amansieae	Amansieae	-	Amansieae
Waldoia W.R.Taylor 1962	-	-	Chondrieae	Chondrieae
Wilsonaea F.Schmitz 1893	Bostrychieae	-	incertae sedis (Womersley, 2003)	-
Wilsonosiphonia D.Bustamante, Won & T.O.Cho 2017	-	-	Incertae sedis	Incertae sedis
Womersleyella Hollenberg 1967	-	-	Polysiphonieae	Pterosiphonieae
Wrightiella F.Schmitz 1893	Lophothalieae	Lophothalieae	-	Lophothalieae
Xiphosiphonia Savoie & G.W.Saunders 2016			Pterosiphonieae	Pterosiphonieae
Yuzurua (Nam) Martin-Lescanne 2010	-	-	Laurencieae	Laurencieae

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Table S2. Generic composition of the rhodomelacean tribes in Falkenberg´s (1901) and Hommersand´s (1963) classifications. The tribal placement of genera described after 1963 is also indicated, as well as the generic composition of tribes resulting from this work. N.d. = no data; d.p. = different position.

Tribe	Falkenberg 1901	Hommersand 1963	Genera described after 1963 / Notes	This work
Alsidieae Ardissone 1883				
	d.p.	d.p.	-	*Alsidium* C.Agardh 1827
	d.p.	d.p.	-	*Bryothamnion* Kützing 1843
	d.p.	d.p.	-	*Digenea* C.Agardh 1822
Amansieae F.Schmitz 1889				
	n.d.	n.d.	*Aneurianna* L.E.Phillips 2006	*Aneurianna* L.E.Phillips 2006
	Adamsiella angustifolia (Harvey) L.E.Phillips & Nelson and *A. chauvinii* (Harvey) L.E.Phillips & Nelson as *Lenormandia*	n.d.	*Adamsiella* L.E.Phillips & W.A.Nelson in Phillips 2002	*Adamsiella* L.E.Phillips & W.A.Nelson in Phillips 2002
	Amansia J.V.Lamouroux 1809	*Amansia* J.V.Lamouroux 1809	-	*Amansia* J.V.Lamouroux 1809
	Enantiocladia Falkenberg in Schmitz & Falkenberg 1897	*Enantiocladia* Falkenberg in Schmitz & Falkenberg 1897	-	n.d.
	Epiglossum Kützing (as *Lenormandia* Sonder 1945)	n.d.	-	*Epiglossum* Kützing
	Halopithys Kützing 1843	*Halopithys* Kützing 1843	-	*Halopithys* Kützing 1843
	Kentrophora S.M.Wilson & Kraft in Henderson et al. 2001 (as *Kuetzingia* Sonder 1845)	n.d.	*Kentrophora* S.M.Wilson & Kraft in Henderson et al. 2001	n.d.
	Kuetzingia Sonder 1845	*Kuetzingia* Sonder 1845	-	*Kuetzingia* Sonder 1845
	Lenormandia Sonder 1845	*Lenormandia* Sonder 1845	-	*Lenormandia* Sonder 1845
	Nanopera S.M.Wilson & G.T.Kraft 2000 (as *Enantiocladia axillaris* Falkenberg 1901)	n.d.	*Nanopera* S.M.Wilson & G.T.Kraft 2000	*Nanopera* S.M.Wilson & G.T.Kraft 2000
	Neurymenia J.Agardh 1863	*Neurymenia* J.Agardh 1863	-	*Neurymenia* J.Agardh 1863
	Osmundaria J.V.Lamouroux 1813	*Osmundaria* J.V.Lamouroux 1813	-	*Osmundaria* J.V.Lamouroux 1813

Protokuetzingia Falkenberg in Schmitz and Falkenberg 1897	*Protokuetzingia* Falkenberg in Schmitz and Falkenberg 1897	-	*Protokuetzingia* Falkenberg in Schmitz and Falkenberg 1897
Rytiphlaea C.Agardh 1817	*Rytiphlaea* C.Agardh 1817	-	*Rytiphlaea* C.Agardh 1817
Vidalia J.V.Lamouroux ex J.Agardh 1863	*Vidalia* J.V.Lamouroux ex J.Agardh 1863	-	*Vidalia* J.V.Lamouroux ex J.Agardh 1863
Bostrychieae Falkenberg 1901			
Bostrychia Montagne 1842	*Bostrychia* Montagne 1842	-	*Bostrychia* Montagne 1842
n.d.	n.d.	*Bostrychiocolax* Zuccarello & J.A.West 1994	*Bostrychiocolax* Zuccarello & J.A.West 1994
Colacopsis De Toni 1903	d.p.	-	n.d.
n.d.	n.d.	*Dawsoniocolax* A.B.Joly & Yamaguishi-Tomita 1970	*Dawsoniocolax* A.B.Joly & Yamaguishi-Tomita 1970
Wilsonaea F.Schmitz 1893	n.d.	-	n.d.
Cladureae trib. nov.			
d.p.	d.p.	d.p.	*Cladurus* Falkenberg in Schmitz and Falkenberg 1897
Chondrieae Schmitz & Falkenberg 1897			
n.d.	*Acrocystis* Zanardini	-	*Acrocystis* Zanardini
Acanthophora J.V.Lamouroux 1813	*Acanthophora* J.V.Lamouroux 1813	-	*Acanthophora* J.V.Lamouroux 1813
n.d.	d.p.	*Benzaitenia* Yendo 1913 was reported in the Chondrieae by Kurihara et al. (2010)	*Benzaitenia* Yendo 1913
Chondria C.Agardh 1817	*Chondria* C.Agardh 1817	-	*Chondria* C.Agardh 1817
Cladhymenia Harvey in Hooker & Harvey 1845	*Cladhymenia* Harvey in Hooker & Harvey 1845	-	*Cladhymenia* Harvey in Hooker & Harvey 1845
Cladurus Falkenberg in Schmitz and Falkenberg 1897	*Cladurus* Falkenberg in Schmitz and Falkenberg 1897	-	d.p.
Coeloclonium J.Agardh 1876	*Coeloclonium* J.Agardh 1876	-	*Coeloclonium* J.Agardh 1876

Gonatogenia J.Agardh 1896 (as *Maschalostroma* F.Schmitz in Schmitz and Falkenberg 1897)	d.p.	-	n.d.
n.d.	*Husseya* J.Agardh 1901 (as *Husseyella* Papenfuss 1958)	-	n.d.
n.d.	n.d.	*Jantinella* Kylin 1941 was placed in the Chondrieae by Morrill (1976), while Kylin placed it in the "*Levringiella* Gruppe" with other parasitic genera	n.d.
n.d.	n.d.	*Ululania* K.E.Apt & K.E.Schlech 1998	*Ululania* K.E.Apt & K.E.Schlech 1998
n.d.	n.d.	*Waldoia* W.R.Taylor 1962	*Waldoia* W.R.Taylor 1962
Dipterosiphonieae trib. nov.			
d.p.	d.p.	-	*Dipterosiphonia* Schmitz & Falkenberg 1897
Endosiphonia group			
Chamaethamnion Falkenberg in Schmitz and Falkenberg 1897	d.p.	-	n.d.
Endosiphonia Zanardini 1878	d.p.	-	n.d.
Pachychaeta Kützing 1862	d.p.	-	n.d.
Herposiphonieae Schmitz & Falkenberg 1897			
Herposiphonia Nägeli 1846	d.p.	-	*Herposiphonia* Nägeli 1846
n.d.	n.d.	*Herposiphoniella* Womersley	n.d.
Dipterosiphonia Schmitz & Falkenberg 1897	d.p.	-	d.p.
n.d.	n.d.	*Ditria* Hollenberg 1967	n.d.
n.d.	n.d.	*Gredgaria* Womersley 2003	d.p.
Herpopteros Falkenberg	d.p.	*Herpopteros* Falkenberg	n.d.
Metamorphe Falkenberg in Schmitz and Falkenberg 1897	d.p.	-	n.d.

Microcolax F.Schmitz in Schmitz and Falkenberg 1897	d.p.	-	n.d.
Placophora J.Agardh 1863	d.p.	-	n.d.
Streblocladia F.Schmitz in Schmitz and Falkenberg 1897	d.p.	-	d.p.
n.d.	n.d.	*Tiparria* Womersley 2003	n.d.
Heterocladieae Falkenberg 1901			
Heterocladia Decaisne 1841	*Heterocladia* Decaisne 1841	-	*Heterocladia* Decaisne 1841
Laurencieae F.Schmitz 1889			
n.d.	n.d.	*Chondrophycus* (Tokida & Saito) Garbary & Harper 1998	*Chondrophycus* (Tokida & Saito) Garbary & Harper 1998
Coronaphycus Metti 2015 (as *Laurencia* J.V.Lamouroux 1813)	n.d.	*Coronaphycus* Metti 2015	*Coronaphycus* Metti 2015
d.p.	*Erythrocystis* J.Agardh 1876	-	n.d.
Janczewskia Solms-Laubach 1877	*Janczewskia* Solms-Laubach 1877	-	*Janczewskia* Solms-Laubach 1877
Laurencia J.V.Lamouroux 1813	*Laurencia* J.V.Lamouroux 1813	-	*Laurencia* J.V.Lamouroux 1813
n.d.	n.d.	*Laurenciella* V.Cassano, Gil-Rodríguez, Sentíes, Díaz-Larrea, M.C.Oliveira & M.T.Fujii in Cassano et al. 2012	*Laurenciella* V.Cassano, Gil-Rodríguez, Sentíes, Díaz-Larrea, M.C.Oliveira & M.T.Fujii in Cassano et al. 2012
n.d.	n.d	*Ohelopapa* Martin- Lescanne, Payri & L.Le Gall 2017	n.d.
Osmundea Stackhouse 1809 (as *Laurencia* J.V.Lamouroux 1813)	n.d.	*Osmundea* Stackhouse 1809	*Osmundea* Stackhouse 1809
n.d.	n.d.	*Palisada* K.W.Nam 2007	*Palisada* K.W.Nam 2007
Rodriguezella F.Schmitz 1895	*Rodriguezella* F.Schmitz 1895	-	n.d.
n.d.	n.d.	*Yuzurua* (K.W.Nam) Martin-Lescanne	*Yuzurua* (K.W.Nam) Martin-Lescanne

Lophosiphonia group / Lophosiphonieae nom. nud.

Lophosiphonia Falkenberg in Schmitz and Falkenberg 1897	*Lophosiphonia* Falkenberg in Schmitz and Falkenberg 1897	-	d.p.
n.d.	*Oligocladella* P.C.Silva (as *Oligocladus* Weber-van Bosse nom. illeg.)	-	n.d.
Ophidocladus Falkenberg in Schmitz and Falkenberg 1897	*Ophidocladus* Falkenberg in Schmitz and Falkenberg 1897	-	d.p.
n.d.	*Stichothamnion* Børgesen 1930	-	n.d.
Pleurostichidium Heydrich 1893	d.p.	-	d.p.
Vertebrata S.F. Gray 1821 (in part, as *Ctenosiphonia* Falkenberg in Schmitz and Falkenberg 1897)	*Vertebrata* S.F. Gray 1821 (in part, as *Ctenosiphonia* Falkenberg in Schmitz and Falkenberg 1897)	-	d.p.

Lophothalieae F.Schmitz & Falkenberg 1897

n.d.	*Antarctocolax* Skottsberg 1953	-	n.d.
n.d.	*Ardissonula* J.De Toni 1936	-	n.d.
n.d.	*Benzaitenia* Yendo 1913	*Benzaitenia* Yendo 1913 was reported in the Chondrieae by Kurihara et al. (2010)	d.p.
d.p.	*Chamaethamnion* Falkenberg in Schmitz and Falkenberg 1897	-	n.d.
d.p.	*Colacopsis* De Toni 1903	-	n.d.
Doxodasya (Schmitz) Falkenberg 1901	*Doxodasya* (Schmitz) Falkenberg 1901	-	*Doxodasya* (Schmitz) Falkenberg 1901
n.d.	n.d.	*Echinophycus* Huisman 2001	n.d.
d.p.	*Endosiphonia* Zanardini 1878	-	n.d.
n.d.	*Erythrostachys* J.Agardh ex Jean White in Ewart et al. 1912 (as *Rhodolophia* Kylin 1956)	-	n.d.
d.p.	*Gonatogenia* J.Agardh 1896	-	n.d.

d.p. (Dasyaceae)	-	*Haplodasya* Falkenberg in Schmitz and Falkenberg 1897 was placed in the Lophothalieae by Parsons (1975)	n.d.
Heterodasya Joly & Oliveira 1966 (as *Brongniartella* Bory 1822)	n.d.	*Heterodasya* Joly & Oliveira 1966	incertae sedis
Holotrichia F.Schmitz in Schmitz & Falkenberg 1897	*Holotrichia* F.Schmitz in Schmitz & Falkenberg 1897	-	n.d.
Lophocladia (J.Agardh) F.Schmitz 1893	*Lophocladia* (J.Agardh) F.Schmitz 1893	-	*Lophocladia* (J.Agardh) F.Schmitz 1893
Lophothalia (Harvey) Kützing 1849	*Lophothalia* (Harvey) Kützing 1849	-	*Lophothalia* (Harvey) Kützing 1849
d.p.	*Micropeuce* J.Agardh 1899		incertae sedis
Murrayella F.Schmitz 1893	*Murrayella* F.Schmitz 1893		*Murrayella* F.Schmitz 1893
n.d.	*Onychocolax* M.A.Pocock 1956		n.d.
d.p.	*Pachychaeta* Kützing 1862	-	n.d.
Picconiella De Toni fil. 1936 (as *Pteronia* F.Schmitz in Schmitz and Falkenberg 1897)	*Picconiella* De Toni fil. 1936	-	n.d.
n.d.	n.d.	*Schizochlaenion* M.J.Wynne & R.E.Norris 1982	n.d.
n.d.	*Spirocladia* Børgesen 1933	-	*Spirocladia* Børgesen 1933
n.d.	n.d.	*Spirophycus* A.J.K.Millar	n.d.
n.d.	*Sporoglossum* Kylin in Kylin & Skottsberg 1919	-	n.d.
d.p.	*Stromatocarpus* Fakenberg in Schmitz and Falkenberg 1897	-	n.d.
n.d.	n.d.	*Trichidium* J.M.Noble & Kraft 1984	n.d.
n.d.	*Veleroa* Dawson 1944	-	n.d.
Wrightiella F.Schmitz 1893	*Wrightiella* F.Schmitz 1893	-	*Wrightiella* F.Schmitz 1893

Neotenophyceae Kraft & I.A.Abbott 2002			
n.d.	n.d.	*Neotenophycus* Kraft & I.A.Abbott 2002	n.d.
Ophidocladeae trib. nov.			
d.p.	d.p.	-	*Ophidocladus* Falkenberg in Schmitz & Falkenberg 1897
Pleurostichidieae Hommersand 1963			
d.p.	*Pleurostichidium* Heydrich 1893	-	*Pleurostichidium* Heydrich 1893
Polysiphonieae F.Schmitz 1889			
n.d.	n.d.		
Alsidium C.Agardh 1827	*Alsidium* C.Agardh 1827	-	d.p.
d.p.	*Aphanocladia* Falkenberg in Schmitz & Falkenberg 1897	-	d.p.
Bryocladia F.Schmitz in Schmitz & Falkenberg 1897	*Bryocladia* F.Schmitz in Schmitz & Falkenberg 1897	-	*Bryocladia* F.Schmitz in Schmitz and Falkenberg 1897
Bryothamnion Kützing 1843	*Bryothamnion* Kützing 1843	-	d.p.
Chiracanthia Falkenberg in Schmitz & Falkenberg 1897	*Chiracanthia* Falkenberg in Schmitz & Falkenberg 1897	-	n.d.
Digenea C.Agardh 1822	*Digenea* C.Agardh 1822	-	d.p.
n.d.	*Diplocladia* Kylin 1956	-	n.d.
d.p.	*Dipterosiphonia* Schmitz & Falkenberg 1897	-	d.p.
Echinothamnion Kylin 1956 (as *Polysiphonia* Greville 1823)	*Echinothamnion* Kylin 1956	-	d.p.
d.p.	*Herpopteros* Falkenberg in Schmitz & Falkenberg 1897	-	n.d.
d.p.	*Herposiphonia* Nägeli 1846	-	d.p.
n.d.	n.d.	*Lampisiphonia* H.-G.Choi, Diaz Tapia & Bárbara in Bárbara et al. 2013	d.p.

d.p.	*Pollexfenia* Harvey 1844 (as *Jeannerettia* J.D.Hooker & Harvey nom. illeg.)	-	d.p.
d.p. (as ?Ophidocladus)	*Leptosiphonia* Kylin 1956	-	d.p.
n.d.	*Levringiella* Kylin 1956	-	n.d.
d.p.	d.p.	-	*Lophosiphonia* Falkenberg in Schmitz & Falkenberg 1897
Lophurella F.Schmitz in Schmitz & Falkenberg 1897	*Lophurella* F.Schmitz in Schmitz & Falkenberg 1897	-	d.p.
n.d.	n.d.	*Meridiocolax* J.Morrill 1976	n.d.
d.p.	*Metamorphe* Falkenberg in Schmitz & Falkenberg 1897	-	n.d.
n.d.	*Periphykon* Weber-van Bosse 1929	-	d.p.
n.d.	n.d.	*Perrinia* Womersley 2003	n.d.
Pityophykos Papenfus 1958 (as *Pithyopsis* Falkenberg in Schmitz & Falkenberg 1897, nom. illeg)	*Pityophykos* Papenfus 1958	-	n.d.
d.p.	*Placophora* J.Agardh 1863	Placed in the "*Placophora* group" by Kylin (1956) and Womersley (2003)	n.d.
d.p. (as *Pterosiphonia* Falkenberg in Schmitz and Falkenberg 1897)	n.d.	*Polyostea* Rupertch 1850	d.p.
Polysiphonia Greville 1823	*Polysiphonia* Greville 1823	-	*Polysiphonia* Greville 1823
Stromatocarpus Fakenberg in Schmitz & Falkenberg 1897	d.p.	-	n.d.
n.d.	n.d.	*Symphyocolax* M.-S.Kim in Kim & Cho 2010	n.d.
Tolypiocladia F.Schmitzin in Schmitz & Falkenberg 1897	*Tolypiocladia* F.Schmitzin in Schmitz & Falkenberg 1897	-	d.p.
Vertebrata S.F. Gray 1821 (in part, as *Polysiphonia* Greville)	*Vertebrata* S.F. Gray 1821 (in part, as *Boergeseniella* Kylin)	*Vertebrata* S.F. Gray 1821	d.p.

n.d.	n.d.	*Womersleyella* Hollenberg 1967	d.p.
Polyzonieae F.Schmitz & Falkenberg 1897			
n.d.	n.d.	*Abbottella* Hollenberg 1967	n.d.
Cliftonaea (Harvey) Harvey 1863	*Cliftonaea* (Harvey) Harvey 1863	-	*Cliftonaea* (Harvey) Harvey 1863
Dasyclonium J.Agardh 1894 (as *Euzoniella* Falkenberg 1901)	*Dasyclonium* J.Agardh 1894	-	*Dasyclonium* J.Agardh 1894
Echinosporangium Kylin 1956 as *Cliftonaea* (Harvey) Harvey 1863	*Echinosporangium* Kylin 1956	-	n.d.
Leveillea Decaisne 1839	*Leveillea* Decaisne 1839	-	*Leveillea* Decaisne 1839
Polyzonia Suhr 1834	*Polyzonia* Suhr 1834	-	*Polyzonia* Suhr 1834
Pterosiphonieae Falkenberg 1901			
Aphanocladia Falkenberg in Schmitz and Falkenberg 1897	d. p.	-	*Aphanocladia* Falkenberg in Schmitz and Falkenberg 1897
n.d.	*Amplisiphonia* Hollenberg 1939	-	*Amplisiphonia* Hollenberg 1939
Dictyomenia Greville 1830	*Dictyomenia* Greville 1830		*Dictyomenia* Greville 1830
d.p. (as *Polysiphonia* Greville 1823)	d.p.	-	*Echinothamnion* Kylin 1956
n.d.	n.d.	Placed in the Herposiphonieae by Womersley (2003)	*Gredgaria* Womersley 2003
n.d.	n.d.	*Heterostroma* Kraft & M.J.Wynne 1992	n.d.
d. p.	d. p.	-	*Lophurella* F.Schmitz in Schmitz and Falkenberg 1897
n.d.	d. p.	-	*Periphykon* Weber-van Bosse 1929
Pollexfenia Harvey 1844	d. p.	-	*Pollexfenia* Harvey 1844
Pterochondria Hollenberg 1942 (as *Pterosiphonia* Falkenberg in Schmitz and Falkenberg 1897)	*Pterochondria* Hollenberg 1942	-	d.p.

Pterosiphonia Falkenberg in Schmitz and Falkenberg 1897	*Pterosiphonia* Falkenberg in Schmitz and Falkenberg 1897	-	*Pterosiphonia* Falkenberg in Schmitz and Falkenberg 1897
n.d.	*Rhodomelopsis* Pocock 1953	-	*Rhodomelopsis* Pocock 1953
Symphyocladia Falkenberg in Schmitz and Falkenberg 1897	*Symphyocladia* Falkenberg in Schmitz and Falkenberg 1897	-	*Symphyocladia* Falkenberg in Schmitz and Falkenberg 1897
d.p. (as *Streblocladia*)	*Tayloriella* Kylin 1938	-	*Tayloriella* Kylin 1938
-	*Vertebrata* S.F.Gray (P. fastigiata = V. lanosa)	-	d.p.
n.d.	n.d.	-	*Womersleyella* Hollenberg 1967
Xiphosiphonia Savoie & G.W. Saunders 2016 (as *Pterosiphonia*)	-	*Xiphosiphonia* Savoie & G.W. Saunders 2016	*Xiphosiphonia* Savoie & G.W. Saunders 2016
Rhodomeleae (Areschoug) F.Schmitz 1889			
n.d.	n.d.	*Beringiella* M.J.Wynne 1980	n.d.
n.d.	n.d.	Placed in the Rhodomelaceae by Zuccarello et al. (2004)	*Choreocolax* Reinsch 1875
		Placed in the Rhodomelaceae by Zuccarello et al. (2004)	*Harveyella* F.Schmitz & Reinke 1889
		Placed in the Rhodomelaceae by Zuccarello et al. (2004)	*Leachiella* Kugrens 1982
Neorhodomela larix (Turner) Masuda 1982 as *Rhodomela* C.Agardh 1822	n.d.	*Neorhodomela* Masuda 1982	*Neorhodomela* Masuda 1982
Odonthalia Lyngbye 1819	*Odonthalia* Lyngbye 1819	-	*Odonthalia* Lyngbye 1819
Rhodomela C.Agardh 1822	*Rhodomela* C.Agardh 1822	-	*Rhodomela* C.Agardh 1822
n.d.	n.d.	*Rhodolachne* M.J.Wynne 1970	n.d.
Sonderelleae L.E.Phillips 2001			
Not included in the Rhodomelaceae	n.d.	*Sonderella* F.Schmitz 1897	*Sonderella* F.Schmitz 1897
Not included in the Rhodomelaceae	n.d.	*Lembergia* Saenger 1971	*Lembergia* Saenger 1971

Streblocladieae trib. nov.

n.d.	n.d.	d.p.	*Aiolocolax* M.A.Pocock 1956
d.p.	d.p.	-	*Lampisiphonia* H.-G.Choi, Diaz Tapia & Bárbara in Bárbara et al. 2013
d.p.	d.p.	-	*Leptosiphonia* Kylin 1956
d.p.	d.p.	-	*Melanothamnus* Bornet & Falkenberg in Falkenberg 1901
d.p.	*Microcolax* F.Schmitz in Schmitz & Falkenberg 1897	-	n.d.
d.p. (as *Pterosiphonia* Falkenberg in Schmitz & Falkenberg 1897)	-	-	*Polyostea* Rupertch 1850
d.p.	*Streblocladia* F.Schmitz in Schmitz & Falkenberg 1897	-	*Streblocladia* F.Schmitz in Schmitz & Falkenberg 1897
d.p.	d.p.	-	*Tolypiocladia* F.Schmitz in Schmitz & Falkenberg 1897
d.p.	d.p.	-	*Vertebrata* S.F. Gray 1821

Incertae Sedis

n.d.	n.d.	*Aiolocolax* M.A.Pocock 1956	d.p.
d.p.	d.p.	*Chamaethamnion* Falkenberg (Womersley 2003)	n.d.
n.d.	n.d.	*Choreocolax* Reinsch 1875	d.p.
n.d.	n.d.	*Dawsoniella* Hollenberg 1967	n.d.
n.d.	n.d.	*Dipterocolax* J.Morrill 1977	n.d.
Erythrocystis J.Agardh	d.p.	-	n.d.
d.p.	*Erythrostachys* White (as *Brongniartella* Bory)	-	
n.d.	n.d.	*Exophyllum* Weber-van Bosse 1911	n.d.
Halydictyon Zanardini 1843	*Halydictyon* Zanardini 1843	-	n.d.
n.d.	n.d.	*Harveyella* F.Schmitz & Reinke 1889	d.p.

n.d.	n.d.	*Hawaiia* Hollenberg 1967	n.d.
n.d.	n.d.	*Laurenciocolax* A.D.Zinova & Perestenko 1964	n.d.
n.d.	n.d.	*Leachiella* Kugrens 1982	d.p.
Melanothamnus Bornet & Falkenberg in Falkenberg 1901	*Melanothamnus* Bornet & Falkenberg in Falkenberg 1901	-	d.p.
Micropeuce J.Agardh 1899	d.p.	-	*Micropeuce* J.Agardh 1899
n.d.	n.d.	*Phaeocolax* Hollenberg 1967	n.d.
n.d.	n.d.	*Pterosiphoniella* E.Y.Dawson 1963	n.d.
n.d.	n.d.	*Pycnothamnion* P.J.L.Dangeard 1953	n.d.
Tylocolax F.Schmitz in Schmitz & Falkenberg 1897	*Tylocolax* F.Schmitz in Schmitz & Falkenberg 1897	-	n.d.
d.p.	n.d.	*Wilsonaea* F.Schmitz 1893 (Womersley 2003)	n.d.
n.d.	n.d.	*Wilsonosiphonia* D.Bustamante, Won & T.O.Cho 2017	*Wilsonosiphonia* D.Bustamante, Won & T.O.Cho 2017

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Table S3. GenBank accession numbers of the chloroplast genomes included in the phylogenetic analysis.

Species	Collection site; date; habitat / Publication	ID	Genbank accesion number
Bostrychia moritziana	Culture strain	JW3660	MF101419
Bostrychia simpliciuscula	Culture strain	JW3897	MF101421
Bostrychia tenella	Culture strain	JW3079	MF101417
Bryothamnion seaforthii	Ponta Castelhanos, Espírito Santo, Brazil; 9.iv.2014; intertidal	PD644	MF101430
Chondria sp.	Praia de Parati, Espírito Santo, Brazil; 8.iv.2014; intertidal	PD620	MF101429
Chondria sp.	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1582	MF101451
Chondria sp.	Port Arlington, Victoria, Australia; 9.xi.2014; subtidal (-2 m)	PD745	MF101431
Choreocolax polysiphonieae	Salomaki et al. 2015	-	KP308096
Cliftonaea pectinata	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1561	MF101450
Dasyclonium flaccidum	Point Ritchie, Victoria, Australia; 27.xii.2014; drift	PD1087	MF101443
Dictyomenia sonderi	Green Head, Western Australia; 21.iii.2015; drift	PD1725	MF101455
Digenea simplex	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1820	MF101465
Dipterosiphonia australica	Killornei, Victoria, Australia; 27.xii.2014; intertidal	PD1107	MF101444
Gredgaria maugeana	The Rip, Victoria, Australia; 16.i.2015; subtidal (- 20 m)	PD1230	MF101446
Herposiphonia versicolor	Sant Leonards, Victoria, Australia; 27.xi.2014; subtidal (-2 m)	PD852	MF101434
Kuetzingia canaliculata	Surfers Point, Prevelly, Western Australia; 12.iii.2015; drift	PD1540	MF101449
Laurencia snackeyi	Verbruggen & Costa 2015	JFC0032	LN833431
Laurencieae sp.	Margate, KwaZulu-Natal, South Africa; 12.xii.2014; intertidal	JFC1711	MF101412
Laurenciella marilzae	Pta Hidalgo, Tenerife, Spain; 10.vi.2015	H.1501	MF101410
Lophocladia kuetzingii	Albany, Western Australia; 11.iii.2015; subtidal (-5 m)	PD1509	MF101448
Lophosiphonia teges	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1823	MF101457-64, MF101466
Melanothamnus harveyi	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD890	MF101437
Ophidocladus simpliciusculus	Queenscliff, Victoria, Australia; 02.xii.2014; intertidal	PD949	MF101440
Osmundaria fimbriata	Culture strain	JW2841	MF101415
Palisada sp.	Two Rocks, Western Australia; 19.iii.2015; drift	PD1686	MF101453
Periphykon beckeri	Barrow Island, Western Australia; 16.xi.2014; epiphytic on *Halimeda discoidea*	JH1427	MF101413

Polysiphonia brodiei	Doaghbeg, Donegal, Ireland; 11.v.2014; intertidal	PD516	MF101425
Polysiphonia elongata	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD547	MF101427
Polysiphonia infestans	Lighthouse reef, Victoria, Australia; 08.xi.2014; intertidal	PD763	MF101432
Polysiphonia schneideri	Jurien Bay marina; Western Australia; 21.iii.2015; pontoon	PD1720	MF101454
Polysiphonia scopulorum	Queenscliff, Victoria, Australia; 01.xii.2014; intertidal	PD899	MF101438
*Polysiphonia sertularioides*1	Cabo de las Huertas, Alicante, Spain; 24.ii.2014; intertidal	PD0001	MF101423
*Polysiphonia sertularioides*2	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD863	MF101435
“Polysiphonia” sp.	Barrow Island, Western Australia; 14.xi.2014; subtidal	JH1432	MF101414
“Polysiphonia” sp.	Coral Bay, Western Australia; 24.iii.2015; subtidal (- 10 m)	PD1760	MF101456
Polysiphonia stricta	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD550	MF101428
Rhodomela confervoides	Glashagh Bay Donegal, Ireland; 11.v.2014; drift	PD508	MF101424
Sonderella linearis	Merry Island, Victoria, Australia; 29.xii.2014; drift	PD1151	MF101445
Symphyocladia dendroidea	Culture strain	JW3780	MF101420
Thaumatella adunca	The Rip, Victoria, Australia; 29.i.2015; subtidal (- 20 m)	PD1388	MF101447
Tolypiocladia glomerulata	Flat Rocks, Western Australia; 23.iii.2015; intertidal	PD1825	MF101467
Vertebrata australis	Pope´s Eye, Victoria, Australia;1.xii.2014; subtidal (-15 m)	PD931	MF101439
Vertebrata isogona	Frankston, Dave´s Bay, Victoria, Australia; 19.xi.2014; subtidal (-2 m)	PD831	MF101433
Vertebrata lanosa	Salomaki et al. 2015	-	KP308097
Vertebrata thuyoides	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD546	MF101426
OUTGROUP			
Acrosorium ciliolatum	Genome obtained as epiphytic contaminant	-	MF101411
Caloglossa beccarii	Culture strain	JW4523	MF101422
Caloglossa intermedia	Culture strain	JW3535	MF101418
Caloglossa monosticha	Culture strain	JW3046	MF101416
Ceramium cimbricum	Hughey and Boo 2016	UC2050592	KR025491
Dasya naccarioides	13th Beach, Victoria, Australia; 30.xi.2014; intertidal	PD888	MF101436
Dipterocladia arabiensis	Mirbat, Dhofar, Oman; 24.ix.2003	DHO101	MF101408
Platysiphonia delicata	13th Beach, Victoria, Australia; 01.xii.2015; intertidal	H.1445	MF101409
Spyridia filamentosa	Queenscliff, Victoria, Australia; 11.xii.2014; seagrass, subtidal (-2 m)	PD1020	MF101441
Taenioma perpusillum	Yanchep, Western Australia; 19.iii.2015; intertidal	PD1676	MF101452
Thuretia quercifolia	Queenscliff, Victoria, Australia; 11.xii.2014; seagrass, subtidal (-2 m)	PD1024	MF101442

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Verbruggen, H. & Costa, J. F. 2015. The plastid genome of the red alga *Laurencia*. *J. Phycol.* 51:586–9.

Table S3. GenBank accession numbers of the chloroplast genomes included in the phylogenetic analysis.

Species	Collection site; date; habitat / Publication	ID	Genbank accesion number
Bostrychia moritziana	Culture strain	JW3660	MF101419
Bostrychia simpliciuscula	Culture strain	JW3897	MF101421
Bostrychia tenella	Culture strain	JW3079	MF101417
Bryothamnion seaforthii	Ponta Castelhanos, Espírito Santo, Brazil; 9.iv.2014; intertidal	PD644	MF101430
Chondria sp.	Praia de Parati, Espírito Santo, Brazil; 8.iv.2014; intertidal	PD620	MF101429
Chondria sp.	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1582	MF101451
Chondria sp.	Port Arlington, Victoria, Australia; 9.xi.2014; subtidal (-2 m)	PD745	MF101431
Choreocolax polysiphonieae	Salomaki et al. 2015	-	KP308096
Cliftonaea pectinata	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1561	MF101450
Dasyclonium flaccidum	Point Ritchie, Victoria, Australia; 27.xii.2014; drift	PD1087	MF101443
Dictyomenia sonderi	Green Head, Western Australia; 21.iii.2015; drift	PD1725	MF101455
Digenea simplex	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1820	MF101465
Dipterosiphonia australica	Killornei, Victoria, Australia; 27.xii.2014; intertidal	PD1107	MF101444
Gredgaria maugeana	The Rip, Victoria, Australia; 16.i.2015; subtidal (- 20 m)	PD1230	MF101446
Herposiphonia versicolor	Sant Leonards, Victoria, Australia; 27.xi.2014; subtidal (-2 m)	PD852	MF101434
Kuetzingia canaliculata	Surfers Point, Prevelly, Western Australia; 12.iii.2015; drift	PD1540	MF101449
Laurencia snackeyi	Verbruggen & Costa 2015	JFC0032	LN833431
Laurencieae sp.	Margate, KwaZulu-Natal, South Africa; 12.xii.2014; intertidal	JFC1711	MF101412
Laurenciella marilzae	Pta Hidalgo, Tenerife, Spain; 10.vi.2015	H.1501	MF101410
Lophocladia kuetzingii	Albany, Western Australia; 11.iii.2015; subtidal (-5 m)	PD1509	MF101448
Lophosiphonia teges	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1823	MF101457-64, MF101466
Melanothamnus harveyi	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD890	MF101437
Ophidocladus simpliciusculus	Queenscliff, Victoria, Australia; 02.xii.2014; intertidal	PD949	MF101440
Osmundaria fimbriata	Culture strain	JW2841	MF101415
Palisada sp.	Two Rocks, Western Australia; 19.iii.2015; drift	PD1686	MF101453
Periphykon beckeri	Barrow Island, Western Australia; 16.xi.2014; epiphytic on *Halimeda discoidea*	JH1427	MF101413

Polysiphonia brodiei	Doaghbeg, Donegal, Ireland; 11.v.2014; intertidal	PD516	MF101425
Polysiphonia elongata	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD547	MF101427
Polysiphonia infestans	Lighthouse reef, Victoria, Australia; 08.xi.2014; intertidal	PD763	MF101432
Polysiphonia schneideri	Jurien Bay marina; Western Australia; 21.iii.2015; pontoon	PD1720	MF101454
Polysiphonia scopulorum	Queenscliff, Victoria, Australia; 01.xii.2014; intertidal	PD899	MF101438
*Polysiphonia sertularioides*1	Cabo de las Huertas, Alicante, Spain; 24.ii.2014; intertidal	PD0001	MF101423
*Polysiphonia sertularioides*2	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD863	MF101435
“*Polysiphonia*” sp.	Barrow Island, Western Australia; 14.xi.2014; subtidal	JH1432	MF101414
“*Polysiphonia*” sp.	Coral Bay, Western Australia; 24.iii.2015; subtidal (- 10 m)	PD1760	MF101456
Polysiphonia stricta	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD550	MF101428
Rhodomela confervoides	Glashagh Bay Donegal, Ireland; 11.v.2014; drift	PD508	MF101424
Sonderella linearis	Merry Island, Victoria, Australia; 29.xii.2014; drift	PD1151	MF101445
Symphyocladia dendroidea	Culture strain	JW3780	MF101420
Thaumatella adunca	The Rip, Victoria, Australia; 29.i.2015; subtidal (- 20 m)	PD1388	MF101447
Tolypiocladia glomerulata	Flat Rocks, Western Australia; 23.iii.2015; intertidal	PD1825	MF101467
Vertebrata australis	Pope´s Eye, Victoria, Australia;1.xii.2014; subtidal (-15 m)	PD931	MF101439
Vertebrata isogona	Frankston, Dave´s Bay, Victoria, Australia; 19.xi.2014; subtidal (-2 m)	PD831	MF101433
Vertebrata lanosa	Salomaki et al. 2015	-	KP308097
Vertebrata thuyoides	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD546	MF101426
OUTGROUP			
Acrosorium ciliolatum	Genome obtained as epiphytic contaminant	-	MF101411
Caloglossa beccarii	Culture strain	JW4523	MF101422
Caloglossa intermedia	Culture strain	JW3535	MF101418
Caloglossa monosticha	Culture strain	JW3046	MF101416
Ceramium cimbricum	Hughey and Boo 2016	UC2050592	KR025491
Dasya naccarioides	13th Beach, Victoria, Australia; 30.xi.2014; intertidal	PD888	MF101436
Dipterocladia arabiensis	Mirbat, Dhofar, Oman; 24.ix.2003	DHO101	MF101408
Platysiphonia delicata	13th Beach, Victoria, Australia; 01.xii.2015; intertidal	H.1445	MF101409
Spyridia filamentosa	Queenscliff, Victoria, Australia; 11.xii.2014; seagrass, subtidal (-2 m)	PD1020	MF101441
Taenioma perpusillum	Yanchep, Western Australia; 19.iii.2015; intertidal	PD1676	MF101452
Thuretia quercifolia	Queenscliff, Victoria, Australia; 11.xii.2014; seagrass, subtidal (-2 m)	PD1024	MF101442

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Table S4. GenBank accession numbers of the sequences included in the phylogenetic analysis. Numbers printed in bold correspond to newly determined sequences.

Species	Collection site; date; habitat / Notes	ID	Genbank accesion number		
			18S	*rbc*L	*cox*1
Acanthophora pacifica		ARS03720	GU223751	-	-
Acanthophora pacifica		ARS03733	-	-	HQ422947
Acanthophora sp.	Rottnest Island, Western Australia; 15.iii12015; subtidal (-20 m)	PD1564	-	**MF094033**	-
Acanthophora spicifera		ARS03563	GU223753	-	GU223869
Acanthophora spicifera		AC192	-	GQ252538	-
Acrocystis nana		SAP106293	GU223764	-	-
Adamsiella angustifolia	As *Lenormandia angustifolia*	MELU000066	AF339892	-	-
Adamsiella lorata	As *Lenormandia* sp.	MELU64	AF339898	-	-
Adamsiella melchori	As *Lenormandia* sp.	MELU65	AF339897	-	-
Aiolocolax pulchellus		24480	-	-	KF671160
Alsidium corallinum	Ancona, Italy; 28.vii.2015; subtidal (-2 m)	PD2013	-	**MF094034**	**-**
Alsidium corallinum	Ancona, Italy; 28.vii.2015; subtidal (-2 m)	PD2018	-	**-**	**MF094017**
Amansia fimbrifolia		03114	HM582913	-	-
Amansia fimbrifolia		03086	-	-	HM582889
Amansia mamillaris	As *Melanamansia mamillaris*	G0389	AF203889	-	-
Amansieae sp. A1	Point Peron, Western Australia;18.iii.2015; drift	PD1662	-	**MF094035**	-
Amansieae sp. A2	Heron Island, Queensland;18.v.2015; subtidal (- 15 m)	PD1972	-	**MF094036**	-
Amansieae sp. A3	Drumonde Cove, Western Australia; 27.iii.2015; drift	PD1816	-	**MF094037**	-
Amansieae sp. A4	Heron Island, Queensland;18.v.2015; subtidal (- 15 m)	PD1979	-	**MF094038**	-
Amansia glomerata 1		03091	HM582911	-	HM582895
Amansia glomerata 2		02806	HM582910	-	-

Amansia glomerata 2		ARS04053	-	-	HQ423024
Amansia glomerata 3		02336	HM582912	-	-
Amansia glomerata 3		ARS03601	-	-	HQ422913
Amplisiphonia pacifica		FHL14029	-	KM253836	-
Aneurianna dentata		MURUJB673	AY237280	-	-
Aphanocladia stichidiosa	Ferrol, Galicia, Spain; 21.v.2015; subtidal (-3 m)	PD2164	-	**MF094039**	-
Aphanocladia stichidiosa	Marseille, France; 9.v.2015; subtidal (-2 m)	25814	-	-	**MF094018**
Benzaitenia yenoshimensis		KashiwazakiA1	GU223738	-	-
Bostrychia anomala		JAW4588	-	KC768865	-
Bostrychia arbuscula		Bst.SI.4	-	-	JN881547
Bostrychia arbuscula		Moa084	-	KM502821	-
Bostrychia binderi	As *Bostrychia tenella*	3181	-	AY920836	-
Bostrychia calliptera		3400	-	AY920806	-
Bostrychia gracilis		T01	-	KM502824	KM502799
Bostrychia harveyi		D670	-	AY920808	-
Bostrychia intricata		Chl009	-	KM502835	KM502810
Bostrychia kelanensis		3214	-	AY920853	-
Bostrychia montagnei		JAW057	-	KP796026	-
Bostrychia moritziana	Culture strain	JW3660	**MF093912**	Table S3	**MF093965**
Bostrychia moritziana 2A		JAW3001	-	KC768870	-
Bostrychia moritziana 3		VZ3149	-	AF458709	-
Bostrychia moritziana 7		4069SAb	-	AY920816	KM502788
Bostrychia pilulifera		4200	-	AY920817	-
Bostrychia radicans 5A		3367	-	AY920823	-
Bostrychia radicans 6A		2649	-	AY920818	-
Bostrychia radicosa		4178	-	DQ087407	-
Bostrychia scorpioides	Poole, England, UK; 17.i.2016; intertidal	PD2183	-	-	**MF094019**
Bostrychia scorpioides		E130	-	AY920825	-
Bostrychia simpliciuscula	Culture strain	JW3897	**MF093913**	Table S3	**MF093966**

Bostrychia simpliciuscula 2	As *Bostrychia tenuissima*	NSW3111	-	AF458710	-
Bostrychia simpliciuscula 2		3562	-	-	KM502789
Bostrychia simpliciuscula 3		3546	-	AY920843	-
Bostrychia tangatensis		3266	-	AY920851	-
Bostrychia tenella	Culture strain	JW3079	**MF093914**	Table S3	**MF093967**
Bostrychia tenella 1		2815	-	AY920831	-
Bostrychia vaga V4		Cab010	-	KM502817	KM502791
Bostrychia vaga V3		Gta527	-	KM502818	KM502792
Bostrychia vaga V1		3716	-	KM502819	KM502793
Bostrychiocolax australis		-	AY617125	-	-
Bryocladia cuspidata			-	AF259498	-
Bryocladia thrysigera	Praia de Santa Cruz, Espírito Santo, Brazil; 10.ix.2014; intertidal	PD662	-	**MF094040**	-
Bryothamnion seaforthii	Ponta Castelhanos, Espírito Santo, Brazil; 9.iv.2014; intertidal	PD644	**MF093915**	Table S3	**MF093968**
Bryothamnion triquetrum	Boca del Río, Veracruz, Mexico; 29.v.2014; drift	NR347	-	**MF094041**	**MF094020**
Chondria arcuata		ARS00628	-	-	HQ423044
Chondria armata		SAP106294	GU223766	-	-
Chondria baileyana		GWS007984	-	-	HM916980
Chondria californica		LAF07150011	-	KF564781	-
Chondria capensis	Port Edward, KwaZulu-Natal, South Africa; 11.xii.2014; low intertidal	JFC1671	-	**MF094042**	-
Chondria coerulescens	Biarritz, France; 19.iii.2011; intertidal	25428	-	**MF094043**	-
Chondria coerulescens	Serantes, Asturias, Spain; 28.vii.2010; intertidal	24340	-	-	KF671147
Chondria collinsiana		SP399.865	-	GU330225	-
Chondria crassicaulis		KashiwazakiA2	GU223757	-	GU223873
Chondria dangeardii		ARS03692	GU223770	-	-
Chondria dangeardii		ARS03592	-	-	GU223879

Chondria dasyphylla		31393	-	CDU04021	-
Chondria decipiens		Ce121	-	KF672855	-
Chondria expansa		SAP106300	GU223772	-	-
Chondria littoralis 1		ce102	-	KF672853	-
Chondria littoralis 2		ce106	-	KF672854	-
Chondria polyrhiza		LAF51206215	-	KF564787	-
Chondria ryukyuensis		SAP106301	GU223773	-	-
Chondria scintillans		JML0048	-	KF492775	KF492717
Chondria sp. A1	Port Arlington, Victoria, Australia; 9.xi.2014; subtidal (-2 m)	PD745	**MF093920**	Table S3	**MF093972**
Chondria sp. A2	Coral Bay, Western Australia; 23.iii.2015; subtidal (-2 m)	PD1739	-	**MF094044**	-
Chondria sp. A3	Geelong, Victoria, Australia; 3.ii.2015; intertidal	PD1426	-	**MF094045**	-
Chondria sp. A4	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1582	**MF093921**	Table S3	**MF093973**
Chondria sp. A5	Coral Bay, Western Australia; 24.iii.2015; subtidal (-10 m)	PD1759	-	**MF094046**	-
Chondria sp. A8	Geelong, Victoria, Australia; 3.ii.2015; intertidal	PD1430	-	**MF094047**	-
Chondria sp. A10	Exmouth, Western Australia; 25.iii.2015; subtidal (-2 m)	PD1778	-	**MF094048**	-
Chondria sp. A11	Heron Island, Queensland, Australia; 17.v.2015; subtidal (-15 m)	PD1961	-	**MF094049**	-
Chondria sp. BR	Praia de Parati, Espírito Santo, Brazil; 8.iv.2014; intertidal	PD620	**MF093919**	Table S3	**MF093974**
Chondria sp. FL		LAF074980101	-	KF564780	-
Chondria sp. HI1		ARS03847	GU223775	-	GU223881
Chondria sp. HI2		ARS02916	GU223774	-	GU223880
Chondria sp. HI4		ARS02062	GU223777	-	-
Chondria sp. HI4		ARS03588	-	-	HQ422895

Chondria sp. HI5		ARS02748	GU223776	-	-
Chondria sp. HI5		ARS03562	-	-	HQ422964
Chondria tenuissima	Swanage, England, UK; 7.vi.2015; intertidal	PD2129	-	**MF094050**	**MF094021**
Chondrophycus cf. *cartilagineus*		ARS02693	GU223797	-	GU223896
Chondrophycus intermedius		-	-	DQ787585	-
Chondrophycus tronoi	As *Laurencia tronoi*	-	-	AF489864	-
Chondrophycus sp.		IRD96	-	FJ785310	-
Chondrophycus succisus		ARS02583	GU223778	-	-
Chondrophycus succisus		ARS01606	-	-	HQ422621
Chondrophycus cf. *undulatus*		ARS03324	GU223780	-	GU223886
Choreocolax polysiphonieae		-	AY617126	-	-
Choronaphycus elatus		JE01	-	KY120339	-
Choronaphycus novus		YM194	-	KY120340	-
Cladhymenia lyallii		-	-	AF259496	-
Cladurus elatus	Queenscliff, Victoria, Australia; 11.i.2015; drift	PD1176	-	**MF094051**	-
Cliftonaea pectinata	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1561	**MF093922**	Table S3	**MF093975**
Coeloclonium umbelula	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-5 m)	PD1606	-	**MF094052**	-
Dasyclonium flaccidum	Point Ritchie, Victoria, Australia; 27.xii.2014; drift	PD1087	**MF093924**	Table S3	**MF093977**
Dasyclonium incisum 1	Killornei beach, Victoria, Australia; 27.xii.2014; drift	PD1100	-	**MF094053**	-
Dasyclonium incisum 3	13th beach; Victoria, Australia; 4.xii.2014; intertidal	PD978	-	**MF094054**	-
Dasyclonium incisum 4	The Rip, Victoria, Australia; 16.i.2014; subtidal (-20 m)	PD1248	-	**MF094055**	-

Dasyclonium incisum 5	Aliwal Shoal, KwaZulu-Natal, South Africa; 14.xii.2014; subtidal (-20 m)	JFC1784	-	**MF094056**	-
Dawsoniocolax bostrychiae		-	AY617127	-	-
Dictyomenia sonderi	Green Head, Western Australia; 21.iii.2015; drift	PD1725	**MF093925**	Table S3	**MF093978**
Dictyomenia tridens		PD1642	-	**MF094057**	-
Digenea cymatophila	As *Alsidium cymatophilum*	ARS03736	GU223765	-	HQ422944
Digenea simplex	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1820	**MF093926**	Table S3	**MF093979**
Dipterosiphonia australica	Killornei, Victoria, Australia; 27.xii.2014; intertidal	PD1107	**MF093928**	Table S3	**MF093981**
Dipterosiphonia dendritica 1	Rottnest Island, Western Australia; 17.iii.2015; subtidal (-2 m)	PD1654	-	**MF094058**	-
Dipterosiphonia dendritica 2	Drumonde Cove, Western Australia; 27.iii.2015; drift	PD1799	-	**MF094059**	-
Dipterosiphonieae sp. 2	Channel Rocks, Western Australia; 13.iii.2015; subtidal (-2 m)	PD1559	-	**MF094060**	-
Dipterosiphonieae sp. 5	Rottnest Island, Western Australia; 17.iii.2015; subtidal (-2 m)	PD1638	-	**MF094061**	-
Dipterosiphonieae sp. 6	Albany, Western Australia; 11.iii.2015; subtidal (-5 m)	PD1517	-	**MF094062**	-
Dipterosiphonieae sp. BR	Praia de Parati, Espírito Santo, Brazil; 8.ix.2014; intertidal	PD623	-	**MF094063**	-
Doxodasya bolbochaete	Cape Conran, Victoria, Australia; 15.iv.2015; drift	PD1865	-	**MF094064**	-
Echinothamnion hookeri	Pope´s Eye, Victoria, Australia; 1.xii.2014; subtidal (-15 m)	PD916	-	**MF094065**	-
Epiglossum proliferum	As *Lenormandia prolifera*	MELUK10608	AF203895	-	-
Epiglossum smithiae	As *Lenormandia smithiae*	MELU000026	AF339895	-	-
Epiglossum smithiae	Cape Conran, Victoria, Australia; 15.iv.2015; drift	PD1848	-	**MF094066**	-

Epizonaria prostrata		PD1549	-	**MF094087**	-
Gredgaria maugeana	The Rip, Victoria, Australia; 16.i.2015; subtidal (- 20 m)	PD1230	**MF093929**	Table S3	**MF093982**
Halopithys incurva		MELUJAW1547	AF251513	-	-
Halopithys incurva		451	-	AF281882	-
Halopithys incurva	Punta Plata, Cádiz, Spain; 19.ii.2011; intertidal	26545	-	-	**MF094022**
Harveyella mirabilis		HarvOW	AY617130	-	-
Herposiphonia calothrix	Sorento, Victoria, Australia; 28.ii.2015; intertidal	PD1478	-	**MF094067**	-
Herposiphonia parca		CH426	JX828166	JX828127	-
Herposiphonia parca		ARS03083	GU223781	-	HQ423007
Herposiphonia pectinella	Geelong, Victoria, Australia; 3.ii.2015; intertidal	PD1415	-	**MF094068**	-
Herposiphonia sp. HI1		ARS03785	-	-	HQ423014
Herposiphonia sp. HI3		ARS03734	GU223783	-	-
Herposiphonia sp. HI3		ARS03048	-	-	HQ422862
Herposiphonia sp. HI4		ARS03734	-	-	HQ422946
Herposiphonia sp. HI5		ARS01722	-	-	HQ423087
Herposiphonia sp. HI6		ARS04514	-	-	HQ423041
Herposiphonia sp. HI7		ARS03084	GU223782	-	HQ422857
Herposiphonia sp. HI8		ARS02733	-	-	HQ423096
Herposiphonia sp. HI9		ARS03171	-	-	HQ422847
Herposiphonia sp. HI10		ARS03412	-	-	HQ422837
Herposiphonia sp. IP1	Almograve, Portugal; 22.ii.2011; intertidal	24671	**MF093962**	**MF094070**	**MF094023**
Herposiphonia sp. QL2	Heron Island, Queensland, Australia; 15.v.2015; intertidal	PD1910	-	**MF094071**	-
Herposiphonia sp. QL3	Heron Island, Queensland, Australia; 15.v.2015; intertidal	PD1933	-	**MF094072**	-

Herposiphonia sp. WA2	Coral Bay, Western Australia; 24.iii.2015; subtidal (-15 m)	PD1757	-	**MF094073**	-
Herposiphonia sp. WA3	Channel Rocks, Western Australia; 13.iii.2015; subtidal (-2 m)	PD1554	-	**MF094074**	-
Herposiphonia sp. WA4	Rottnest Island, Western Australia; 17.iii.2015; subtidal (-2 m)	PD1650	-	**MF094075**	-
Herposiphonia sp. WA5	Geraldton, Western Australia, 26.iii.2015; drift	PD1781	-	**MF094076**	-
Herposiphonia sp. BR	Ponta Castelhanos, Espírito Santo, Brazil; 9.iv.2014; intertidal	PD632	-	**MF094069**	-
Herposiphonia tenella IP1		24249	-	-	KF671179
Herposiphonia tenella IP1	Virgen del Mar, Cantabria, Spain; 7.xi.2010; intertidal	PD322	-	**MF094077**	-
Herposiphonia tenella IP2		HerpoNC.1	-	GU385834	-
Herposiphonia tenella IP2		25620	-	-	KF648513
Herposiphonia tenella IP3	Marseille, France; 9.v.2015; subtidal (-2 m)	25835	-	**MF094078**	-
Herposiphonia tenella IP3		25480	-	-	KF648522
Herposiphonia versicolor	Sant Leonards, Victoria, Australia; 27.xi.2014; subtidal (-2 m)	PD852	**MF093930**	Table S3	**MF093983**
Herposiphonia verticillata		GWS021436	-	-	KM254944
Heterocladia australis		G0388	AF203890	-	-
Heterocladia caudata		G0378	AF203891	-	-
Heterocladia umbellifera		MELUK10586	AF203892	-	-
Heterodasya mucronata		NCWeed.862	-	KF367797	KC567678
Janczewskia hawaiiana		ARS02521	GU223742	-	GU223858
Janczewskia morimotoi		Kinaoshi.A5	GU223741	-	GU223857
Kuetzingia canaliculata	Surfers Point, Prevelly, Western Australia; 12.iii.2015; drift	PD1540	**MF093931**	Table S3	**MF093984**
Lampisiphonia iberica		CH1414	JX828168	JX828129	-
Lampisiphonia iberica		24260	-	-	**MF094024**

Laurencia aldingensis		SP399.855	-	JF810351	-
Laurencia brongniartii		-	-	AF465814	-
Laurencia caduciramulosa		TFCPHYC14600	-	JF781525	-
Laurencia caraibica		-	-	EF658642	-
Laurencia clavata		PD1300	-	**MF094079**	-
Laurencia complanata		-	-	AF465813	-
Laurencia crustiformans		ARS00688	-	-	HQ423049
Laurencia dendroidea	As *Laurencia majuscula*	ARS02692	GU223784	-	GU223887
Laurencia dendroidea		SP399.926	-	GU330236	-
Laurencia filiformis		MELUK10609	AF203894	-	-
Laurencia filiformis		GWS016158	-	-	HM918076
Laurencia flexuosa		-	-	AF465815	-
Laurencia flexuosa		HEC15398	-	-	HQ956873
Laurencia glomerata	Port Alfred, Eastern Cape, South Africa; 6.xii.2014; intertidal	JFC1271	-	**MF094080**	-
Laurencia intricata		-	-	EF658644	-
Laurencia cf. *kuetzingii*		IRD104	-	FJ785322	-
Laurencia laurahuertana		ENCB19900	-	KF279401	-
Laurencia cf. *majuscula*		IRD132	-	FJ785312	-
Laurencia cf. *mariannensis*		IRD75	-	FJ785313	-
Laurencia cf. *mcdermidiae*		IRD119	-	FJ785314	-
Laurencia mcdermidiae		ARS02522	GU223761	-	GU223877
Laurencia natalensis		-	-	AF465816	-
Laurencia nidifica		ARS02581	GU223785	-	GU223888
Laurencia nipponica		Kinaoshi.A6	GU223760	-	GU223876
Laurencia viridis		TFCPhyc.N#13130	-	EF686004	-
Laurencia oliveirana		SP399.857	-	JF810352	-
Laurencia pacifica		GWS022084	-	-	HQ544189
Laurencia pacifica		LAFL37	-	AY588411	-
Laurencia pyramidalis		PC0146011	-	FJ785316	-

Laurencia pumila		KZNb2273	-	-	HQ956835
Laurencia rigida		-	-	AY920852	-
Laurencia saitoi		GWS018581	-	-	HQ544127
Laurencia saitoi 2		GWS018651	-	-	HQ544040
Laurencia snackeyi		JFC0032	**MF093932**	Table S3	**MF093985**
Laurencia sp.		ARS02760	GU223791	-	GU223858
Laurencia sp. 2		ARS02701	GU223786	-	-
Laurencia sp. 3		ARS03166	-	-	GU223890
Laurencia tasmanica		PD1289	-	**MF094081**	-
Laurencia translucida	As *Chondrophycus translucida*	SP356242	-	AY588408	-
Laurencia venusta		-	-	EF061655	-
Laurencieae sp.	Margate, KwaZulu-Natal, South Africa; 12.xii.2014; intertidal	JFC1711	**MF093933**	Table S3	**MF093986**
Laurenciella marilzae	Pta Hidalgo, Tenerife, Spain; 10.vi.2015	HV1501	**MF093934**	Table S3	**MF093987**
Laurenciella sp.	Twen Reef; Victoria, Australia; 19.i.2015; intertidal	PD1524	-	**MF094082**	-
Leachiella pacifica		LeachPP1	AY617132	-	-
Lembergia allanii		WELTA22990	AF373215	-	-
Lenormandia latifolia		MELU000036	AF339893	-	-
Lenormandia marginata		LEP61.1	AY237281	-	-
Lenormandia muelleri		GWS000164	AF203897	-	-
Lenormandia pardalis		MELU000034	AF339894	-	-
Lenormandia spectabilis		MELU000031	AF339896	-	-
Lenormandia spectabilis	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1630	-	**MF094083**	-
Leptosiphonia schousboei		CH826	JX828170	JX828133	-
Leptosiphonia schousboei		24149	-	-	KF671176
Leveillea jungermannioides		ARS01774	-	-	HQ423107
Leveillea jungermannioides 1	Heron Island, Queensland, Australia; 15.v.2015; intertidal	PD1920	-	**MF094084**	-

Leveillea jungermannioides 2	Point Peron, Western Australia;18.iii.2015; drift	PD1659	-	**MF094085**	-
Lophocladia kuesteri		-	GQ504016		-
Lophocladia kuetzingii	Albany, Western Australia; 11.iii.2015; subtidal (-5 m)	PD1509	**MF093935**	Table S3	**MF093988**
Lophocladia sp. 1		ARS00772	-	-	HQ422836
Lophocladia trichoclados		-	GQ504015	-	-
Lophocladia trichoclados			-	-	AF083380
Lophosiphonia obscura	Vilalonga, Galicia, Spain; 9.vi.2011; lagoon	26325	**MF093963**	**MF094086**	**MF094025**
Lophosiphonia teges	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1822	**MF093936**	**-**	-
Lophosiphonia teges	Drumonde cove, Western Australia; 27.iii.2015; intertidal	PD1823	-	**MF094089**	-
Lophosiphonia simplicissima	Niembro, Asturias, Spain; 28.v.2010; intertidal	24157	-	**MF094088**	-
Lophosiphonia simplicissima	Ártabra, A Coruna, Spain; 14.v.2010; intertidal	24433	-	-	**MF094026**
Lophothalia hormoclados		MELUK10881	AF373216	-	-
Lophothalieae sp.	Isipingo Beach, Durban, KwaZulu-Natal; South Africa; 15.xii.2014; intertidal	JFC1889	-	**MF094090**	-
Lophurella periclados	13th Beach, Victoria, Australia; 13.xi.2014; intertidal	PD772	-	**MF094091**	-
Melanothamnus afaqhusainii		GWS014134	-	KU564460	-
Melanothamnus balianus	As *Neosiphonia baliana*	-	-	KF146879	-
Melanothamnus bajacali	As *Neosiphonia bajacali*	MEX04.9	-	HM573572	HM573526
Melanothamnus collabens	As *Streblocladia collabens*	CH2526	-	JX828157	-
Melanothamnus collabens	As *Streblocladia collabens*	24251	-	-	KF671158
Melanothamnus ferulaceus	As *Neosiphonia ferulacea*	PHYKOS.2287	-	HM573584	-
Melanothamnus ferulaceus	As *Neosiphonia ferulacea*	PHYKOS.1996	-	-	HM573512
Melanothamnus flavimarinus	As *Neosiphonia flavimarina*	6N.flav.Bangpo	-	DQ787481	-

Melanothamnus forfex		PD1571	-	KX499565	-
Melanothamnus hancockii		LMI0001	-	KX499548	-
Melanothamnus harveyi	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD890	**MF093937**	Table S3	**MF093989**
Melanothamnus incomptus		JFC734	-	KX499560	-
Melanothamnus minutissimum		LMI1585	-	KX499557	-
Melanothamnus nudus	As *Polysiphonia* sp.	PHYKOS.2613	HM560648	HM573571	-
Melanothamnus peruviensis	As *Neosiphonia peruviensis*	TC6510	-	JN989969	-
Melanothamnus pseudovillum	As *Polysiphonia pseudovillum*	PHYKOS.3533	HM560650	HM573568	HM573524
Melanothamnus sphaerocarpus	As *Neosiphonia spaherocarpa*	FL05.6	-	HM573569	-
Melanothamnus sphaerocarpus	As *Neosiphonia spaherocarpa*	FL05.5B	-	-	HM573527
Melanothamnus strictissimus	As *Polysiphonia strictissima*	NZ04.552	HM560640		-
Melanothamnus strictissimus	As *Polysiphonia strictissima*	NZ04.80	-	HM573582	-
Melanothamnus strictissimus	As *Polysiphonia strictissima*	NZ04.147	-	-	HM573534
Melanothamnus teradomariensis	As *Neosiphonia teradomariensis*	CH424	JX828174	-	-
Melanothamnus thailandicus	As *Neosiphonia thailandica*	N4	-	KM502787	-
Melanothamnus ramireziae	As *Neosiphonia ramireziae*	TC6520	-	KC493352	-
Melanothamnus savatieri		LMI1579	-	KX499558	-
Melanothamnus silvae	As *Neosiphonia silvae*	-	-	KF146878	-
Melanothamnus somalensis		2774	-	KX499555	-
Melanothamnus teradomariensis	As *Neosiphonia teradomariensis*	CH424	-	JX828136	-
Melanothamnus tongatensis	As *Neosiphonia tongatensis*	PHYKOS.2704	HM560642	HM573570	HM573518
Melanothamnus upolensis	As *Neosiphonia upolensis*	ARS03263	-	-	HQ422784
Melanothamnus unilateralis		JF0192	KX499572	KX499549	**MF094027**
Melanothamnus yendoi	As *Neosiphonia yendoi*	CH420	JX828175	JX828137	-
Micropeuce strobiliferum		MELUK10654	AF203896	-	-
Murrayella periclados		G0311	AF203887	-	-

Nanopera merrifieldiae	Geraldton, Western Australia; 26.iii.2015; drift	PD1789	-	**MF094092**	-
Neorhodomela aculeata		AC174	-	GQ252552	-
Neorhodomela larix		-	AY617140	-	-
Neorhodomela larix		AC136	-	GQ252553	
Neorhodomela munita		Mbccc42	-	-	JQ619149
Neorhodomela oregona		AC301	-	GQ252556	-
Neurymenia fraxinifolia	Flat Rocks, Western Australia; 28.iii.2015; drift	PD1830	-	**MF094094**	-
Neurymenia fraxinifolia 2	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1628	-	**MF094093**	-
Odonthalia corymbifera		OK230	JX828176	JX828138	
Odonthalia dentata		GWS005346	-	-	JX572142
Odonthalia floccosa 1		-	AY617141	-	-
Odonthalia floccosa 1		AC166	-	GQ252492	-
Odonthalia floccosa 2		AC266	-	GQ252559	-
Odonthalia washintoniensis		-	AY617142		-
Odonthalia washintoniensis		AC107	-	GQ252561	-
Ophidocladus simpliciusculus	Queenscliff, Victoria, Australia; 02.xii.2014; intertidal	PD949	**MF093938**	Table S3	**MF093990**
Osmundaria fimbriata	Culture strain	JW2841	**MF093939**	Table S3	**MF093991**
Osmundaria melvillii		KZNb2276	-	-	HQ956836
Osmundaria obtusiloba	Praia de Parati, Espírito Santo, Brazil; 8.iv.2014; intertidal	PD624	-	**MF094105**	-
Osmundaria obtusiloba 2		03151	HM582914	-	-
Osmundaria obtusiloba 2		3949	-	-	HM582900
Osmundaria prolifera		MELUK11047a	AF339900	-	-
Osmundaria prolifera		G0376	-	-	HM915825
Osmundaria serrata		KZN2258	-	-	HQ956811
Osmundea blinksii		-	-	AY172575	-

Osmundea hybrida		-	GU223794	-	-
Osmundea hybrida		PC0146010	-	FJ785317	-
Osmundea oederi		MMS0208	-	KU566557	KU566527
Osmundea osmunda		PC0146009	-	FJ785318	-
Osmundea pinnatifida		CH528	JX828178	JX828140	-
Osmundea pinnatifida		MMS0004	-	-	KU566513
Osmundea prudhommevanreinei		MMS0144	-	KU566568	-
Osmundea prudhommevanreinei		MMS0057	-	-	KU566547
Osmundea silvae		MMS0060	-	KU566561	-
Osmundea silvae		MMS0058	-	-	KU566539
Osmundea sinicola		LAF680	-	AY588407	-
Osmundea spectabilis		AC163	-	GQ252562	-
Osmundea spectabilis		GWS006426	-	-	HM916767
Osmundea splendens		-	-	AY172576	-
Osmundea splendens		GWS021984	-	-	KM254322
Osmundea sp.		LLG2016	-	KU566562	-
Osmundea truncata		TFCPHYC14660	-	JF781524	-
Osmundea truncata		MMS0138	-	-	KU566542
Palisada ceylanica		HEC16043	-	-	HQ956935
Palisada corallopsis	As *Chondrophycus corallopsis*	-	-	EF061646	-
Palisada cf. *cruciata*		IRD127	-	FJ785319	-
Palisada flagellifera		LLGMMS0095	-	-	KF492772
Palisada flagellifera		SP399.941	-	GU330227	-
Palisada furcata		SP399.928	-	GU330226	-
Palisada paniculata	As *Laurencia paniculata*	-	-	AF489863	-
Palisada papillosa		ODC1507	-	-	HQ956980
Palisada parvipapillata		ARS02921	GU223796	-	GU223895
Palisada patentiramea	As *Laurencia patentiramea*	-	-	AF489862	-

Palisada perforata		HRJ10840	-	EU256331	-
Palisada cf. *robusta*		IRD92	-	FJ785321	-
Palisada sp.	Two Rocks, Western Australia; 19.iii.2015; drift	PD1686	**MF093940**	Table S3	**MF093992**
Periphykon beckeri	Barrow Island, Western Australia; 16.xi.2014; epiphytic on *Halimeda discoidea*	JH1427	**MF093941**	Table S3	**MF093993**
Pleurostichidium falkenbergii		-	AF251511	-	-
Pollexfenia sp.	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-5 m)	PD1599	-	**MF094095**	-
Polyostea bipinnata	As *Pterosiphonia gracilis* in GenBank, label modified according to Savoie & Saunders 2016	AC179	-	GQ252573	-
Polyostea robusta	As *Pterosiphonia bipinnata* in GenBank, label modified following Savoie & Saunders 2016	AC155	-	GQ252571	-
Polysiphonia amplacapilli		12sp405	-	KF479253	-
Polysiphonia anomala		FL09.41B	HM560654	-	-
Polysiphonia anomala		FL09.78	-	HM573550	HM573502
Polysiphonia aterrima		NZ04.525	HM560638		-
Polysiphonia atlantica		CH1268	JX828179	JX828141	-
Polysiphonia atlantica	Llas, Asturias, Spain; 19.iv.2011; intertidal	26230	-	-	**MF094028**
Polysiphonia atlantica 2		NC.4	HM560631	EU492910	-
Polysiphonia atlantica 2		NC.28	-	-	HM573539
Polysiphonia artctica		GWS005220	-	-	JX572047
Polysiphonia aterrima		NZ04.512	-	GU385831	-
Polysiphonia aterrima		NZ04.525	-	-	HM573536
Polysiphonia binneyi		PHYKOS.2517	HM560636	HM573555	-
Polysiphonia brodiei	Doaghbeg, Donegal, Ireland; 11.v.2014; intertidal	PD516	**MF093943**	Table S3	**MF093995**
Polysiphonia denudata	As *Polysiphonia polyspora*	CH1363	JX828182	JX828147	-

Polysiphonia denudata	Peinzás, Galicia, Spain; 19.iv.2011; intertidal	26232	-	-	**MF094029**
Polysiphonia dokdoensis		TC9524	-	KJ407267	-
Polysiphonia echinata		FL09.44	-	HM573559	-
Polysiphonia echinata		FL09.75	-	-	HM573506
Polysiphonia elongata	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD547	**MF093944**	Table S3	**MF093996**
Polysiphonia elongella		ID468	-	AF342913	-
Polysiphonia fibrata		PD2105	KX499576	-	-
Polysiphonia fibrata		ID257	-	AF342915	-
Polysiphonia fibrata	La Franca, Asturias, Spain; 23.iii.2011; intertidal	25621	-	-	**MF094030**
Polysiphonia fibrillosa		PD2127	KX499577	-	-
Polysiphonia fibrillosa		ID255	-	AF342912	-
Polysiphonia fibrillosa	Loquemeau, Brittany, France; 20.iii.2011; intertidal	25538	-	-	**MF094031**
Polysiphonia freshwateri		CUK10427-H1	-	KJ957812	-
Polysiphonia havanensis		PHYKOS.2628	HM560641	HM573554	-
Polysiphonia havanensis		PHYKOS.3186	-	-	HM573522
Polysiphonia homoia		PHYKOS.3525	HM560653	HM573553	HM573507
Polysiphonia infestans	Lighthouse reef, Victoria, Australia; 08.xi.2014; intertidal	PD763	**MF093945**	Table S3	**MF093997**
Polysiphonia kapraunii		NC.11	HM560630	EU492920	GU385830
Polysiphonia koreana		CUK9556-H1	-	KJ957811	-
Polysiphonia macrocarpa		PHYKOS.2627	HM560632	-	HM573538
Polysiphonia morroides		12sp505	-	KF479257	-
Polysiphonia morrowii		CH043	AF427532	-	-
Polysiphonia morrowii		SS0023	-	KC152488	-
Polysiphonia morrowii		NZ04.130	-	-	HM573540
Polysiphonia muelleriana		WELTASA356	-	AY588412	-

Polysiphonia pacifica		GWS000405	AF427533	-	-
Polysiphonia pacifica		P194	-	AY958162	-
Polysiphonia pacifica 2		AC181	-	GQ252565	-
Polysiphonia paniculata		-	AY617144	-	-
Polysiphonia pentamera		PHYKOS.3529	HM560643	HM573564	-
Polysiphonia pentamera		PHYKOS.1995	-	-	HM573510
Polysiphonia sabulosia		12sp103	-	KF479250	-
Polysiphonia schneideri	Jurien Bay marina; Western Australia; 21.iii.2015; pontoon	PD1720	**MF093946**	Table S3	**MF093998**
Polysiphonia scopulorum	Queenscliff, Victoria, Australia; 01.xii.2014; intertidal	PD899	**MF093947**	Table S3	**MF093999**
Polysiphonia scopulorum var. *villum*		NC.33	HM560633	EU492915	-
Polysiphonia scopulorum var. *villum*		NC.9	-	-	HM573535
Polysiphonia sertularioides FL1		PHYKOS.2257	HM560646	HM573548	-
Polysiphonia sertularioides FL2		PHYKOS.3534	HM560652	HM573547	HM573509
Polysiphonia sertularioides FL3		PHYKOS.3226	HM560647	HM573546	HM573519
Polysiphonia sertularioides 1	Cabo de las Huertas, Alicante, Spain; 24.ii.2014; intertidal	PD0001	**MF093948**	Table S3	**MF094000**
Polysiphonia sertularioides 2	Queenscliff marina, Victoria, Australia; 29.xi.2014; pontoon	PD863	**MF093949**	Table S3	**MF094001**
"Polysiphonia" sp.	Barrow Island, Western Australia; 14.xi.1996; subtidal	JH1432	**MF093950**	Table S3	**MF094002**
"Polysiphonia" sp.	Coral Bay, Western Australia; 15.xi.2014; subtidal (- 10 m)	PD1760	**MF093951**	Table S3	**MF094003**
"*Polysiphonia*" sp. 3538		PKI02	AB219926	-	-
"*Polysiphonia*" sp. 3538		PHYKOS.3538	-	HM573544	HM573523

Polysiphonia sp.	As *Polysiphonia pernacola*	NZ04.291	HM560637	HM573576	-
Polysiphonia sp.	As *Polysiphonia pernacola*	NZ04.309	-	-	HM573495
Polysiphonia sp. A4	Rottnest Island, Western Australia; 15.iii.2015; subtidal (-20 m)	PD1575	-	**MF094096**	-
Polysiphonia sp. A9	Heron Island, Queensland, Australia; 14.v.2015; intertidal	PD1896	-	**MF094097**	-
Polysiphonia sp. A10	Heron Island, Queensland, Australia; 16.v.2015; intertidal	PD1936	-	**MF094098**	-
Polysiphonia stricta	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD550	**MF093952**	Table S3	**MF094004**
Polysiphonia subtilissima		NC.21	HM560634	-	-
Polysiphonia subtilissima		NC.24	-	EU492918	HM573529
Polysiphonia ulleungensis		TC9483	-	KJ028026	-
Polysiphonia virgata		GWS000360	AF427536	-	-
Polysiphonia virgata		CH1671	-	JX828152	-
Polyzonia elegans	Palm Beach, KwaZulu-Natal, South Africa; 10.xii.2014; intertidal	JFC1562	**MF093953**	**MF094099**	**MF094005**
Protokuetzingia australasica		MELUK10807	AF339901	-	-
Protokuetzingia australasica		PD1701	-	**MF094100**	-
Pterochondria woodii		GWS22318	-	-	KM254839
Pterochondria woodii		AC248	-	GQ252570	-
Pterosiphonia cloiophylla		P2023	-	GQ867080	-
Pterosiphonia complanata	Biarritz, France; 19.iii.2011; intertidal	25423	-	-	**MF094032**
Pterosiphonia complanata		P732	-	GQ867079	-
Pterosiphonia spinifera		CUK14857	-	KU252581	-
Pterosiphonia stangeri		CUK14394	-	KU252582	-
Pterosiphonieae sp.	Pope´s Eye, Victoria, Australia; 11.xii.2014; subtidal (-15 m)	PD1017	-	**MF094101**	-
Rhodomela confervoides	Glashagh Bay Donegal, Ireland; 11.v.2014; drift	PD508	**MF093954**	Table S3	**MF094006**

Rhodomela lycopodioides		GWS005450	-	-	JX572153
Rhodomela lycopodioides 2		GWS005208	-	-	JX571959
Rhodomela virgata	As *Rhodomela* sp in GenBank, but see Saunders & McDevit 2013	GWS005437	-	-	JX571969
Rhodomelopsis africana	Kenton-on-sea, Eastern Cape, South Africa; 8.xii.2014; intertidal	JFC1451	-	**MF094102**	-
Rytiphlaea tinctoria		MELULEP.R170	AY237284	-	-
Sonderella linearis	Merry Island, Victoria, Australia; 29.xii.2014; drift	PD1151	**MF093955**	Table S3	**MF094007**
Spirocladia barodenis		ARS02022	-	-	HQ423090
Spirocladia hodgsoniae		ARS00755	-	-	HQ422660
Streblocladia glomerulata		NZ	KX499579	-	-
Symphyocladia dendroidea	Culture strain	JW3780	**MF093956**	Table S3	**MF094009**
Symphyocladia glabra		120408	-	KF048951	-
Symphyocladia jejuinsula	As *Symphyocladia* sp.	S199	-	JF967651	-
Symphyocladia latiuscula		S67	-	GQ867072	-
Symphyocladia latiuscula		mbccc58	-	-	KC782862
Symphyocladia linearis		CH419	JX828189	JX828158	-
Symphyocladia marchantioides	Sandrigham, Victoria, Australia; 8.i.2015; subtidal (-2 m)	PD1169	-	**MF094104**	-
Symphyocladia parasitica	San Felipe, Ferrol, Galicia, Spain; 14.x.2015; subtidal (-3 m)	PD2170	-	**MF094103**	-
Symphyocladia parasitica		25631	-	-	KF648524
Symphyocladia pumila		S204	-	GU731228	-
Thaumatella adunca	The Rip, Victoria, Australia; 29.i.2015; subtidal (- 20 m)	PD1388	**MF093958**	Table S3	**MF094011**
Tolypiocladia glomerulata	Flat Rocks, Western Australia; 23.iii.2015; intertidal	PD1825	**MF093960**	Table S3	**MF094013**
Ululania stellata		ARS03565	GU223744	-	-
Ululania stellata		ARS03701	-	-	GU223865

Vertebrata australis	Pope´s Eye, Victoria, Australia; 1.xii.2014; subtidal (-15 m)	PD0931	KX499570	KX499546	**MF094014**
Vertebrata byssoides		PD549	KX499571	-	-
Vertebrata byssoides	As *Brongniartella byssoides*	-	-	DQ787584	-
Vetebrata constricta	As *Polysiphonia constricta*	NZ04.308	HM560639	-	HM573542
Vetebrata constricta	As *Polysiphonia constricta*	NZ04.256	-	GU385832	-
Vetebrata foetidissima	As *Polysiphonia foetidissima*	LLAS3	-	JQ653284	-
Vetebrata fruticulosa	As *Boergeseniella fruticulosa*	CH049	AF427526	JX828161	-
Vetebrata fruticulosa	As *Boergeseniella fruticulosa*	PC0157036	-	-	KC238313
Vertebrata fucoides	As *Polysiphonia fucoides*	CH044	AF427530	-	-
Vertebrata fucoides	As *Polysiphonia fucoides*	CH046	-	JX828163	-
Vertebrata fucoides	As *Polysiphonia fucoides*	NC.12	-	-	HM573496
Vertebrata furcellata		LMI469	-	KX499559	-
Vertebrata hypnoides		24410	-	KX499547	-
Vertebrata hypnoides	As *Ctenosiphonia hypnoides*	24156	-	-	KF671184
Vertebrata isogona	Frankston, Dave´s Bay, Victoria, Australia; 19.xi.2014; subtidal (-2 m)	PD0831	KX499578	Table S3	**MF094015**
Vertebrata lanosa		CH045	AF203886	Table S3	-
Vertebrata lobophoralis	As *Polysiphonia* sp.	2DWF2011	HM560657	-	-
Vertebrata lobophoralis	As *Polysiphonia* sp.	PHYKOS.3537	-	HM573551	-
Vertebrata nigra	As *Polysiphonia nigra*	CH048	AF427534	JX828164	-
Vertebrata nigra	As *Polysiphonia nigra*	24148	-	-	KC130868
Vertebrata reptabunda		25139	KX499574	KX499554	-
Vertebrata reptabunda	As *Lophosiphonia reptabunda*	28240	-	-	KF648519
Vertebrata simulans		PD2192	KX499575	KX499568	-
Vertebrata stimpsonii	As *Enelittosiphonia stimpsonii*	CH073	AF427527	JX828126	-
Vertebrata subulifera		LMI1017	-	KX499564	-
Vertebrata thuyoides	Fanad Head, Donegal, Ireland; 15.vi.2014; intertidal	PD546	**MF093961**	Table S3	**MF094016**
Vertebrata tripinnata		22246	-	KX499566	-

Vertebrata tripinnata	As *Polysiphonia tripinnata*	24256	-	-	KC130871
Vertebrata urbana		JFC1486	-	KX499567	-
Vidalia colensoi	As *Osmundaria colensoi*	MELULEPR112	AY237285	-	-
Vidalia spiralis	As *Osmundaria spiralis*	MELULEPR125	AY237287	-	-
Vidalia spiralis	Rottnest Island, Western Australia; 15.iii12015; subtidal (-5 m)	PD1620	-	**MF094106**	-
Waldoia sp. 1		LAF092405212	-	KF564786	-
Waldoia sp. 2		Ce82	-	KF672859	-
Waldoia sp. 3		LAF09049828	-	KF564783	-
Waldoia sp. 4		LAF09049827	-	KF564785	-
Waldoia antillana		LAF-06-4-05-2-4	-	KF564784	-
Wilsonosiphonia howei		JAW2922	AY237282	-	-
Wilsonosiphonia howei		PHYKOS.3141	-	HM573543	HM573520
Womersleyella setacea		CH050	AF427537	JX828160	-
Wrightiella tumanowiczii		Wri.tuman	-	EU492922	-
Xiphosiphonia ardreana	La Arena, Basque Country, Spain; 22.iii.2011; intertidal	25640	-	**MF094107**	KF648523
Xiphosiphonia pennata	As *Pterosiphonia pennata*	24615	-	-	KF671154
Xiphosiphonia pennata	Langre, Asturias, Spain; 6.xi.2010; intertidal	24618	-	**MF094108**	-
Xiphosiphonia pinnulata	As *Pterosiphonia pennata*	CH977	JX828187	JX828155	-
Xiphosiphonia pinnulata	As *Pterosiphonia pennata*	24342	-	-	KF671155
Yuzurua poiteaui		-	-	EF061652	-
OUTGROUP					
Acrosorium ciliolatum	Genome obtained as epiphytic contaminant	-	**MF093911**	Table S3	**MF093964**
Caloglossa beccarii	Culture strain	JW4523	**MF093916**	Table S3	**MF093969**
Caloglossa intermedia	Culture strain	JW3535	**MF093917**	Table S3	**MF093970**
Caloglossa monosticha	Culture strain	JW3046	**MF093918**	Table S3	**MF093971**
Ceramium cimbricum	Hughey and Boo 2016		-	Table S3	-

Dasya naccarioides	13th Beach, Victoria, Australia; 30.xi.2014; intertidal	PD888	**MF093923**	Table S3	**MF093976**
Dipterocladia arabiensis	Mirbat, Dhofar, Oman; 24.ix.2003	DHO101	**MF093927**	Table S3	**MF093980**
Platysiphonia delicata	13th Beach, Victoria, Australia; 01.xii.2015; intertidal	HV1445	**MF093942**	Table S3	**MF093994**
Spyridia filamentosa		PD1020	-	Table S3	**MF094008**
Taenioma perpusillum	Yanchep, Western Australia; 19.iii.2015; intertidal	PD1676	**MF093957**	Table S3	**MF094010**
Thuretia quercifolia	Queenscliff, Victoria, Australia; 11.xii.2014; seagrass, subtidal (-2 m)	PD1024	**MF093959**	Table S3	**MF094012**

Tribe	Habit	Cortication	Attachment	Pericentral cells	Branches	Trichoblasts
Sonderelleae	Erect. Blade-like.	Absent.	Basal disc.	3 or 4, differentiated into 2 lateral and 1-2 adaxial	-	Absent
Polyzonieae	Erect or postrate. Filiform or pseudoparenchymatous *(Polyzonia ;* base of *Echinothamnion*). Indeterminate axes bearing determinate branches.	Present or absent.	Basal disc (*Cliftonaea* and *Echinosporangium*). Rhizoids cut off from two adjoining pericentral cells, multiseriate filaments, multicellular discoid pads (*Leveillea*). Rhizoids in open connection to the axial cell, formed by two adjoining cells each producing half of the rhizoid, with multicellular haptera (*Dasyclonium*). Clump of rhizoids with multicellular terminations	3 in determinate branches, 6 or 7 in indeterminate branches	Indeterminate axes endogenous, determinate axes exogenous	Absent (*Dasyclonium* , *Polyzonia*). Unpigmented and deciduous (*Leveillea*). Pigmented and persistent (*Cliftonaea* , *Echinothamnion*)
Bostrychieae	Prostrate axes bearing erect branches. Filiform.	Present or absent.	Peripherohapteron (clusters of rhizoids from pericentral or cortical cells) or cladohapteron (haptera borne terminally on special branches).	4-9, transversely divided with the basal cell retaining the pit connection to the axial cell	Exogenous (rarely some endogenous)	Absent
Heterocladieae	Erect. Pseudoparenchymatous, terete or flattened.	Present.	Basal disc.	4, longitudinally divided	-	Persistent and pigmented
Lophothalieae	Erect, some species with prostrate axes. Filamentous or pseudoparenchymatous.	Present or absent.	Basal disc or multicellular rhizoids.	4-7. Transversely divided in *Holotrichia* and *Schizolaenium.*	-	Persistent and pigmented.
Amansieae	Erect. Blade-like (terete). Mostly pseudoparenchymatous.	Present or absent.	Basal disc.	5-6, differentiated in dorsal, lateral and ventral. Pseudopericentral cells in some species.	-	Absent or present. Sometimes adventitious. Deciduous and unpigmented when mature.
Cladureae	Erect. Pseudoparenchymatous, terete.	Present.	Basal disc.	5	-	Deciduous and unpigmented when mature. Spirally arranged.

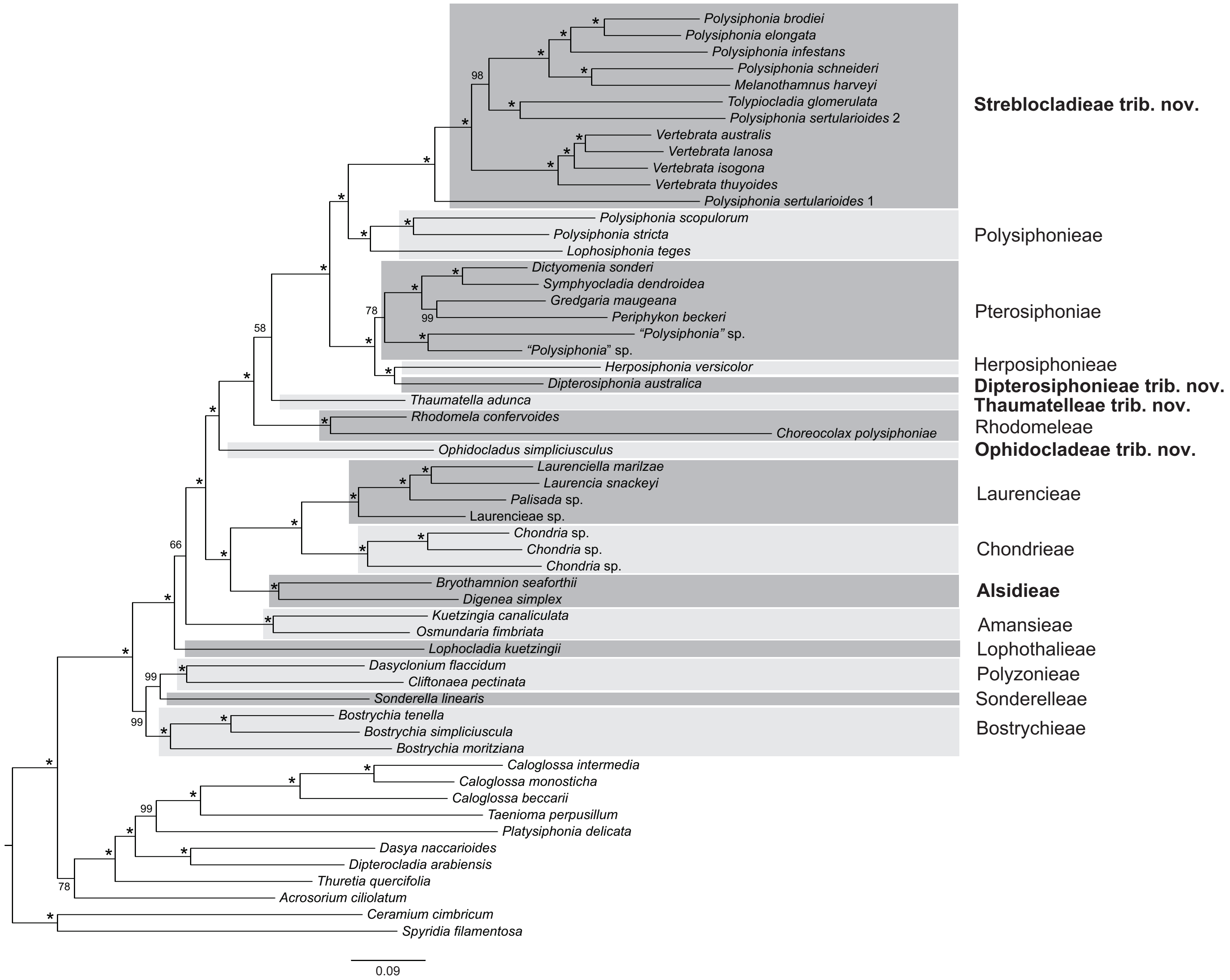
Tribe	Habit	Cortication	Attachment	Pericentral cells	Branches	Trichoblasts
Alsidieae	Erect. Pseudoparenchymatous, terete or compressed.	Present	Basal disc or crust.	5-12	-	Absent or present. Deciduous and unpigmented when mature.
Chondrieae	Erect (or stoloniferous). Pseudoparenchymatous, terete (compressed)	Covering the thallus, obscuring polysiphonous structure.	Basal disc (and secondary multicelluar haptera formed by groups of rhizoidal filaments in stoloniferous thalli).	5	-	Deciduous and unpigmented. Spirally arranged, usually in an apical depression.
Laurencieae	Erect (or stoloniferous). Pseudoparenchymatous, terete (compressed).	Covering the thallus, obscuring polysiphonous structure.	Basal disc (and secondary multicellular haptera in stoloniferous thalli).	2 or 4	-	Deciduous and unpigmented. Spirally arranged in an apical depression.
Ophidocladeae	Prostrate and erect axes. Filiform	Absent.	Rhizoids cut off from anterior end of pericentral cells, terminated by multicellular discoid pads formed by the division of cells from the base of the rhizoidal filament.	12-28	Endogenous	Deciduous and unpigmented. Alternately arranged.
Thaumatelleae	Prostrate, filiform	Absent.	Rhizoids cut off from the middle of pericentral cells, with a multicellular uniseriate filament and multicellular haptera formed by cells cut off from the base of the rhizoidal filament.	4		Pigmented and persistent. Spirally arranged.
Rhodomeleae	Erect. Pseudoparenchymatous, terete or compressed.	Present.	Basal disc.	6-7. Dividing transversely, with distal cell retaining the pit connection to the axial cell.	Exogenous and endogenous	Absent or present. Deciduous and unpigmented when mature. Spirally or dorsiventrally arranged.

Tribe	Habit	Cortication	Attachment	Pericentral cells	Branches	Trichoblasts
Pterosiphonieae	Erect or prostrate. Terete, compressed or blade-like. Filiform or pseudoparenchymatous. Indeterminate prostrate axes bearing determinate branches, laterals sometimes fused with the main axes.	Absent or present.	Rhizoids cut off from pericentral cells in anterior position , also from the posterior of adjoining pericentral cells in *Gredgaria* and *Pterosiphonieae* sp.; terminated by multicellular discoid pads formed by the division of cells at the end of the rhizoidal filament. Basal disc in the largest species.	4-14	Exogenous and endogenous	Absent or deciduous and unpigmented when mature; spirally arranged
Herposiphonieae	Indeterminate axes (prostrate or erect) bearing erect determinate branches. Filiform.	Absent.	Rhizoids cut off from the anterior part of pericentral cells; terminated by multicellular discoid pads formed by extension of the rhizoidal filament into a digitate structure with dividing apical cells.	6-16	Exogenous. Regular pattern of determinate and indeterminate branches, commonly 3:1	Deciduous and unpigmented when mature. Spirally arranged
Pleurostichidieae	Erect. Obligate epiphyte. Pseudoparenchymatous, compressed.	Present.	-	10-20	Endogenous	Adventitious and unpigmented. Dorsiventrally arranged.
Dipterosiphonieae	Indeterminate prostrate axes bearing determinate branches. Filiform	Absent.	Rhizoids cut off from the anterior part of pericentral cells, terminated by multicellular discoid pads formed by the division of cells from the base of the rhizoidal filament.	4-10	Exogenous. Regular pattern, alternating pairs of determinate branches	Deciduous and unpigmented when mature. Spirally arranged
Polysiphonieae	Erect with a short prostrate system, or extensive prostrate systems, either decumbent or a true prostrate axes, bearing erect axes. Filiform.	Absent.	Rhizoids in open connection with pericentral cells, unicellular.	4 (-7-12)	Exogenous and endogenous	Deciduous and unpigmented when mature. Spirally arranged
Streblocladieae	Erect with or without a short prostrate system, or extensive prostrate systems, either decumbent or with a true prostrate axes, bearing erect axes. Filiform (pseudoparenchymatous in some heavily corticated species).	Absent or present.	Rhizoids cut off from the posterior ends of pericentral cells, unicellular (except *Lampisiphonia,* which has muticellular haptera). Basal disc in the largest species.	4-24	Exogenous and endogenous	Deciduous and unpigmented when mature (pigmented and persistent). Spirally (dorsiventrally) arranged.

Tribe	Procarps	Sterile groups on procarps	Pericarp	Cystocarp	Spermatangia	Tetrasporangia	Tetrasporangial cover cells	References
Sonderelleae	On adaxial pericentral cell	Two, both 1-celled	Prefertilization	Ovoid to urceloate	On spermatangial blades, on the blade surface.	In stichidia, two per segment	2 presporangial, dividing to form four	Phillips 2001; Womersley 1965
Polyzonieae	On determinate laterals	-	-	Ovoid	On triradiate lateral branches with sterile margin.	On endogenous short lateral branches.	3 cover cells, 2 of them dividing once or twice	Scagel 1953, Hommersand 1963, Womersley 2003, pers. obs.
Bostrychieae	On determinate laterals	One, 2-6-celled	Postfertilization	Spherical	On determinate polysiphonous branches.	In stichidia, forming whorls	2-3 cover cells	Hommersand 1963, Maggs & Hommersand 1993, Zuccarello et al. 2004
Heterocladieae	On trichoblasts	One, 3-celled	Prefertilization	Ovoid	Cylindrical spermatangial branches. On several branches of trichoblasts.	In stichidia. One per segment.	Absent	Hommersand 1963, Phillips et al. 2000, Womersley 2003
Lophothalieae	On trichoblasts	One or two	Prefertilization	Ovoid, globose or urceloate	Cylindrical spermatangial branches. On several branches of trichoblasts.	On branches or in stichidia. One, two paired/decussate, or four per segment.	2 presporangial, in most genera also one postporangial.	Hommersand 1963, Parsons 1975, Parsons &Womersley 2003
Amansieae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Ovoid	Ovoid spermatangial branches. On modified trichoblasts.	In stichidia. Two per segment.	2 presporangial and 1 postsporangial when known	Hommersand 1963, Womersley 2003, Maggs & Hommersand 1993
Cladureae	Probably on trichoblasts.	-	-	Ovoid	Cylindrical spermatangial branches. On several branches of trichoblasts.	In stichidia.	-	Womersley 2003

Tribe	Procarps	Sterile groups on procarps	Pericarp	Cystocarp	Spermatangia	Tetrasporangia	Tetrasporangial cover cells	References
Alsidieae	-	-	-	Globose	Plate-like spermatangial branches. On modified trichoblasts.	In stichidia, one per segment	-	Falkenberg 1901, Kützing 1865, Norris 1994
Chondrieae	On trichoblasts	Two: the lateral 6-12-celled and the basal 2-8-celled.	Prefertilization	Globose	Plate-like spermatangial branches. On modified trichoblasts.	On branches, from pericentral (inner cortical) cells	2 presporangial	Hommersand 1963, Maggs & Hommersand 1993, Womersley 2003
Laurencieae		Two: the lateral 4-6-celled and the basal 2-3-celled.	Prefertilization	Ovoid or fused with the branches	On trichoblasts. Inside receptacles.	On branches, from pericentral cells	2 presporangial	Hommersand 1963, Maggs & Hommersand 1993, Womersley 2003
Ophidocladeae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Ovoid	Quadrifurcate to globose spermatangial branches. Covering the two basal dichotomies of trichoblasts.	On branches. Two per segment.	2 presporangial	Saenger, 1971, Díaz-Tapia & Bárbara 2013
Thaumatelleae			Prefertilization	Stongly urceolate	Ovoid spermatangial branches. On several branches of trichoblasts.	On branches. One per segment		Womersley 2003, this work
Rhodomeleae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Globose to urceloate	On polysiphonous branches or on modified trichoblasts.	On branches. Two per segment.	2 presporangial	Hommersand 1963, Masuda 1982, Maggs & Hommersand 1963

Tribe	Procarps	Sterile groups on procarps	Pericarp	Cystocarp	Spermatangia	Tetrasporangia	Tetrasporangial cover cells	References
Pterosiphonieae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Spherical or ovoid	Cylindrical spermatangial branches. On modified trichoblasts.	On branches. One per segment.	2 presporangial and 1 postsporangial	Hommersand 1963, Maggs & Hommersand 1993, Womersley 2003
Herposiphonieae	On trichoblasts	-	Prefertilization	Ovoid	Cylindrical spermatangial branches. On modified trichoblasts.	On determinate branches	2-3 cover cells	Womersley 2003
Pleurostichidieae	On adventitious trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Spherical	Ovoid spermatangial branches. On adventitious branchlets.	In stichidia. Forming whorls of up to 19	2 presporangial	Hommersand 1963, Phillips 2000
Dipterosiphonieae	On trichoblasts	-	Prefertilization	Ovoid	Cylindrical spermatangial branches. On modified trichoblasts.	On determinate branches. One per segment		Womersley 2003, this work
Polysiphonieae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Spherical, ovoid or urceolate	Cylindrical spermatangial branches. On one (two) branch(es) of trichoblasts or on modified trichoblasts.	On branches. One per segment.	2 presporangial, in some species also one postporangial	Hommersand 1963, Maggs & Hommersand 1993, Womersley 2003
Streblocladieae	On trichoblasts	Two: the lateral 2-celled and the basal 1-celled	Prefertilization	Sphaerical, ovoid	Cylindrical spermatangial branches. On one (two) branch of trichoblasts or on modified trichoblasts.	On branches. One (two) per segment.	2 presporangial	Hommersand 1963, Maggs & Hommersand 1993, Womersley 2003


Polysiphonia brodiei
Polysiphonia elongata
Polysiphonia infestans
Polysiphonia schneideri
Melanothamnus harveyi
Tolypiocladia glomerulata
Polysiphonia sertularioides 2
Vertebrata australis
Vertebrata lanosa
Vertebrata isogona
Vertebrata thuyoides
Polysiphonia sertularioides 1
Streblocladieae trib. nov.
Polysiphonia scopulorum
Polysiphonia stricta
Lophosiphonia teges
Polysiphonieae
Dictyomenia sonderi
Symphyocladia dendroidea
Gredgaria maugeana
Periphykon beckeri
"Polysiphonia" sp.
"Polysiphonia" sp.
Pterosiphoniae
Herposiphonia versicolor
Herposiphonieae
Dipterosiphonia australica
Dipterosiphonieae trib. nov.
Thaumatella adunca
Thaumatelleae trib. nov.
Rhodomela confervoides
Choreocolax polysiphoniae
Rhodomeleae
Ophidocladus simpliciusculus
Ophidocladeae trib. nov.
Laurenciella marilzae
Laurencia snackeyi
Palisada sp.
Laurencieae sp.
Laurencieae
Chondria sp.
Chondria sp.
Chondria sp.
Chondrieae
Bryothamnion seaforthii
Digenea simplex
Alsidieae
Kuetzingia canaliculata
Osmundaria fimbriata
Amansieae
Lophocladia kuetzingii
Lophothalieae
Dasyclonium flaccidum
Cliftonaea pectinata
Polyzonieae
Sonderella linearis
Sonderelleae
Bostrychia tenella
Bostrychia simpliciuscula
Bostrychia moritziana
Bostrychieae
Caloglossa intermedia
Caloglossa monosticha
Caloglossa beccarii
Taenioma perpusillum
Platysiphonia delicata
Dasya naccarioides
Dipterocladia arabiensis
Thuretia quercifolia
Acrosorium ciliolatum
Ceramium cimbricum
Spyridia filamentosa
98
78
99
58
66
99
99
99
78
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0.09


Streblocladieae trib. nov.
Bryocladia / Falkenbergiella
Polysiphonia
Lophosiphonia
Epizonaria gen. nov.
Polysiphonieae
Herposiphonieae
Pleurostichidieae
Dipterosiphonieae
Pterosiphonieae
Rhodomeleae
Thaumatelleae trib. nov.
Ophidocladeae trib. nov.
Laurencieae
Chondrieae
Alsidieae
Cladureae trib. nov.
Amansieae
Lophothalieae
Bostrychieae
(Peripherohapteron-clade)
Bostrychiocolax australis
Dawsoniocolax bostrychiae
Bostrychieae
(Cladohapteron-clade)
Heterocladieae
Bostrychieae (Cladohapteron2)
Polyzonieae
Sonderelleae
Dasyclonium incisum 5
Dasyclonium flaccidum
Polyzonia elegans
Leveillea jungermannioides 2
Leveillea jungermannioides 1
Leveillea jungermannioides
Cliftonaea pectinata
Sonderella linearis
Caloglossa beccarii
Taenioma perpusillum
Dipterocladia arabiensis
Dasya naccarioides
Thuretia quercifolia
Acrosorium ciliolatum
Spyridia filamentosa
0.07