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ADDITIONS TO THE MOSS FLORA OF TAVEUNI ISLAND (FIJI, SOUTH PACIFIC)

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Abstract. Information about recent collections of mosses on Taveuni Island, the third largest island of Fiji, is presented. Seven species – *Barbula javanica* Dozy & Molk., *Dendro-hypnum flagelliferum* (Broth. & Watts) N. E. Bell, A. E. Newton & D. Quandt, *Distichophyllum leiopogon* Dixon, *Leucophanes glaucum* (Schwägr.) Mitt., *Mniomalia semilimbata* (Mitt.) Müll. Hal., *Philonotis secunda* (Dozy & Molk.) Bosch & Sande Lac., and *Phyllodon lingulatus* (Cardot) W. R. Buck – are newly recorded from Fiji and 30 species are newly recorded from Taveuni Island. *Hymenodon chenianus* Pócs, a species recently described from Viti Levu (Fiji) was firstly found with sporophytes. A description of its sporophytes is provided.

Key words: South Pacific, Melanesia, Fiji, biodiversity, mosses

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INTRODUCTION

The moss flora of Fiji is poorly documented and most of the islands of Fiji can be classified as undercollected (Konrat *et al.* 2011). The last comprehensive inventory of the mosses of Fiji was published by Miller *et al*. (1978). This overview is mainly based on the previously published works of Schultze-Motel (1973) and Whittier (1975). Everything material to the moss flora of Fiji published since is to be found scattered in various individual sources and therefore difficult to evaluate. Only a few bryologists have made moss collections on Fiji after 1978: Masanobu Higuchi and Zennoske Iwatsuki in 1981 and 1991–1992 (see e.g. Matsui & Iwatsuki 1993; Iwatsuki & Suzuki 1996; Watanabe 1987); Tamás Pócs in 2003, 2008 (Pócs 2007); Allan J. Fife and Alifereti Naikatini in 2006–2008 (Fife & Naikatini 2011).

In contrast to the situation of the mosses, in the last decade, there has been an increasing interest in the Fijian liverwort flora, as exemplified by a series of publications (Pócs 2008a, b; Pócs & Eggers 2007; Pócs *et al.* 2011) and the publication of a new checklist (Söderström *et al.* 2011).

The author visited the Fijian island of Taveuni for three days in 2003 during a short stay on Fiji before travelling to New Caledonia. The moss material obtained from this expedition is now almost completely processed. The main results of the identified collections are presented here. Among these collections are 7 species new for Fiji and 30 species new for Taveuni Island.

TAVEUNI ISLAND AND THE COLLECTION SITES

Taveuni with a total land area of 435 square kilometers is the third-largest island of Fiji, after Vanua Levu and Viti Levu. The island of Taveuni, about 15 km wide and 42 km long, is the top of an elongated shield volcano which erupted from a northeast-southwest trending rift on the ocean floor. The highest mountains are Uluigalau, Fiji's second highest peak at 1241 m, and Des Voeux Peak, next in height at 1195 m. Taveuni is sparsely populated. Most of the 12.000 inhabitants live along the west coast. There are no major cities, just small towns. The low density of population has resulted in less devastation from land clearing than has occurred on other areas of Fiji. Therefore big areas with natural rain forests still remain.

During this short stay on the island only a limited number of localities were visited. These are compiled in the following list.

LIST OF THE COLLECTION SITES

1 – TAVEUNI ISLAND: Des Voeux Peak (1195 m), descend from the summit along the driveway to the north, montane rainforest; 16°49′S, 179°59′W; 23 August 2003.

2 – TAVEUNI ISLAND: east of Taveuni Estates, 200 m, remnants of lowland rainforest; 16°51′S, 179°59′E; 25 August 2003.

3 – TAVEUNI ISLAND: Lavena Coastal Walk between Lavena and the Wainibau Falls, *ca* 5–50 m, lowland rainforest with brook valley and waterfalls; 16°52′S, 179°54′W; 24 August 2003.

4 – TAVEUNI ISLAND: Tavoro Falls near Bouma, *ca* 20 m, remnants of lowland rainforest with waterfalls; 16°50′S, 179°52′W; 24 August 2003.

5 – TAVEUNI ISLAND: Waterslides near Waiyevo, lowland rainforest in a brook valley, *ca* 100 m; 16°47′S, 179°59′W; 25 August 2003.

Voucher specimens are in the herbarium of the University of Dresden (DR).

SPECIES LIST

SPECIES NEW FOR FIJI

Barbula javanica Dozy & Molk.

Collection site 1; on slopes, *F. Müller NC577* (det. Ph. Sollman). Collection site 2; on soil at the border of a brook, *F. Müller NC651*.

New for Fiji. The species is closely related, but using the characters in Eddy (1990) clearly separated from *B. consanguinea* (Thwaites & Mitt.) A. Jaeger *sensu* Eddy. The nearest known records are from Papua New Guinea (Norris & Koponen 1989).

Dendro-hypnum flagelliferum (Broth. & Watts) N. E. Bell, A. E. Newton & D. Quandt

Hypnodendron flagelliferum Broth. & Watts

Collection site 1; epiphytic, *F. Müller NC568*.

First confirmed record for Fiji. The species is unique among *Hypnodendron* s.l. by the presence of long microphyllous flagella (Touw 1971). The species was previously known with certainty only from Vanuatu (New Hebrides: Aneityum). In Mitten's herbarium (NY) Touw found a specimen which is said to have been collected in Fiji. Touw (1971) doubted the presence of the species in Fiji, as records from Fiji are not given in Mitten's part of Seemann's *Flora Vitiensis* (Mitten 1873) and as such a peculiar plant could hardly have been overlooked by other collectors.

Distichophyllum leiopogon Dixon

Collection site 1; epiphytic, *F. Müller NC682*.

New for Fiji. As stated by Ho *et al.* (2010), this species is distinct in having at least some leaves narrowly cucullate at the leaf apex, especially the dorsal leaves.

The hitherto known distribution includes Philippines (Mindanao, Camiguin Island), Indonesia (Seram, Papua), and Papua New Guinea (Ho *et al.* 2010).

Leucophanes glaucum (Schwägr.) Mitt.

Collection site 3; epiphytic, *Müller NC566*, *NC567*.

This species is distributed from India to Malesia, Japan, northeastern Australia, Vanuatu, New Caledonia, the islands of the tropical Pacific and Guadeloupe (West Indies) (Salazar 1993). The species is known from many islands around Fiji and therefore the presence of the species on Fiji is not surprising.

Mniomalia semilimbata (Mitt.) Müll. Hal.

Collection site 3; on wet rocks and boulders, *F. Müller NC574*, *NC575*.

New for Fiji. This species is widespread throughout tropical Asia (China, Vietnam, Thailand, India, Sri Lanka, Taiwan), Malesia (Malaysia Peninsula, Philippines, Java, Sumatra, Borneo, Papua New Guinea), and Oceania (Carolines, Samoa, Solomon, Vanuatu, Ryukyus) (Miller *et al.* 1978; Norris & Koponen 1987; Eddy 1996; O'Shea 2002; Tan & Iwatsuki 1993). Records in Australia (Queensland) are unconfirmed (AusMoss 2012).

Philonotis secunda (Dozy & Molk.) Bosch & Sande Lac.

Collection site 1; earthy slope along a path, *F. Müller NC589*, *NC668*.

This species is new for Fiji and not included in Miller *et al.* (1978) for Polynesia. The species is very common throughout tropical and subtropical Asia (Eddy 1996). Virtanen and Koponen (1998) have shown that the New Caledonian *Breutelia neocaledonica* Broth. & Paris is a synonym and their conclusion extends the known distribution to the Southern Pacific. This record on Fiji is therefore not surprising.

Phyllodon lingulatus (Cardot) W. R. Buck

Collection site 1; on boulders in a brook, *F. Müller NC573*.

New for Fiji. The relationships of this species remain unresolved and therefore its distribution is insufficiently known. As stated by Tan *et al.* (2006) the taxonomic distinction between this species and *Phyllodon bilobatus* (Dixon) P. Câmara is in need of clarification and it is possible that the two taxa are synonymous. In the naming of the above mentioned material from Fiji I utilized features mentioned in Tixier (1988), because the Taveuni material has relatively few conduplicately bilobed lateral leaves and differs from *Ph. bilobatus* with strongly conduplicately bilobed lateral leaves.

SPECIES NEW FOR TAVEUNI ISLAND

The species new for Taveuni, but already known from other islands of Fiji are summarized in Table 1.

Hymenodon chenianus Pócs with sporophytes

The species was recently described as new for science from Viti Levu (Pócs 2007). The identity of the specimen from Taveuni (see Table 1) was kindly confirmed by T. Pócs. The specimen from Taveuni is much more robust than the type material. The characteristics of the species, the extremely fragile, hyaline, unicellular hairpoint of the leaves and the thick walled leaf cells, are clearly visible. The Taveuni material has sporophytes and therefore the description of the species given by Pócs (2007) can be added by the following sporophytic characters:

Sporophytes single, seta 9–13 mm long, smooth; calyptra cucullate, rostrate, 1.1–1.2 mm long; capsules erect, ovoid, lid 0.7–0.8 mm long, long rostrate, rostrum 0.5 mm long, urn 0.8–0.9 mm long, exothecial cells isodiametric, 17–27 μm wide, 18–29 μm long, with thick, brownish walls, about 20 phaneroporous stomata in the neck; peristome consisting of 16 endostome segments arising from a tall basal membrane, endostome segments narrow, 48–54 μm wide in basal part, *ca* 350 μm long, yellowish-green, slightly striate, in upper part at borders slightly papillose, exostome vestigial or apparently absent; spores 15–20 μm, brownish, slightly warty.

Comments on Spiridens flagellosus Schimp.

Spiridens flagellosus Schimp. is already recorded from Taveuni and occurs furthermore on Fiji on Viti Levu, Ovalau, and Vanua Levu (e.g., Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978). During the recent excursion the species was collected at two sites:

Collection site 1 – epiphytic on tree ferns, *F. Müller NC571*, and Collection site 2 – epiphytic on tree ferns, *F. Müller NC610*.

Norris *et al.* (2010) suggest that further study will show *S. flagellosus* to be synonymous with the widely distributed *S. reinwardtii*. According to Norris *et al.* (2010) the flagellar tips of the branches seem to be of little taxonomic value and result from a period of storage before drying of the original collection. However, the flagellar tips were already present in the field and give the species a very characteristic appearance. The flagellar tips are up to 10 cm long and resemble shoots of loosely foliate, pendulous Meteoriaceae like *Floribundaria* or *Aerobryopsis*. The leaves are narrow, loosely appressed to distant, becoming smaller to the stem tips, in the basal part of the stems *ca* 4 mm long, at the stem tips 2–3 mm long. Other characteristics of the species allowing a separation from *S. reinwardtii* include: stem leaves (not the leaves of the flagellar tips) with a well developed arista

Table 1. Species new for Taveuni, but already known from other islands of Fiji. Numbers 1–5 in square brackets – collection sites (see p. 198).

Species name	Record details on Taveuni	Known distribution on Fiji
Calymperes crassinerve (Mitt.) A. Jaeger	[3] epiphytic on coconut, *F. Müller NC638.*	Fiji, without collection details (Reese & Mohamed 1985; Reese *et al.* 1986).
Calymperes porrectum Mitt.	[4] earthy slopes along a path, *F. Müller NC620*.	Viti Levu (Bartram 1948; Schultze-Motel 1973; Miller *et al.* 1978).
Calymperes tahitense (Sull.) Mitt.	[2] epiphytic, *F. Müller NC661*. [3] on wet rocks, *F. Müller NC591*.	Viti Levu, Vanua Levu, and Ovalau (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Campylopodium medium (Duby) Giese & J.-P. Frahm	[1] earthy slopes along a path, *F. Müller NC573*, *NC614*.	Viti Levu, and Ovalau [as *C. euphorocladum* (Müll. Hal.) Besch.; Schultze-Motel 1973; Miller *et al.* 1978].
Cryptogonium phyllogonioides (Sull.) Isov.	[2] epiphytic, *F. Müller NC670*. [3] on boulders, *F. Müller NC623*. [5] epiphytic, *F. Müller NC641*.	Vanua Levu, Viti Levu, and Vanua Balavu (Lin 1984; Norris & Koponen 1987; Fife & Naikatini 2011).
Ectropothecium pacificum Mitt.	[1] epiphytic, *F. Müller NC588*, *NC606*, *NC639*.	Viti Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Ectropothecium sodale (Sull.) Mitt.	[2] on decaying wood and boulders, *F. Müller NC626*, *NC658*. [3] wet rocks and boulders near the waterfall, *Müller NC594*, *NC649*.	Viti Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Floribundaria floribunda (Dozy & Molk.) M. Fleisch.	[1] epiphytic, *F. Müller NC619*. [2] epiphytic, *F. Müller NC601*. [4] on boulders, *F. Müller NC611*.	Viti Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Garckea flexuosa (Griff.) Margad. & Nork.	[3] earthy slopes along a path, *F. Müller NC662*.	Viti Levu, and Vanua Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Himantocladium cyclophyllum (Müll. Hal.) M. Fleisch.	[2] epiphytic, *F. Müller NC653*. [3] on rocks, *F. Müller NC590*. [5] on rocks, *F. Müller NC648*.	Viti Levu, Ngau, Ovalau, and Vanua Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978; Enroth 1992).
Hymenodon chenianus Pócs	[1] epiphytic on tree fern, *F. Müller NC677* (conf. T. Pócs).	Viti Levu (Pócs 2007).
Hyophila involuta (Hook.) A. Jaeger	[3] on boulders, *F. Müller NC650*.	Viti Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Hypopterygium tamarisci (Sw.) Brid. *ex* Müll. Hal.	[2] on boulders along a brook, *F. Müller NC660*.	Viti Levu, Vanua Levu, and Matuku (p.p. as *H. debile* Reichardt, *H. muelleri* Hampe, *H. nadeaudianum* Besch., *H. tahitense* Ångström; Schultze-Motel 1973; Miller *et al.* 1978; Kruijer 2002).
Leucobryum candidum (Brid. *ex* P. Beauv.) Wilson	[1] epiphytic, *F. Müller NC597*.	Vanua Levu, Ovalau, Viti Levu, Ngau, Kambara, and Kandavu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Leucobryum aduncum var. *scalare* (Müll. Hal. *ex* M. Fleisch.) A. Eddy	[1] on decaying wood, *F. Müller NC657*.	Viti Levu (Bartram 1944, 1956; Schultze-Motel 1973; Miller *et al.* 1978).
Leucoloma tenuifolium Mitt.	[1] epiphytic, *F. Müller NC631*.	Viti Levu, and Vanua Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Leucomium strumosum (Hornsch.) Mitt.	[2] on boulders and decaying wood in a brook valley, *F. Müller NC674*, *NC643*. [3] on decaying wood, *F. Müller NC671*.	Viti Levu, Vanua Levu, Ovalau, Ngau, and Koro [as *L. aneurodictyon* (Müll. Hal.) A. Jaeger; Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978].

Table 1. *Continued.*

Species name	Record details on Taveuni	Known distribution on Fiji
Leucophanes octoblepharioides Brid.	[1] epiphytic, *F. Müller NC627*. [2] epiphytic, *F. Müller NC587*.	Viti Levu (as *L. smaragdinum* Mitt.; Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Meiothecium hamatum (Müll. Hal.) Broth.	[1] epiphytic, *F. Müller NC562* (conf. B. C. Tan), *NC676*.	Viti Levu (Bartram 1936; Miller *et al.* 1978; Fife & Naikatini 2011).
Microdus flaccidulus (Mitt.) Besch.	[1] on soil along a path, *F. Müller NC629*, *NC669*. [2] earthy slopes along a brook, *F. Müller NC663*.	Viti Levu, Vanua Levu, and Ovalau (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Pelekium velatum Mitt.	[3] epiphytic on basal parts of tree stems, *F. Müller NC603*.	Viti Levu, and Vanua Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Philonotis hastata (Duby) Wijk & Margad.	[4] wet rocks at the waterfall, *F. Müller NC616* .	Viti Levu, and Ovalau (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Pogonatum neesii (Müll. Hal.) Dozy	[1] earthy slopes along a path, *F. Müller NC608*, *NC618*.	Viti Levu [as *P. junghuhnianum* (Dozy & Molk.) Dozy & Molk.; Bartram 1950; Schultze-Motel 1973; Miller *et al.* 1978].
Pogonatum subtortile (Müll. Hal.) A. Jaeger	[3] on earthy slopes, *F. Müller NC 605*.	Viti Levu, Ovalau, and Koro (as *P. graeffeanum* Müll. Hal. and *P. vitiense* Mitt.; Dixon & Greenwood 1930; Bartram 1950; Schultze-Motel 1973; Miller *et al.* 1978).
Pyrrhobryum setosum Mitt.	[1] epiphytic, *F. Müller NC 599*.	Viti Levu, Ovalau, and Ngau (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Spiridens reinwardtii Nees	[1] epiphytic on tree ferns, *F. Müller NC640*.	Viti Levu, and Ngau (as *S. balfourianus* Grev.; Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).
Syrrhopodon confertus Lac.	[1] epiphytic, *F. Müller NC597*. [4] epiphytic, *F. Müller NC584*.	Fiji, without record details (Mohamed & Reese 1985; Reese *et al.* 1986).
Syrrhopodon prolifer Schwägr.	[1] epiphytic in basal parts of tree stems, *F. Müller NC630*.	Fiji, without record details (Reese *et al.* 1986).
Syrrhopodon tristichus Nees *ex* Schwägr.	[1] an decaying wood, *F. Müller NC632*.	Viti Levu (Fife & Naikatini 2011).
Trematodon longicollis Michx.	[1] earthy slopes along a path, *F. Müller NC673*.	Viti Levu (Dixon & Greenwood 1930; Schultze-Motel 1973; Miller *et al.* 1978).

5–6 mm long; presence of multistratose bands of elongate cells among the isodiametric cells between the margin and the rip in the leaf area above the sheathing base. My interpretation of these features as taxonomically useful conform with the earlier taxonomic interpretation of Sherrin (1937).

Discussion

The moss flora of Fiji remains far from completely investigated. New records, for Fiji or for individual islands, are likely, as exemplified by this paper and that recent paper of Fife and Naikatini (2011). Fife and Naikatini (2011) reported five species as new for Fiji and *Trachyloma indicum* Mitt. var. *indicum*, *Bryobrothera crenulata* (Broth. & Paris) Thér., *Daltonia contorta* Müll. Hal., *Distichophyllum cuspidatum* Dozy & Molk., *D. graeffeanum* (Müll. Hal.) Broth., and *Calyptrochaeta subremotifolia* (Broth.) Fife as new for Taveuni. The author also collected all of the above species beside the last one.

Among the new records presented in this paper, *Barbula javanica*, *Leucophanes glaucum*,

Mniomalia semilimbata, *Philonotis secunda*, and *Phyllodon lingulatus* are more or less widely distributed in Southeast Asia, Melanesia or Oceania. Their discovery on Fiji is therefore not surprising. The first confirmed record of *Dendro-hypnum flagelliferum* marked an interesting range extension to the east. In the worldwide view the species seems to be very rare, known only from one island of Vanuatu and now from one island of Fiji. The newly discovered *Distichophyllum leiopogon* marked an interesting extension of its known distribution to the east to eastern Melanesia. The nearest hitherto known localities are on Papua New Guinea.

Recent collecting trips by various bryologists on Taveuni have only covered a very limited number of collecting sites. A preferred area visited repeatedly by different collectors (T. Pócs, A. J. Fife, F. Müller) during the last decade is Des Voeux Peak, the second highest peak of Taveuni. One reason for this is the easy access to the summit because a driveway exists up to the top. In the central mountainous area of Taveuni there are a lot of additional sites which most likely contain an interesting moss flora, but remain undersurveyed. These include the area around Lake Tagimaucia and the highest peak of Taveuni, Mt. Uluigalau. These areas are recommended as objectives of further collecting trips.

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