Bry. Div. Evo. 46 (1): 074–087
https://www.mapress.com/bde

Article

ISSN 2381-9677 (print edition)
BRYOPHYTE DIVERSITY & EVOLUTION
ISSN 2381-9685 (online edition)

https://doi.org/10.11646/bde.46.1.11

Additional Bryophyte Taxa from the Cook Islands

JOHN GAME[1,2,*], PETER J. DE LANGE[3], MATT VON KONRAT[4], MEREIA TABUA[5], DAVID R. TOREN[6], GERALD McCORMACK[7], JOHN J. ENGEL[4], TAMÁS PÓCS[8], GARY MERRILL[4] & ANDREA SASS-GYARMATI[8]

[1]*University Herbarium, University of California, Berkeley, California 94720, USA*
[2]*National Tropical Botanical Garden, Kauai, Hawai'i 96741*
[3]*School of Environmental & Animal Sciences, Unitec Institute of Technology, Auckland, Aotearoa/New Zealand*
[4]*Gantz Family Collections Center, Science & Education, Field Museum, Chicago, IL 60605 U.S.A*
[5]*Pacific Islands Development Forum, 56 Domain Road, Suva, Fiji*
[6]*California Academy of Sciences, Department of Botany, San Francisco, CA 94118-4503*
[7]*Director, Cook Islands Natural Heritage Trust, Rarotonga, Cook Islands*
[8]*Institute of Biology, Eszterházy Károly Catholic University, H-3301 Eger, Hungary*
**Author for correspondence:* *johngame34@gmail.com*

Abstract

It is evident that the bryophyte flora of the Cook Islands remains poorly documented. Here, ten moss species and five liverwort species of Lepidoziaceae are newly reported for the Cook Islands. These records include *Calomnion denticulatum*, previously known only from Samoa, *Ectropothecium viridifolium*, previously known only from Hawai'i, and *Tricholepidozia quadriseta,* previously known only from Australia. Also, thirteen new island records of mosses are reported for Outer Islands of the group and additional information is provided for some previously published reports.

Key words: Aitutaki, *Bazzania*, Mangaia, Mitiaro, Rarotonga

Introduction

The Cook Islands are part of over 4,500 islands of the Polynesia-Micronesia biodiversity hotspot. The region is one of thirty-five global hotspots and is widely considered as an epicentre of the current global extinction crisis (Critical Ecosystem Partnership Fund, https://www.cepf.net). Alarmingly, Bellard *et al.* (2014) identified Polynesia-Micronesia as one of three global hotspots that were particularly vulnerable to global changes.

The Cook Islands are an independent country located in the South Pacific Ocean, west of the Society Islands and east of Samoa (Figure 1). The islands lie between 9°S–22°S and 157°W–166°W (Sykes 2016) and are widely separated, which means that the country is large given the amount of ocean territory (2.2 million km^2) that is included within its boundaries. The country is part of the recently developed Blue Pacific Concept that provides for cooperation and collaboration between Pacific Island Nations (Wallis *et al.* 2023). There are fifteen islands, consisting of six in a Northern group, of which five are atolls, and nine in a Southern group, of which two are atolls. The southern island of Rarotonga (Figure 2) reaches an elevation of 653 meters. It is the highest and botanically the most diverse island in the group, and its rugged central section consists of mostly well-preserved forest. A small area of cloud forest occurs on the higher peaks of Rarotonga, from about 400m upward. In contrast, the outer islands contain no cloud forest, but several have prominent "makatea" zones, i.e., regions of limestone representing former coral reefs that have become raised above the surrounding ocean. Swampy areas also occur on some outer islands, especially Atiu, Mangaia and Mitiaro, inland of their makatea zones. The makatea zones, as well as the swamps, support distinctive floras including species that are not found on Rarotonga.

Wood (1967) outlined the geology and a geological history for the 15 Cook Islands. All the islands are the summit portions of extinct Tertiary volcanoes. Rarotonga is the youngest island and is an estimated 2.68 million years old. Mangaia is about 19.5 million years old and is the oldest Cook Island to still have exposed volcanic rocks. It may be the oldest such island on the Pacific plate, although many atolls in the Cook Islands and elsewhere are much older (McCormack, 2021).

 Submitted: 23 Nov. 2023; Accepted by Christine Cargill: 20 Dec. 2023; published: 29 Dec. 2023

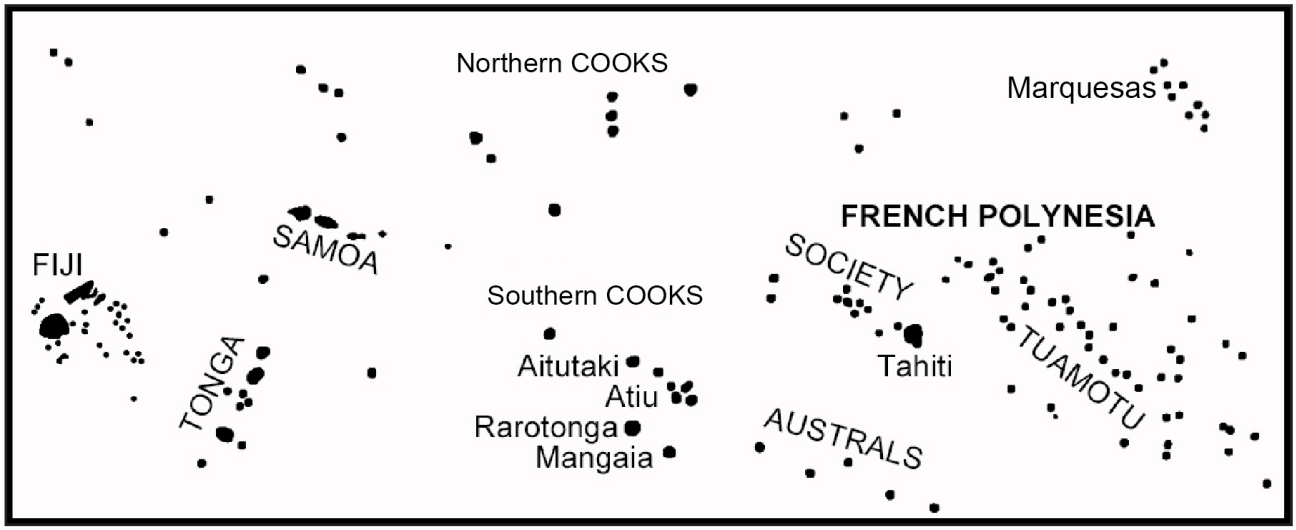

FIGURE 1. Map of the South Pacific showing the Northern and Southern Cook Islands. Individual island images are enlarged compared to the distances between them.

The vascular plants of the Cook Islands are well known. Those on Rarotonga were first surveyed by Cheeseman (1903) and recently an excellent Flora for the whole group has been published (Sykes 2016). A survey of the endemic vascular flora for threat assessments has been undertaken (Martin *et al.* 2012). It is clear that bryophytes have been overlooked historically compared to seed plants, birds, and other organisms, forming a gap in the knowledge of the flora of the Cook Islands. Moreover, the state of the floristic knowledge of these organisms is deficient compared to many other biodiversity hotspots and other ecologically significant areas of the globe. The Cook Islands Biodiversity Database (McCormack 2007) currently lists 47 mosses for the Cook Islands but has no records for liverworts or hornworts. A list of 45 moss taxa collected on Rarotonga was published by Bartlett (1986). Schultze-Motel (2002) added several more species. A more extensive Cook Islands moss list was provided by O'Shea (2008). He listed 62 taxa and reviewed the history of bryophyte collecting there and literature about Cook Islands Bryophytes. In addition, W. R. Sykes made substantial bryophyte collections in the Cook Islands from 1972 to 2002. These are as yet largely undocumented in the literature and many are unidentified. Scant publications have reported on liverworts and hornworts for the Cook Islands (de Lange *et al.* 2017), and most that do give only incidental mention in papers dealing with other island groups or regions, e.g., Braggins *et al.* (2014), Renner & de Lange (2011). In this report we list our collections of taxa that are not in previously published lists. We note that additional or prior collections of some of these taxa exist in herbaria, but the taxa were not reported by O'Shea (2008) or included in other publications that we know of.

The first author of this report made multiple visits to the southern Cook Islands between 1983 and 2005. The primary purpose was to study ferns, but many bryophyte collections were also made. Some of the mosses in these collections were listed by O'Shea (2008) but many others remained unidentified until recently. Or own moss collections are now mostly identified and we have found ten taxa among them that were not included in O'Shea's 2008 checklist. We list these here and believe they represent previously unpublished records for the Cook Islands. Also, we list nine previously unpublished records for the island of Mangaia and four unpublished records for Mitiaro, and we add some collection details that were omitted in O'Shea's checklist for seven Cook Islands specimens cited there (O'Shea (2008).

In addition, we list five new records of liverworts of the family Lepidoziaceae from Rarotonga, including *Bazzania* Gray (1821: 704)—a genus whereby Dr. David Meagher was recognized as a leading expert (Meagher 2010, 2019)—and to whom we dedicate this publication. The new liverwort records represent ongoing studies and interest in the Cook Islands liverwort and hornwort flora inspired by the second author, de Lange, who has led several field trips there over the past 15 years including most recently in 2017. Prior fieldwork by de Lange has provided several cryptogamic plant links to the Kermadec Islands and Aotearoa/New Zealand some 3,200 km away in the southwestern Pacific (Renner & de Lange 2011; de Lange & Beever 2015).

FIGURE 2. Rarotonga. Looking east from Te Kou at the cloud forest ridge from Te Manga (left) to Te Atukura (right). Photo by John Game, December 1986.

Materials and Methods

Specimens were collected in the field, dried, and returned to the United States at the University of California Herbarium at Berkeley or the Field Museum, Illinois for study and identification before being deposited in the indicated herbaria. Identifications were undertaken using multiple literature sources as well as comparison with existing identified herbarium specimens, where possible. Worldwide distributions of the relevant taxa were determined by consulting the Global Biodiversity Information Facility (GBIF), the Consortium of Bryophyte Herbaria (Bryoportal), and cited literature as well as the Early Land Plants Today project outlined by Söderström *et al*. (2012a). Herbarium acronyms follow Thiers (2013). Where uncertainty in a reported range exists, for example due to changes in circumscription of a species since the identification was made, we have indicated this.

Results

Additional moss taxa for the Cook Islands:

Acroporium hyalinum (Reinwardt ex Schwägrichen) Mitten **(**1868: 183). Sematophyllaceae Broth

Basionym:—*Hypnum hyalinum* Reinw. ex Schwägr. in Schwägr., Sp. Musc. Frond. Suppl. Tertium (1)(2): 227b (1828).

Specimens collected:—COOK ISLANDS. Rarotonga: Moss in cloud forest just off the west peak of Te Manga ~6m down towards Te Kou, probably north of ridge, *Fitchia*, *Ascarina* and *Metrosideros* common in this area, 8 October 2005, *J. Game 05/035B*, det. D. Toren x.2019 (CAS); between the peaks of Te Manga, 8 October 2005, *J.*

Game 05/037F, det. D. Toren x.2019 (CAS); in cloud forest on or near the high ridge running from Te Atukura to Te Vaakauta, eastern Rarotonga, estimated elevation 460 to 550m, Oct. 2005*, J. Game 05/092D*, det. D. Toren x.2019 (CAS).

Distribution:—Indian subcontinent; Eastern Asia; Indo-China; Malesia. In the Pacific, known from The Philippines, Indonesia, New Guinea, Solomon Islands, New Caledonia, Australia, Fiji, The Federated States of Micronesia and French Polynesia.

Notes:—Chua *et al.* (2018) lectotypified *Acroporium hyalinum* and provided a broad circumscription of the species. *Acroporium lepinei* (Bescherelle 1895: 48) Fleischer (1923: 1303) has been commonly recognized historically, but is here accepted as a synonym of *Acroporium hyalinum* (Chua *et al.* 2018).

Anoectangium aestivum (Hedwig) Spruce (1867: 5). Pottiaceae Hampe

Basionym:—*Gymnostomum aestivum* Hedw. Species Muscorum Frondosorum 32. 2 f. 4–7. 1801.

Specimens collected:—COOK ISLANDS. Rarotonga: Small mat-forming moss on wood in forest, in the N.W. part of the Turangi valley, elevation probably ~300m, 5 January 1989, *J. Game 89/034*, det. D. Toren x.2019 (CAS).

Distribution:—Very widespread in the northern and southern hemispheres. In the Pacific, known at least from Japan, The Philippines, Indonesia, New Guinea, Australia, Aotearoa/New Zealand, Fiji, Hawai'i, French Polynesia and the Galapagos Islands.

Bryum argenteum Hedwig (1801: 181). Bryaceae Rchb

Specimens collected:—COOK ISLANDS. Rarotonga: At or near the base of Te Rua Manga, central Rarotonga, elevation about 395m, December 1988, *J. Game 87/077A*, det. D. Toren x.2019 (CAS); on exposed north-facing rock at base of Maungatea Bluff, elevation ~230m, 1 January 1994, *J. Game 94/005*, det. D. Toren x.2019 (CAS)

Distribution:—Cosmopolitan, all continents including Antarctica. In the Pacific, known at least from Japan, The Philippines, Indonesia, New Guinea, Australia, Lord Howe and Norfolk Islands, Kermadec Islands, Aotearoa/New Zealand, Hawai'i, Clipperton Island and the Galapagos Islands. Probably elsewhere but possibly under-collected.

Calomnion denticulatum Mitten (1868: 192). Calomniaceae Kindb

Specimens collected:—COOK ISLANDS. Rarotonga: In the cloud forest zone in the area of high ravines south east of Te Atukura Peak, southeast Rarotonga, ~490 to 550m elevation, 1 February 1994, *J. Game 94/044A*, det. Dale Vitt viii.2022 (CAS, MO, PTBG).

Distribution:—Known elsewhere only from the island of Upolu in Samoa.

Notes:—Rare and not seen elsewhere on Rarotonga.

Campylopus schmidii (Müll. Hal.) Jaeger (1872: 439). Dicranaceae Schimp

Basionym:—*Dicranum schmidii* Müll. Hal. Botanische Zeitung (Berlin) 11: 37. 1853.

Specimens collected:—COOK ISLANDS. Rarotonga: On bare rocks and soil at the east edge of the Raemaru plateau, 4 October 2005, *J. Game 05/011*, det. D. Toren x.2019 (BM, CAS, PTBG). Mangaia: On a soil bank in fernland habitat (*Dicranopteris* Bernh.) on the way up to Rangimotia, December 1989, *J. Game 89/177,* det. D. Toren xi.2023 (CAS).

Distribution:—Southeast Asia, Madagascar, North America. In the Pacific known from The Philippines, Indonesia, New Guinea, Australia and Hawai'i.

Ectropothecium pacificum Mitten (1868: 180) Hypnaceae Schimp

Specimens collected:—COOK ISLANDS. Rarotonga: In cloud forest on the very steep side of the ridge that ascends

Te Manga from the north, 6 to 9m off the ridge to the left (as going up), elevation 580m, 8 October 2005, *J. Game 05/034D*, det. D. Toren x.2023 (CAS); moss in cloud forest just off the right-hand peak of Te Manga ~6m down towards Te Kou, probably north of ridge, *Fitchia*, *Ascarina* and *Metrosideros* common in this area, 8 October 2005, *J. Game 05/035A*, det. D. Toren x.2023 (PTBG); Rarotonga: In the vicinity of the telecommunication tower, on trunk of bryophyte-covered tree, ca. 475m elevation, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21673,* det. J. Larraín (F, CAS).

Distribution:—Known primarily from the southwest Pacific, including Indonesia, New Guinea, Solomon Islands, Vanuatu, New Caledonia, Fiji and Samoa.

Ectropothecium viridifolium Bartram (1933: 249). Hypnaceae

Specimens collected:—COOK ISLANDS. Rarotonga: On damp rocks by the Totokoitu Stream, 45 to 90m downstream from the Water Intake, elevation ~65m, *J. Game 05/079A*, 15 October 2005, det. D. Toren x.2019 (CAS, DAV); in forest on the Avana side of Avana/Turangi saddle, just south of saddle, elevation ~425m, December 1988, *J. Game 88/138A & 88/138B*, det. D. Toren x.2019 (CAS); on wood, middle elevation (probably ~245–305m) in Avana Valley, 28 January 1994, *J. Game 94/017*, det. D. Toren x.2019 (CAS).

Distribution:—Known elsewhere only from the Hawaiian Islands.

Fissidens asplenioides Hedwig (1801: 156). Fissidentaceae Schimp

Specimens collected:—COOK ISLANDS. Rarotonga: Forming large light green patches on a very shady rocky soil face flanking the right side of the Avana Stream (as going down), estimated elevation ~105–120m, 5 October 2005, *J. Game 05/023*, det. D. Toren x.2019 (CAS, PTBG).

Distribution:—Widespread, especially in the Southern Hemisphere. In the Pacific, known from Japan, Indonesia, The Philippines, Australia, Lord Howe Island, Norfolk Island, Aotearoa/New Zealand, Solomon Islands, New Guinea, New Caledonia, French Polynesia, Galapagos Islands and Juan Fernandez Islands.

Fissidens hyalinus Wilson & Hooker (1840: 89). Fissidentaceae

Specimens collected:—COOK ISLANDS. Rarotonga: On a rocky bank by a stream in a moist shady place by the track up Te Kou, estimated elevation 120–150m, 9 October 2005, *J. Game 05/041*, det. D. Toren, x.2019 (as either *F. hyalinus* or *F. nymannii* Fleischer (1904: 19), which are here considered synonymous) (CAS).

Distribution:—Known from Eastern Asia and North and South America. In the Pacific, seemingly known elsewhere only from Japan, The Philippines, Indonesia and Australia.

Notes:—The name *Fissidens nymanii* has often been used in the literature and it might be known by this name, but this is currently accepted as a synonym of *Fissidens hyalinus*.

Hypnodendron samoanum Mitten (1868: 192). Hypnodendraceae Broth

Specimens collected:—COOK ISLANDS. Rarotonga: On bare rock in a stream bed (dry at time of collection) in wet forest in the northwest quadrant of the Upper Avana watershed, elevation probably ~365m, 28 January 1994, *J. Game 94/018A*, det. B. Tan & J. Game 2015, (CAS, DAV, PTBG).

Distribution:—Known elsewhere from Samoa to French Polynesia.

Notes:—Rare here and not seen elsewhere on Rarotonga.

New moss records for the Outer Cook Islands

Aitutaki:—This island is ~264 km north of Rarotonga. Its land area is ~18km^2 with a volcanic remnant ~123m high, and there is a large lagoon more typical of atolls. From literature research we found a report by Townsend (1975)

that cited six Cook Islands moss specimens collected by D. Stoddart that are not included in the checklist by O'Shea (2008). One of the taxa in Townsend's report is not elsewhere listed for the island of Aitutaki. This is:

Brachymenium indicum (Dozy & Molk.) Bosch & Sande Lacoste in Dozy & Molkenboer (1860: 141). Bryaceae

Basionym:—*Bryum indicum* Dozy & Molk. Musci Frondosi Inediti Archipelagi Indici 1: 22. 1845.

COOK ISLANDS: Aitutaki: Akitua, *Stoddart 2216* (K); Te O, *Stoddart 2271* (sterile, probably this species), (K).

Distribution—Rarotonga, Mitiaro. This is a Pacific moss known from Hawai'i and at least Indonesia, New Guinea, New Caledonia, Federated States of Micronesia, Kiribati, Samoa, Niue, Tonga, French Polynesia, Rapa Nui (Easter Island), Pitcairn Islands (Oeno), and possibly Chile.

Mangaia:—The island is ~208 km south southeast of Rarotonga, with a land area of ~52 km^2 and a central hilly region of volcanic soil rising to ~170m elevation. It is the second largest and second highest of the Cook Islands. A ring of low-lying swamps surrounds the central region, and this in turn is surrounded by a dramatic ring of limestone makatea cliffs up to 75m elevation (Figure 3). The makatea zone is forested and contains deep chasms and caves.

FIGURE 3. Mangaia. A central open area with red volcanic soil is surrounded by swamps and wooded makatea limestone in the distance. Photo by John Game, 1986.

Calymperes afzelii Swartz (1818: 3). Calymperaceae

Specimens collected:—COOK ISLANDS. Mangaia: Terrestrial in cracks in makatea limestone in the Ra'i district of southeast Mangaia, December 1989, *J. Game 89/199B*, det. D. Toren xi.2023 (CAS).

Distribution:—Rarotonga, Mitiaro; widespread in tropical and subtropical regions in the northern and southern hemispheres; in the Pacific known at least from The Philippines, Indonesia, New Guinea, Australia, Fiji and the Galapagos Islands.

Calymperes tenerum Müller (1873: 174). Calymperaceae

Specimens collected:—COOK ISLANDS. Mangaia: Terrestrial in cracks in makatea limestone in the Ra'i district of southeast Mangaia, December 1989, *J. Game 89/199A*, det. D. Toren xi.2023 (CAS); without locality, January 1998, *J. Game 98/042*, det. D. Toren xi.2023 (CAS).

Distribution:—Aitutaki, Rarotonga; widespread in tropical regions of the world. In the Pacific, widespread from Japan to Australia and Aotearoa/New Zealand across to Pitcairn Island; Hawai'i.

Campylopus schmidii Dicranaceae

This taxon is newly reported for the Cook Islands, with collections from both Mangaia and Rarotonga. Details for the Mangaian specimen and distribution of this species are given in the section dealing with new records for the Cook Islands.

Fissidens zollingeri Montagne (1845: 114). Fissidentaceae

Specimens collected:—COOK ISLANDS. Mangaia: In a shady gully in the southwest of Mangaia, between Oneroa and Ivirua, December 1988, *J. Game 88/188A*, det. D. Toren xi.2023 (CAS).

Distribution:—Rarotonga; widespread in tropical and warm temperate regions; elsewhere in the Pacific, known from Japan, The Philippines, Indonesia, New Guinea, Indonesia, Solomon Islands, Australia, New Caledonia, Fiji, Palau, The Federated States of Micronesia, Guam, and Tahiti.

Leucophanes octoblepharioides Bridel (1827: 763). Calymperaceae

Specimens collected:—COOK ISLANDS. Mangaia: On the base of a coconut tree near Oneroa, December 1989, *J. Game 89/185*, det. D. Toren xi.2023 (CAS).

Distribution:—Rarotonga; Sao Tome and Principe, Gabon, Seychelles, India, Sri Lanka, Southeast Asia, Malaysia, Brunei; in the Pacific, known elsewhere from Taiwan, Japan, The Philippines, Indonesia, New Guinea, Solomon Islands, Australia, New Caledonia, Vanuatu, Palau, Marshall Islands, Northern Mariana Islands, Federated States of Micronesia, Kiribati, Fiji, Samoa and French Polynesia.

Mitthyridium fasciculatum (Hook. & Grev.) Robinson (1975: 433) *subsp.* ***obtusifolium*** (Lindb.) M. Menzel (Menzel and Schulze-Motel 1990: 502). Calymperaceae

Basionym:—*Syrrhopodon obtusifolius* Lindb. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar 21: 605. 1864.

Specimens collected:—COOK ISLANDS. Mangaia: Terrestrial in makatea limestone in the Ra'i district of southeast Mangaia, December 1998, *J. Game 98/040*, det. D. Toren xi.2023 (CAS).

Distribution:—Rarotonga; elsewhere the species is reported from Nigeria, Madagascar, Mauritius, Seychelles, India, Sri Lanka, Nepal, China, South East Asia, Christmas Island, Peru and Chile; in the Pacific it is known from The Philippines, New Guinea, Solomon Islands, Australia, Aotearoa/New Zealand, New Caledonia, Palau, Guam, Vanuatu, Fiji, Samoa, and Pitcairn Island. Specimens identified as subsp. *obtusifolium* or the synonymous *Mitthyridium obtusifolium* (Lindb.) Robinson (1975: 434) are reported elsewhere at least from Seychelles, Singapore and Chile, and in the Pacific from New Guinea, Australia, New Caledonia, Vanuatu, Fiji, Samoa, French Polynesia and Pitcairn Island.

Neckeromnion lepineanum (Mont.) S. Olsson, Enroth, Huttunen & D. Quandt (2016: 66) Neckeraceae Schimp

Basionym:**—***Neckeropsis lepineana* Montagne (1848: 107).

Specimens collected:—COOK ISLANDS. Mangaia: In deep shade in the inner makatea zone near a cutting running inland from Ivirua, eastern Mangaia, January 1989, *J. Game 89/005A*, det. J.Game & D. Toren xi.2023 (CAS).

Distribution:—Rarotonga; Africa, Madagascar, Sri Lanka, Southwest Asia; in the Pacific, known from Japan, Taiwan, The Philippines, Indonesia, New Guinea, Solomon Islands, Australia, Aotearoa/New Zealand, New Caledonia, Vanuatu, Fiji, Tonga, Palau, Guam, Samoa, French Polynesia and Hawai'i.

Papillaria intricata (Mitt.) Müller & Brotherus (1900: 505). Meteoriaceae Kindb

Basionym:**—***Meteorium intricatum* Mitten (1868: 171).

Specimens collected:—COOK ISLANDS. Mangaia: In deep shade in the inner makatea zone near a cutting running inland from Ivirua, eastern Mangaia, January 1989, *J. Game 89/005B*, det. D. Toren xi.2023 (CAS).

Distribution:—Rarotonga; a Pacific species known elsewhere from Australia, Guam, Northern Mariana Islands, Vanuatu, Fiji, Samoa and French Polynesia.

Vesicularia aperta (Sull.) Thériot (1922: 465). Hypnaceae

Basionym:—*Hypnum apertum* Sulli. Not. Sp. Moss. 1854.

Specimens collected:—COOK ISLANDS. Mangaia: In a shady gully in the southwest of Mangaia, between Oneroa and Ivirua, December 1988, *J. Game 88/188B*, det. D. Toren x.2019 (CAS).

Distribution:—Rarotonga; this is a Pacific species known elsewhere from New Caledonia, Vanuatu, Tahiti and possibly Hawai'i.

Mitiaro:—The island of Mitiaro is ~300 km northeast of Rarotonga. It is about 6km across with a wide outer makatea zone rising to ~12m above the ocean, and a swampy region with lakes and a small agricultural area near the centre. O'Shea (2008) lists four moss species known from Mitiaro, and our own collections add four more, as follows:

Brachymenium indicum. Bryaceae

Specimens collected:—COOK ISLANDS. Mitiaro: Terrestrial moss (small acrocarp) in the open soil between the airstrip and low oceanic makatea scrub, north side of the island, 11 October 2005, *J. Game 05/051*, det. D. Toren x.2019 (CAS, DAV).

Distribution:—See record for Aitutaki above.

Calymperes afzelii. Calymperaceae

Specimens collected:—COOK ISLANDS. Mitiaro: On the trunk of a palm tree, (*Pritchardia mitiaroana* Dransfield & Ehrhart (1995: 37)) in a small clearing in makatea shrubland in western Mitiaro, 10 October 2005, *J. Game 05/050F*, det. B. O'Shea (BM, PTBG). Cited without island or locality data by O'Shea (2008).

Distribution:—See record for Mangaia above.

Taxithelium tenuisetum (Sullivant 1854: 8) Mitten (1873: 397). Sematophyllaceae

Specimens collected:—COOK ISLANDS. Mitiaro: Epiphytic in tall makatea forest well off the road that runs northeast from the main village, 12 October 2005, *J. Game 05/064A*, det. D. Toren x.2019 (CAS, DAV, PTBG).

Distribution—Rarotonga; this is a Pacific species reported from The Philippines, New Guinea, The Marshall Islands, Fiji and Samoa.

Thuidiopsis furfurosa (Hooker & Wilson in Hooker (1854: 107)) Fleischer (1923: 1497, 1517, 1725). Thuidiaceae

Specimens collected:—COOK ISLANDS. Mitiaro: Near Vaimere Cave, December 1988, *J. Game 88/178*, det. D. Toren x.2019 (CAS).

Distribution—Rarotonga; South and Central America, The United States, South Atlantic Islands; in the Pacific known from New Guinea, New Caledonia, Australia, Lord Howe and Norfolk Islands, New Zealand, French Polynesia and Juan Fernandez Islands.

New Information for moss specimens cited by O'Shea (2008):

Calymperes afzelii. Calymperaceae. *Game 05/050F* is cited by O'Shea (2008), who states "location unknown". Details for this collection from Mitiaro are given above, under new records for that island.

Entodon mackaviensis Müller (1873: 155) Entodontaceae. Rarotonga: Raemaru Plateau, 2005. The collection number is incorrectly cited as *Game 05/79F* (O'Shea 2008). The correct number is *J. Game 05/009A*. Further details are: Large julaceous mat-forming moss, summit plateau of Raemaru near south end, estimated elevation ~335m, intermingled with *Mitthyridium fasciculatum* subsp. *obtusifolium*, 4 October 2005, det. B. O'Shea (BM, DAV, PTBG).

Floribundaria floribunda (Dozy & Molk.) Fleischer (1905: 302). Meteoriaceae

Basionym:—*Leskea floribunda* Dozy & Molk. Musc. Frond. Archip. Ind. 15. 1844.

Game 05/017 is cited by O'Shea (2008), who states "location unknown". Details for this collection are: Rarotonga: Pendulous epiphyte from trees in the middle Avana, elevation ~120–135m. Common here, 5 October 2005, det. B. O'Shea (BM, DAV, PTBG).

Himantocladium implanum (Mitten 1868: 169) Fleischer (1908: 886) Neckeraceae. *Game 05/079F* is cited by O'Shea (2008), with "location unknown". Details are: Rarotonga: On damp rocks by the Totokoitu Stream, 45 to 90m downstream from the Water Intake, 15 October 2005, det. B. O'Shea (BM, PTBG).

Oxyrrhynchium rugosipes (Bescherelle 1898: 120) Brotherus (1905: 1155) Brachytheciaceae. *Game 05/037I* is cited by O'Shea (2008), with "location unknown". Details are: Rarotonga: in cloud forest between the peaks of Te Manga, 8 October 2005, det. B. O'Shea (BM, PTBG).

Symphysodontella cylindracea (Montagne 1848: 109) Fleischer (1908: 692) Pterobryaceae. *Game 05/037J* and *Game 05/079E* are cited by O'Shea (2008), with "location unknown". Details are: *05/037J* Rarotonga: in cloud forest between the peaks of Te Manga, 8 October 2005, det. B. O'Shea, (BM, PTBG); *05/079E* Rarotonga: On damp rocks by the Totokoitu Stream, 45 to 90m downstream from the Water Intake, 15 October 2005, det. B. O'Shea (BM).

Newly identified liverworts of Lepidoziaceae for the Cook Islands:

Bazzania erosa (Reinw., Blume & Nees) Trevisan (1877: 415)

Basionym:—*Jungermannia erosa* Reinw., Blume & Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 230. 1825.

Specimens collected:—Cook Islands: Rarotonga: in vicinity of Te Kou Summit, near telecommunications, 21°14'25"S, 159°46'37"W, ca 500 m., on bark of tree, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21676,* det. T. Pócs & M. von Konrat 2023 (F, CAS, AK).

Distribution:—The Philippines, Australia, Sri Lanka, Java, Sumatra, Bangka, Celebes, Halmahera, New Guinea, New Caledonia, Caroline Is, Solomon Is, Samoa and Fiji, as well as Cambodia, Borneo, India, and Vanuatu.

Bazzania nitida (Weber) Grolle (1960: 210)

Basionym:—*Jungermannia nitida* F.Weber, Hist. Musc. Hepat. Prodr.: 43, 1815.

Specimens collected:—Cook Islands: Rarotonga: Te Kou Summit 'Northern ridge', 21°14.406' S, 159°46.622'W, 250 m, on *Davallia solida* (fern) stem, 1 October 2017, *P. J. de Lange & T.J.P. de Lange 249B,* det. T. Pócs 2021 (F, CAS, AK).

Distribution:—A pan-south-temperate species distributed from South America through south and tropical Africa and Australasia to Aotearoa/New Zealand. New to the Pacific tropics.

Bazzania subtilis (Sande Lac.) Trevisan (1877: 414)

Basionym:—*Mastigobryum subtile* Sande Lac. Ann. Mus. Bot. Lugduno-Batavi 1: 302. 1864.

Specimens collected:—Cook Islands: Rarotonga: in vicinity of Te Kou Summit, near telecommunications, 21°14'25"S, 159°46'37"W, ca 500 m., on floor under protected niche at base of tree, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21679,* det. T. Pócs & A. Sass-Gyarmati 2023 (F, CAS, AK).

Distribution:—Known from Australia, Indonesia, and Papua New Guinea as well as The Philippines, Malaya, Borneo, New Caledonia, and Samoa.

Bazzania cf. francana (Steph.) Kitagawa (1972: 446)

Basionym:—*Mastigobryum francanum* Steph. Species Hepaticarum 6: 463. 1924.

Specimens collected:—Cook Islands: Rarotonga: Te Kou Summit Ridge, 'South Western Side', 21º14.524'S, 159º 46.647'W, common, terricolous on clay in dense cloud forest, 1 October 2017, *P.J. de Lange & T.J.P. de Lange, CK223*, det. T. Pócs & A. Sass-Gyarmati 2023 (F, CAS, AK).

Distribution:—Hitherto only known from New Caledonia and Australia, if the identification is correct.

Notes:—*Bazzania* is the largest genus of the family Lepidoziaceae and as noted by Gradstein (2017) the genus is considered notoriously difficult in terms of species recognition. Nonetheless, no *Bazzania* records have previously been documented for the Cook Islands. We here document three *Bazzania* species as new for the Cook Islands and predict more species based on the collections and various phenotypes that continue to be examined as part of a broader study. The difficulty is amplified with no revision at all for the tropical Pacific species, including New Caledonia and Fiji. Yet, many have been described and a significant number are only known from the type collection; thus, a degree of uncertainty exists with species identification without studying type material.

Neolepidozia wallichiana (Gottsche) Fulford & Taylor (1959: 84)

Basionym:—*Lepidozia wallichiana* Gottsche, Syn. Hepat. 2: 204, 1845.

Specimens collected:—Cook Islands: Rarotonga: Summit area of Te Kou, on floor of cloud forest, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21671*, det. M. von Konrat & G. Merrill (F, CAS, AK); Rarotonga, above caldera, midslopes toward summit of Te Kou, on trunk of bryophyte-covered tree, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21674*, det. M. von Konrat, G. Merrill, J. Engel & T. Pócs 2023 (F, CAS, AK).

Distribution:—Widespread Indomalaysian-Pacific species (Engel & Merrill 2004).

Tricholepidozia quadriseta (Steph.) Cooper (2013: 60)

Basionym:—***Lepidozia quadriseta*** Steph. Species Hepaticarum 3: 582. 1909.

Specimens collected:—Cook Islands. Rarotonga: Te Kou Summit, 'Northern ridge' 21º 14.406'S, 159º 46.622'W, common on earth at base of *Syzygium jambos* tree in cloud forest, 1 October, 2017, *P.J. deLange & T.J.P. de Lange, CK250*, det. M. von Konrat, G. Merrill, J. Engel & T. Pócs 2023 (F, CAS, AK); Rarotonga: in vicinity of Te Kou Summit, near telecommunications, 21°14'25"S, 159°46'37"W, ca 500 m., on floor under protected niche at base of tree, 1 October 2017, *M. von Konrat, P. de Lange, M. Tabua et al. 21699*, det. M. von Konrat, G. Merrill, J. Engel & T. Pócs 2023 (F, CAS, AK).

Distribution:—Hitherto only known from Australia where Engel & Merrill (2004) noted it was known from a few collections in Queensland and the type specimens of the synonyms *Lepidozia quadriseta* and *L. quadricilia* Stephani (1922: 338)—both of New South Wales.

Notes:—Engel & Merrill (2004) noted that *Tricholepidozia quadriseta* [as *Telaranea quadriseta* (Stephani 1909: 582) Engel & Merrill 2004: 95], with its soft and delicate appearance coupled with the leaf disc only 2 cells high, resembles *Tricholepidozia lindenbergii* (Gottsche *et al*. 1845: 213) Cooper (2013: 59). However, as they note it is distinguished by the incubous inserted stem leaves, longer leaf lobes with distinctly constricted septa and the scabrous cuticle. Engel & Merrill (2004) provide a very detailed comparison between *T. quadriseta* and another species with a scabrous cuticle—*Telaranea granulata* (Engel & Merrill 2004: 103)—but note the two are unlikely to be confused, since they have a number of morphological differences, including the shorter leaf lobes of *Telaranea granulata*. We do note that the material from Rarotonga has both 3 and 4-lobed stem leaves where the Australian form is more consistently 4-lobed.

Discussion

The Cook Islands have a diverse but under-studied bryophyte flora. The bryophytes of Rarotonga, especially, are very conspicuous, as with other tropical islands with high relief. They occur from low-lying coral cay islands and coastal remnants up to cloud forest. Our studies continue to be in an early stage, but it is very possible the total number of taxa of mosses, liverworts, and hornworts on Rarotonga could exceed 150 species (de Lange *et al.* 2017).

Mosses:—The specimens cited above bring the total number of moss taxa known from the Cook Islands to 72. It is almost certain that additional taxa will be found there by future collectors. The great majority of collecting has been on Rarotonga. Very few bryophyte taxa are recorded in published literature from the Outer Islands. The moss specimens cited above plus those listed by O'Shea (2008) include just three taxa from Aitutaki, nine from Mangaia, two from Mauke, eight from Mitiaro, one from Pukapuka and none from the other islands. Atiu and Mangaia are islands with significant complexity and habitat diversity and bryophytes are common there, but few taxa have been documented.

Calomnion denticulatum is perhaps the most interesting addition to the moss flora. The distinctive genus *Calomnion* Hooker f. & Wilson (1854: 97) is currently placed in the family Calomniaceae and nine species are recognised (Vitt 1995). Most are from the South Pacific and Australasia and many are insular endemics or restricted to single archipelagos (Vitt, 1995). *C. denticulatum* until now has been considered endemic to Samoa and known only from the island of Upolu, hence the Rarotongan find is an interesting extension. A second moss representing an interesting range extension is *Ectropothecium viridifolium*, which is otherwise known only from the Hawaiian Islands. Also of note is *Hypnodendron samoanum*, a distinctive moss known only from French Polynesia to the east and Samoa to the west.

Liverworts & hornworts:—The liverwort and hornwort flora is extremely poorly known. There are only about eighteen Cook Islands species recorded in the published literature and most of these are derived from literature reports with only a few citing specimens (pers. comm. A. Hagborg). Miller *et al.* (1983) provided a comprehensive checklist of liverworts and hornworts from the tropical islands of the Pacific, including those of the Cook Islands, only recording eight liverwort species. We have collections of at least one hornwort taxon from Rarotonga but we have not identified it to species yet. The current paper is part of a larger series of papers focusing on increasing our floristic knowledge in the South Pacific including nearby Fiji (e.g., Söderström *et al.* 2011; Pócs *et al.* 2011; von Konrat *et al.* 2011), Tonga (Söderström *et al.* 2012), New Caledonia (Thouvenot *et al.* 2011), and the Kermadec Islands (de Lange & Beever 2015). Almost four decades after Miller *et al.* (1983) we hope this series of papers will work towards the same goal, in the same spirit as them, helping to promote further research in the South Pacific.

Acknowledgements

This paper is dedicated to the memory of David Meagher (1958–2023). The team is very grateful to the Cook Islands government for facilitating collection permits. W. R. (Bill) Sykes† shared information about bryophytes and provided much encouragement and companionship to the first author on field excursions. Eddy Saul also provided help, information and encouragement. David Hutton and Benito Tan† in Berkeley, Brian O'Shea† in London and Dale Vitt at Southern Illinois University provided help with identification of mosses. The Biodiversity Heritage Library is acknowledged for the facility they provide that has greatly aided our research as well as L. Söderström and A. Hagborg

of the Early Land Plants Today project. The generous support by the National Science Foundation (Award 2001509) is gratefully acknowledged. We recognize curatorial support provided by Y. Rodriguez, L. Kawasaki and A. Balla (Field Museum, Chicago, U.S.A.). We acknowledge the Mohamed bin Zayed Species Conservation Fund, Conservation International, the Warrick Foundation, the Negaunee Foundation, the Field Museum Woman's Board, Field of Dreams Program and the Museum Science Collections Fund, and especially the Feay family who provided financial support for fieldwork. Gillian M. Crowcroft, Theo J.P. de Lange, and Finn J.T. de Lange, Natural Resource Assessors, Auckland, Aotearoa/New Zealand provided instrumental support with collecting, logistics and accommodation. The Grainger Bioinformatics Center digital microscopic facilities are also acknowledged. We thank the curators and staff at AK.

We thank the two reviewers and the Editor, Chis Cargill, for useful comments on the manuscript.

References

Bartlett, J.K. (1986) Some mosses of Rarotonga, Cook Island Group. *Journal of Bryology* 14: 359–362. https://doi.org/10.1179/jbr.1986.14.2.359

Bartram, E.B. (1933) Manual of Hawaiian mosses. *Bishop Museum Bulletin* 101: 1–275.

Bellard, C., Leclerc, C., Leroy, B., Bakkenes, M., Veloz, S., Thuiller, W. & Courchamp, F. (2014) Biodiversity hotspots and global change. *Global Ecology and Biogeography* 23: 1376–1386**.** https://doi.org/10.1111/geb.12228

Bescherelle, E. (1895) Florule Bryologique de Tahiti et des Iles de Nukahiva et Mangareva. *Annales des Sciences Naturelles; Botanique*, sér. 7 20: 1–62.

Bescherelle, E. (1898) Florule Bryologique deTahiti (Supplement) Deuxieme Partie – Pleurocarpes (1). *Bulletin de la Société Botanique de France* 45: 116–128. https://doi.org/10.1080/00378941.1898.10830828

Braggins, J.E., Renner, M.A.M. & de Lange, P.J. (2014) Additions to the liverwort flora of the Kermadec Islands, New Zealand Botanical Region. *Telopea* 17: 183–194. https://doi.org/10.7751/telopea20147709

Bridel, S.É. v. (1827) *Bryologia Universa* 1: [i]–xlvi, 747–856.

Brotherus, V.F. (1905) Die Natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten, insbesondere den Nutzpflanzen, unter Mitwirkung zahlreicher hervorragender Fachgelehrten begründet. *Die Natürlichen Pflanzenfamilien* I: 1155.

Cheeseman, T.F. (1903) The Flora of Rarotonga, the chief Island of the Cook Group. *Transactions of the Linnean Society, 2nd series, Botany* 6: 261–313. https://doi.org/10.1111/j.1095-8339.1903.tb00277.x

Chua, M.-S., Ho, B.-C., Suleiman, M., Zuo, Q., Zhang, D.X. & Zhang, L. (2018) Lectotypification of *Acroporium hyalinum* (Rheinw. ex Schwägr.) Mitt. (Hypnales: Sematophyllaceae). *Telopea* 21: 1751855. https://doi.org/10.7751/telopea12957

Consortium of Bryophyte Herbaria (2023) Available from: http//:bryophyteportal.org/portal/index.php (accessed 16 October 2023)

Cooper, E.D., Söderström, L., Hagborg, A. & von Konrat, M.J. (2013) Notes on Early Land Plants Today. 38. New combinations and synonyms in Lepidoziaceae (Marchantiophyta). *Phytotaxa* 97 (2): 52–62. https://doi.org/10.11646/phytotaxa.97.2.5

Critical Ecosystem Partnership Fund (2013) https://www.cepf.net/our-work/biodiversity-hotspots/polynesia-micronesia (accessed 15 October 2023)

de Lange, P.J. & Beever, J.E. (2015) A checklist of the mosses of the Kermadec Islands. *Bulletin of the Auckland Museum* 20: 183–206.

de Lange, P.J., von Konrat, M., Tabua, M., McCormack, G., de Lange, T.J., Crowcroft, G.M. & de Lange, J.T. (2017) Cook Islands bryophyte survey. *Trilepidea* 168: 9–12.

Dozy, F. & Molkenboer, J.H. (1844) *Musci Frondosi Archipelagi Indici.* H. W. Hazenberg & Soc., Leiden, [vi] + 22 pp.

Dozy, F. & Molkenboer., J.H. (1845–1854) *Musci Frondosi Inedti Archipelagi Indici* 1–7. H. W. Hazenberg, Lugduni-Batavorum, i–viii + 1–185 pp.

Dozy, F. & Molkenboer, J.H. (1860) *Bryologia Javanica* 1. A. W. Sythoff, Leiden, 161 pp.

Dransfield, J. & Ehrhart, Y. (1995) A new species of *Pritchardia* from Mitiaro, Cook Islands. *Principes* 39: 36–41.

Engel, J.J. & Merrill, G.L.S. (2004) Austral Hepaticae 35. A taxonomic and phylogenetic study of *Telaranea* (Lepidoziaceae), with a monograph of the genus in temperate Australasia and commentary on extra-Australasian taxa. *Fieldiana. Botany* 44: 1–265. https://doi.org/10.3158/0015-0746(2004)44[1:AHATAP]2.0.CO;2

Fleischer, M. (1904) *Die Musci der Flora von Buitenzorg* Band 1. Leiden, pp. 1–379.
Fleischer, M. (1905) Neue Gattungen und Arten der Musc. Archip. Ind. *Hedwigia* 44: 301–330
Fleischer, M. (1908) *Die Musci der Flora von Buitenzorg* Band 3. Brill, Leiden, pp. i–xxiv + 645–1103.
Fleischer, M. (1923) *Die Musci der Flora von Buitenzorg* Band 4. Brill, Leiden, pp. i–xxxi + 1105–1729.
Fulford, M. & Taylor, J. (1959) The segregate genera of the *Lepidozia* complex (Hepaticae). Part 1. *Sprucella* Steph. and *Neolepidozia* gen. nov. *Brittonia* 11 (2): 77–85.
https://doi.org/10.2307/2805175
Global Biodiversity Information Facility (2023) Available from: https://www.gbif.org (accessed 16 October 2023)
Gottsche, C.M., Lindenberg, J.B.W. & Nees, C.G. (1845) *Synopsis hepaticarum, fasc. 2*. Meissner, Hamburg, pp. 145–304.
https://doi.org/10.5962/bhl.title.15221
Gradstein, S.R. (2017) *Bazzania* (Marchantiophyta) in South America. *Nova Hedwigia* 105: 243–266.
https://doi.org/10.1127/nova_hedwigia/2017/0409
Gray, S.F. (1821) *Natural arrangement of British plants. Vol. 1*. Baldwin, Craddock, and Joy, London, 824 pp.
https://doi.org/10.5962/bhl.title.43804
Grolle, R. (1960) Notulae hepaticologicae I.-II.-III. *Revue Bryologique et Lichénologique* 29 (3/4): 207–211.
Hedwig, J. (1801) Species muscorum frondosorum: descriptae et tabulis aeneis l xxvii coloratis illustratae. *Barthius:* 1–353.
https://doi.org/10.5962/bhl.title.26
Hooker, J.D. (1855)[1854]. *Flora Novae-Zelandiae* 2. Lovell Reeve, London, 378 pp.
Jaeger, A. (1872) Bericht über die Thätigkeit der St. Gallischen *Naturwissenschaftlichen Gesellschaft* 1870–1871: 357–451.
Kitagawa, N. (1972) Miscellaneous notes on little-known species of hepaticae, 1-25. *Journal of the Hattori Botanical Laboratory* 36: 444–454.
Lindberg, S.O. (1864 [1865]) *Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar* 21: 605.
Martin, T., de Lange, P.J., Myers, S., McCormack, G., Apera, E. & Rattle, C. (2012) *Survey of the endemic flora of Rarotonga and preparation of IUCN threat assessments*. Wildlands Consultants Ltd, Report Number 2497.
McCormack, G. (2007) *Cook Islands Biodiversity Database*, Version 2007.2. Cook Islands Natural Heritage Trust, Rarotonga. Available from: http://cookislands.bishopmuseum.org (accessed 15 October 2023)
McCormack, G. (2021) Is Mangaia the oldest Pacific island? [https://cinature.org/2021/01/05/is-mangaia-the-oldest-pacific-island/]
Meagher, D. (2010) Studies on *Bazzania* 2. Seven poorly known species from Australia. *Nova Hedwigia* 90: 395–411.
https://doi.org/10.1127/0029-5035/2010/0090-0395
Meagher, D.A. (2019) A synopsis of the genus *Bazzania* (Marchantiophyta: Lepidoziaceae) in Australia. *Australian Systematic Botany* 32: 310–362.
https://doi.org/10.1071/SB18025
Menzel, M. & Schultze-Motel, W. (1990) The bryophytes of Sabah (N. Borneo) with special reference to the BRYOTROP transect of Mt. Kinabalu. XI. Calymperaceae (Bryopsida). *Willdenowia* 19: 475–542.
Miller, H.A., Whittier, H.O. & Whittier, B.A. (1983) Prodromus florae hepaticarum Polynesiae. Catalogue of hepaticae and anthocerotae. *Bryophytorum Bibliotheca* 25: 1–423.
Mitten, W. (1868) A list of the Musci collected by the Rev. Thomas Powell in the Samoa or Navigators Islands. *Botanical Journal of the Linnean Society* 10: 166–192.
https://doi.org/10.1111/j.1095-8339.1868.tb02029.x
Mitten, W. (1873) Musci. *In*: Seemann, B.C. (Ed.) *Flora Vitiensis*. L. Reeve and Co., London, pp. 378–404.
Montagne, J.P.F.C. (1845) Cinquième centurie de plantes cellulaires exotiques nouvelles. Décades I a VI. *Annales des Sciences Naturelles; Botanique* sér. 3 4: 86–123.
https://doi.org/10.5962/bhl.title.6485
Montagne, J.P.F.C. (1848) Sixième centurie de plantes cellulaires exotiques nouvelles. Décades I et II. *Annales Des Sciences Naturelles, Botanique* sér. 3 10: 106–136.
Müller, C. (1873)[1872] Musci Australici praesertim Brisbanici novi. *Linnaea* 37: 143–162.
https://doi.org/10.1007/978-3-642-99187-5_5
Müller, C. & Brotherus, V.F. (1900) Ergebnisse einer Reise nach dem Pacifik. Musci Schauinslandiani. *Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereins zu Bremen* 16 (3): 493–512.
Olsson, S., Enroth, J., Huttunen, S. & Quandt, D. (2016) Phylogeny of *Neckeropsis* and *Himantocladium* (Neckeraceae, Bryophytina). *Bryophyte Diversity and Evolution* 38 (2): 53–70.
https://doi.org/10.11646/bde.38.2.4
O'Shea, B.J. (2008) Mosses of Cook Islands. *Tropical Bryology* [*Bryophyte Diversity and Evolution*] 29 (1): 71–79.
https://doi.org/10.11646/bde.29.1.10

Pócs, T., Sass-Gyarmati, A., Naikatini, A.N., Tuiwawa, M., Braggins, J., Pócs, S. & von Konrat, M. (2011) New Liverwort (Marchantiophyta) records for the Fiji Islands. *Telopea* 13 (3): 455–494.
https://doi.org/10.7751/telopea20116031

Renner, M.A.M. & de Lange, P.J. (2011) Additions to the Lejeuneaceae flora of New Zealand: New species from the Kermadec Islands and range extensions of New Zealand species into the South Pacific. *New Zealand Journal of Botany* 49: 421–433.
https://doi.org/10.1080/0028825X.2011.580765

Robinson, H.E. (1975) A new name for the moss genus, *Thyridium. Phytologia* 32: 432–435.

Schultze-Motel, W. (2002) Zur kenntnis der Laubmoose von Rarotonga (Cook Inseln). *Botanische Jahrbucher für Systematik* 124: 77-81.
https://doi.org/10.1127/0006-8152/2002/0124-0077

Söderström, L., Hagborg, A., Pócs, T., Sass-Gyarmati, A., Brown, E., von Konrat, M.J. & Renner, M.A.M. (2011) Checklist of hornworts and liverworts of Fiji. *Telopea* 13 (3): 405–454.
https://doi.org/10.7751/telopea20116030

Söderström, L., von Konrat, M., Hagborg, A. & Séneca, A. (2012a) Early Land Plants Today–a community driven approach. *Studia Botanica Hungarica* 43: 47–58.

Söderström, L., Hagborg, A. & von Konrat, M. (2012b) The friendly islands–Checklist of hornworts and liverworts of Tonga. *Polish Botanical Journal* 57 (1): 129–135.

Spruce, R. (1867) *Catalogus Muscorum fere Omnium quos in Terris Amazonicus et Andinis, per Annos 1849–1860*, *legit Ricardus Spruceus* 5. E. Newman, London, 22 pp.

Stephani, F. (1909) *Species hepaticarum 3*. George & Cie, Genève & Bale, pp. 517–693.
https://doi.org/10.5962/bhl.title.95494

Stephani, F. (1922) *Species hepaticarum 6*. George & Cie, Genève & Bale, pp. 241–368.
https://doi.org/10.5962/bhl.title.95494

Sullivant, W.S. (1854) *Notices of some new species of mosses, from the Pacific Islands, in the collection of the United States Exploring Expedition, under Captain Wilkes [3]*. Metcalf and Company, Cambridge, [Part 1], pp. 1–12.

Swartz, O. (1818) *Calymperes*, eine neue Moosgattung. *Jahrbücher der Gewächskunde* 1 (1): 1–5.

Sykes, W.R. (2016) *Flora of the Cook Islands*. National Tropical Botanical Garden, Kauai.

Thériot, I. (1922) A systematic account of the plants collected in New Caledonia and the Isle of Pines by Prof. R. H. Compon M.A. in 1914: Musci. *Journal of the Linnean Society, Botany* 45: 462–466.
https://doi.org/10.1111/j.1095-8339.1922.tb00133.x

Thiers, B. (2013) Index herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available from: http://sweetgum.nybg.org/ih/ (accessed 25 September 2023)

Thouvenot, L., Gradstein, S.R., Hagborg, A., Söderström, L. & Bardat, J. (2011) Checklist of the Liverworts and Hornworts of New Caledonia 1. *Cryptogamie, Bryologie* 32 (4): 287–390.
https://doi.org/10.7872/cryb.v32.iss4.2011.287

Townsend, C.C. (1975) Bryophytes from the Cook Islands. *Atoll Research Bulletin* 190: 85.

Trevisan de Saint-Léon, V.B.A. (1877) Schema di una nuova classificazione delle epatiche. *Memorie del Reale Istituto Lombardo di Scienze e Lettere, Serie 3, Classe di Scienze Matematiche e Naturali* 4 (13): 383–451.

Vitt, D.H. (1995) The genus *Calomnion* (Bryopsida): taxonomy, phylogeny, and biogeography. *The Bryologist* 98: 338–358.
https://doi.org/10.2307/3243372

von Konrat, M., Naikatini, A., Tuiwawa, M., Söderström, L., Fife, A., Renner, M., Brownsey, P., Perrie, L., Hagborg, A., Pócs, T., Lumbsch, H.T., Braggins, J., Séneca, A. & Brown, E. (2011) A brief history of the cryptogams of Fiji and prospects for the future. *Telopea* 13: 361–374.
https://doi.org/10.7751/telopea20116028

Wallis, J., Koro, M. & O'Dwyer, C. (2023) The 'Blue Pacific'strategic narrative: rhetorical action, acceptance, entrapment, and appropriation? *The Pacific Review:* 1–28.
https://doi.org/10.1080/09512748.2023.2253377

Wilson, W. & Hooker, W.J. (1841) [1840] On a new species of *Fissidens*, found by T. G. Lea, Esq., in North America. *Journal of Botany* (Hooker) 3: 89–90.

Wood, B.L. (1967) Geology of the Cook Islands. *New Zealand Journal of Geology and Geophysics* 10: 1429–1445.
https://doi.org/10.1080/00288306.1967.10423227