

## Studies on the Bryophyte Flora of Vanuatu. 11. Anomodontaceae and Thuidiaceae (Musci)\*

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**Abstract** New records from Vanuatu are presented of eight species in five genera in the families Anomodontaceae and Thuidiaceae, based on collections made by Sugimura (1997, 2000) and Higuchi (1996, 2001). *Thuidiopsis sparsa* is reported as new to the moss flora of Vanuatu. Keys to the species are provided.

**Key words:** Anomodontaceae, Thuidiaceae, mosses, Vanuatu.

This paper deals with the Anomodontaceae and Thuidiaceae occurring in Vanuatu, based on previous reports and new collections made by Dr. K. Sugimura in 1997, 2000 and Higuchi in 1996, 2001 (cf. Higuchi 2002, 2005). The specimens examined are kept in the herbarium of the Department of Botany, National Museum of Nature and Science (TNS), and the duplicates in the herbaria of the Nationaal Herbarium Nederland, Leiden University branch (L) and the Department of Forestry, Republic of Vanuatu (PVNH). The keys and previously published distribution data are mainly based on the taxonomic revision presented by Touw (2001b).

Higuchi (1996) reported from Vanuatu a single species of Anomodontaceae, *Herpetineuron toccoae*, and seven species in two genera of Thuidiaceae, viz., *Pelekium* (*P. velatum*) and *Thuidium* (*T. campbellianum*, *T. cymbifolium*, *T. glaucinoides*, *T. glaucinum*, *T. meyenianum* and *T. plumulosum*). Subsequently, Touw (2001b) revised the Thuidiaceae of tropical Asia, the west-

ern Pacific and Hawaii. From Vanuatu he listed six species in three genera, *Aequatoriella* (*A. bifaria*), *Pelekium* (*P. gratum*, *P. synoicum* and *P. velatum*) and *Thuidium* (*T. cymbifolium* and *T. pristocalyx* var. *samoanum*). The fifty-six specimens collected by Sugimura and Higuchi consist of one species of Anomodontaceae and seven species in four genera of Thuidiaceae. Among these, *Thuidiopsis sparsa* is new to the moss flora of Vanuatu.

### Key to the genera of Anomodontaceae and Thuidiaceae in Vanuatu

1. Leaf margin coarsely dentate above; costa strongly flexuose or zigzag above ..... 1. *Herpetineuron*
1. Leaf margin almost entire, crenulate, or serrulate; costa almost straight ..... 2
2. Dioicous, sporogones mostly absent; stem in most species exceeding 8 cm; paraphyllia unbranched or branched, mostly more than 5 cells long when all unbranched. .... 3
2. Monoicous, sporogones and gametoecea mostly present; stem rarely exceeding 5 cm; paraphyllia unbranched, occasionally with 1 or 2 branches mostly shorter than the stem, mostly to 5 cells long ..... 2. *Pelekium*
3. Paraphyllia strongly branched; abaxial face of

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- leaf cells papillose, adaxial face smooth or ornamented near the leaf margin and on folds; axillary hairs with to 5 distal cells; seta and calyptra smooth.....3. *Thuidium*
3. Paraphyllia unbranched, occasionally with 1 or 2 lateral branches shorter than the stem; leaf cells papillose on both leaf faces; axillary hairs with 1 or 2 distal cells .....4
4. Branch leaf cells 1-papillose or smooth; stem leaves mostly triangular to ovate; margin plane or narrowly recurved; seta spinose; calyptra campanulate, scabrous, bearing a few scattered hairs .....4. *Aequatoriella*
4. Branch leaf cells pluripapillose; stem leaves broadly rounded cordate-triangular, narrowly acuminate; margin broadly recurved; seta smooth; calyptra cucullate, smooth, often sparingly ciliate by paraphysal hairs .....5. *Thuidiopsis*

**Anomodontaceae**

1. **Herpetineuron toccoe** (Sull. et Lesq.) Cardot, Beih. Bot. Centralbl. **19**(2): 127 (1905).

Specimen examined. Espiritu Santo, between Matantas and Butmas, 220 m, on tree-trunk, Nov. 7, 2000 (*Sugimura 3631*).

Distribution. Almost cosmopolitan, excluding Europe and Siberia.

Note. This species has been reported before from Epi (Brotherus and Watts, 1915), Ambrym (Thériot, 1938), and Espiritu Santo (Streimann and Reese, 2001).

**Thuidiaceae**

Key to the species of *Pelekium* in Vanuatu

1. Median branch leaf cells 2–8-papillose; autoicous .....3. *Pelekium gratum*
1. Median branch leaf cells 1(–3)-papillose; autoicous or synoicous .....2
2. Calyptra campanulate, hispid; seta spinulose; perichaetial leaves eciliate; autoicous.....2. *Pelekium velatum*
2. Calyptra cucullate or subcylindrical, smooth; seta mammillose; inner perichaetial leaves eciliate or bearing to 5 short cilia; synoicous...

.....4. *Pelekium synoicum*

2. **Pelekium velatum** Mitt., J. Linn. Soc. Bot. **10**: 176 (1868).

Specimens examined. Espiritu Santo, Tangoa, 20 m, on rock, Oct. 12, 1997 (*Sugimura 1455*); Matantas, 30 m, on decaying log, Nov. 6, 2000 (*Higuchi 40016*); 50 m, on tree-trunk, Nov. 6, 2000 (*Sugimura 3617*); Tanafo–Matantas, 350 m, on rock, Oct. 8, 1997 (*Sugimura 1433*); Mt. Vutimele–Peavot, 300 m, on boulder, Nov. 26, 1996 (*Higuchi 32318*). Efate, Pang Pang, 20 m, on rock, Oct. 3, 1997 (*Sugimura 1420*); Cascades Waterfall, 90 m, on rock, Nov. 11, 2000 (*Sugimura 3653*).

Distribution. Tropical East Africa (Tanzania), Sri Lanka, Nicobars, Thailand, Botel Tobago, Malay Peninsula, Anambas Islands, Sumatra, Mentawai Islands, Krakatau, Java, Borneo, Babayan Group (Dalupiri), Luzon, Catanduanes, Mindoro, Palawan, Lumbucan, Samar, Leyte, Negros, Panay, Mindanao, Sulu Archipelato (Basilan, Malamaui, Jolo), Talaud Islands (Karakelong), Sulawesi, Moluccas (Halmahera, Buru, Seram, Ambon, Banda, Tanimbar, Aru, Kai), New Guinea and adjacent islands, Bismarcks (Musau, New Britain, Duke of York), Solomons (Buka, Bougainville, Choiseul, Malaita, Guadalcanal, San Christobal), Vanuatu (Espiritu Santo, Epi, Tongoa Santo), New Caledonia (Ile des Pins), Fiji (Viti Levu), Tonga (Eua), Samoa (Savaii, Upolu, Tutuila), Marianas (Guam), Carolines (Yap, Sorol, Truk, Ifaluk), Marshalls (Ujelang), Ellice Islands (Rotuma, Funafuti) . New to Efate in Vanuatu.

Note. *Pelekium velatum* has been recorded before from Epi and Espiritu Santo by Brotherus and Watts (1915) and from Espiritu Santo by Tixier (1973). In Vanuatu this is a common lowland species.

3. **Pelekium gratum** (Mitt.) Touw, J. Hattori Bot. Lab. **90**: 203 (2001a).

Specimens examined. Espiritu Santo, Matantas, 50 m, on decaying log, Nov. 6, 2000 (*Sugimura 3613*); Kerepua, 70 m, on rock, Oct. 28,

2000 (*Sugimura 3473*); Kerepua River, 90 m, on rock, Oct. 29, 2000 (*Sugimura 3481*); Kerepua–Mt. Tabwemasana, 200 m, on rock, Nov. 4, 1996 (*Higuchi 31461*).

**Distribution.** West, Central and East tropical Africa, Comores, Madagascar, Mascarenes, Sri Lanka, Peninsular and eastern India, Himalayas (Nepal, Sikkim, Bhutan), Burma, Thailand, Laos, Cambodia, Vietnam, southern China (Yunnan, Hainan), Andamans, Nicobars (Katchall), Malay Peninsula, Sumatra, Java, Lesser Sunda Islands (Lombok, Flores, Alor), Luzon, Palawan, Negros, Mindanao, Sulawesi, Buton, Moluccas (Tidore, Seram, Ambon, Saparua, Tanimbar, Aru, Kai), New Guinea and adjacent islands, Bismarcks (New Britain), Solomons (Bougainville, Guadalcanal), Vanuatu (Malekula, Epi, Espiritu Santo, Mallicolo, Aniwa, Pentecost, Tanna), New Caledonia, Loyalty Islands (Lifu), Fiji (Viti Levu, Wakoya), Tonga, Samoa (Savaai, Upolu, Manono, Tutuila, Tau), Australia (Northern Territory, Queensland).

**Note.** This species has been reported before under the name *Thuidium meyenianum* (Hampe) Dozy et Molk. (New Hebrides, Hürlimann, 1965) and Mallicolo (Tixier, 1974). A specimen from Espiritu Santo listed under that name by Tixier (1973) belongs to *Pelekium synoicum*.

**4. *Pelekium synoicum*** (Touw) Touw, J. Hattori Bot. Lab. **90**: 205 (2001).

**Specimens examined.** Espiritu Santo, Matantas, 30 m, on root, Oct. 29, 2001 (*Higuchi 39997*); Peavot, 50 m, on tree-trunk, Nov. 27, 1996 (*Higuchi 32343*); Mt. Vutimele–Peavot, 500 m, on boulder, Nov. 26, 1996 (*Higuchi 32315*). Efate, Mt. Bernier, 190 m, on decaying log, Oct. 28, 1997 (*Sugimura 1743*).

**Distribution.** Peninsular Thailand, Java, Lesser Sunda Islands (Bali), Borneo, Luzon, Negros, Mindanao, Sulawesi, Moluccas (Seram), Papua New Guinea, Bismarcks (New Britain), Solomons (Bougainville), Vanuatu (Espiritu Santo, Epi), Loyalty Islands (Maré), Fiji (Viti Levu), Samoa (Upolu), Australia (Queensland). New to Efate in Vanuatu.

**Note.** This species has been reported before from Espiritu Santo and Epi (Touw 2001b). It is similar to *P. gratum* and *P. velatum*, but differs from both by having synoicous gametoecia.

**Key to the species of *Thuidium* in Vanuatu**

1. Stem leaves muticous .....
  - .....6. *Thuidium pristocalyx* var. *samoanum*
1. Stem leaves ending in an uniseriate hair tip ...
  - .....2
2. Branch leaf costa strongly cristate abaxially, its epidermal cells similar to the adjacent laminal cells; setae mammillose; calyptrae scabrid; plants very densely and neatly bipinnate .....
  - .....7. *Thuidium plumulosum*
2. Branch leaf costa not cristate, its abaxial epidermal cells longer than the adjacent laminal cells; setae and calyptrae smooth; plants less densely and regularly bipinnate or tripinnate ..
  - .....5. *Thuidium cymbifolium*

**5. *Thuidium cymbifolium*** (Dozy et Molk.) Dozy and Molk., Bryol. Jav. **2**: 115 (1865).

**Specimens examined.** Espiritu Santo, along Pinalap River, 150 m, on rock, Oct. 14, 1997 (*Sugimura 1467+Aequatoriella bifaria*); Mt. Vutimele, 870 m, on rock, Oct. 18, 1997 (*Sugimura 1661*); Mt. Tabwemasana, 1000 m, on boulder, Nov. 9, 1996 (*Higuchi 31908*); 1000–1300 m, on rock-cliff, Oct. 25, 2001 (*Higuchi 39905*). Anatom, Anelghowha–Mt. Nidwon Nelcai, 60 m, on boulder, Nov. 6, 2001 (*Higuchi 40169+Thuidium pristocalyx* var. *samoanum*).

**Distribution.** Sri Lanka, peninsular and eastern India, Himalayas (Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Nepal, Bhutan), Burma, Thailand, Laos, Vietnam, southern and eastern China, Taiwan, Japan (Ryukyu, Kyushu, Shikoku, Honshu), Malay Peninsula, Sumatra, Java, Lesser Sunda Islands (Bali, Lombok, Flores, Timor), Borneo, Batan, Luzon, Mindoro, Palawan, Leyte, Negros, Mindanao, Sulawesi, Moluccas (Halmahera, Seram, Ambon, Saparua), New Guinea, Bismarcks, Solomons, Vanuatu, New Caledonia, Loyalty Islands, Fiji, Samoa, Kermadecs, Hawaiian Islands (Kauai, Oahu,

Molokai, Lanai, Maui, Hawaii).

Note. This species has been reported before from Anatom and Espiritu Santo by Brotherus and Watts (1915) and from Espiritu Santo and Efate by Tixier (1974). It has been reported under the name of *Thuidium ramentosum* (Mitt.) Mitt. from Anatom and Epi (Brotherus and Watts, 1915).

6. ***Thuidium pristocalyx*** (Müll.Hal.) A.Jaeger var. *samoanum* (Mitt.) Touw, J. Hattori Bot. Lab. **91**: 41 (2001b).

Specimens examined. Espiritu Santo, Matantatas, 50 m, on tree-trunk, Nov. 6, 2000 (*Sugimura 3612*); Narango, 300 m, on tree-trunk, Nov. 8, 2000 (*Sugimura 3637*); along Pialap River, 560 m, on rock, Oct. 19, 1997 (*Sugimura 1675*); Mt. Vutimena, 640 m, on humus, Oct. 18, 1997 (*Sugimura 1623*); Mt. Vutimele, 600 m, on the basal part of tree-trunk, Nov. 21, 1996 (*Higuchi 31980*); 1200 m, on boulder, Nov. 23, 1996 (*Higuchi 32166*); Mt. Tabwemasana, 1000 m, on boulder, Nov. 6, 1996 (*Higuchi 31558*); Nov. 8, 1996 (*Higuchi 31824*); on decaying log, Nov. 6, 1996 (*Higuchi 31565*); Nov. 9, 1996 (*Higuchi 31913*); on root (*Higuchi 31586, 31757*); Nov. 9, 1996 (*Higuchi 31886*); 1050 m, on tree-trunk, Oct. 22, 2001 (*Higuchi 39752*). Efate, Forari, 300 m, on decaying log, Nov. 14, 2000 (*Sugimura 3662*). Anatom, Anelghowhat–Mt. Nidwon Nelaicai, 60 m, on boulder, Nov. 6, 2001 (*Higuchi 40169+Thuidium cymbifolium*); Anelghowhat–Mt. Ukapaerek, 170 m, on decaying log, Nov. 5, 2001 (*Higuchi 40082*).

Distribution. Malay Peninsula, Sumatra, Bangka, Java, Lesser Sunda Islands (Bali, Lombok, Sumbawa, Flores, Timor), Natunas (P. Bunguran), Borneo, Luzon, Mindoro, Palawan, Negros, Mindanao, Sulawesi, Buton, Moluccas (Buru, Seram, Ambon, Halmahera or Ternate), New Guinea, Bismarcks (Manus, Mussau, New Ireland, New Britain), Solomons (Bougainville, Kolombangara, Santa Ysabel, Guadalcanal, Rennell), Vanuatu (Espiritu Santo, Tongoa Santo, Efate, Anatom), New Caledonia, Fiji (Viti Levu, Ovalau), Samoa (Savaii, Upolu, Tutuila, Tau),

Carolines (Ponape).

Note. This species has been reported before under the names of *Thuidium glaucinoides* Broth. (Espiritu Santo, Brotherus and Watts 1915, Tixier 1974; New Hebrides, Fleischer 1923; Futuna, Thériot 1938) and of *T. glaucinum* (Mitt.) Bosch et Sande Lac. (Anatom, Epi and Espiritu Santo, Brotherus and Watts 1915; Tanna, Thériot 1938; Anatom and Espiritu Santo, Tixier 1973).

7. ***Thuidium plumulosum*** (Dozy et Molk.) Dozy et Molk., Bryol. Jav. **2**: 118 (1865).

Specimen examined: none, see note.

Distribution. Peninsular Thailand, Malay Peninsula, Sumatra, Mentawai Is, Java, Lesser Sunda Islands (Flores), Borneo, Luzon, Mindoro, Palawan, Visayas (Samar, Leyte, Cebu, Negros), Camiguin de Mindanao, Mindanao, Talaud Is (Karakelong), Sulawesi, Moluccas (Morotai, Halmahera, Buru, Seram, Ambon, Aru, Kai), New Guinea and adjacent islands, Admiralty Islands (Manus), Bismarcks (Manus, Los Negros, Mussau, New Ireland, New Britain), Solomons (Choiseul, Santa Ysabel, Malaita, Russell Islands, Guadalcanal, Rennell, Faule), Fiji (Viti Levu, Ovalau, Vanua Levu), Samoa Is (Savaii, Upolu), Marianas (Rota, Guam), Carolines (Palau, Sonsorol, Kapingamarangi), Norfolk, Australia (northern Queensland).

Note. *Thuidium plumulosum* is not represented among the new Vanuatu collections, but has been reported under that name (not as *T. meyenianum*, an error made by Touw, 2001b) from Espiritu Santo (Brotherus and Watts, 1915) and from Aniwa, Pentecost and Tanna (Tixier, 1938). These specimens concerned have not been examined, but their identification is almost certainly correct, *T. plumulosum* being an easily known, common and widespread lowland species that one would expect to find in Vanuatu.

8. ***Aequatoriella bifaria*** (Bosch et Sande Lac.) Touw, J. Hattori Bot. Lab. **90**: 202 (2001a).

Specimens examined. Espiritu Santo, along Pialap River, 150 m, on rock, Oct. 14, 1997 (*Sug-*

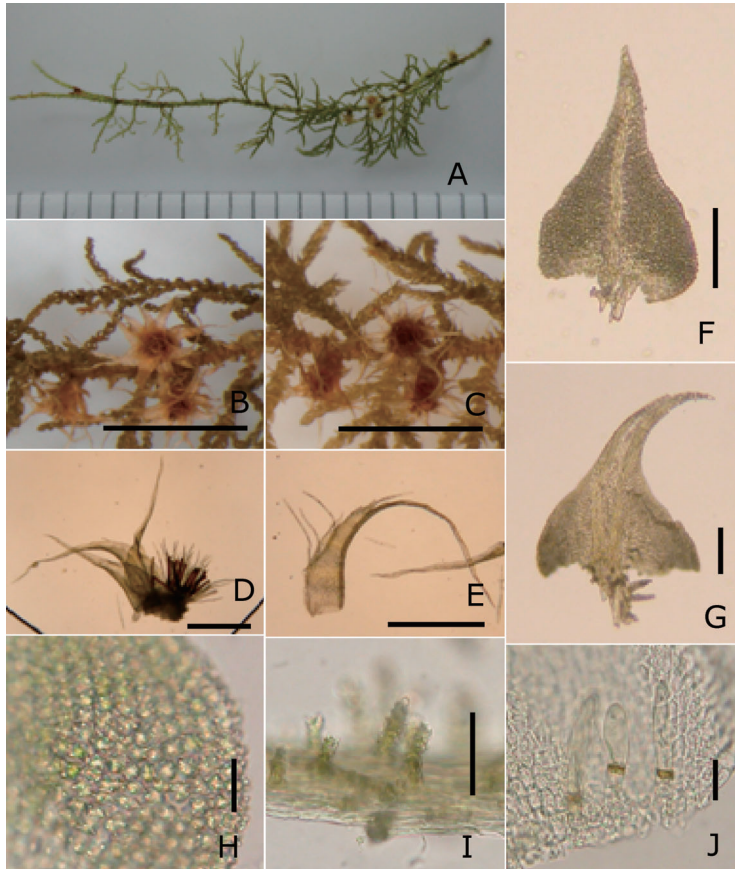


Fig. 1. *Thuidiopsis sparsa* (J. D. Hook. et Wilson) Broth. (*Higuchi 31581*). A. Plant. B, C. Perichaetia (B: dry, C: wet). D. Perichaetium with archegonia, paraphyses and perichaetial leaves. E. Inner perichaetial leaf. F. Branch leaf. G. Malformed stem leaf. H. Laminal cells of stem leaf. I. Paraphyllia on stem. J. Axillary hairs. Scale=1 mm for A. Scale bars for B, C=1 mm; D, E=0.2 mm; F, G=0.1 mm; H, J=20  $\mu$ m; I=50  $\mu$ m.

*imura 1467+Thuidium cymbifolium*); 560 m, on rock, Oct. 19, 1997 (*Sugimura 1671*); Mt. Tabwemasana, 780 m, on decaying log, Nov. 5, 1996 (*Higuchi 31495*); 1100 m, on rock, Oct. 31, 2000 (*Sugimura 3517*). Efate, Mele, 20 m, on tree-trunk, Oct. 20, 2000 (*Sugimura 3397*).

Distribution. Hung-t'ou hsü (Botel Tobago), Nicobars, Peninsular Thailand, Malay Peninsula, Sumatra, Nias, Mentawai Islands (Sipora, Enggano), Java, Lesser Sunda Islands (Bali, Flores), Borneo, Batan, Luzon, Mindoro, Palawan, Visayas (Samar, Panay), Mindanao, Sulawesi, Moluccas (Seram, Ambon), New Guinea, Bismarcks (New Britain), Solomons (Guadalcanal, Choiseul), Vanuatu (Espiritu Santo, Malekula,

Pentecost, Tongoa Santo, Erromango, Anatom), Fiji (Viti Levu, Lautoka).

Note. This species has been reported from Erromanga under the name of *Cyrtohypnum campbellianum* Hampe (Hampe, 1874, as sp. nov.). Reports by Mitten (1882) and Brotherus and Watts (1925) under the name *Thuidium campbellianum* (Hampe) A.Jaeger, from an unspecified locality in Vanuatu probably relate to the original Campbell collection.

9. ***Thuidiopsis sparsa*** (J.D.Hook. et Wilson) Broth. in Engler et Prantl, Nat. Pfl. ed. 2, **11**: 323 (1925). [Fig. 1]

Specimens examined. Espiritu Santo, Mt. Tab-

wemasana, 450 m, on boulder, Nov. 5, 1996 (*Higuchi 31487*); 1000 m, on tree-trunk, Nov. 6, 1996 (*Higuchi 31539*); on root (*Higuchi 31581*); on basal part of tree-trunk, Nov. 9, 1996 (*Higuchi 31850*); on decaying log (*Higuchi 31860*); 1450 m, on decaying log, Oct. 23, 2001 (*Higuchi 39829, 39842*).

Distribution. Java, Lesser Sunda Islands (Bali, Lombok, Flores), Borneo, Sulawesi, Papua New Guinea, New Caledonia, Fiji (Viti Levu, Matuka), Cook Islands (Rarotonga), Australia, New Zealand, South America (including Juan Fernandez), Tristan da Cunha, Comoros. New to Vanuatu.

Note. *Thuidiopsis* shows a wide gondwanan distribution and is characterized by a dioicous sexual condition, unbranched paraphyllia (Fig. 1, I), axillary hairs with one or two distal cells (Fig. 1, J), smooth setae and smooth, cucullate calyptrae often bearing paraphysal hairs. *Thuidiopsis sparsa* is mainly distinguished from *T. furfurosa* (J.D.Hook. et Wilson) M.Fleisch. by the number and shape of the papillae on the leaf cells. In *T. sparsa* unipapillose cells are absent or present near the leaf tip only (Fig. 1, H), whereas pluripapillose cells are absent or present in a small number of cells in *T. furfurosa*, usually in the basal half of the leaf. In *Higuchi 31581* a malformed stem leaf with double costa was observed (Fig. 1, G).

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