

## A Supplement to the Moss Flora of Paraguay

Marian Kuc

6 Lewer Street, Gloucester, Ontario K1V 1G9, Canada

### Introduction

In "A Preliminary List of the Mosses of Paraguay" Buck (1985) commented on the low level of bryological knowledge in this country. He also pointed out the need for muscological studies and encouraged collectors "to gather bryophytes whenever possible". The present article follows this recommendation.

The mosses listed below were collected on the Cerro Cristo Rey mountain, 24° 30' S and 57° 30' W, located ca. 3.5 km E of Caacupé (ca 65 km E of Asunción). It is about 3 km long and 2.5 km wide and 200 m high. At its low western elevations occur wet meadows with several springs, the village is immediately to its south and to the north and east it is surrounded by palm plantations, agricultural fields and pastures. From the middle elevations up to its summit it is covered by a relatively dense, strongly human altered, xeric forest, composed of tall shrubs with single or small groups of trees. On the rocky peak there is a religious sanctuary connected with

the highway by one unpaved road merging with many foot paths. Steep rock outcrops are common on summit areas, from where commence narrow streams which percolate water in rainy seasons. Soils, except for agricultural ones, represent a mixture of weathered local rock residues and forest humus.

Field work was performed between January 5-12, 1984. Collected specimens received numbers P:1-12 and are deposited in NY. Some duplicate material is in G.

### List of Species

*Bryum densifolium* Brid. - About twenty depauperate individual plants (most of them used for sectioning) were collected on wet soil around springs. Sterile. P-1.

Special attention was paid to the double dentition of the leaves. It is irregular, occurring rarely between single teeth and its origin seems to be anomalous. One tooth is always longer,

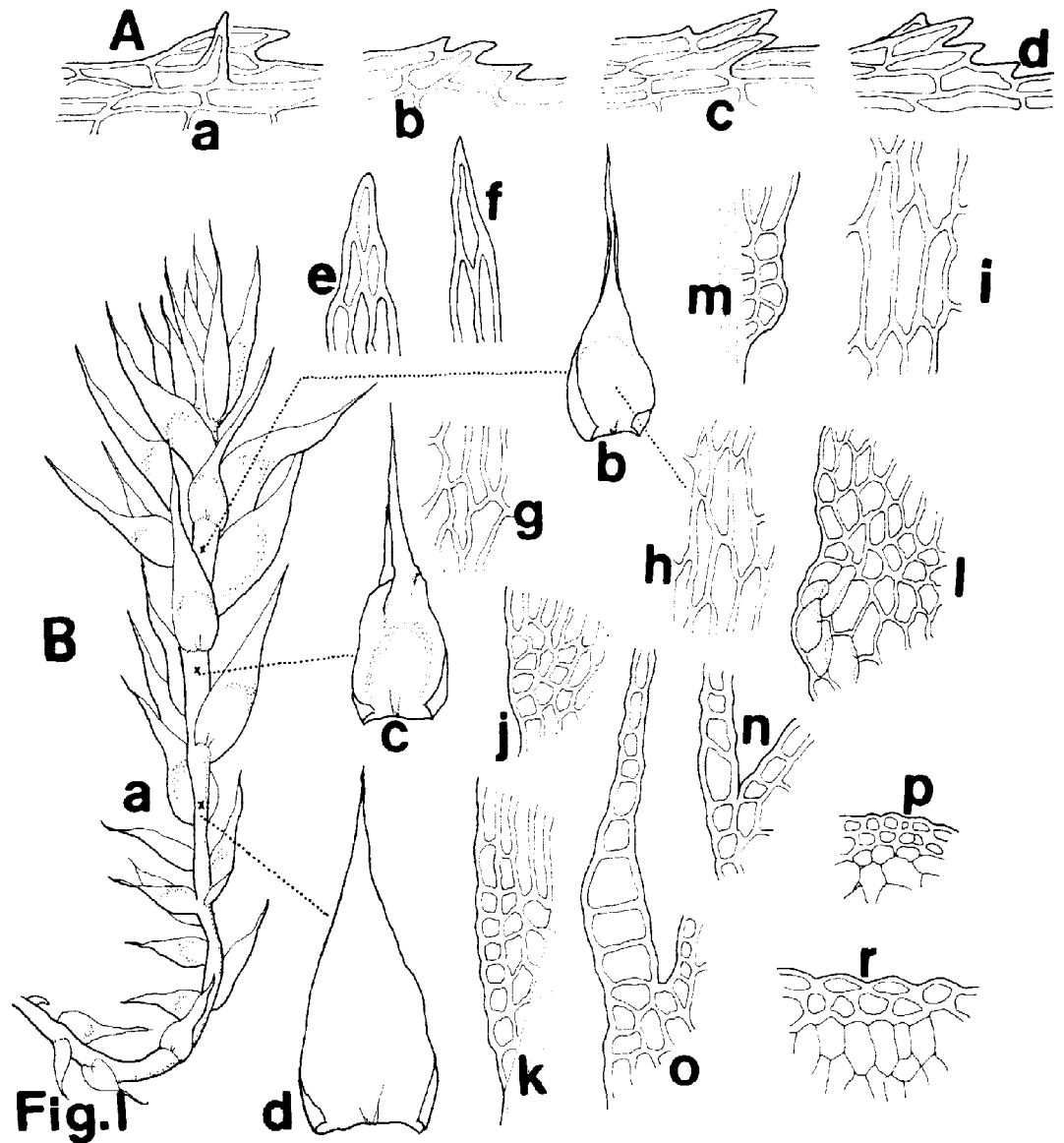


Fig. 1. A. *Bryum densifolium*. a-d: irregularities of leaf dentition (x250). B. *Campylium polygamum*. a - habit (ca. 2.5 cm long), b - upper stem leaf (x40), c - middle stem leaf (x40), d - lower stem leaf (x40), e - apex of lower stem leaf (x660), f - apex of upper stem leaf (x660), g - areolation of upper part of upper stem leaf (x620), h - areolation of lower part of upper stem leaf (x600), i - areolation between margin and central part of leaf (x580), j - alar cells of middle stem leaf (x400), k - alar cells of lower stem leaf (x380), l - auricle alar group (x320), m - alar cells of upper stem leaf (x370), n - longitudinal section of alar region of upper stem leaf, o - longitudinal section of aerolation in B1 (x290), p - cross-section of a first year stem rate (x440), 4 - cross-section of a two year old stem rate (x400).

sharper and stronger with a large lumen and is directed at a 45° angle (Fig. 1Aa), while the accompanying one is smaller, blunt and attached laterally or on the back of main one (Fig. 1Ac). On two of the forty examined leaves were observed three teeth joined together. This irregularity of the dentition of *B. densifolium* was also noted on specimens which I collected at Iguazu Falls (Brazil/Argentina).

*Campylium polygamum* (B.S.G.) C. Jens. [syn. *Campyliadelphus polygamus* (B.S.G.) Kanda, *Drepanocladus polygamus* (B.S.G.) Hedenäs]. - Moist meadows, among grassland and around springs from where originates the tributary of Rio Piribeúay. In small dense patches or as individuals mingled within grasses. Sterile. P-2.

This is the first record of any Amblystegiaceae from the Paraguay flora. Examined specimens were slightly different than *C. polygamum* var. *polygamum*, mainly in their small dimensions, therefore some explanations are required.

Stems brown, thin, straight to ascending, 3(5) cm long; usually single or slightly and irregularly branched; the branches to 0.5 cm wide; erecto-patent to subsquarrose. Leaves not decurrent, 1.2-1.8 mm long, 0.4-0.8 mm wide, with an ovate or rounded base suddenly narrowing into a narrow, channelled or tubular and gradually tapering point at least as long as the blade, with sharp apex. Margin entire or nearly so, strongly recurved from leaf base, often to mid-leaf. Costa weak, double and very short. Median cells of lamina long-rectangular with square or shortly tapering ends, 5-7 times longer than wide, smooth or sometimes abaxially prostrate in upper leaf parts and sometimes close to the costa; basal laminal cells variable, from small and irregularly quadrate to much larger and hexagonal or ovate, those at leaf insertion frequently red on older portions of stems. Alar cells differentiated, from square to ovate, larger than adjacent and usually quadrate or short-rectangular cells, nonporose or with single pores, extending 50% of distance to nerve. Stem in cross-section with two outer layers: an external layer of more or less isodiametric red stereids, and a subexternal one of rectangular cells; central strand small. Rhizoids smooth, red, sparsely

distributed along stem, often parallel joined or in small fascicles. Paraphyllia and pseudoparaphyllia were not observed. Fig. 1B.

Among blanket moss-bogs in Uruguay and in the *Notofagus* zone in Chile I also collected specimens of *Campylium* which were quite similar to *C. polygamum* var. *polygamum*. It is quite possible that they are intermediate forms between the plants described above and typical ones. To avoid taxonomic chaos, I have avoided creating a separate systematic rank for the Paraguayan specimens.

Following the convincing concept of Buck (1998, p. 213), affiliations of *C. polygamum* to *Campyliadelphus* or *Drepanocladus* are not accepted here.

Hitherto *C. polygamum* has been known in South America from Argentina, Bolivia, Peru and Venezuela (Delgadillo et al. 1995). It seems to be more frequent in Holantarctic countries than in tropical ones.

*Fissidens zollingeri* Mont. A small collection gathered once only below the summit area, on shaded red soil between stones. Fertile. P-3. A duplicate is in the herbarium of Dr. R.A. Pursell.

Specimens were not typical in several respects, especially in the small, strongly bulging cells of leaf areolation, in the incomplete border below the leaf apex and in having leaves usually shorter than 5 mm. Dr. R.A. Pursell examined these features and concluded that they are within the range of variability of *F. zollingeri*.

*Hyophila involuta* (Hook.) Jaeg. On moist rocks or wet soil and on anthropogenic habitats, e.g. sandy and clayey compacted soil along paths frequented by man or on wet masonry at bases of the chapel walls. Often with *Tortula muralis*. Sterile. P-4. Previously not reported from Paraguay.

The Cerro Cristo Rey specimens differ slightly from typical plants in the following features: stems mostly simple, to (0.6)1.0(1.2) cm, brown to bronze-green, with brood bodies on older stems; leaves (1.8)2(2.2) mm long, oblong lanceolate; apex obtuse to more or less acute, sometimes mucronate, entire or with few blunt teeth; costa strong, percurrent to distinctly ending below apex; other morphological and

anatomical features are as in typical forms.

Brotherus (1900) described *H. paraguayensis* from sterile materials, which lacked brood bodies, hitherto known only from the *locus classicus* (l.c., p. 17: cf. also Buck 1985) and stated: "Species praecedenti (*H. mattogrossensis* Broth. - M.K.) affinissima, sed foliis spatulato-oblongis angustioribus, brevissime mucronatus dignoscenda" and noticed that *H. mattogrossensis* (l.c.) is "Species *H. (Hyophila - M.K.) Tortulae* (Schwaegr.), (syn. *H. involuta - M.K.*) et *H. Barbulae* (Schwaegr.), [syn. *Luisierella barbula* (Schwaegr.) Steere - M.K.] affinis, sed foliorum forma et structura diversa". The monospecific genus *Luisierella* is anatomically and morphologically different from *Hyophila*, which is clearly documented by Steere (1945) and Zander (1994), and is genetically different from it. Other features of *H. paraguayensis* such as narrow, obtuse, entire, spatulate-oblong, very shortly mucronate, small leaves (1.4 mm long? - M.K.) etc., are in the scope of the extensive variability of *H. involuta*.

Zander (1993) accepted 88 species of this genus of which 23 were reported from South American Neotropics and 16 of these are known only from loci classici (Delgadillo et al. 1995). This genus evidently needs a monographer's massive revision.

*Isopterygium tenerum* (Sw.) Mitt. (sensu Ireland 1991, 1992 - peristome double, paraphyllia typical but seldom). Found among other mosses during preparation of specimens in the laboratory. Fertile. P-5. The determination was confirmed by Dr. R.R. Ireland.

*Macrocoma orthotrichoides* (Raddi) Wijk & Marg. On lower parts of trees, also on a dry log on the summit near the chapel. Fertile. P-6. Determined by Dr. W.R. Buck.

*Ptychomitrium sellowianum* (Mull. Hal.) A. Jaeg. On smooth, hard, rock surfaces at summit elevations (especially frequent near the chapel). Fertile. P-7. New to the moss flora of Paraguay.

The collection was determined by Dr. W.R. Buck who carefully examined this difficult taxon and stated (pers. comm.) that "the leaf of *P. sellowianum* is bistratose, except at the margin

where it becomes 3-4-stratose", while *P. vaginatum*, its very close relative, has "the leaf unistratose, and 2-3-stratose at the margin". There are also differences in the general morphology of the leaves. *Ptychomitrium sellowianum* has leaves elongate, gradually tapering into a rather sharp point, while *P. vaginatum* has straight, non-tapering blunt leaves arising from a distinctly sheathing base.

*Schlotheimia* sp. Collected only once on a log near the chapel. Sterile, small specimens strongly stressed by decaying processes. P-8.

*Sematophyllum subpinnatum* (Brid.) Britt. Abundant on lower parts of trees, sometimes also on weathered rock surfaces and on thin rocky soil covering them. Fertile but without capsules, which were cut off by animals (probably birds). P-9. Widespread within the whole forested area.

The habit of this species varies depending on the habitat. On strongly xeric, exposed substrates with a prolonged water deficit, specimens are distinctly smaller, with short, strongly recurved lateral branches of a gold-brownish colour. Alar cells of one year old leaves are hyaline, while on older ones they are yellow to brown. These are definitely distinct ecological adaptations with no taxonomic value.

*Tortella humilis* (Hedw.) Jenn. On rocks, in their fissures and on thin mineral soils. Fertile. P-10. Frequent at upper elevations.

*Tortula muralis* Hedw. Abundant on brick and concrete walls of the chapel, very rarely found on rocky uppermost sides of stream beds. Fertile. P-11.

Habitually these specimens are similar to *T. muralis* var. *aestiva* but axillary hairs are hyaline, long, and slightly curled, or if short, are curved and brown or yellow below. The wider, yellow margin of some upper leaves reflects the influence of prolonged desiccation, rather than a permanent taxonomic feature. Perhaps these features and the small dimensions of these forms were used for distinguishing *Barbula muricola* C. Muell., considered a synonym of *T. muralis* by Brotherus (1902); see also Buck (1985).

*Uleastrum pagaguensis* (Besch.) Buck. On lower parts of palm trees, between the trunk and bases of cut off fronds; with green and blue algae. Fertile. P-12. Collected once but observed on many palms in plantations and on trees near houses at S and SE part of the studied area.

#### Miscellaneous remarks

The 12 species listed above represent nearly 10% of all hitherto known mosses of Paraguay (Buck 1985). Collected specimens were carefully studied, including microtome sectioning, with an aim to discover features which would support a suggestion of high endemism in the Paraguay bryoflora. Unfortunately, all examined morpho-anatomical differences which could be criteria of endemic taxa were responses to local environments.

The moss flora of the studied area was not rich in species and the bryophyte cover was poorly developed. However, it was selected for a detailed study as a result of a reconnaissance made of several similar isolated rock outcrops in its vicinity, which have much poorer bryofloras.

Several one-day visits were made to the Chaco Boreal region, along the tourist trail in the jungle along the Paraguay River north of Concepción and to plantations in eastern Paraguay. An area with a rich moss flora was not found there, except for wet, partly cultivated meadows and small swamps ca. 10 km south of Villeta at Paraguay River where abundant moss growth was observed.

**Acknowledgments.** Thanks are due to Drs. W.R. Buck, R.R. Ireland and R.A. Pursell for determinations or revisions of some taxa. The author is grateful to Drs. J.-P. Frahm, L.R. Stark and P. Geissler for their helpful advice. The late Prof. P. Tixier and Drs. J. Enroth, H. Jalkanen and L. Hedenäs are thanked for loans of herbarium specimens.

#### Literature Cited

- Brotherus, V.F. 1893-1909.** Musci. In: A. Engler & K. Prantl, Die natürlichen Pflanzenfamilien 1(3): 701-1246. Leipzig.
- Brotherus, V.F. 1900.** Die Laubmoose der ersten Regnelischen Expedition. Bih. Kongl. Svenska Vetensk.-Akad. Handl. Afd. 3, 26(7): 1-65.
- Buck, W.R. 1985.** A preliminary list of the mosses of Paraguay. *Candollea* 40: 201-209.
- Buck, W.R. 1998.** Pleurocarpous mosses of the West Indies. *Mem. New York Bot. Gard.* 82: 1-400.
- Delgadillo M., C., B. Bello, A. Cardenas S. 1995** Latmoss. A catalogue of neotropical mosses. *Monog. Syst. Bot., Missouri Bot. Gard.* 56: 1-191.
- Ireland, R.R. 1991.** A preliminary study of the moss genus *Isopterygium* in Latin America. *Caldasia* 16: 265-276.
- Ireland, R.R. 1992.** The moss genus *Isopterygium* (Hypnaceae) in Latin America. *Tropical Bryology* 6: 111-132.
- Steere, W.C. 1945.** *Luisierella*, a genus of mosses new to North America. *The Bryologist* 48: 83-85.
- Zander, R.H. 1993.** Genera of the Pottiaceae: Mosses of Harsh Environments. *Bull. Buffalo Soc. Nat. Sci., Vol. 32, 378 pp.* Buffalo, New York.
- Zander, R.H. 1994.** *Luisierella* Thér. & P. Varde ex P.-Varde. In A.J. Sharp, H. Crum & P.M. Eckel, Eds., *The Moss Flora of Mexico*, pp. 382-384. *Memoirs of the New York Botanical Garden Vol. 69, Bronx, New York.*

