

## Adaptations of lowland jungle mosses to anthropogenic environments in Guyana

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**Abstract:** Sixteen lowland jungle mosses growing in anthropogenic habitats at Santa and The Bell - Ituni localities on the Demerara River in Guyana were examined in detail with the aim of detecting any features which would indicate their adaptations to new habitats. Amounts of chlorophyll in leaf cells, protective coloration, alterations in leaf morphology, characteristics of old stems, rhizoid tomentum and fertility are considered as the most pronounced adaptive features of these species to new localities. The ecology, general appearance and morpho-anatomical changes of specimens from anthropogenic habitats were observed and compared with their equivalents from habitats occurring in the closest natural environments. No one species grows or has local centers of occurrence only in anthropogenic habitats. Generally, invasion of lowland jungle mosses into anthropogenic environments is considered as difficult, slow and limited.

### Introduction

Guyana is a suitable country for a study of mosses of anthropogenic habitats. The histories of plantations, deforestation resulting from timber production and mining, and urban developments are well known and are often documented by land registry evidence. Primary jungles cover most of the country. Boundaries between them and anthropogenic environments are distinct and traceable with the help of cadastral maps. The Guyana moss flora consists of ca. 120 species and after recent studies (Buck 1990, Cornelissen & Gradstein 1990, Delgadillo et al. 1995, Florschütz 1964, Florschütz-de Waard 1986, 1990, 1992, 1996, Frahm & Gradstein 1987,

Gradstein & Florschütz-de Waard 1989) has been quite critically examined and is relatively well-known. Among them mosses of habitats changed by man's activities were not separately studied.

Two areas were selected for observations of jungle mosses in anthropogenic habitats. The first locality (coded below as "P") is a small settlement, called Santa, situated ca. 37 km SSW. of Georgetown. This is a complex of several old wooden and a few modern masonry houses erected on sandy, gravelly, and deforested gentle hills separated by spring moss-bogs and surrounded by dark, wet, boundless lowland jungle stretching to the horizon. It was inhabited

by Amerindians in prehistoric times. The primary deforestation of hills was done by fire and recently it has been extirpated mechanically to a radius of 1.5 to 3 km from the houses. Deforested areas were partly used as minor agricultural fields, but has since been recovered by sparse, several decades old forest, which at present is stressed by rural development. This forest is divided by treeless glades, interspersed here and there with spots of nearly barren sand. In the neighbourhood of the houses are small gardens and vegetable fields.

The second area (coded as "II") starts from the vicinity of The Bell, ca. 45 km S of Georgetown and ends at the northern section of the bauxite mine in Ituni. Many various anthropogenic habitats have been controlled there. Most intensively occupied by mosses are the following: vicinities of houses, foot paths, roofs, damp places, casings of wells, concrete and wooden accesses to water, plantations, gardens, escarpments at roads, ditches, ends of culverts, small pastures and ruins of dwellings. By the 1840's, there were already plantations. The number of houses was limited until the bauxite mine started and the modern highway was built.

The method of field investigations, performed in August and September of 1981, was based on a comparison of detailed characteristics of mosses from anthropogenic environments with analogous features of species from natural habitats closest to them. Only representative specimens will be housed, numbered from G1-G21, and deposited at NY.

### Observed Species

*Campylopus savannorum* (C. Müll.) Mitt. and *C. surinamensis* C. Müll. **I**. On sandy and gravelly terrain leveled by a plow, on old fallows, and in glades in recovering forests. Luxuriant specimens, up to 5 cm tall, abound in fresh ground furrows. Specimens under tree canopies and in shrubby thickets were distinctly shorter, in extreme cases only 0.5-1.5 cm long, and darker. Their leaf morphology and anatomy were typical, except for the branching costa of *C.*

*surinamensis* which occurred sometimes in leaves appressed to stems between rosettes.

*Cyrto-hypnum scabrosulum* (Mitt.) Buck & Crum. **II**. On thick, old trunks of cultivated trees, sometimes forming rings up to 1/2m above ground. In less shadowy habitats specimens are rust-coloured. Other features caused by anthropogenic conditions were not detected.

*Henicodium geniculatum* (Mitt.) Buck. **I, II**. On trunks and thick boughs in abandoned plantations and old gardens. On single trees at roads and at houses, branches of this moss were long, thin, gradually tapering and pendent. Leaf cells contained distinctly reduced amounts of chloroplasts and leaves were light green.

*Neckeropsis distichia* (Hedw.) Kindb. and *N. undulata* (Hedw.) Reichardt. **I, II**. On lower parts of thicker trunks in gardens, on boards of wooden cases of inactive wells, log culverts, fairly decayed tops of poles in rivers and on the ruins of a mill. Lateral branches were short, up to 3 cm long, yellowish, with leaf dentition considerably reduced and cells of areolation poor in chloroplasts.

*Octoblepharum albidum* Hedw., *O. pulvinatum* (Dozy & Molk.) Mitt. and *O. stramineum* Mitt. **I, II**. On a large mass of decaying cultivated plants, on rotten tops of pales extending above the water level, on horizontal elements of old moldy wooden fences, and on moist parts of palm fronds or sugar cane roofs usually under a canopy of trees. Specimens of these habitats do not differ anatomically or morphologically from those of natural environments. Synecologically, they grow as single specimens among other plants or rarely form small, loose cushions.

*Orthostichopsis tetragona* (Sw.) Broth. **II**. The ecology of this species when found growing on anthropogenic substrates requires a more detailed explanation. On flooded terraces of some tributaries of the Demerara River near The Bell it occurs on upper parts of tall shrubs and on tree branches overhanging just above the high water mark. These specimens are luxuriant and extraordinarily long, reaching as much as 24 cm

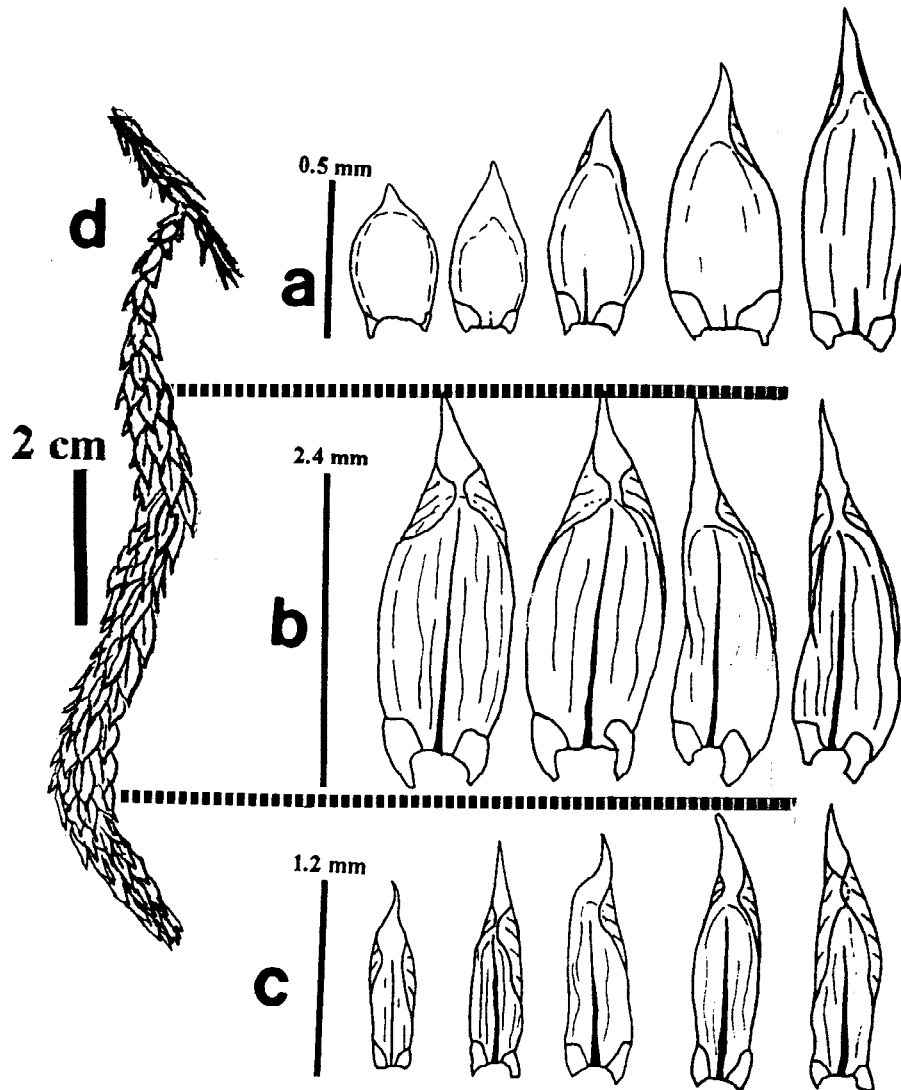


Figure 1. Variability in branch leaves of *Orthostichopsis tetragona* (Sw.) Broth. from anthropogenic habitats: a - primordial leaves, b - middle leaves, c - apical leaves, d - an average branch.

in length (averaging 16-18 cm based on 66 measured samples from various localities). The stem length of *O. tetragona* in Neotropical moss floras is reported as 8-12 cm. These extra long stems are not firmly attached to their substrates and most probably were introduced onto branches by turbulent wave action. If a plant was thrown onto a support more or less in the middle of its length, then pendent branches would grow quickly at both ends. Wave action

can also hang specimens of *O. tetragona* on fences, cultivated shrubs and lower branches of garden trees within the range of flooding. These plants, however are much shorter, not luxuriant, and exhibit a considerable difference in the morphology of their branch leaves. Fig. 1 presents three general categories of leaves: 1 - apical, 2 - mid-stem, 3 - primordial. Branches of specimens from anthropogenic habitats have many more leaves of the third category, which

quantitatively dominates leaves of the first two categories. They exhibited extensive red coloration, and their cells contain fewer chloroplasts.

*Philonotis* sp. cf. *uncinata* (Schwaegr.) Brid. *sensu lato* **I, II**. On borders of muddy accesses to rivers, permanently moist bare escarpments left after excavations, fissures in ends of masonry culverts, tops of poles above water table, casings of old wells, and borders of permanent plashes in areas excavated for mining purposes. The current year's growth of this plant is erect and lacks rhizoids. The stems from the previous year are inclined and bear long, red, loose and extensively branching rhizoids. Older stems are horizontal, are able to produce new shoots and are strongly covered by a rhizoid tomentum. This growth structure is very resistant to erosion, bombardments of rain drops, disintegration, water deficit, and coverage by fines introduced on them. These features are particularly well-developed on specimens of anthropogenic habitats. However, the leaves of these plants are often pale green or whitish, the only feature distinguishing them from specimens on natural habitats.

*Sematophyllum subsimplex* (Hedw.) Mitt. **I, II**. On flat tops of cut stumps, decaying wood, rotten boards, lower parts of wet wooden fences, on thick tree trunks at ground level in plantations and gardens, on moist straw roofs and also on tall stems of *Campylopus savannorum*. These specimens of anthropogenic habitats are commonly less green and have more extensive brown colouration than those of more natural habitats.

*Splachnobryum obtusum* (Brid.) C. Müll. **II**. This species is not well-known in the Guianas, where it is probably frequent. It can be found on the borders of moist trampled places, bare loamy soil around pools and permanent plashes, on dirt in wooden gutters, bare soil beneath outflows of eaves-troughing systems, and moist parts of clayey escarpments at roadways.

*Taxithelium planum* (Brid.) Mitt. **I, II**. On lower parts of trees in gardens and plantations,

various rotten wood structures, old, moist and decayed palm or cane roofs. Specimens of this species in natural habitats are less brown.

*Trichosteleum papillosum* (Hornsch.) Jaeg. **I, II**. As above species but rare.

*Zelometeorium patulum* (Hedw.) Manuel. **I, II**. Frequently found on trunks and branches of trees and shrubs in gardens and plantations, less so on single trees at roads, on strongly rotten straw roofs and various moist wooden structures. Also on large older, often partly dead, leaves of coffee, cacao, citrus, palm and banana plants. The variability of specimens on these habitats was not extensive in contrast to their great variability in natural environments. *Z. patulum* was observed on naked terrain near the bauxite mine and on deforested areas where it occurs in masses on shrubs up to 1.5m high. It apparently begins to colonize the shrubs from their middle parts upwards, eventually establishing themselves most strongly on their twigs and leaves, from where frequently extend long, thin, pendent, loosely leafed branches. On some shrubs were observed stems of this moss that were not attached to twigs or were just starting to wind around them. These facts suggest their dispersion by wind from nearby trees, on which the species occurred abundantly. A very similar phenomenon was also observed on various plants in gardens.

### Discussion

All mentioned above mosses (except the poorly known *Splachnobryum obtusum*) are common or frequent inhabitants of Neotropical lowland jungles, characterized by a great vitality. They are not ubiquitous and polyedaphic species but belong to defined aut- and synecological categories and have narrow life amplitudes. The summarized area of anthropogenic habitats occupied by them is a small portion of their acreage in primary jungles.

No one species was found occurring only on anthropogenic habitats or having on them its main distribution centre. Invasion of jungle

mosses into anthropogenic habitats seems to be difficult and they do not exhibit a mass or explosive appearance. It seems probable that most of the jungle mosses invade anthropogenic habitats after they have been partially changed by other plants.

*Cyrto-hypnum scabrosum*, *Octoblepharum stramineum*, *Sematophyllum subsimplex*, *Taxithelium planum*, and *Trichosteleum papillosum* were seen with sporophytes but to a much lesser degree than on natural habitats.

Dry parkland plant formations, both cultivated and semi-natural, especially with extensive grass growth, are poorest in mosses. Most favourable are moist bare soils, gardens, abandoned wells, old ruins, some wooden or wet masonry structures, large semi-dead leaves, and straw roofs.

The results of observations and the generalizations presented above cannot be applied to jungles in higher mountains, where many species of mosses participate in the process of invasion into anthropogenic habitats, often forming extensive coverage on them.

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