

Moss Flora of Angkor, Cambodia

Masanobu Higuchi

Department of Botany, National Museum of Nature and Science,
Amakubo 4–1–1, Tsukuba 305–0005, Japan
E-mail: higuchi@kahaku.go.jp

Abstract The moss flora of Angkor, Cambodia, was investigated in 2005 and 2006 with special attention to Ta Nei site. The bryophytes recognized comprise 11 families, 14 genera and 19 species. *Calymperes motleyi*, *Ectropothecium dealbatum*, *Fissidens crenulatus*, *F. flaccidus*, *F. teysmannianus*, *Hyophila rosea*, *Leptobryum pyriforme*, *Scopelophila cataractae* and *Splachnobryum flaccidum* are reported as new to the moss flora of Cambodia. For each species recognized here, locality, substrate, specimen number and taxonomic note are provided.

Key words: Angkor, Cambodia, mosses, Ta Nei.

Introduction

This study deals with the moss flora of Angkor, Cambodia based on the collections under a research program, “Research on the deterioration and conservation of materials constituting cultural heritage in Asia,” by the National Research Institute for Cultural Properties, Tokyo, Japan in collaboration with the Authority for the Protection and Management of Angkor and the Region of Siem Reap, Cambodia. In 2005 and 2006 I made field researches and collected bryophytes mainly from Ta Nei site (13°27'N, 103°53'E), Angkor, north of Siem Reap, Cambodia.

Ta Nei is a late 12th Century stone temple, and it is located in densely forest near the northwest corner of the East Baray which is a large former lake in Angkor (Fig. 1). The ruins are made of laterite and sandstone. Ta Nei has been the object of minimal reconstruction and clearing effort, so that it has been left as it originally was for the most part.

The mosses of Cambodia have been reported by Tixier (1966, 1967, 1975, 1979, 1980). Tan and Iwatsuki (1993) compiled a checklist of Indochinese mosses, and list 73 genera and 152 species from Cambodia. The purpose of this

study is to investigate the moss flora of Angkor and compile it based on the specimens collected.

Materials and Methods

Field studies were carried out in December 2005 and July 2006 and a total of ca. 100 specimens were collected. The sites investigated are divided as follows. The collections are preserved in the herbarium of the National Museum of Nature and Science (TNS).

- I: Prasat Suor Prat, 30 m alt., 13°27'N, 103°53'E, December 15, 2005.
- II: Western Prasat Top, 40 m alt., 13°26'N, 103°51'E, December 15, 2005.
- III: Ta Nei, 40 m alt., 13°27'N, 103°53'E, December 16, 17 and 18, 2005, July 17, 18, 19 and 22, 2006.
- IV: Banteay Srei, 60 m alt., 13°35'N, 103°57'E, July 20, 2006.
- V: Banteay Samre, 30 m alt., 13°26'N, 103°58'E, July 20, 2006.
- VI: Bayon, 35 m alt., 13°26'N, 103°51'E, July 22, 2006.

Results and Discussion

The mosses recognized in this study comprise



Fig. 1. Photographs showing Ta Nei site and several species growing there. A. Outer view of Ta Nei site. B. Inner view of Ta Nei site. C. *Trachyphyllum inflexum* growing on base of stone-walls. D. *Hyophila rosea* growing on sandstone boulder. E. *Fissidens ceylonensis* growing on laterite wall. F. *Taxithelium nepalense* growing on sandstone boulder.

11 families, 14 genera and 19 species. Nine species, *Calymperes motleyi*, *Ectropothecium dealbatum*, *Fissidens crenulatus*, *F. flaccidus*, *F. teysmannianus*, *Hyophila rosea*, *Leptobryum pyriforme*, *Scopelophila cataractae* and *Splachnobryum flaccidum*, are new additions to the moss flora of Cambodia. Among them *Lepto-*

bryum pyriforme and *Scopelophila cataractae* are new to Indochina including Cambodia, Laos, Myanmar, Thailand and Vietnam.

In Ta Nei, *Fissidens ceylonensis*, *Hyophila comosa*, *Taxithelium nepalense* and *Trachyphyllum inflexum* are common and growing abundantly (Fig. 1). Bryophytes were vigorously

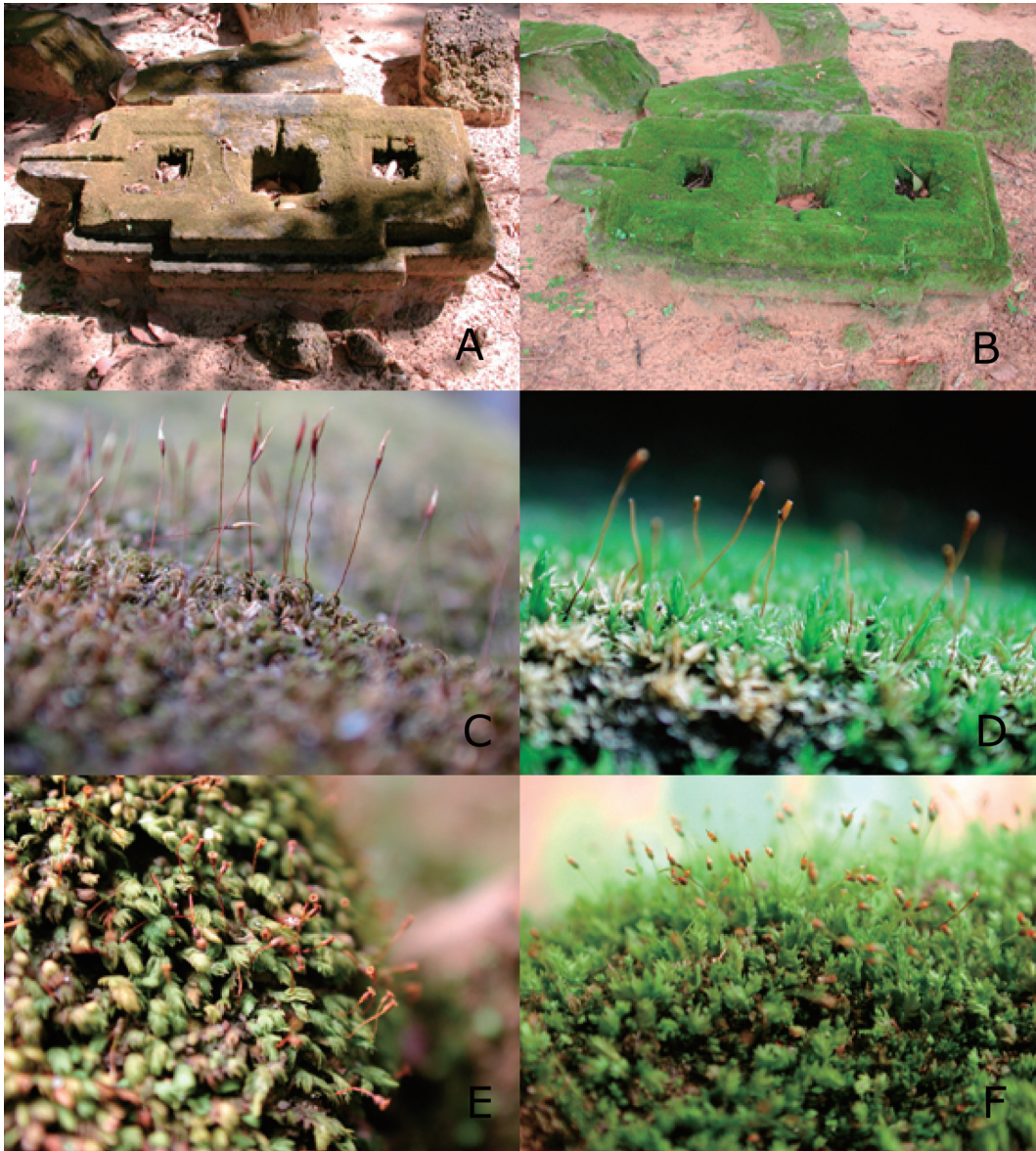


Fig. 2. Comparison of bryophytes growing at Ta Nei site between dry and wet season. A, C and E were taken from December 2005, and B, D and F from July 2006. A and B. Bryophyte communities composed of *Taxithelium nepalense* mainly on a kind of stone-works in dry (A) and wet season (B). C and D. *Hyophila rosea* growing on sandstone boulder in dry (C) and wet season (D). Plants in C having mature capsules with calyptrae, while those in D having sporophytes with empty capsules. E and F. *Fissidens ceylonensis* growing on laterite wall in dry (E) and wet season (F). Plants in E having sporophytes with empty capsules, while those in D having mature capsules with calyptrae.

growing in July 2006 as compared with those in December 2005 (Fig. 2, A & B). It might be caused by the difference between dry and wet season, i.e., they have dry season from the begin-

ning of November to the middle of May and wet season from the end of May to the end of October. The walls of ruins which are one of main habitats of bryophytes in this area are made of

laterite and sandstone. The epiphytic floras of mosses on the walls were scarcely different between laterite and sandstone.

Enumeration of species

The families, genera and species are arranged alphabetically. The generic position follows Goffinet *et al.* (2009). In the following enumeration an asterisk (*) preceding a species indicates "new to Cambodia." Each species is referred by collecting site (I–VIII), substrate and specimen number, and some species taxonomic notes. The specimens cited here are deposited in the herbarium of the Department of Botany, National Museum of Nature and Science (formerly National Science Museum) (TNS).

Bartramiaceae

1. *Philotis hastata* (Duby) Wijk & Marg., Taxon 8: 74 (1959).

Specimen examined. VI, on flagstone (*Higuchi 46193*+*Fissidens ceylonensis*, *Splachnobryum flaccidum*).

Distribution. Pantropical.

Notes. This species has been reported from Cambodia by Tixier (1979).

Bryaceae

2. **Leptobryum pyriforme* (Hedw.) Wilson, Bryol. Brit. 219 (1851).

Specimens examined. III, on soil, July 17, 2006 (*Higuchi 46142*), July 18, 2006 (*Higuchi 46152*, *46159*).

Distribution. Cosmopolitan.

Notes. This species is a weed of cultivated area, but it has never been recorded from not only Cambodia but also Indochina (cf. Tan and Iwatsuki, 1993).

Calymperaceae

3. **Calymperes motleyi* Mitt. in Dozy & Molck., Bryol. Java. 1: 48 (1856) (Fig. 3).

Specimen examined. IV, on trunk of *Artocarpus ridigus* (*Higuchi 46178*+*Octoblephalum albidum*, *Trocholejeunea sandvicensis*).

Distribution. Polynesia, Malesia and northern Australia (cf. Eddy, 1990).

Notes. This species is characterized by small plants, gemmiferous leaf apices (Fig. 3, C) and lacks of teniolae and expanded gemma receptacles. This is a new addition to the bryophyte flora of Cambodia.

4. *Octoblephalum albidum* Hedw., Spec. Mus. 50 (1851).

Specimens examined. III, on stone-walls, July 20, 2006 (*Higuchi 46176*+*Fissidens ceylonensis*); IV, on trunk of *Artocarpus ridigus* (*Higuchi 46178*+*Calymperes motleyi*, *Trocholejeunea sandvicensis*).

Distribution. Pantropical.

Notes. This species has been reported from Cambodia by Tixier (1966, 1967, 1975, 1980).

Ditrichaceae

5. *Garckea flexuosa* (Griff.) Margad. & Nork., J. Bryol. 7: 440 (1973).

Specimens examined. III, on soil, Dec. 17, 2005 (*Higuchi 44846*), Dec. 18, 2005 (*Higuchi 44857*).

Distribution. Pantropical.

Notes. This species has been reported from Cambodia by Tixier (1966, 1967, 1979, 1980).

Fissidentaceae

Ten species of *Fissidens* including *F. crenulatus*, *F. flaccidus* and *F. teysmannianus* newly added here are known from Cambodia. The following key is revised from Li and Iwatsuki (2001). *Fissidens asperifolius* M. Fleisch. var. *cambodianus* Tixier, endemic to Cambodia, is not available here because of the lack of information. The species with double asterisk (**) are not present in this collection.

Key to the species of *Fissidens* in Cambodia

1. Leaves soft; cells of apical laminae lax and

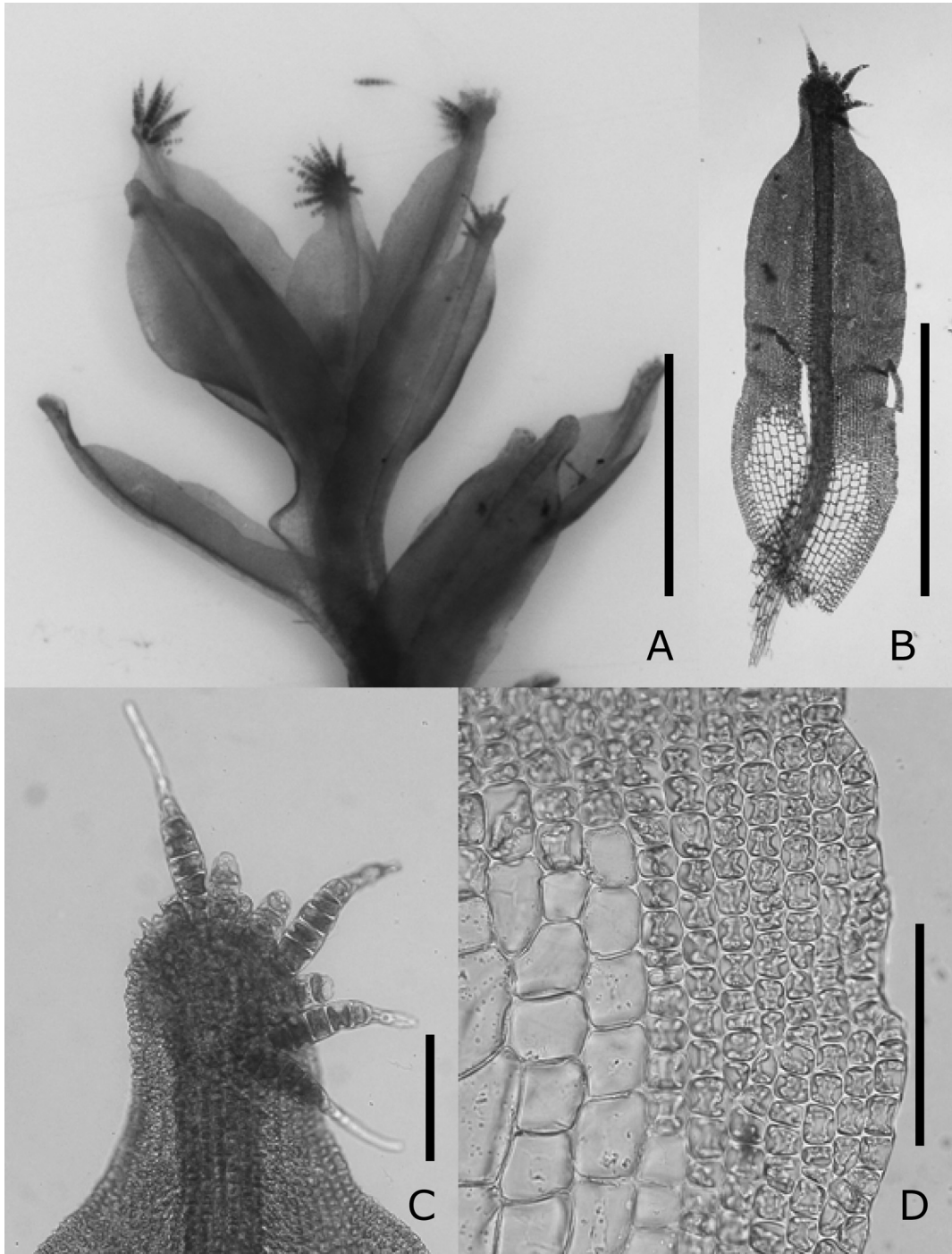


Fig. 3. *Calymperes motleyi* Mitt. (Higuchi 46178). A. Plant. B. Leaf. C. Leaf apex with gemmae. D. Leaf-shoulder margin showing cancellinae and laminal cells. Scale bars in A & B=1 mm; C & D=100 µm.

- large, 19–50 μm long *F. flaccidus*
1. Leaves more or less firm; cells of apical laminae dense, usually not more than 20 μm long 2
 2. Leaves at least partially limbate 3
 2. Leaves not limbate 6
 3. Cells at base of vaginant laminae up to 42 μm long, much longer than those of apical and dorsal laminae (5–14 μm long); axillary hyaline nodules well differentiated. . . *F. zollingeri*
 3. Cells at base of vaginant laminae up to 21 μm long, only slightly longer than those of apical and dorsal laminae (9–21 μm long); axillary hyaline nodules not or weakly differentiated . 4
 4. Leaf cells with 1 (rarely 2) small papillae. *F. crenulatus*
 4. Leaf cells pluripapillose 5
 5. Setae more or less scabrous; perigonia in axils of leaves. *F. hollianus***
 5. Setae always smooth; perigonia terminal on main stems, rarely on short lateral branches *F. ceylonensis*
 6. Leaf margins dark in color, 2–4 cells thick *F. nobilis***
 6. Leaf margins not differentiated from other laminal cells 7
 7. Axillary hyaline nodules very prominent *F. crispulus***
 7. Axillary hyaline nodules not well differentiated 8
 8. Cells of vaginant laminae with 3–4 papillae at corners *F. teysmannianus*
 8. Cells of vaginant laminae not papillose at corners *F. pellucidus*

6. *Fissidens ceylonensis* Dozy & Molk., Ann. Sci. Nat. Bot. Ser. 3, 2: 304 (1844).

Specimens examined. I, on stone-walls (*Higuchi 44803*+*F. zollingeri*); III, on stone-walls, Dec. 16, 2005 (*Higuchi 44816, 44822*), on boulder (*Higuchi 44825*); on stone-walls, Dec. 17, 2005 (*Higuchi 44837*+*F. flaccidus, 44839, 44844*), on boulder (*Higuchi 44841, 44847*), on soil (*Higuchi 44852*); on stone-walls, Dec. 18, 2005 (*Higuchi 44864*), on soil (*Higuchi 44856*); on stone-walls, July 17, 2006 (*Higuchi 46137*),

on boulder, July 18, 2006 (*Higuchi 46150*), on stone-walls (*Higuchi 46165*), on flagstone, July 20, 2006 (*Higuchi 46171*), on stone-walls (*Higuchi 46176*+*Octoblepharum albidum*), on flagstone, July 22, 2006 (*Higuchi 46187*), on soil (*Higuchi 46188*), on boulder (*Higuchi 46183*); VI, on boulder (*Higuchi 46197, 46198*), on flagstone (*Higuchi 46193*+*Philonotis hastata, Splachnobryum flaccidum*).

Distribution. Nepal, India, Sri Lanka, Vietnam, Cambodia, Thailand, Malaysia, Indonesia, Philippines, China and New Zealand (cf. Li and Iwatsuki, 2001).

Notes. This species has been reported from Cambodia by Tixier (1966, 1967, 1975, 1980). The plants observed in July had mature sporophytes with calyptrae, while those in December had empty capsules (Fig. 2, E & F). It suggests that mature of sporophytes occurs in wet season in this species.

7. *Fissidens crenulatus* Mitt., J. Linn. Proc. Soc. Bot. Suppl. 1: 140 (1859).

Specimens examined. III, on boulder, July 22, 2006 (*Higuchi 46181*), on soil (*Higuchi 46182*).

Distribution. Nepal, India, Myanmar, Vietnam, Malaysia, Philippines, New Guinea, Micronesia, China and Japan (cf. Li and Iwatsuki, 2001).

Notes. This species is a new addition to the bryophyte flora of Cambodia.

8. *Fissidens flaccidus* Mitt., Trans. Linn. Soc. London 23: 56 (1860).

Specimens examined. II, on stone-walls (*Higuchi 44815*); III, on stone-walls, Dec. 17, 2005 (*Higuchi 44837*+*F. ceylonensis*).

Distribution. Nepal, India, Sri Lanka, Myanmar, Vietnam, Java, Borneo, New Guinea, Philippines, Carolines, China, Taiwan, Japan, Australia, Africa and Americas (cf. Li and Iwatsuki, 2001).

Notes. This species is a new addition to the bryophyte flora of Cambodia.

9. *Fissidens pellucidus* Hornsch., Linnaea 15: 146 (1841).

Specimen examined. III, on stone-walls, Dec. 16, 2005 (*Higuchi 44828*).

Distribution. Nepal, India, Sri Lanka, Myanmar, Vietnam, Cambodia, Thailand, Singapore, Sumatra, Java, Borneo, Philippines, Hong Kong, Taiwan, Japan and South America (cf. Li and Iwatsuki, 2001).

Notes. This species has been reported under the name of *F. lusus* Sull. & Lesq. from Cambodia by Tixier (1967, 1975, 1979).

10. *Fissidens teysmannianus Dozy & Molk., *Plant. Junghuhn*. 317 (1854).

Specimens examined. III, on stone-walls, Dec. 16, 2005 (*Higuchi 44821*), Dec. 17, 2005 (*Higuchi 44843*).

Distribution. Malaysia (Peninsula), Java, China, Korea and Japan (cf. Li and Iwatsuki, 2001).

Notes. This species is a new addition to the bryophyte flora of Cambodia.

11. Fissidens zollingeri Mont., *Ann. Sci. Nat. Bot. Sér.* 3, 4: 114 (1845).

Specimens examined. I, on stone-walls (*Higuchi 44803*+*F. ceylonensis*); II, on stone-walls (*Higuchi 44811*); III, on soil, July 17, 2006 (*Higuchi 46139*), on boulder, July 18, 2006 (*Higuchi 46149*); VI, on boulder (*Higuchi 46196*).

Distribution. Widely distributed in southwestern Asia and Oceania, New Zealand and South America and North America (cf. Li and Iwatsuki, 2001).

Notes. This species has been reported from Cambodia by Tixier (1966, 1967).

Hypnaceae

12. *Ectropothecium dealbatum (Reinw. & Hornsch.) A. Jaeger, *Ber. S. Gall. Naturw. Ges.* 1977–78: 264 (1880).

Specimens examined. II, on stone-walls, Dec. 15, 2005 (*Higuchi 44810*); III, on stone-walls, Dec. 17, 2005 (*Higuchi 44836, 44845*), July 22, 2006 (*Higuchi 46180*).

Distribution. India, Sumatra, Java, Borneo and Philippines (cf. Gangulee, 1980).

Notes. This species is a new addition to the bryophyte flora of Cambodia.

Pottiaceae

13. Hyophila involuta (Hook.) A. Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1871–72: 354 (1873).

Specimens examined. I, on stone-walls (*Higuchi 44802*); IV, on flagstone (*Higuchi 46175*); V, on flagstone (*Higuchi 46179*); VI, on boulder (*Higuchi 46190, 46191*).

Distribution. Europe, India, Laos, Myanmar, Vietnam, Cambodia, Thailand, Indonesia, China, Japan, Oceania, North America, Central America and South America (cf. Tan and Iwatsuki, 1993; Zander, 1994).

Notes. This species has been reported from Cambodia by Tixier (1966, 1967, 1975, 1979).

14. *Hyophila rosea R. S. Williams, *Bull. New York Bot. Gard.* 8(31): 341 (1914).

Specimens examined. II, on stone-walls (*Higuchi 44805, 44809*); III, on stone-walls, Dec. 16, 2005 (*Higuchi 44819*), Dec. 17, 2005 (*Higuchi 44838*), Dec. 18, 2005 (*Higuchi 44860, 44861, 44862, 44865*), on boulder, July 18, 2006 (*Higuchi 46148*), on flagstone, July 19, 2006 (*Higuchi 46163*).

Distribution. India, Thailand, Philippines and Mexico (cf. Tan and Iwatsuki, 1993; Zander, 1994).

Notes. This species is a new addition to the bryophyte flora of Cambodia. Although the type locality is Philippines, Zander (1994) pointed out that the type of *Hyophila rosea* has stellate propagula, but Indian populations may have oval propagula (illustrated by Gangulee, 1972). The plants of *Higuchi 46148* and *44860* have stellate propagula. In *Fissidens ceylonensis* mature sporophytes with calyptrae were observed in July, while in *Hyophila rosea* those were found in December, i.e., in dry season (Fig. 2, C & D). Time of the reproduction probably differs

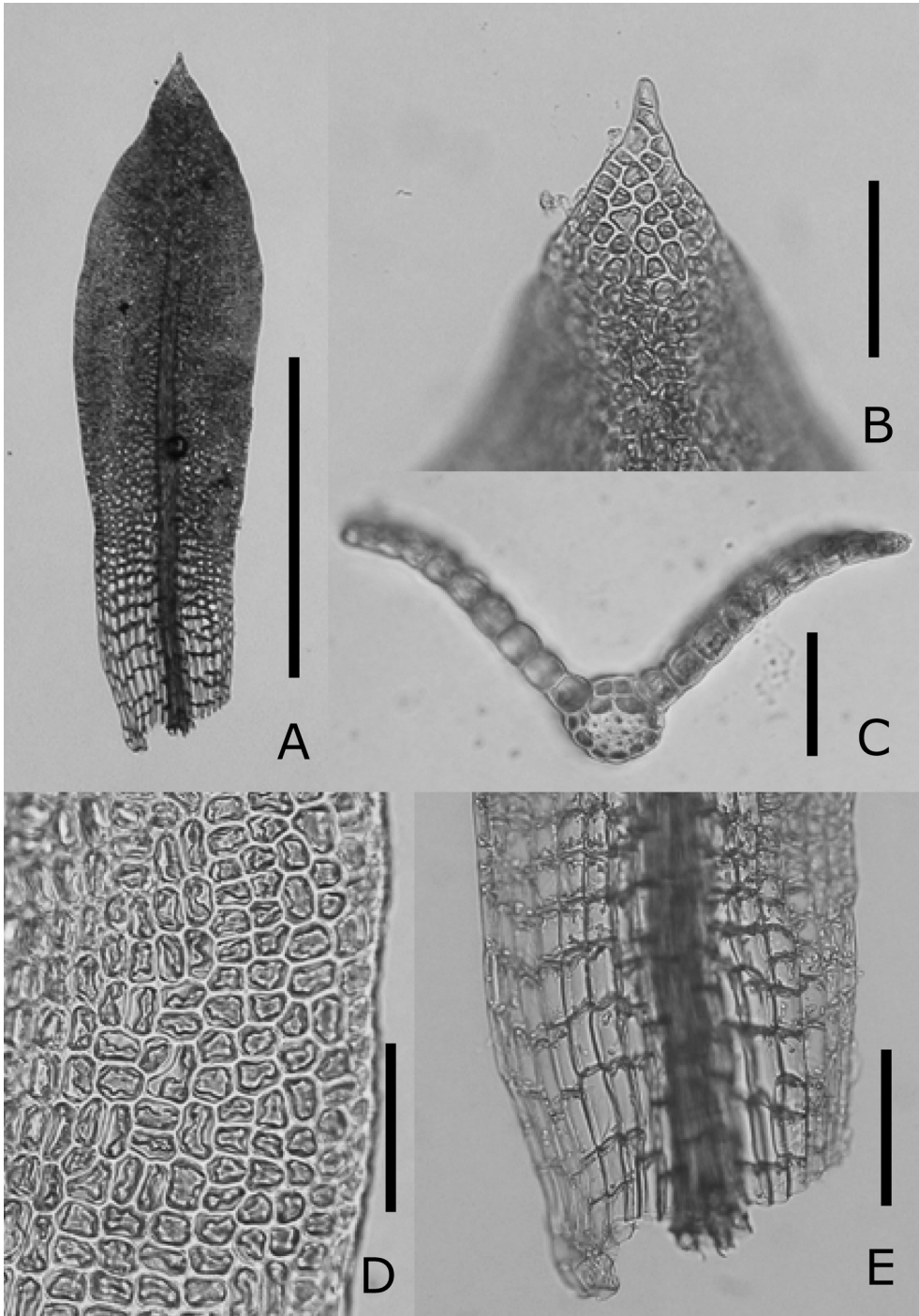


Fig. 4. *Scopolophila cataractae* (Mitt.) Broth. (Higuchi 46177). A. Leaf. B. Leaf apex. C. A transverse cross-section of middle leaf. D. Middle leaf margin. E. Leaf base. Scale bars in A=0.5 mm; B & E=0.1 mm; C & D=50 μ m.

between the both species.

15. *Scopelophila cataractae (Mitt.) Broth. in Engler & Prantl, Nat. Pfl. 1(3): 436 (1902).

Specimen examined. IV, on stone-walls (*Higuchi 46177*).

Distribution. Central America, Mexico, United States, Europe, the Himalayan Mountains, Indonesia, Philippines, Taiwan and Japan (cf. Shaw, 1993).

Notes. This species is characterized by linguulate leaves with abruptly short-acuminate apices, smooth laminal cells, enlarged thin-walled basal cells and costa with two layers of ventral epidermal cells. *Scopelophila cataractae* occurs discontinuously and has never recorded from Indochina. The species is also known as one of copper mosses that exhibit an ecological association with substrates with higher than average concentrations of copper or other metals (Shaw, 1993). It was growing on stone-walls made of laterite in Angkor.

Pterigynandraceae

16. Trachyphyllum inflexum (Harv.) A. Gepp, Cat. Afr. Pl. 2(2): 299 (1901).

Specimens examined. II, on stone-walls (*Higuchi 44814*); III, on stone-walls, Dec. 16, 2005 (*Higuchi 44817*), on boulder (*Higuchi 44823*), Dec. 17, 2005 (*Higuchi 44840*), Dec. 18, 2005 (*Higuchi 44858*), July 18, 2006 (*Higuchi 46154*); VI, on boulder (*Higuchi 46189*).

Distribution. Africa, China, Myanmar, Cambodia, India, Laos, Nepal, Sikkim, Sri Lanka, Thailand, Vietnam, Philippines, Papua New Guinea, New Caledonia and Australia (cf. Norris and Koponen, 1990).

Notes. This species has been reported from Cambodia by Tixier (1966, 1967).

Sematophyllaceae

17. Taxithelium nepalense (Schwägr.) Broth., Monsunia 1: 51 (1899).

Specimens examined. II, on stone-walls

(*Higuchi 44804*); III, on stone-walls, Dec. 16, 2005 (*Higuchi 44818*), on boulder (*Higuchi 44824*), Dec. 18, 2005 (*Higuchi 44859*), on boulder (*Higuchi 44863*), on flagstone, July 17, 2006 (*Higuchi 46136, 46146*), on boulder, July 18, 2006 (*Higuchi 46153*), on flagstone, July 19, 2006 (*Higuchi 46164*), on boulder (*Higuchi 46170*), on soil, July 22, 2006 (*Higuchi 46184*); VI, on boulder (*Higuchi 46192*).

Distribution. Nepal, India, Bangladesh, Myanmar, Cambodia, Thailand, Malaysia (Peninsula), Java, Molucca, New Guinea, Fiji, Samoa and Tasmania (cf. Gangulee, 1980).

Notes. This species has been reported from Cambodia by Tixier (1966, 1967, 1975, 1979, 1980).

Splachnobryaceae

18. *Splachnobryum flaccidum (Harv.) Braithw., Grevillea 1: 28 (1872).

Specimen examined. VI, on flagstone (*Higuchi 46193*+*Fissidens ceylonensis*, *Philonotis hastata*).

Distribution. India, Myanmar, Thailand and Malaysia (Peninsula) (cf. Eddy, 1996).

Notes. This species is characterized by triangular-lanceolate leaves broadest near insertion and apical laminal cells not sharply differentiated in size from lower cells, and it is a new addition to the bryophyte flora of Cambodia.

Thuidiaceae

19. Pelekium investe (Mitt.) Touw, J. Hattori Bot. Lab. 91: 203 (2001).

Specimens examined. III, on stone-walls, Dec. 15, 2005 (*Higuchi 44806*), Dec. 16, 2005 (*Higuchi 44820*), Dec. 17, 2005 (*Higuchi 44835*), July 17, 2006 (*Higuchi 46145*).

Distribution. Tropical West and Central Africa, Comores, Madagascar, Sri Lanka, Peninsular and eastern India, Nepal, Sikkim, Nicobars, Myanmar, Thailand, Cambodia, Vietnam, Taiwan, Java, Lesser Sunda Islands, Borneo, Philippines, Sulawesi, Seram, Papua New Guinea, New Cale-

donia, Fiji, Society Islands and Australia (Northern Territory, Queensland) (cf. Touw, 2001).

Notes. This species has been reported from Cambodia by Touw (2001).

Acknowledgements

I am grateful to Y. Futagami, N. Kuchitsu and S. Aoki of the National Research Institute for Cultural Properties, Tokyo, and S. Sophearin of the Authority for the Protection and Management of Angkor and the Region of Siem Reap for their kind help in this study.

References

- Eddy, A. 1990. A Handbook of Malesian Mosses. Vol. 2. Leucobryaceae to Buxbaumiaceae. 256 pp. The Natural History Museum, London.
- Eddy, A. 1996. A Handbook of Malesian Mosses. Vol. 3. Splachnobryaceae to Leptostomataceae. 277 pp. The Natural History Museum, London.
- Gangulee, H. C. 1972. Mosses of Eastern India and adjacent Regions. Vol. I, fasc. 3, pp. 567–830. Calcutta.
- Gangulee, H. C. 1980. Mosses of Eastern India and adjacent Regions. Vol. I, fasc. 8, pp. 1753–2145. Calcutta.
- Goffinet, B., Buck, W. R. and Shaw, A. J. 2009. Morphology, anatomy, and classification of the Bryophyta. In: Goffinet, B. and Shaw, A. J. (eds.), *Bryophyte Biology*. 2nd ed., pp. 55–138. Cambridge University Press, New York.
- Li, Z.-H. and Iwatsuki, Z. 2001. Fissidentaceae. In: Li, X.-J. and Crosby, M. R. (eds.), *Moss Flora of China*. Vol. 2, pp. 3–67. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis.
- Norris, D. H. and Koponen T. 1990. Bryophyte flora of the Huon Peninsula, Papua New Guinea. XXXIII. Leskeaceae and Fabroniaceae (Musci) plus corrigenda and addenda to previous papers. *Annales Botanici Fennici*, **27**: 1–12.
- Shaw, A. J. 1993. Morphological uniformity among widely disjunct populations of the rare “copper moss,” *Scopelophila cataractae* (Pottiaceae). *Systematic Botany* **18**: 525–537.
- Tan, B. C. and Iwatsuki, Z. 1993. A checklist of Indo-Chinese mosses. *The Journal of the Hattori Botanical Laboratory* **74**: 325–405.
- Tixier, P. 1966. Bryophytae Indosinicae. A preliminary contribution to the bryoflora of Angkor (Cambodia). *The Natural History Bulletin of the Siam Society* **21**: 129–133.
- Tixier, P. 1967. Bryophytae Indosinicae. Inventaire bryologique de massif de Kirirom (Cambodge). *Annales de la Faculté des Sciences, Université de Phnom Penh* **1**: 41–68.
- Tixier, P. 1975. Bryophytae Indosinicae.—XXIII. A preliminary contribution to the knowledge of the coastal southern bryoflora of Cambodia. *The Natural History Bulletin of the Siam Society* **26**: 11–24.
- Tixier, P. 1979. Bryogéographie du Mont Bokor (Cambodge) (Bryophyta Indosinicae XXIV). *Bryophytorum Bibliotheca* **18**: 1–113.
- Tixier, P. 1980. Bryophytae Indosinicae.—XXVI. Cambodian bryoflora. Collections from Phnom Kulen. *Nova Hedwigia* **32**: 369–376.
- Touw, A. 2001. A taxonomic revision of the Thuidiaceae (Musci) of tropical Asia, the western Pacific, and Hawaii. *The Journal of the Hattori Botanical Laboratory* **91**: 1–136.
- Zander, R. H. 1994. *Hyophila*. In: Sharp, A. J., Crum, H. and Eckel, P. M. (eds.), *The Moss Flora of Mexico*. Part 1, pp. 270–273. Memoires of the New York Botanical Garden, Vol. 69.