Research Article

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Kapraunia silviae (Rhodomelaceae, Rhodophyta), a new species from the South Atlantic Ocean

https://doi.org/10.1515/bot-2023-0101
Received November 27, 2023; accepted May 29, 2024;
published online July 3, 2024

Abstract: *Kapraunia* is a genus recently segregated from *Polysiphonia sensu lato*, with only four species so far known. However, no species have been found on the South Atlantic coast. Recent collections in southwestern Brazil revealed specimens morphologically similar to *Kapraunia* spp. To investigate the identity of these specimens, we carried out a morphological and molecular study based on COI-5P and *rbc*L sequences. Phylogenetic analysis placed our samples within the genus *Kapraunia* as a new species with full support, described here as *Kapraunia silviae* sp. nov. *K. silviae* is recognizable by a combination of characters such as attachment by a basal disc and a prostrate system, branches developing laterally to the trichoblasts, 5–6 pericentral cells, rarely 4. The species differs from *K. pentamera* by the attachment form, segment proportions and tetrasporangial dimensions, and from *K. schneideri* by the number of pericentral cells, branch development and tetrasporangial arrangement. Re-examination of herbarium samples from Brazil in older collections also revealed misidentifications of *K. silviae* as "*Carradoriella denudata*". This new species seems to be restricted to the Brazilian coast, being found only on the northern coast of São Paulo state. Our results reinforce the need for revision of *Polysiphonia s.l.* species on the Brazilian coast.

Keywords: COI-5P; molecular phylogeny; *Polysiphonia sensu lato*; *rbc*L; Streblocladieae

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1 Introduction

Polysiphonia Greville is one of the most speciose genera within the family Rhodomelaceae, comprising over 200 taxa worldwide (Guiry and Guiry 2024). The taxonomy of *Polysiphonia sensu lato* has historically used the number of pericentral cells per segment as the primary character to distinguish species. However, detailed studies showed that several species shared a set of other features that could be used in combination to delimit taxa within the group such as: rhizoid type, branching pattern, origin of the branches, presence and disposition of trichoblasts, tetrasporangial arrangement, position of spermatangia, presence or absence of cortication (Choi et al. 2001; Kim and Lee 1999; Stuercke and Freshwater 2008). A combination of morphological and molecular studies resulted in a major redefinition of *Polysiphonia s. l.*, leading to the proposal of several new genera such as *Acanthosiphonia* Savoie *et* G.W. Saunders (Savoie and Saunders 2019), *Eutrichosiphonia* Savoie *et* G.W. Saunders (Savoie and Saunders 2019), *Lampisiphonia* H.-G. Choi, Díaz Tapia *et* Bárbara (Bárbara et al. 2013) and *Savoiea* M.J. Wynne (Savoie and Saunders 2016; Wynne 2018), as well as the resurrection of *Melanothamnus* Bornet *et* Falkenberg and *Vertebrata* Gray (Díaz-Tapia et al. 2017a), and also the segregation of the tribe Streblocladieae from the Polysiphonieae (Díaz-Tapia et al. 2017b), previously recognized by Kylin (1956) and Hommersand (1963).

The Streblocladieae includes 12 genera that share as synapomorphy rhizoids cut off from the mid-proximal end of pericentral cells. Only four of these genera are currently recognized to occur in the South Atlantic, *Carradoriella* P.C. Silva, *Melanothamnus*, *Vertebrata* and *Tolypiocladia* F. Schmitz (Bustamante et al. 2017).

The genus *Kapraunia* Savoie *et* G.W. Saunders was segregated from *Polysiphonia s.l.* (Savoie and Saunders 2019) and formally assigned to the tribe Streblocladieae, proposed by Díaz-Tapia et al. (2017a). Previously, *Kapraunia* was referred to as "*Polysiphonia schneideri*" clade, a sister clade to the genus *Melanothamnus*, which presented similar characteristics to *Polysiphonia sensu stricto* and

Melanothamnus (Díaz-Tapia et al. 2017a). *Kapraunia* is characterized by a discoid holdfast with secondary prostrate axes, rhizoids cut off from the pericentral cells, and – the most distinctive character – branches that are borne laterally from the basal cell of trichoblasts or replacing the trichoblasts (Savoie and Saunders 2019). This last character is considered a unique feature that was historically overlooked in morphological reevaluations of *Polysiphonia s.l.* species. Over the years it was thought that lateral branches could develop in three ways (Figure 1): (i) independently of trichoblasts (Figure 1A), (ii) replacing trichoblasts (Figure 1B) and (iii) in the axils of trichoblasts (Figure 1C–E). The first authors who referred to this feature were Mamoozadeh and Freshwater (2012), who noted that *K. pentamera* (Hollenberg) Savoie *et* G.W. Saunders and *K. schneideri* (Stuercke *et* Freshwater) Savoie *et* G.W. Saunders presented a fourth type, with branches formed laterally from the basal trichoblast cell (Figure 1F–H).

Since its proposal, only four *Kapraunia* species have been recognized: *K. schneideri* (the generitype), *K. amplacapilli* (B. Kim *et* M.S. Kim) Savoie *et* G.W. Saunders, *K. morroides* (B. Kim *et* M.S. Kim) Savoie *et* G.W. Saunders and *K. pentamera*, occurring in tropical and subtropical areas of the Pacific and Atlantic Oceans, and introduced into southern Europe (Díaz-Tapia et al. 2013; Kim and Kim 2014; Mamoozadeh and Freshwater 2012; Savoie and Saunders 2019; Sfriso et al. 2019).

For the South Atlantic, there is no record of any *Kapraunia* species. On the other hand, *K. pentamera* and *K. schneideri* are cited in the northwestern Atlantic for Panama, Bermuda, USA, Mexico and Cuba (Mamoozadeh and Freshwater 2011, 2012; Mendoza-González et al. 2017; Moreira-González et al. 2019; Stuercke and Freshwater 2010). Both species were referred to as *Polysiphonia*, and *K. schneideri* includes misidentifications of *P. denudata* (Dillwyn) Greville ex Harvey [now *C. denudata* [(Dillwyn) Savoie *et* G.W. Saunders (Mamoozadeh and Freshwater 2011; Savoie and Saunders 2019; Wynne 2022)]. The lack of records of *Kapraunia* in the South Atlantic might be due to the scarcity of studies focusing on *Polysiphonia s.l.* species. Guimarães et al. (2004) were the only authors to include a deeper taxonomic discussion of the *Polysiphonia s.l.* occurring in Brazil, but based only on morphological and anatomical data. The implementation of molecular data, especially DNA barcodes, has been providing a new perspective on the Brazilian algal diversity, revealing new, overlooked and sometimes cryptic and/or endemic taxa (Brito et al. 2024; Carneiro et al. 2023; Cassano et al. 2019; Gomes et al. 2020; Guimarães et al. 2019; Jesus et al. 2019; Lyra et al. 2016; Pestana et al. 2021; Santos et al. 2020, 2023; Soares et al. 2018).

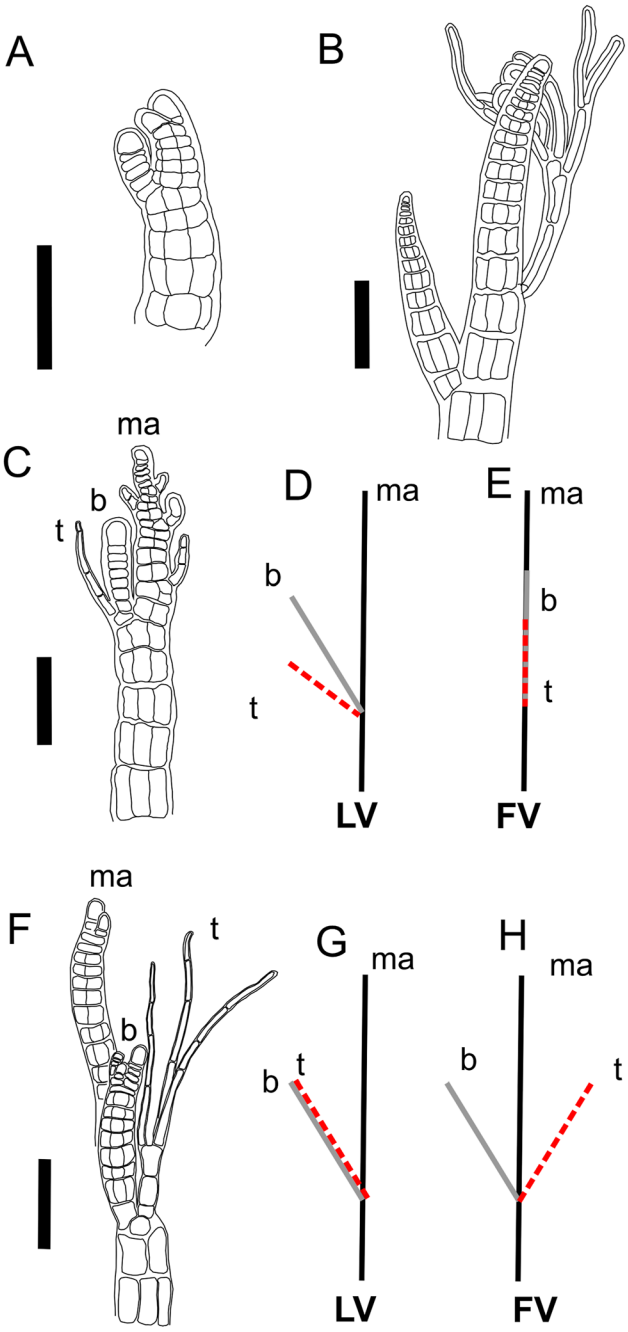

Figure 1: Relationship between lateral branches and trichoblasts in *Polysiphonia s.l.* (A–E) and in *Kapraunia* (F–H). (A) Branches developing independently of trichoblasts. (B) Branches replacing trichoblasts. (C) Branches developing at the axils of trichoblasts. (D–E) Schematic representation of the axillary development. (F) Branches developing laterally to the trichoblasts. (G–H) Schematic representation of the lateral development. LV, lateral view; FV, frontal view; ma, main axis; b, branch; t, trichoblast. Scale bars: (A, C, F) = 50 µm; (B) = 25 µm.

In our recent collections of *Polysiphonia*-like specimens in the southeastern Brazilian coast we found specimens morphologically similar to *K. schneideri*. To investigate their

identity, we provide detailed descriptions of morpho-anatomical and reproductive characters and *rbc*L and COI-5P genes sequences of a new *Kapraunia* species.

2 Materials and methods

The four samples were recently collected in Vermelha do Sul and Fortaleza beaches, Ubatuba, São Paulo state, south-eastern Brazil (Table 1). They were preserved in 70 % ethanol for morphological observations, and small fragments were dried in silica gel for molecular analysis. Additional material from the São Paulo University herbarium (SPF) collections was also studied, chosen by the similarities with *Kapraunia* species. Morphological analyses were performed using a stereoscopic microscope Zeiss Axioplan (Oberkotchen, Germany) and an optical microscope Zeiss with Canon digital camera SD950IS (Tokyo, Japan) for photographic documentation. Transverse hand sections were obtained with a razor blade for observation of the number of pericentral cells. For each specimen studied, a minimum of 20 measurements of each morphometric character were made, when possible, to establish the range of morphological variation. Measurements are given as length × diameter. The specimens were deposited in the SPF herbarium. Abbreviation follows *Index herbariorum* (Thiers 2024).

Total DNA was extracted using NucleoSpin Plant II Kit (Macherey-Nagel Düren, Germany). For phylogenetic analyses, we amplified the mitochondrial gene COI-5P using the primers GazF1-GazR1 (Saunders 2005) and the plastidial *rbc*L gene using F57-R492, F492-R1150 and F753a-*Rrbc*S Start (Cassano 2009; Freshwater and Rueness 1994; Saunders 2005). The PCR reactions were performed in 25 µl final volume: 1 × PCR *buffer*, 3 mM of $MgCl_2$, 0.06 mM of BSA, 1.6 mM of dNTP, 0.4 mM of each primer, 0.31 U of *Taq* DNA polymerase (Promega Corp., Madison, Wisconsin, USA) and 1 µl of extracted DNA. The PCR cycle for COI-5P consisted of an initial denaturation (94 °C for 3 min), 35 cycles of denaturation (94 °C for 30 s), primers annealing (45 °C for 1 min), extension (72 °C for 2 min), and a final extension (72 °C for 7 min). The PCR cycle for *rbc*L consisted of an initial denaturation (94 °C for 4 min), 35 cycles of denaturation (94 °C for 1 min), primers annealing (45 °C for 1 min), extension (72 °C for 1 min 30 s), and a final extension (72 °C for 10 min). PCR products were checked in agarose gels stained with UniSafe Dye (UniScience, Miami, Florida, USA), with bands compared with 1 Kb DNA Ladder (Invitrogen, Waltham, Massachusetts, USA). The products were purified using Illustra GFX PCR DNA and Gel Purification Kit (GE Healthcare Life Sciences, Piscataway, New Jersey USA), and then bidirectionally sequenced using the same primers from PCR and the BigDye Terminator Cycle Sequencing Ready to Reaction Kit (Applied Biosystems Foster City, California, USA) on an ABI PRISM Genetic Analyzer (Applied Biosystems).

Consensus sequences were built using BioEdit v7.0.4.1 (Hall 1999). The generated sequences and sequences acquired in GenBank (Table S1) were aligned using ClustalW within BioEdit (Larkin et al. 2007). The final alignment of *rbc*L included 42 sequences from GenBank (Spm1) with a 1,210 bp extension, while COI-5P included 38 sequences from GenBank (Spm1) with a 587 bp extension. Representatives of Streblocladieae from different genera closely related to *Kapraunia* were included in the alignment and *Bryocladia* F. Schmitz sequences available in GenBank were used as outgroups to reassess the positioning of *Kapraunia* and its species. The COI-5P + *rbc*L were concatenated using MEGAX tool (Kumar et al. 2018) and included 35 samples of

Table 1: Samples of *Kapraunia siliviae* sp. nov. included in morphological and molecular analysis.

Taxon	Voucher	Accession		Locality	Collection date	Collector	Latitude	Longitude
		COI-5P	*rbc*L					
Kapraunia silviae sp. nov.	SPF58817	PP401683	PP395808	Fortaleza Beach, Ubatuba, São Paulo, Brazil	15.VII.2022	Brito, J.O.F. et al.	23°31′54.4″S	45°09′47.3″W
Kapraunia silviae sp. nov.	SPF58818 (holotype)	PP401684	PP401680	Fortaleza Beach, Ubatuba, São Paulo, Brazil	15.VII.2022	Brito, J.O.F. et al.	23°31′54.4″S	45°09′47.3″W
Kapraunia silviae sp. nov.	SPF58819	PP401685	PP401681	Fortaleza Beach, Ubatuba, São Paulo, Brazil	15.VII.2022	Brito, J.O.F. et al.	23°31′54.4″S	45°09′47.3″W
Kapraunia silviae sp. nov.	SPF58820	PP401686	PP401682	Vermelha do Sul Beach, Ubatuba, São Paulo, Brazil	15.VII.2022	Brito, J.O.F. et al.	23°30′43.2″S	45°10′20.8″W
Kapraunia silviae sp. nov.	SPF3727	–	–	Saco da Ribeira Beach, Ubatuba, São Paulo, Brazil	05.IX.1963	Joly, A.B. et al.	23°30′18.8″S	45°07′20.8″W
Kapraunia silviae sp. nov.	SPF3724	–	–	Barreiros Beach, Ilhabela, São Paulo, Brazil	08.IV.1950	Joly, A.B.	23°45′49.8″S	45°20′58.2″W

Strebloclad ieae and *Bryocladia* for which both markers were available. The final alignment of concatenated data was 1,674 bp long. The best evolutionary model was calculated using jModeltest under the AIC criterion (Darriba et al. 2012), with GTR + I + G being the best suited model for all datasets. Maximum Likelihood (ML) analyses were performed in MEGAX, with 1,000 bootstrap replicates and Bayesian Inference (BI) was performed in MrBayes v.3.2.2 (Ronquist et al. 2012), with two runs and four MCM chains, with 5,000,000 generations sampling one tree every 1,000 generations and *burnin* verified in the software Tracer v1.7 (Rambaut et al. 2018). The consensus ML tree was used as base for the phylogenetic tree in figures and the bootstrap (BS) and posterior probabilities (PP) values above 60 % and 0.6, respectively, were indicated at the tree nodes. Genetic distance values of *rbc*L and COI-5P within and between species were calculated using uncorrected '*p*' distances on MEGA X.

3 Results

3.1 Phylogenetic analyses

Our four newly generated sequences for COI-5P and *rbc*L were recovered in the genus *Kapraunia* with strong support in all analysis. The single *rbc*L (Figure 2), COI-5P (Figure 3) and concatenated (COI-5P + *rbc*L) (Figure 4) datasets reconstructed similar topology in all trees, with *Kapraunia* as sister to *Melanothamnus*. Our sequences formed a distinct clade in all analyses with full support, reinforcing their status as a new taxon. In the *rbc*L dataset, all *Kapraunia* sequences were recovered in a moderate to well-supported clade (BS = 88; PP = 0.99) (Figure 2). The Brazilian sequences were recovered in the *Kapraunia* clade forming a full supported and distinct clade (Figure 2) in a well-supported sister relationship with *K. amplacapilli* and *K. schneideri* (BS = 99; PP = 1). The *K. schneideri* generitype clade was recovered with high support (BS = 98; PP = 0.99), including sequences from South Carolina, USA, very near to the type locality, New Hanover, North Carolina, USA.

The *rbc*L genetic distances within the *Kapraunia* species clade vary by 0–8.7 % (Table S2). All our new *Kapraunia* sequences were identical and 1.9 % divergent from *K. amplacapilli* sequences. Both lineages were 2.3–2.8 % distant from the type species, *K. schneideri*, whose sequences formed the most intraspecific divergent clade, ranging by 0–1.3 %.

The genetic barcode marker COI-5P placed all *Kapraunia* species together with full support (Figure 3), with the new species forming a fully supported clade related to *K. schneideri* but supported only for BI (PP = 0.99). Sequences of the new species were 0–0.5 % distinct from each other, while distances from *K. schneideri* varied by 7.2–8.0 % (Table S3). *Kapraunia schneideri* showed a high genetic variation with sequences differing by 0–3%.

In the concatenated dataset only sequences of *K. schneideri* and *K. pentamera* are available for both markers, and both formed fully supported clades (Figure 4). Our sequences grouped together in a fully supported distinct clade, which was recovered as a sister clade to *K. schneideri* with high support (BS = 98; PP = 1). Based on both analyses, *rbc*L and *rbc*L + COI-5P, we propose *Kapraunia silviae* sp. nov. from the South Atlantic Ocean.

3.2 Morphological observations

3.2.1 *Kapraunia silviae* J.O.F. Brito *et* Cassano, sp. nov. (Figures 5 and 6)

Diagnosis: Prostrate and erect axis with 4–6 pericentral cells per segment, ecorticate with length:diameter ratio of segments 1–1.3. Erect axis, 90–324 μm in diameter. Tetrasporangia 28–44 μm in diameter.

Holotype: SPF58818, deposited in the herbarium of University of São Paulo (SPF), São Paulo, Brazil, collected on 17 July 2022 by J.O.F. Brito et al.

Isotypes: Brazil, São Paulo, Ubatuba, Fortaleza beach, 23°31′54.4″S, 45°09′47.3″W, growing on other macroalgae, e.g. *Jania* sp. and members of Gelidiales, in intertidal pools, collected on 17 July 2022 by J.O.F. Brito et al. (SPF58817; SPF58819).

Paratype: Brazil, São Paulo, Ubatuba, Vermelha do Sul beach, 23°30′43.2″S, 45°10′20.8″W, growing on submerged ropes, collected on 17 July 2022 by J.O.F. Brito et al. (SPF58820).

Type locality: Fortaleza beach, Ubatuba, São Paulo, Brazil (23°31.54′S, 45°9.45′W).

Etymology: Named in honor of Dra. Silvia Maria Pita de Beauclair Guimarães for her significant contributions to knowledge of *Polysiphonia* from the Brazilian coast.

Additional material examined: SPF3724 as "*P. denudata*", collected on 8 April 1950, A.B. Joly et al., Barreiros beach, Ilhabela, São Paulo; SPF3727 as *P. denudata*, collected on 5 September 1963, A.B. Joly et al., Saco da Ribeira, Ubatuba, São Paulo, Brazil.

Previously misapplied names for Brazil: *P. denudata* (Joly 1965, pp. 221–222, pr. XLVIII, figs 586–590).

Distribution: Saco da Ribeira (Joly 1965), Fortaleza and Vermelha do Sul beaches, Ubatuba, São Paulo; Barreiros beach, São Sebastião Island, Ilhabela, São Paulo, Brazil.

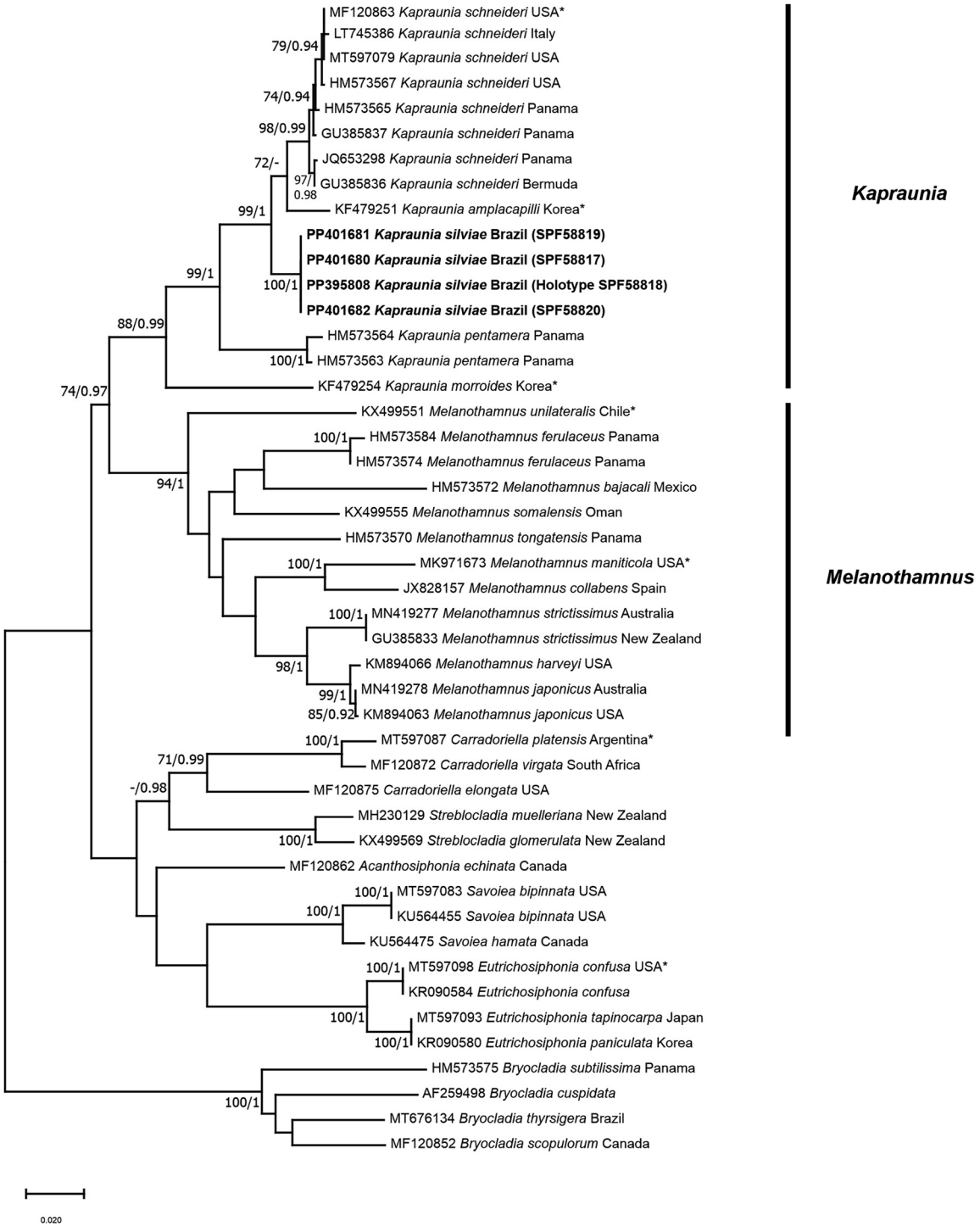

Figure 2: Maximum likelihood of *rbc*L consensus tree for *Polysiphonia s.l.* Values above 60/0.6 for bootstrap support (BS) and Bayesian posterior probabilities (PP) are shown at the branches. Bold type indicates newly generated sequences. *indicates sequences from the type locality or closest locality.

Habitat: Growing in intertidal pools, epiphytic on other algae or on ropes.

Vegetative morphology: Thalli epiphytic forming tufts up to 1.4 cm long (Figure 5A), pinkish red, delicate in texture, attached to the substratum by a basal disc, 585–745 µm in diameter, formed by dense cluster of rhizoids (Figure 5B). Basal portion forming a secondary prostrate system with prostrate axes attached by

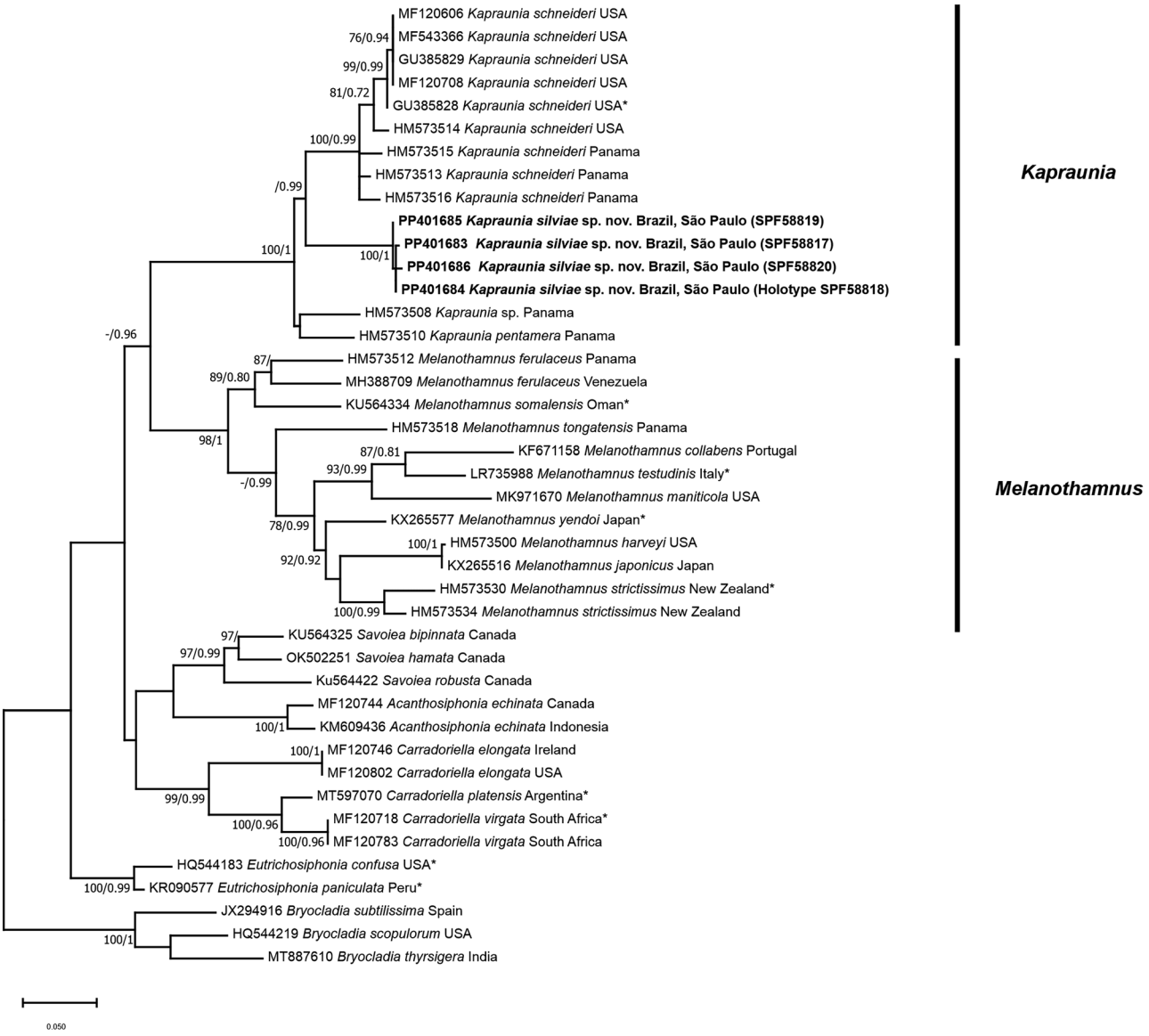

Figure 3: Maximum likelihood of COI-5P consensus tree for *Polysiphonia s.l.* Values above 60/0.6 for bootstrap support (BS) and Bayesian posterior probabilities (PP) are shown at the branches. Bold type indicates newly generated sequences. *indicates sequences from the type locality or closest locality.

unicellular rhizoids formed on the proximal end of the cells, cut off from pericentral cells (Figure 5B), 307–1,041 × 18–45 µm, with lobed ends. Prostrate axes ecorticated, with 4–6 pericentral cells per segment (Figure 5C), (88–) 104–370 (–390) µm in diameter. Erect axes, pseudodichotomously branched (Figure 5D), branching exogenous, constricted at the base (Figure 5E), ecorticated with 5 pericentral cells per segment, 100–324 µm in diameter in median portions, and 30–75 µm in diameter in apical portions (Figure 5F), gradually decreasing towards the apices. Branchlets borne laterally to the trichoblasts (Figure 5G), rarely forming adventitious branches from scars cells in older portions. Segment length:diameter ratio 1–1.3, with plastids scattered against the wall cell (Figure 5H). Apical cells dome-shaped to slightly conical (Figure 5I), conspicuous, 6–13 × 6–13 µm. Trichoblasts short to well-developed, up to 190 µm long, colorless, dichotomously branched 1–3 times (Figure 5J), spirally arranged in every 5–11 segments. Scar cells rare on branches.

Reproductive morphology: Cystocarps globose to urceolate (Figure 6A and B), variable in size, 110–300 µm in diameter. Tetrasporangia arranged in spiral series in

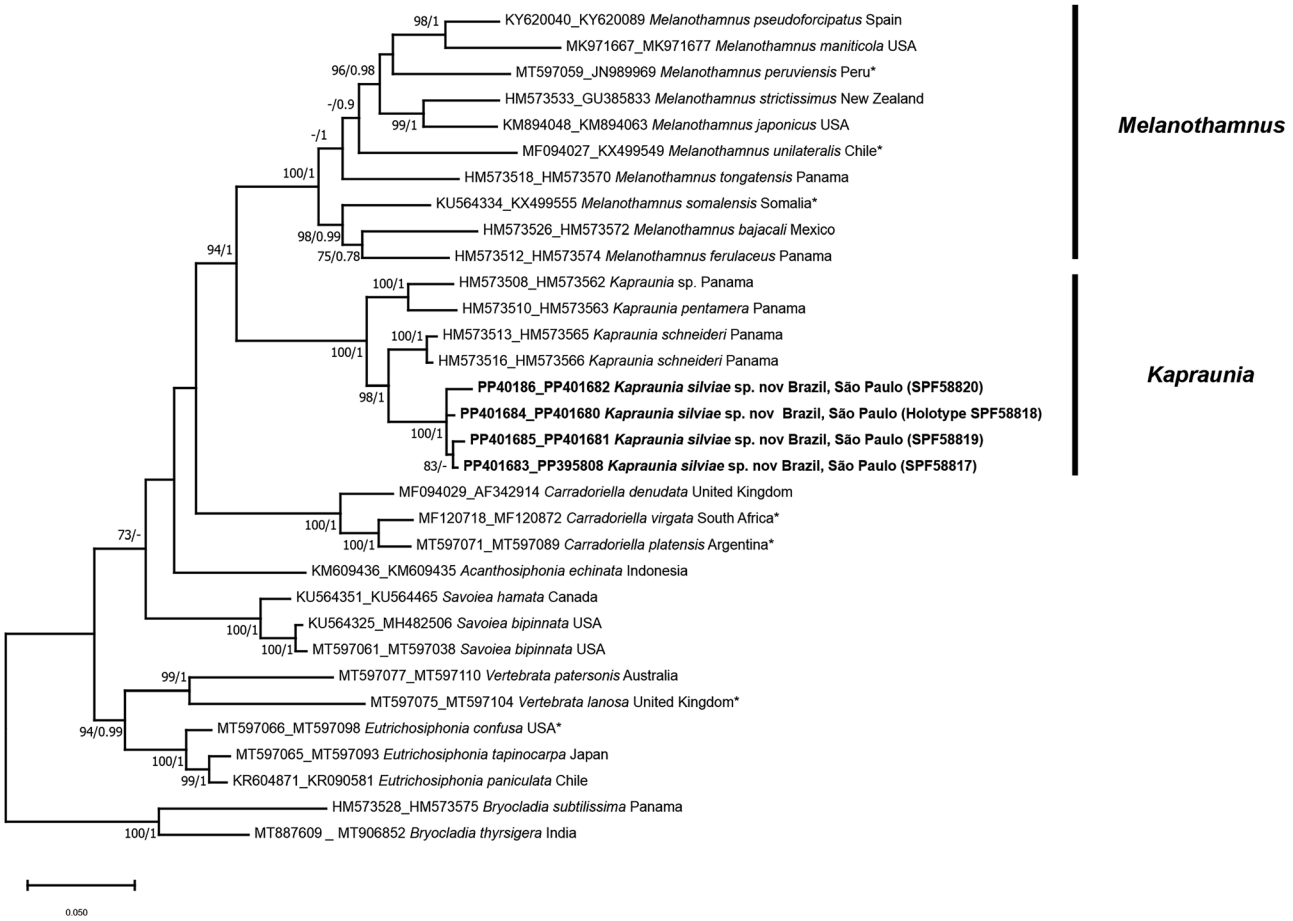

Figure 4: Maximum likelihood of concatenated of COI5-P + *rbc*L consensus tree for *Polysiphonia s.l.* Values above 60/0.6 for bootstrap support (BS) and Bayesian posterior probabilities (PP) are shown at the branches. Bold type indicates newly generated sequences. *indicates sequences from the type locality or closest locality.

upper branches (Figure 6C and D), one per segment, with tetrasporangia 28–44 µm in diameter, covered by two presporangial cover cells (Figure 6E). Procarps not found on fertile individuals. Male plants were not observed.

4 Discussion

Our phylogenetic analyses gave evidence that *K. silviae* sp. nov. represents a distinct lineage within the genus *Kapraunia*, based on different markers and phylogenetic analyses. The high interspecific distance values between *K. silviae* and other *Kapraunia* species (2.02–7.77 for *rbc*L, 7.27–8.36 for COI-5P, Tables S2 and S3) reinforce the proposal of the new species and are comparable to, or higher than, those reported in the genus *Kapraunia* (Bustamante et al. 2021; Díaz-Tapia and Verbruggen 2023; Díaz-Tapia et al. 2020; Mamoozadeh and Freshwater 2012).

Based on both markers, single and concatenated, *K. silviae* is closely related to *K. amplacapilli* and *K. schneideri*. On the other hand, the new species is morphologically similar to *K. pentamera* and *K. schneideri* (Table 2). *Kapraunia pentamera* shares with *K. silviae* five pericentral cells per segment, ecorticated thallus, exogenous branches, segments of erect axes as wide as long, with overlapping diameters (175–250 µm vs. 100–324 µm in *K. silviae*), scar cells not present in every segment and sometimes rare (Hollenberg 1968; Mamoozadeh and Freshwater 2012). However, *K. pentamera* differs from *K. silviae* by an extensive prostrate system, prostrate segments twice as wide as long, branches not constricted at the base, trichoblasts 3–4 times branched and wider tetrasporangia (diameter: 55 µm vs. 28–44 µm). *K. pentamera* was described by Hollenberg (1968) based on material from Eniwetok Atoll, Marshall Islands from Pacific, and currently there is no type material sequenced. The available sequences of *K. pentamera* are from the Caribbean Sea and Pacific coast of Panama,

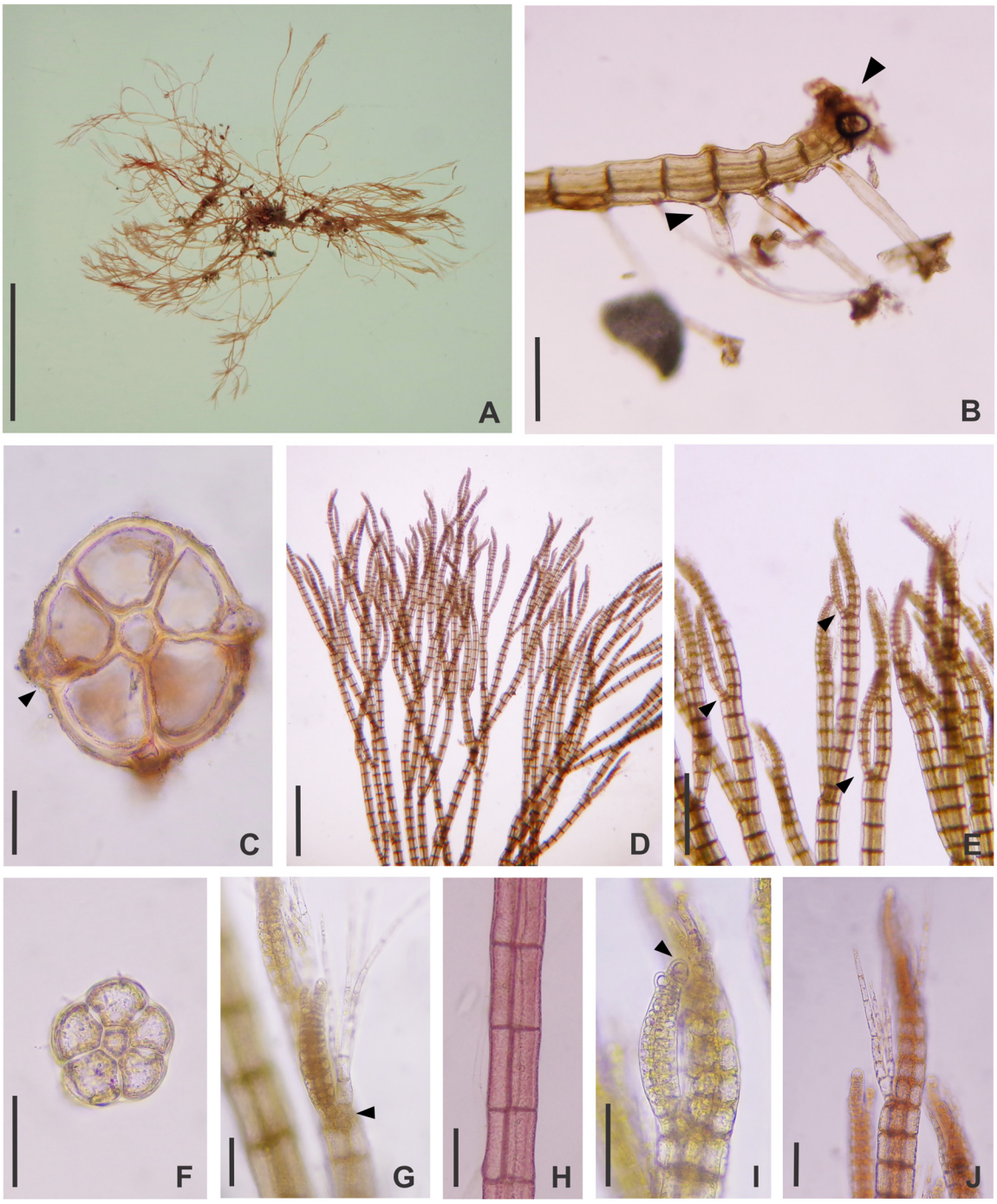

Figure 5: Vegetative morphology of *Kapraunia silviae* sp. nov. (Holotype SPF58818). (A) Habit of specimen. (B) Discoid base (upper arrowhead) forming a prostrate branch with rhizoids cut-off from the proximal end of the pericentral cells (lower arrowhead). (C) Transverse section of a prostrate axis showing five pericentral cells, with cut off rhizoid initial (arrowhead). (D) Detail of apical portions and branching pattern. (E) Branchlets constricted at the base (arrowheads). (F) Transverse section of an erect axis showing five pericentral cells. (G) Branch developing laterally from the basal trichoblast cell (arrowhead). (H) Detail of the plastid arrangement scattered against the wall cell. (I) Dome shaped apical cell (arrowhead). (J) Detail of a trichoblast. Scale bars: (A) = 1 cm; (B, E) = 200 µm; (C, F, G, I, J) = 50 µm; (H, D) = 100 µm.

grouping together with low genetic distance (0.49 %) for *rbc*L and are in accordance with the morphological delineation provided by Hollenberg (1968).

Kapraunia schneideri is also similar to *K. silviae* in forming a basal disc and prostrate branches, ecorticated thallus, exogenous branches, erect axis segments as wide as

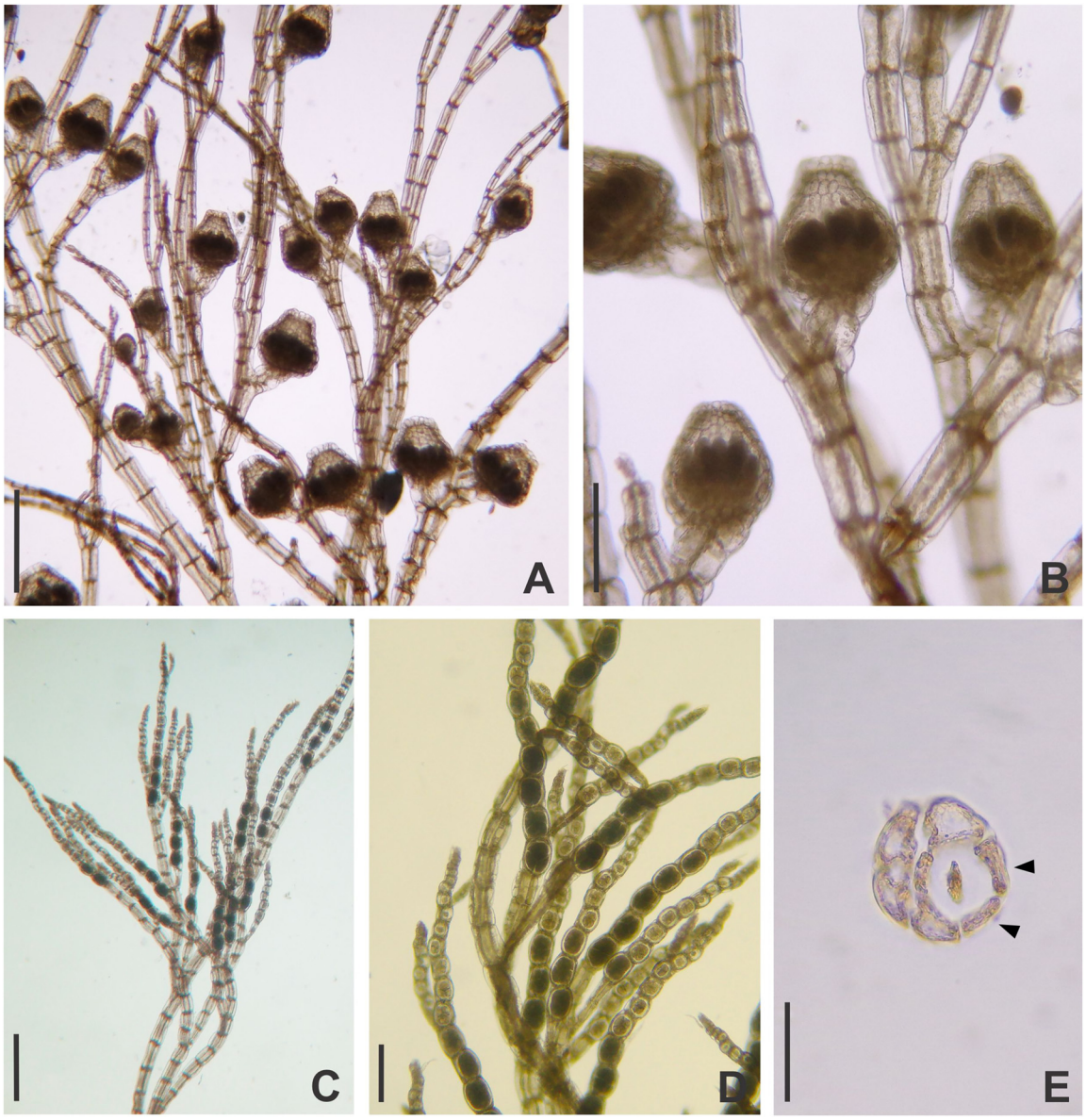

Figure 6: Reproductive morphology of *Kapraunia silviae* sp. nov. (SPF58817). (A) Mature cystocarps globose to urceolate. (B) Detail of the cystocarps. (C) Tetrasporangia in spiral arrangement. (D) Detail of the spiral arrangement of tetrasporangia. (E) Transverse section of a tetrasporangial axis showing four pericentral cells per segment and two presporangial cells (arrowheads). Scale bars: (A, C) = 100 µm; (B, D, E) = 50 µm.

long, with an overlapping segment diameters (50–275 µm vs. 100–324 µm in *K. silviae*), scar cells not in every segment and sometimes rare (Mamoozadeh and Freshwater 2012; Stuercke and Freshwater 2010). On the other hand, *K. schneideri* is distinctive from *K. silviae* by having 5–7 pericentral cells, branching development sometimes in the axils of trichoblasts and tetrasporangia in straight rows (Stuercke and Freshwater 2010; Mamoozadeh and Freshwater 2012). *K. schneideri* was described by Stuercke and Freshwater (2010) for the North Atlantic as *Polysiphonia schneideri* Stuercke *et* Freshwater whose individuals were initially identified as *P. denudata* [currently *Carradoriella denudata* (Dillwyn) Savoie *et* G.W. Saunders] due to the presence of five pericentral cells. However, further morphological and molecular investigations revealed that it belonged to the genus *Kapraunia*, and its transfer to *K. schneideri*, the generitype of *Kapraunia*, was proposed by Savoie and Saunders (2019).

Both *K. amplacapilli* and *K. morroides* are known only for deep waters from Korea and also are morphologically distinct. *Kapraunia amplacapilli* differs from its congeners by having a single basal disc attachment, cortication and

Table 2: Comparison of morphological characteristics of *Kapraunia* species.

	***Kapraunia silviae* sp. nov.**	***K. schneideri* (Stuercke *et* Freshwater) Savoie *et* G.W. Saunders**	***K. pentamera* (Hollenberg) Savoie *et* G.W. Saunders**	***K. amplacapilli* (Kim *et* Kim) Savoie *et* G.W. Saunders**	***K. morroides* (Kim *et* Kim) Savoie *et* G.W. Saunders**
Type locality	Fortaleza beach, Ubatuba, São Paulo, Brazil	New Hanover, North Carolina, USA	Eniwetok, Marshall Islands	Udo Strait, Jeju Island, Korea	Udo Strait, Jeju Island, Korea
Height (cm)	1.2–1.4	3–15	2–3	5–18	6–11
Substratum	Epiphytic	Epiphytic	Epiphytic	Epiphytic	Saxicolous
Habit	Prostrate/Erect	Prostrate/Erect	Prostrate/Erect	Erect	Prostrate
Holdfast	Discoid/rhizoid	Discoid/Rhizoid	Rhizoid	Discoid	Discoid
Type of rhizoid	Cut off	Cut off	Cut off	Cut off	Cut off
Pericentral cell number	4–6	5–7	5	5–7	4
Cortication	Ecorticate	Ecorticate	Ecorticate	Rare cortication on basal parts	Ecorticate
Branching	Pseudodichotomous	Dichotomous to subdichotomous	Subdichotomous	Pseudodichotomous	Pseudodichotomous
Prostrate segment length (µm)	85–211	–	–	–	–
Prostrate segment diameter (µm)	89–181	250–450	175–300	700–1,200	85–120
Erect segment length (µm)	36–122	–	–	–	–
Erect segment diameter (µm)	32–71	50–275	175–250 (300)	200–500	100–170
Trichoblast frequency	Usual	Abundant	Rare	Usual	Abundant
Trichoblast relation to the branches	Lateral	Lateral	Lateral	Lateral	Replacing
Scar cells	Rare	Not every segment or rare	Not every segment or rare	Rare	Rare
Tetrasporangia arrangement	Spiral	Straight	Spiral	Spiral	Spiral
Tetrasporangia dimension (µm)	28–44	55–65	55	90–100	70–95
Spermatangia branches	–	Furcation	–	Furcation	Furcation
Sterile apical cells	–	Rare (1–3)	–	Rare	Rare
Cystocarps	Urceolate to globose	Globose	–	Globose	Globose
Number of cells in carpogonial branches	–	–	–	4	4
References	This work	Stuercke and Freshwater (2010); Mamoozadeh and Freshwater (2012)	Hollenberg (1968); Mamoozadeh and Freshwater (2012)	Kim and Kim (2014)	Kim and Kim (2014)

large trichoblasts (Kim and Kim 2014). The same is observed for *K. morroides*, which is more similar morphologically to species of *Melanothamnus* than to other *Kapraunia* species by having four pericentral cells (Kim and Kim 2014).

Kapraunia silviae is recognizable by a combination of characters, branches developing laterally to the trichoblast, 5–6 pericentral cells per segment, rarely 4, attachment to the substratum by a basal disc and a prostrate system. This species is currently restricted to the Brazilian coast and represents the first report of a *Kapraunia* species for the South Atlantic Ocean, confirmed by molecular data; neither *K. schneideri* nor *K. pentamera*, the Atlantic species of the genus, have been recorded in Brazil. However, it is important to note that Stuercke and Freshwater (2010) reported that some *Kapraunia* species are often misidentified as *C. denudata* due to the presence of five pericentral cells.

C. denudata is a very controversial taxon on the Brazilian coast, with a wide morphological range of characteristics attributed to it. In Brazil, *P. denudata* is recorded for other states, such as Bahia (Almeida 2013; Nunes 2005, as *P.* cf. *denudata*), Rio de Janeiro (Yoneshigue 1985), São Paulo and Espírito Santo (Guimarães et al. 2004, as *P.* cf. *denudata*). However, none of the taxa cited above seem to correspond to the morphological concept of *K. silviae* or to the true *P. denudata*, currently a member of *Carradoriella*. These authors refer to specimens with branches arising only from the axils of trichoblasts and with segments wider than long as *P. denudata* or *P.* cf *denudata*, and they are distinct from *K. silviae*. These specimens also differ from the true *C. denudata* by forming a basal disc and a prostrate system, while *C. denudata* forms a basal disc only. The specimens reported from other Brazilian locations (Almeida 2013; Guimarães et al. 2004; Nunes 2005; Yoneshigue 1985) also differ from each other, indicating that there is more than one species that has been misidentified as *C. denudata* (as *P. denudata*/*P.* cf. *denudata*), and some may belong to the genus *Melanothamnus*.

In contrast, in the first citation of *C. denudata* (as *P. denudata*) from Brazil, Joly (1965) described specimens with 5–7 pericentral cells, and axes with dimensions similar to those found in *K. silviae* (i.e. 250–325 µm in diameter on basal portions and 62–87 µm in diameter in apical portions). This author referred to branches developing in the axils of trichoblasts, but the illustration shows a branch developing laterally to the trichoblast.

The confusion about the origin of the branches of *Kapraunia* species, especially in descriptions prior to the 21st century is very common. Mamoozadeh and Freshwater (2012) were the first authors to describe branches developing laterally to the trichoblast, in addition to previously recognized characters: (i) branches replacing trichoblasts, (ii) branches forming in axils of trichoblasts and (iii) branches independent of trichoblasts. The remarkable and detailed characterization of specimens made by Joly (1965) provided ground for review and evidence of a misinterpretation.

Figure 7: Specimens of *Kapraunia silviae* sp. nov. collected (as *Polysiphonia denudata*) by A.B. Joly et al., 05 Sept. 1963, Saco da Ribeira, Ubatuba, São Paulo, Brazil. (A) Herbarium specimens SPF3727. (B) Detail of apical branches of a tetrasporophyte showing spiral arrangement of tetrasporangia. (C) Transverse section of a prostrate axis showing six pericentral cells (p). Scale bars: (A) = 1 cm; (B) = 200 µm; (C) = 50 µm.

A revision of the herbarium material from São Paulo showed that *P. denudata* is a misapplied name from *K. silviae* in Brazil (Figure 7A–C). The specimens showed 5–6 pericentral cells (no seven-celled individuals were found) and formed a prostrate system with rhizoids cut off and branches developing laterally from trichoblasts. None of the recently collected samples had more than 5 pericentral cells per segment; only specimens collected by Joly (1965) showed 6 or more pericentral cells per segment. This might be related to a later development of the sixth cell, given that specimens collected by A.B. Joly were more than 5 cm long, whereas our newly collected samples were up to only 1.4 cm long.

Our first report of a *Kapraunia* species from the South Atlantic, together with the description of a new species and the recognition of misapplied names, also reveals the need for a revision of *Polysiphonia s.l.* species from the South Atlantic. Given the recent addition and taxonomic adjustments made to *Polysiphonia* and related genera, and the scarce knowledge from the Brazilian coast, the diversity of this group might be underestimated.

Acknowledgments: We are very grateful to Michael Wynne for his critical comments on the manuscript.
Research ethics: Not applicable.
Author contributions: JOFB, investigation, formal analysis, writing – original draft preparation; VC, conceptualization, formal analysis, investigation, writing – original draft preparation, project administration, funding acquisition. Both authors agree with the content of the paper and its submission and publication.
Competing interests: The authors declare that they have no conflict of interest.
Research funding: The authors thank São Paulo Research Foundation (FAPESP, 2022/12597-0, 2022/13278-6) for the financial support. JOFB thanks FAPESP (2021/14076-5) for the doctoral grant awarded. This work was supported in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) – Finance Code 001 and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (165693/2021-5). VC thanks CNPq for the Productivity Fellowship (304141/2020-8).
Data availability: The DNA sequences are available in the public database, National Center for Biotechnology Information, and specimens are deposited in the indexed herbarium SPF.

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Supplementary Material: This article contains supplementary material (https://doi.org/10.1515/bot-2023-0101).

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