

Rhipilia penicilloides sp. nov. (Udoteaceae, Chlorophyta) from Fiji

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Rhipilia penicilloides sp. nov. (Udoteaceae, Chlorophyta) is described from the Fiji Islands, South Pacific. Adult thalli are characterized by a penicilloid capitulum of free, dichotomously branched siphons and an elongated corticated stipe arising from a multisiphonous rhizome-like mat or stolon, whereas juvenile stages possess an infundibular capitulum held together by abundant lateral tenaculiferous branchlets. The generic placement of the new species is debatable owing to its close affinities to both the genera *Chlorodesmis* and *Rhipilia*, but present evidence favors the latter.

INTRODUCTION

The analysis of biogeographical and species richness patterns for the marine macroalgal flora of the tropical Pacific Ocean is impaired by incomplete knowledge of regional floras (N'Yeurt & South 1997). The known macroalgal flora of Fiji and adjacent islands presently consists of 422 taxa. Since the publication of the first list of 79 species by Chapman (1971), an additional 343 species have been recorded (Chapman 1977; Kapraun & Bowden 1978; Garbary *et al.* 1991; Kraft 1984; Kasahara 1985; South & Kasahara 1992; South 1993; South & N'Yeurt 1993; South *et al.* 1993; N'Yeurt 1993, 1995, 1996; N'Yeurt *et al.* 1995; Raj-Prasad & South 1995; N'Yeurt, Littler *et al.* 1996; N'Yeurt, South *et al.* 1996); new records are continually being added.

During continuing investigations of the marine benthic flora of Fiji, a green alga belonging to the genus *Rhipilia* (Udoteaceae) was found to occur in the spur and groove zone of the Suva Barrier Reef, southeastern Viti Levu. An examination of the descriptions of type specimens of the species of *Rhipilia* revealed no presently established species conforming to the material under study, which is described here as a new species.

MATERIALS AND METHODS

Specimens were collected by SCUBA from the Suva Barrier Reef at depths to 20 m and were preserved in 4% formaldehyde (10% commercial formalin) in sea water. For light microscopy, material was mounted on the slides in an isotonic medium (40–50% glycerol). Drawings were made from prepared slides using a Zeiss microscope equipped with an Abbé drawing tube. Voucher specimens of pressed material are housed in the Phycological Herbarium, South Pacific Regional Herbarium, located at The University of the South Pacific Marine Studies Programme (designated here as USP, to differ-

entiate it from the angiosperm collection in SUVA). The holotype was deposited in LD, and isotypes were deposited in BM, MELU, NSW, and SAP.

OBSERVATIONS

Rhipilia penicilloides N'Yeurt et Keats sp. nov.

Figs 1–16

DIAGNOSIS: Plantae atrovirides, stipitatae, exorientes e tegete stoloneve polysiphonio rhizoideo; stipes 15–30 mm longus, teres, aut simplex aut repetite furcatus, solidus, non calce incrustatus et valde corticatus; capitulum adultum discretis siphonibus 32–50 μ m diametro iterum iterumque dichotome ramosis, generaliter cum constrictionibus aequatis supra dichotomias et apicibus rotundatis compositum; siphones aliquantum inflati supra omnes dichotomias, dichotomiis confinibus interdum inter se perpendicularibus; ramuli laterales tenacula ferentia prope basem capituli plantae maturae et presentes ubique in siphonibus et nonnunquam in apicibus plantarum juvenium.

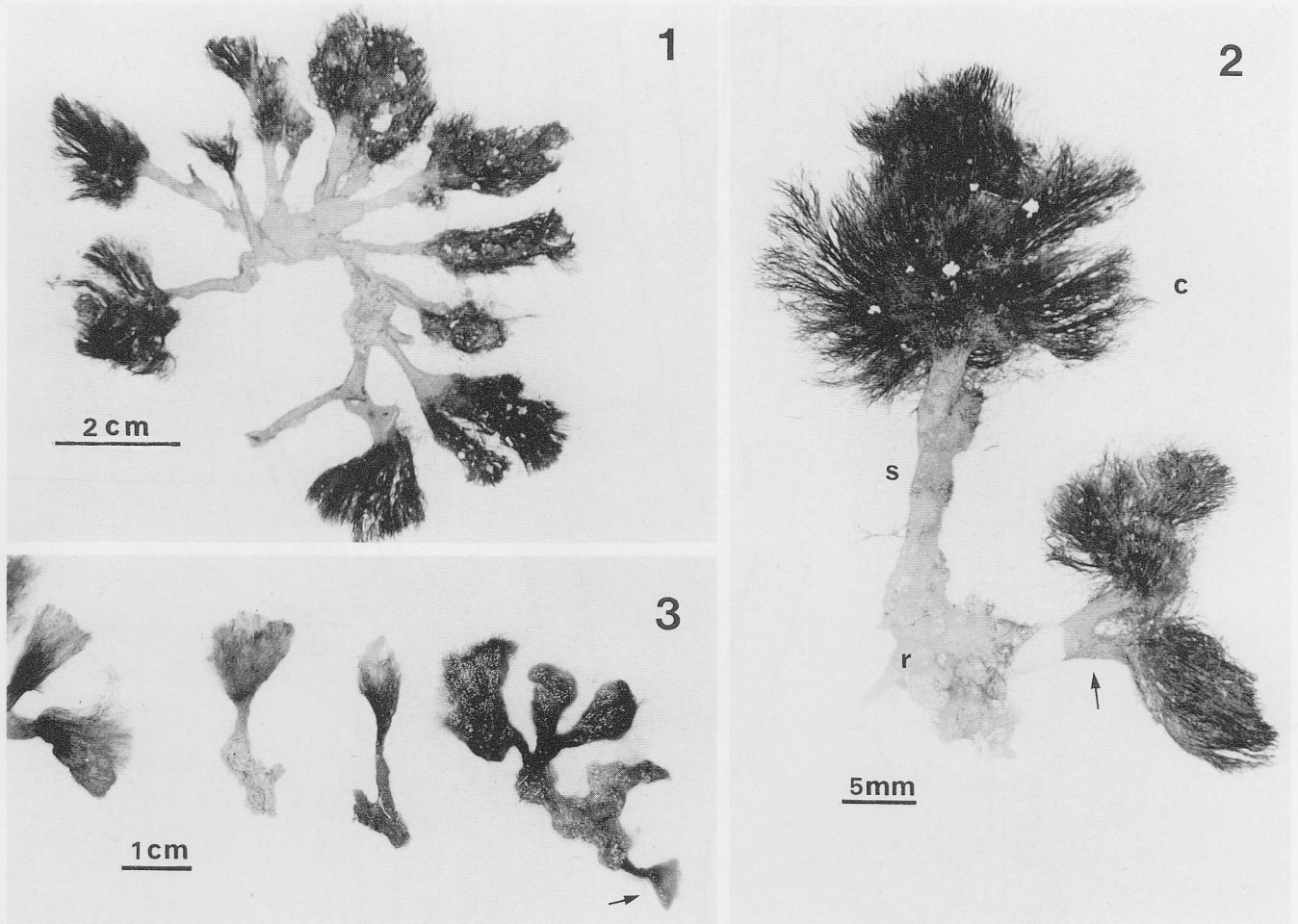
Thallus dark green, stipitate, arising from an extensive multisiphonous rhizoidal mat or stolon. Stipe 15–30 mm long, terete, either simple or repeatedly forked, solid, uncalcified, and heavily corticated. Adult capitulum composed of repeatedly dichotomously branched free siphons, 32–50 μ m in diameter, with generally even supra-dichotomal constrictions and rounded apices; siphons slightly inflated above each dichotomy, with adjacent dichotomies sometimes perpendicular to each other. Lateral tenaculiferous branchlets present in proximity to the base of the capitulum in adult thalli, and occurring all along the siphons and sometimes at apices in young thalli.

HOLOTYPE: Fig. 1. Collected outside Sand Bank, Suva Barrier Reef, Fiji (Keats, 22.x.1994, LD 996.175.691).

ISOTYPES: Suva Barrier Reef, Fiji (Keats, 22.x.1994, BM 54809; MELU GB 004; NSW GB 005; SAP 062212).

REPRESENTATIVE MATERIAL EXAMINED: Suva Barrier Reef, Fiji (Keats, 21.ix.1994, USP 808–810; 19.x.1994, USP 918; 22.x.1994, USP 915, 917, 919, 920. Yeo, 19.ii.1995, USP 916, 921) and numerous liquid-preserved specimens.

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Figs 1–3. *Rhipilia penicilloides* sp. nov.

Fig. 1. Habit of the holotype (GB 001; LD) showing the extensive creeping stolon bearing multiple erect axes.

Fig. 2. Detail of erect adult thalli (USP 917) showing the rhizome (r), stipe (s), penicillate capitulum (c), and dichotomous branching of the stipe (arrow).

Fig. 3. Various stages of development of juvenile thalli showing the laxly woven infundibular capitulum of young thalli (arrow). (From left to right: USP 919, USP 921, USP 920, USP 916).

ETYMOLOGY: *Penicilloides* refers to the plant's brush-like habit, which is reminiscent of the genus *Penicillus* (Udoteaceae, Chlorophyta).

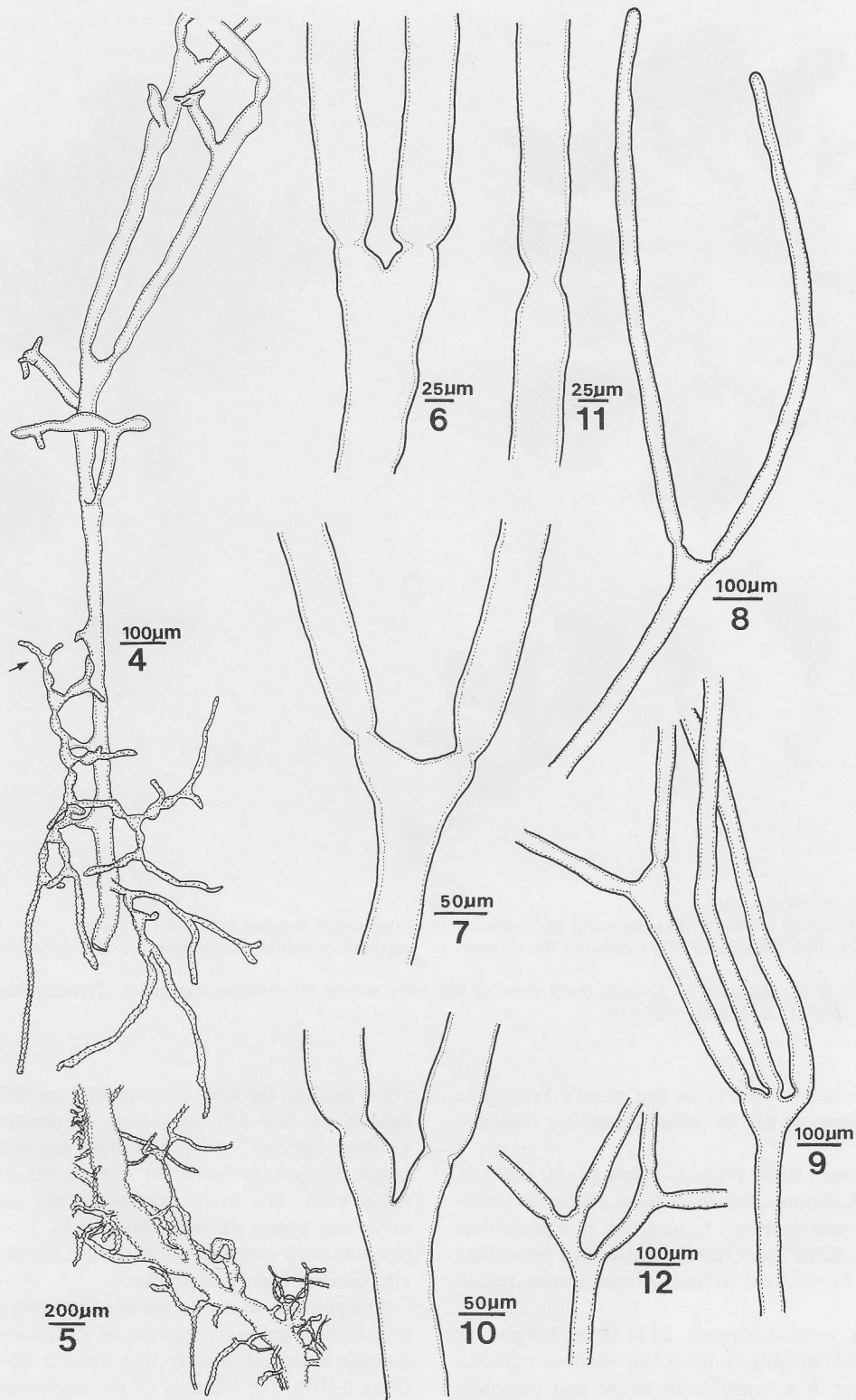
DESCRIPTION: The erect thalli (Figs 1–3) are 10–50 mm tall, stout and uncalcified, stipitate, and arise from a prostrate, multisiphonous rhizome mat or stolon, terminating in a penicillate tuft of free siphons. Adult thalli have a distinctive penicillate appearance (Figs 1, 2), whereas juveniles have a more flabellate habit (Fig. 3).

The stolon is stout, yellowish-green, up to 10 cm long, composed of crowded and irregularly branched torulose siphons, 7–10 μm in diameter. It is variable in shape and thickness according to the substratum. On hard coral rubble, the stolon is strongly appressed to the surface and either forms an irregular mat or is flattened, up to 4 mm wide and 0.5–1 mm thick. In sandy substrata, the stolon assumes a cylindrical habit owing to heavy sand encrustation. Up to ten erect stipes can arise from a single stolon 5–10 cm long (Fig. 1).

The stipe is grayish-green, somewhat rigid but uncalcified, terete, either simple or dichotomously branched, 15–30 mm long and 1.5–4.0 mm thick, solid and strongly corticated. In

cross-section, the stipe consists of a greyish to light-green cortical zone, 500–550 μm thick, composed of tightly woven torulose siphons 7–10 μm in diameter, and a central region of larger, irregularly branched siphons 50–250 μm in diameter (Figs 4–5). The main siphons of the stipe bear irregularly branched, lateral rhizoidal branchlets, 20–28 μm in diameter, truncate with clasping, short rounded apices (Fig. 4) and usually lacking basal constrictions.

The penicilloid capitulum is 11–19 mm high and 15–30 mm broad, dark green, composed of dichotomously and trichotomously branched, mostly free siphons 32–50 μm in diameter (Figs 6–10). The siphons of the capitulum are often slightly inflated above each dichotomy, with generally equal supra-dichotomal constrictions (Fig. 6) and rounded apices (Fig. 8). In some parts of the capitulum, the dichotomies tend to be deeper, narrower, and at times unequally constricted (Fig. 10). Interdichotomal constrictions sometimes occur in the upper parts of the capitulum (Fig. 11) and successive dichotomies are often immediately adjacent and perpendicular to each other (Fig. 12). In adult thalli the siphons of the capitulum lack lateral branchlets except at the very base near the junction to

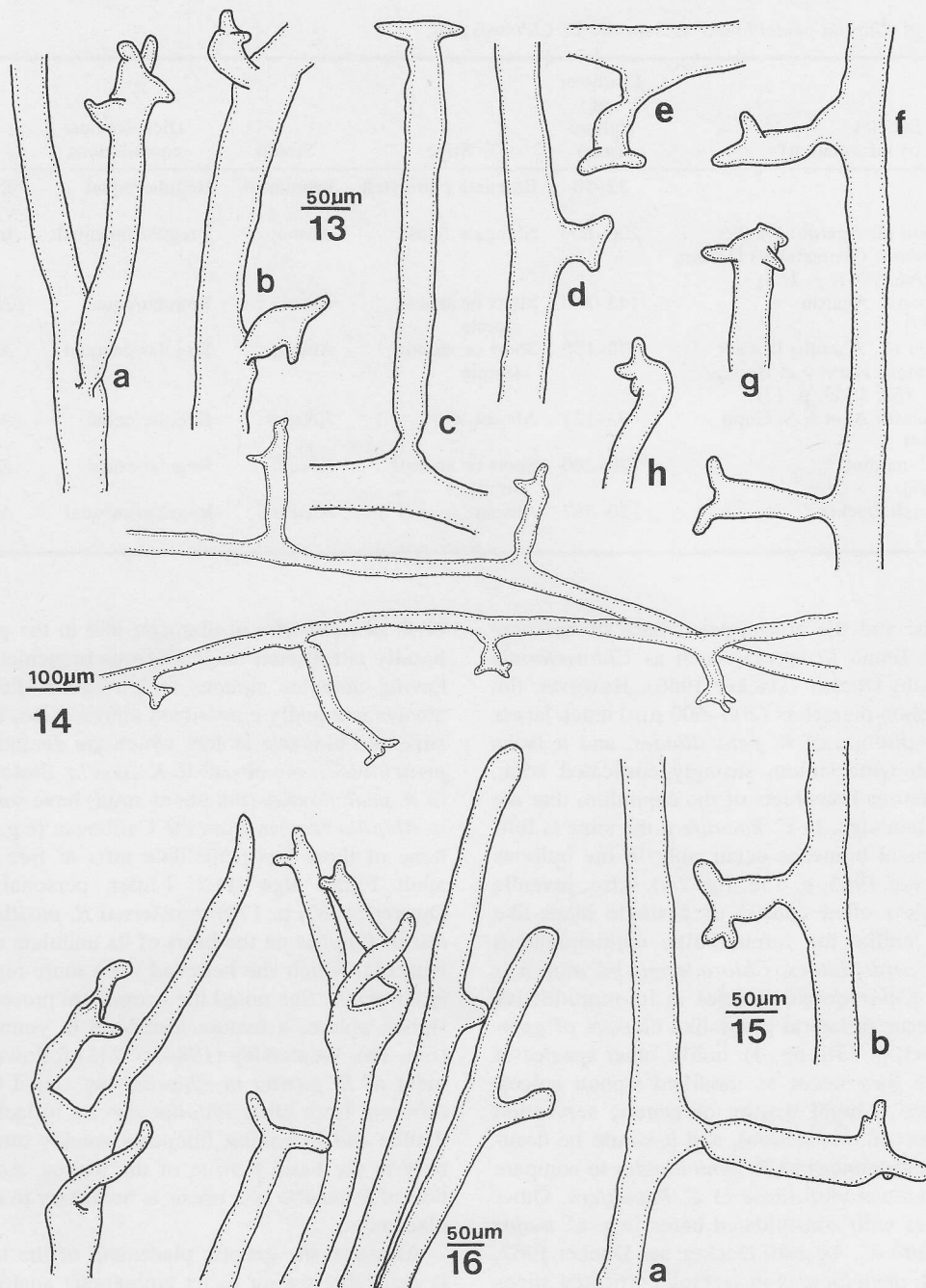


Figs 4–12. Anatomy of *Rhipilia penicilloides*.

Fig. 4. Siphon from upper portion of the adult stipe has lateral rhizoidal branchlets (arrow) and basally constricted tenaculiferous branchlets in lower portions of the capitulum.

Fig. 5. Siphon from the central region of the adult stipe has large diameter and numerous lateral rhizoidal branchlets (USP 915).

Figs 6–12. Variations in siphon dichotomies and constrictions (see text).



Figs 13–16. Anatomy of *Rhipilia penicilloides*.

Figs 13–15. Various kinds of lateral tenaculiferous branchlets on siphons.

Fig. 16. Upper portion of the capitulum of juvenile thalli showing abundant tenaculiferous branchlets on siphon apices (USP 918).

the stipe, where, usually, basally constricted branchlets 100–500 µm long are found and terminate in free, one-to four- (mostly two-)pronged tenacula (Figs 13–15). In juvenile thalli, the capitulum is 5–10 mm high, infundibular, slightly zonate, and laxly held together by abundant lateral tenaculiferous branchlets that occur throughout the length of the siphons and often at the apex (Figs 14, 16).

Reproduction not seen.

HABITAT AND PHENOLOGY: Populations grow in sandy substratum or on coral rubble in the spur and groove zone of Sand Bank, Suva Barrier Reef, Fiji, at 6–10 m depth. The

penicilloid capitula of the adult thalli have a characteristic sway and fluidity in the water currents, contrasting with the rigid erect stipes.

DISTRIBUTION: Known only from the Suva Barrier Reef, Fiji.

DISCUSSION

The new species has strong affinities to both the genera *Rhipilia* and *Chlorodesmis*. The dichotomously branched, free siphons of adult *R. penicilloides* are strongly reminiscent of the

Table 1. Comparison of *Rhipilia penicilloides* and species of *Chlorodesmis*.

Species (source of information)	Diameter of siphons (μm)	Stipe	Stolon	Dichotomies/ constrictions	Lateral branchlets
<i>Rhipilia penicilloides</i> (this paper)	32–50	Elongate corticated	Prominent	Regular/equal	Present
<i>Chlorodesmis baculifera</i> (J. Agardh) Ducker (= <i>Chlorodesmis bulbosa</i> (Womersley) Ducker, see Ducker 1965, 1966, 1967, p. 155)	200–600	Elongate felted	Absent	Irregular/unequal	In bulbous base only
<i>Chlorodesmis caespitosa</i> J. Agardh (Ducker 1967, p. 157)	143–250	Short or absent; simple	Absent	Regular/equal	Absent
<i>Chlorodesmis fastigiata</i> (C. Agardh) Ducker (= <i>Chlorodesmis comosa</i> Harvey et Bailey, see Ducker 1967, p. 160; 1969, p. 17)	72–150	Short or absent; simple	Absent	Regular/unequal	Absent
<i>Chlorodesmis hildebrandtii</i> A. et E.S. Gepp (Ducker 1967, p. 164)	93–123	Absent	Absent	Regular/equal	Absent
<i>Chlorodesmis major</i> Zanardini (Ducker 1967, p. 167)	120–200	Short or absent; simple	Absent	Regular/equal	Absent
<i>Chlorodesmis papenfussii</i> Ducker (Ducker 1969, p. 17)	150–287	Absent	Absent	Regular/unequal	Absent

genus *Chlorodesmis*, and the consolidated base of the new species is a feature found in species such as *Chlorodesmis baculifera* (J. Agardh) Ducker (Ducker 1966). However, the latter species has siphon diameters (200–600 μm) much larger than those in the capitulum of *R. penicilloides*, and it lacks the characteristic elongate stolon, strongly corticated stipe, and lateral tenaculiferous branchlets of the capitulum that are distinctive in the Fijian alga. In *C. baculifera* the stipe is felted, but lateral rhizoidal branches occur only in the bulbous base and stipe (Ducker 1965, p. 152, fig. 2A). Also, juvenile thalli of *C. baculifera* often consist of a single blade-like branched filament, unlike the infundibular, multisiphonous thallus of young *R. penicilloides*. *Chlorodesmis baculifera* is distinct from other *Chlorodesmis* species in its reproductive structures, which occur in lateral grape-like clusters of gametangia (Ducker 1965, p. 156, fig. 4), unlike other species of the genus, in which they occur as modified siphon apices. These differences are thought worthy of generic separation (G.T. Kraft, personal communication), and it would be desirable to obtain fertile specimens of *R. penicilloides* to compare its reproductive structures with those of *C. baculifera*. Other *Chlorodesmis* species with consolidated bases [e.g. *C. major* Zanardini, *C. fastigiata* (C. Agardh) Ducker; see Ducker 1967, 1969] differ from *R. penicilloides* in lacking corticated stipes and rhizomatous bases, in addition to having larger siphon diameters and lacking lateral branchlets. A comparison of *R. penicilloides* with species of *Chlorodesmis* is given in Table 1.

The siphon diameters of *R. penicilloides* are within the range of those of other species in the genus, but the absence of a complanate, consolidated adult thallus and its capitulum of mostly free, dichotomously branched siphons set the Fijian alga apart from most other *Rhipilia* species. A summary of selected characters comparing *R. penicilloides* to other *Rhipilia* species is given in Table 2.

In external morphology and habit the new species superficially resembles *Rhipilia diaphana* Taylor (1950, p. 72, pl. 37, figs 1, 2), but lacks the diaphanous, complanate blade and simple uncorticated stipe seen in that species. *Rhipilia pusilla* (Womersley) Ducker (Womersley 1955, p. 389, fig. 4; Ducker 1967, p. 170, pl. 9, 19) has siphons closely resembling those

of *R. penicilloides* in diameter and in the presence of lateral, basally constricted tenaculiferous branchlets, but it differs in having undulate siphons and irregular dichotomies that are always unequally constricted above. Also, the long corticated stipe and elongate stolon, which are distinctive features of *R. penicilloides*, are absent in *R. pusilla*. Stolons similar to those of *R. penicilloides* (but not as stout) have sometimes been seen in *Rhipilia* species from the Caribbean (e.g. *R. diaphana*), but none of these has penicillate tufts of free filaments like the adult Fijian alga (D.S. Littler, personal communication). Ducker (1967, p. 170) transferred *R. pusilla* from *Chlorodesmis* to *Rhipilia* on the basis of its undulate siphons and lateral tenacula, which she believed were more representative of the latter genus. She noted the occasional presence of tenacula on siphon apices, a feature also seen in young *R. penicilloides* (Fig. 16). Womersley (1984, p. 248) followed Ducker's placement of *R. pusilla* in *Rhipilia*, but stated that this alga was different from other *Rhipilia* species in lacking a complanate thallus and in having filaments weakly attached by tenacula only in the basal portion of the thallus. Additional examination of *R. pusilla* specimens is necessary to confirm its generic placement.

Although the generic placement of the new Fijian species is debatable owing to its ambiguous anatomical characteristics, its morphology (especially juvenile stages) is more characteristic of the genus *Rhipilia* as presently circumscribed. Adult thalli bear a strong resemblance to species of *Chlorodesmis*, but the abundance of lateral tenaculiferous branchlets all along the siphons (and at times the apex) of young thalli, and the small siphon diameter of the capitulum (less than 60 μm) in both juvenile and adult stages are features usually associated with *Rhipilia*. Although we feel the Fijian thalli may belong to the same genus as *R. pusilla* based on anatomical similarities, in the absence of definitive evidence to the contrary we prefer to retain the two species within the circumscription of *Rhipilia* pending further research that might eventually place them in a separate genus. In the absence of reproductive material, no detailed comparison is presently possible with other algae of uncertain generic affinities (such as *C. baculifera* and *R. pusilla*), but it is hoped that further

Table 2. Comparison of *Rhipilia penicilloides* and other *Rhipilia* species.

Species (source of information)	Diam- eter of siphons (μm)	Stipe	Stolon	Capitulum type	Dichotomies/ constrictions	Lateral branchlets/ basal constrictions
<i>R. penicilloides</i> (this paper)	42-50	Branched	Present	Free filaments/ infundibuliform	Regular/equally constricted	100-500 μm long/ basally constricted
<i>R. diaphana</i> Taylor (Taylor 1950, p. 72)	35-50	Branched	Present	Diaphanous single blade	Regular/equally constricted	150-250 μm long/ basally constricted
<i>R. fungiformis</i> Joly et Ugadim (Joly et al. 1965, p. 79)	22-55	Short unbranched	Absent	Spongy lobes	Irregular/unequally constricted	18-20 μm long, rare/ not basally constricted
<i>R. geppii</i> Taylor (Taylor 1950, p. 70)	30-50	Short branched	Absent	Thick obovate blade	Regular/equally constricted	Short/basally constricted
<i>R. micronesica</i> Yamada (Yamada 1944, p. 36)	20-32	Short unbranched	Absent	Thin blade	—	100-200 μm long
<i>R. nigrescens</i> Coppejans et Prud'homme van Reine (Coppejans & Prud'homme van Reine 1989, p. 261; 1990)	35-60	Indistinct unbranched	Absent	Clavate, thick blade	Regular/equally constricted	250-400 μm long/usually not basally constricted
<i>R. orientalis</i> A. et E.S. Gepp (Gepp & Gepp 1911, p. 57)	30-50	Indistinct unbranched	Absent	Infundibuliform thick blade	Regular/unequally constricted	250-500 μm long/at times basally constricted
<i>R. pusilla</i> (Womersley) Ducker (Womersley 1955, p. 389; Ducker 1967, p. 170)	45-75	Short unbranched	Absent	Loosely attached or free filaments	Irregular/unequally (singly) constricted	100-150 μm long, rare/ at times basally constricted
<i>R. sinuosa</i> Gilbert (Gilbert 1978)	16-25	Unbranched	Absent	Zonate blade	Regular/equally constricted	60-140 μm long/not basally constricted
<i>R. tenaculosa</i> A. et E.S. Gepp (Gepp & Gepp 1911, p. 56)	30-70	Unbranched	Horizontal	Rotundato-flabellate blade	Irregular/unequally constricted	50-100 μm long, abundant/ basally constricted
<i>R. tomentosa</i> Kützing (Gepp & Gepp 1911, p. 54)	30-70	Unbranched	Absent	Cuneato-flabellate blade	Irregular/equally constricted	100-150 μm long, frequent/ basally constricted

research on the Fijian flora will help elucidate the affinities of this new species.

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