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BRYOPHYTES AS NON-WOODY BIODIVERSITY INDICATORS: A GUIDE TO THE BRYOPHYTES OF TROPICAL AMERICA. A REPORT

N. Salazar Allen*
S.R. Gradstein **
Steven P. Churchill***

RESUMEN

Existen varias claves y guías para las angiospermas de América tropical que son útiles en actividades de conservación relacionadas con programas de manejo, estrategias de conservación y evaluación de la biodiversidad. En contraste, no hay instrumentos similares para las briofitas. Los musgos y hepáticas tienen ventajas como indicadores de biodiversidad: son un grupo más pequeño que las angiospermas, han sido bien estudiados a nivel genérico en el neotrópico, son característicos de ciertos biotopos y tienen la tendencia a distribuirse ampliamente en diferentes zonas tropicales. En este proyecto se preparará una guía en dos volúmenes para identificar *ca.* 200 géneros de hepáticas y 400 de musgos neotropicales. La introducción de la guía incluirá una sección sobre regiones geográficas del neotrópico, tipos de hábitats y taxa de briofitas que pueden usarse como indicadores de esos hábitats y su importancia en políticas de conservación y manejo. Se incluirán, además, secciones sobre características generales, metodología de colecta, bibliografía selecta para el neotrópico y un glosario ilustrado. La guía se presentará en inglés y español y se organizará un taller durante dos semanas para reunir a conservacionistas, educadores ambientales, profesionales y estudiantes de biología (botánica) de Centro, Sudamérica y el Caribe para discutir y familiarizarse con el uso de la clave. Se espera que la guía se convierta en un instrumento importante para estudios de briofitas en América tropical que contribuya a los esfuerzos de conservación y al uso científico y sustentable de nuestros recursos naturales.

Palabras clave: briofitas, diversidad, América tropical, guía.

* Departamento de Botánica, Universidad de Panamá e Instituto Smithsonian de Investigaciones Tropicales, Panamá.

** Systematisch-Geobotanisches Institut, University of Göttingen, Untere Karspüle 2, 73073 Göttingen, Germany.

*** The New York Botanical Garden, U.S.A.

ABSTRACT

Several keys and guides have been produced for the flowering plants in tropical America. These have been useful in practical conservation activities related to management programmes, conservation strategies and assessments of biodiversity. Nevertheless, there is a lack of similar tools for bryophytes. Mosses and liverworts have several advantages as biodiversity indicators: they are a smaller group than the flowering plants, they have been well studied at the genus level through most of the Neotropics, they are characteristic of certain biotops and tend to be widely distributed over different tropical regions. The project involves the preparation of a two volume Guide to identify *ca.* 200 hepatic and 400 moss genera that occur in the Neotropics. The Guide will have as part of the Introduction a section on geographical regions in the Neotropics, habitat types and bryophyte taxa that can be used as indicators of these habitats and their importance in conservation and management policies. Besides, sections on the general characteristics of bryophytes, methodology for collecting, selected bibliographic references for the Neotropics and an illustrated glossary will be presented. The Guide will be in English and Spanish. There will also be a two week workshop to gather conservationists, environmental educationists and biology (botany) professionals and students from Central, South America and the Caribbean to discuss and familiarize them with the uses of the key. It is expected that this guide will provide a much needed tool for bryophyte studies in tropical America that will contribute to conservation efforts towards a scientific and sustainable use of our natural resources.

Key words: bryophytes, diversity, tropical America, guide.

Two years ago, S.R. Gradstein addressed S.P. Churchill and N. Salazar Allen about a joint project that would provide a working tool in bryology for neotropical countries. It is long known that in most countries of tropical America, bryology is poorly or not developed at all (exceptions are Mexico, Costa Rica, Panama, Colombia, Brazil and Argentina). Floristic inventories generally do not include bryophytes among their plant groups. Checklists and identification keys are essential in practical conservation activities and form the basic elements in developing management programmes and conservation strategies. With the rate of deforestation growing increasingly fast in the tropics, the need for an identification tool (a Guide) emphasizing the importance o these plants in the ecosystem and their role as bioindicators is urgent. Bryophytes have many advantages over vascular plants to be used as indicators of biodiversity. They are a smaller group in number of taxa than flowering plants, are well studied at the generic level throughout most of the Neotropics, are characteristic of certain habitats, and are widely distributed over different tropical regions. A *Guide to the Genera of Bryophytes of Tropical America* was thus conceived as a working tool to be used in practical conservation activities as well as in education (colleges and universities).

Biodiversity has many definitions. It is used here to refer to diversity of taxa (families, genera, species, endemics) not only regionally (*e.g.*, Central America, the Greater Antilles), but also altitudinally in the various types of forests (*e.g.*, montane, submontane). Biodiversity, as defined here, also includes growth forms (thalloid and foliose, in hepatics; tuft, mats, pendent and dendroid in mosses). The proposed Guide also stresses habitat types and types of substrates on which they occur. The Guide is divided into three major sections: 1) introduction, 2) taxonomic treatment for bryophytes including liverworts, hornworts and mosses, and 3) an illustrated glossary of the most important terms used. The introduction includes descriptions of the most important habitat types, substrates and geographical areas in the Neotropics as selected for the Guide. For geographical distributions, the Guide follows closely Gentry's (1982) geographical areas. For hepatics, Gradstein's (1994) monograph provides additional information. For mosses various monographic treatments have been consulted and geographical areas are described according to those accepted by the authors of this Guide. The 12 areas selected for the Guide are: Mexico and Central America, Greater and Lesser Antilles, Chocó region, northern and central Andes, Amazon region (+Orinoco), Guianas, Guayana Highland, the Brazilian Planalto region (dry cerrado region) and southeastern Brazil (Fig. 1). Geographical distributions are considered both on a world-wide basis and regionally. For habitats, the Guide considers various altitudinal vegetation belts following Frahm and Gradstein (1991), *e.g.*, lowland (0-300/600 m), submontane (premontane) belt (300/600-1000/1200 m). Vegetation and landscape physiognomy include forests, savanna, scrub, river, creek, lake, bog and rock outcrop, among others. The distribution of bryophytes in the forest (canopy, understory) if known is also discussed. There will be comments on the most common bryophytes and indicator taxa found in different areas and habitats once the descriptions are finished.

Another section of the introduction deals with relevant morphological features that distinguish the three taxa included as bryophytes (liverworts, hornworts and mosses), techniques for collecting and curating collections and a section on how to use the Guide. Illustrations are provided for these sections. There will be a list of selected publications by geographical region at the end of the introductory chapter. This will provide a much needed literature reference for workers in the Neotropics.

The taxonomic treatment has been divided into two volumes: one for Hepaticae and Anthocerotae and the other for Musci. Each treatment will have a brief description of the orders (for hepatics and hornworts) and dichotomous keys for the families and genera with a short description of each. Treatments for genera will have the following sections:

Genus name: with references to a figure(s), estimated number of species in tropical America and world-wide and regional distribution of the genus.

Habitat: including vegetation zone or geographical area in tropical America, altitudinal range and ecological habitat. Noteworthy species occurring in a specific vegetation zone or habitat are also mentioned here.

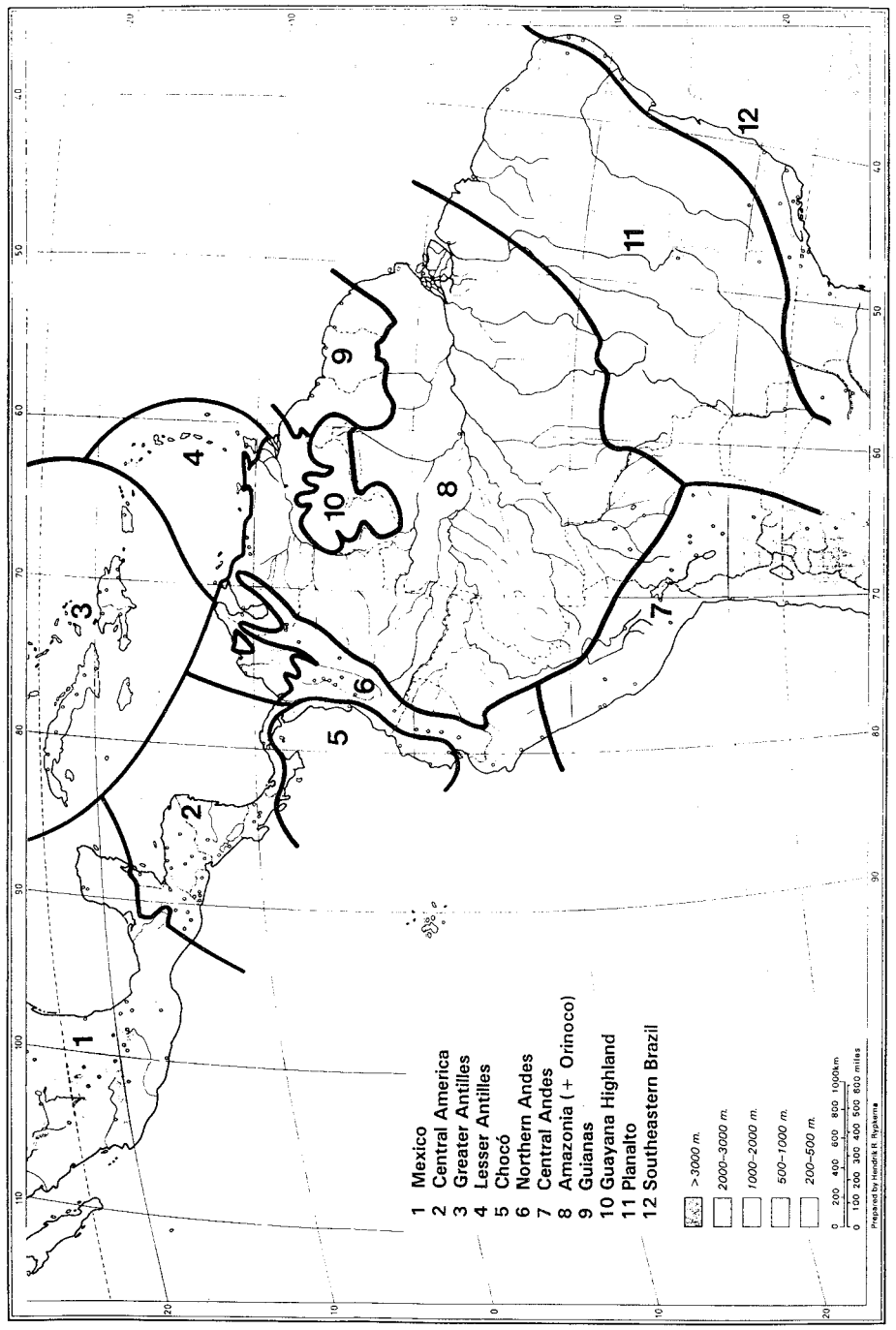

Fig. 1. Regional areas selected for the Guide.

Description: morphological characters that distinguish the genus.

Discussion: salient morphological features that enables quick recognition of the genus; indicator species with notes on characteristic morphological and habitat features that distinguish them and other practical information.

For the Guide, 188 genera in 41 families of Hepaticae are being described and 7 genera in 3 families of Anthocerotae. The number of hepatic species is estimated to be ca. 1250. For mosses 392 genera in 76 families are being described, the estimated number of species is *ca.* 2953 (maximum), 2235 (minimum). For taxa that have not been monographed an estimated number of species is given.

With the descriptions completed to date, a preliminary estimate of biodiversity (as defined at the beginning of the text), mainly for hepatics (which is the smallest taxon when compared to mosses) is briefly discussed. Once the Guide is completed and revised, a more precise evaluation of the taxa treated can be calculated.

The families with the highest number of genera within the Neotropical Jungermanniales are Lejeuneaceae (67), Lepidoziaceae (16), Jungermanniaceae (15), Cephaloziaceae (15) , Geocalycaceae (7), Cephaloziellaceae and Balantiopsidaceae (4). The largest leafy taxa in the Hepaticae are the Lejeuneaceae (67 genera and over 400 spp.), Plagiochilaceae (3 genera and *ca.* 154 spp., 150 of these in Plagiochila), Lepidoziaceae (16 genera, including *Bazzania* and *Lepidozia*, and *ca.* 150 spp.), Jubulaceae (2 genera, 76 spp., 75 of these in *Frullania*) and Radulaceae (monotypic with over 50 spp.); in the thalloids the Metzgeriaceae (60 spp.), Ricciaceae (54 spp.) and Aneuraceae (40-50 spp.).

For mosses, the families with the highest number of genera are the Pottiaceae (52), Dicranaceae (35), Callicostaceae (21), Hypnaceae (20), Sematophyllaceae (18), Bryaceae (15), Ditrichaceae (15), Amblystegiaceae (14), Meteoriaceae (12) and Brachytheciaceae (11). These families are amongst the most species-rich in the Neotropics along with the Bartramiaceae (24 spp.), Fissidentaceae (100 spp.), Grimmiaceae (71 spp.), Polytrichaceae (62 spp.), Funariaceae (57 spp.), Calymperaceae (55 spp.) and Thuidiaceae (54 spp.). These figures are estimates (many based on Churchill's work for the Flora of Colombia) since some of these families have not been monographed.

Moss families predominant in lowland tropical rain forests are the Fissidentaceae, Calymperaceae, Callicostaceae and Sematophyllaceae.

In relation to regional distribution, the richest areas in terms of number of liverwort genera are the northern Andes (Venezuela to northern Peru, *ca.* 140), Central America (*ca.* 135), southeastern Brazil (*ca.* 130 spp.) and Mexico (*ca.* 125 spp.). The least diverse area is central Brazil (dry Planalto Region) with *ca.* 55 genera. Diversity along mountain belts is richest at the submontane to lower montane belts (500-2000 m) with *ca.* 125 genera. This is especially due to the great number of Lejeuneaceae occurring there. The least diverse are the subalpine and alpine belts (3200-5000 m) with 75 genera. The lowland (0-300/600 m) and the upper montane belts (2000/2500-3000/4000 m) are intemediate with about 95 genera each. Nevertheless, the lowlands are as rich in genera as the upper montane for-

est, again mainly due to Lejeuneaceae which is contrary to the general misconception that tropical lowlands are poor in hepatics.

About one-third of the liverwort genera (over 60) are endemic to the Neotropics. Most belong to the Lejeuneaceae and occur in lowland and lower montane areas, below 2000 m. Twenty genera are narrow endemics, known only for one of the neotropical regions. The highest number of endemics are found in the northern Andes (7 local genera), followed by the table mountains of the Guyana Highlands (4 local endemic genera).

The Guide is expected to provide useful information for floristic evaluations, not only considering species richness on a regional basis, but also the number of endemic genera and species, and characteristic habitats in which unique taxa occur that could be endangered by anthropogenic activities. There is a need for understanding not only what bryophytes are, but also what can they tell us about our surroundings and about critical environments in which they are the major plant component. Species richness is one way of looking at biodiversity; nevertheless, bryophyte taxa in critical environments like the high Andes and the tepuis may or may not only be species-rich but they may represent unique taxa found nowhere else and their disappearance is of greater impact to the ecosystem. Thus, conservation issues could be validated or supported by data provided by bryological studies.

A complement to this Guide will be a workshop to be held in March of 1996 in Panama. The objectives of the workshop are: to demonstrate the use of the Guide as a tool for biodiversity indication, to train non-bryologists in the use of the Guide, and to invite experienced bryologists from tropical America to test the Guide. The workshop will include lectures on basic bryology as well as on the importance of bryophytes in a wide range of habitat types in tropical America. There will be excursions to a range of habitat types in Panama to demonstrate the diversity and importance of bryophytes for conservation. Laboratory sessions to use the Guide for identification at the generic level are also an important part of the workshop. We expect the workshop to have a significant multiplier effect since it will be attended by conservationists from the academic world, non-governmental and governmental organizations. They will pass their experiences and knowledge to their colleagues trainee students (botanists, ecologists, forestry majors, among others).

It is our hope that this Guide will encourage the inclusion of bryological studies in the evaluation of natural areas and improve the quality of botanical inventories in the Neotropics. The guide should also be used in decision making policies related to conservation and sustainable use of tropical rainforests and other vegetation types represented in the Neotropics.

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