BOOK REVIEW 2010 - #3

Vanderpoorten, A. and B. Goffinet. Introduction to Bryophytes. 2009. viii + 303 pages (+ 16 pages unnumbered); figures; tables; black and white photographs; colored photographs (plates); line drawings; glossary; references; index. Cambridge University Press, New York, New York. ISBN: 978-0-521-70073-3 (Soft Cover) and ISBN: 978-0-521-87712-1 (Hard Cover); Prices: $45.00 and $110.00, respectively. Available from Cambridge University Press, 32 Avenue of the Americas, New York, NY 10013.

Introduction to Bryophytes (IB) is a noteworthy, up to date, text on the biology, from an evolutionary perspective, of liverworts, hornworts, and mosses. A wide range of topics are explored among ten chapters including, but not limited to, morphology, geography, ecology, physiology, and conservation. Coverages of the topics are enhanced by effective figures and photographs. In addition, selected topics are discussed in special boxed off areas. As the authors intended, the book's contents focus on recent advances in the study of bryophytes. This is evident by the large number of mostly primary literature citations of nearly 500. Of these, about 87% were published from 1990 to some in 2009. Although the book's coverage assimilates selected materials from the more comprehensive tome Bryophyte Biology edited by Goffinet and Shaw (Cited in IB), Introduction to Bryophytes can stand alone and is suitable for beginning students of bryology with an introductory background in botany. Because the book's contents center mostly on relatively recent literature, we will, from time to time, mention older monographs not cited by the authors to assist new students to bryology who might seek additional information, historical perspectives, and different points of views on related bryological topics.

In chapter one, "Evolutionary significance of bryophytes," the authors build a firm comparative morphological case regarding bryophytes as embryophytes along with the other terrestrial plants, the vascular plants. The vascular plants (tracheophytes) of our biosphere are the ferns and fern allies (pteridophytes), the non-flowering seed plants (gymnosperms), and the flowering seed plants (angiosperms). Also, bryophytes and vascular plants are members of the same kingdom, Kingdom Plantae. In addition to the commonality of the life histories among bryophytes and vascular plants; the bryophytes have distinct morphological features that are noteworthy; we will mention two. First, when one sees a liverwort, hornwort, or moss in the field or elsewhere, the observed specimen, with only a very few exceptions, represents the gametophyte (1n) phase of the organism's heteromorphic alternation of phases (or generations). The gametophyte phase of bryophytes is the conspicuous and dominant photosynthetic phase and the gamete producing phase. Secondly, the sporophyte (2n) phase of bryophytes remains attached to its gametophyte parent throughout its development to maturity and often past spore release. In contrast, among the vascular plants the sporophyte (2n) phase is the dominant and major photosynthetic phase; whereas the gametophyte (1n) phase is generally inconspicuous.

Furthermore, in considering the comparative morphological features of bryophytes and vascular plants, the authors explore the evolutionary status of liverworts, hornworts, and mosses among the terrestrial plants with an eye on their ancestral origin and transition from an aquatic environment to an aerial land environment. Different phylogenetic hypotheses among extant lineages of terrestrial plants are considered fairly. The hypothe-

ses are based on evidence from comparative morphological and anatomical studies of extant and extinct plant specimens as well as from the analyses of deoxyribonucleic acid sequences of extant plant specimens. Apparently, one of the currently favored hypotheses concerning the evolutionary status of the bryophytes is that "… hornworts share a common ancestor with tracheophytes, mosses form a sister group to this combined lineage, and liverworts mark the transition to land, …" (Chp. 1, p. 15). With respect to evolutionary considerations, Smith (1955, Fig. 82, pp. 131-134) has an intriguing discussion and line drawing relating to "… an anthocerotean origin of pteridophytes." Also, for further exploratory reading on the life histories of bryophytes (and vascular plants) beginning students should consider the following introductory textbooks: Bold, Alexopoulos, and Delevoryas, 1980; Doyle, 1970; Parihar, 1965; Richardson, 1981; Schofield, 1985; Simpson, 2006; Smith, 1955; and Watson, 1964.

Recognizing that bryophytes have a global distribution and are primary producers in almost all terrestrial ecosystems, including fresh water ecosystems; chapter two, "Ecological significance of bryophytes," covers a range of topics concerning their functional and compositional roles in terrestrial plant communities. Aboveground biomasses for bryophytes compared to vascular plants (+ lichens) vary from small values in temperate deciduous forest communities to major values in *Sphagnum* peat lands and often in arctic tundra communities (Fig. 2.3, p. 29). Hence, in some plant communities, particularly in polar regions, bryophytes are the major primary producers. In addition to Longton's (1988) monograph on the life of polar bryophytes and lichens, investigations on the ecology of arctic bryophytes are reported in topical chapters of the Canadian and United States International Biological Progamme – Tundra Biome volumes edited by Bliss (1977) and Tieszen (1978), respectively. Furthermore, chapter two includes an interesting discussion on *Sphagnum* peat lands and to quote a noteworthy point mentioned on page 29 – "There is more carbon stored in *Sphagnum* and *Sphagnum* litter than any other genus of plants, vascular or non-vascular." Thankfully, the authors indicate what consequences are likely if the carbon dioxide fixed in *Sphagnum* peat lands should be released into the atmosphere by decomposition owing to global warming. Moreover, the chapter covers productivity, mineral nutrient cycling, succession, soil formation, and other topics. In addition to chapter two, selected ecological aspects of bryophytes are treated in chapters seven and eight.

Within the hierarchy of plant classification, many contemporary taxonomists segregate the bryophytes into three divisions (phyla). The next three chapters (3, 4, & 5) provide an overview of each division; that is, the "Liverworts" (Marchantiophyta), "Mosses" (Bryophyta), and "Hornworts" (Anthocerotophyta), respectively. Each chapter starts with an introductory statement about the division. Subsequently, the largest portion of each chapter provides a substantial morphological coverage of its respective division. These treatments are complemented by numerous line drawings, photographs, and photomicrographs. Each chapter ends with a pointed discussion on "Classification and macroevolution" with a focus on phylogeny and summaries on "Biogeography and ecology" for its respective division. For a historical perspective, Bold and coauthors (1980) employed the division names Hepatophyta, Anthocerotophyta, and Bryophyta for the liverworts, hornworts, and mosses, respectively. Other authors placed all three groups of bryophytes into a single division, the Bryophyta, and ranked the liverworts, hornworts, and mosses in classes. For example, Parihar (1965) employed the class names Hepaticopsida,

Anthoceropsida, and Bryopsida, respectively. Whereas, the class names Hepaticae, Anthoceratae, and Musci were employed by Smith (1955) and Schofield (1985), respectively.

Among bryophyte taxa, many species have a broad global distribution (cosmopolitan); probably some species occur on all continents. On the other hand, numerous species are limited to a particular phyto-geographical region (disjunct) but also occur elsewhere even on other continents. And still other species are known to occur only in a particular region (endemic), perhaps only in a particular type of habitat. The authors treat these aspects of the "Biogeography" of bryophytes in chapter six in reference to their taxonomic diversity, origin, and evolution in relation to distribution patterns with interpretations in reference to plate tectonics and long-distance dispersal. Here discussions on disjunct and endemic species are especially noteworthy. As a point of academic interest, new students might note that the "Biogeography" of bryophytes is in the arena of floristic plant geography. An overview of this approach to phytogeography is clearly discussed by Daubenmire (1978).

Chapter seven, "Ecology," concerns the terrestrial distribution and adaptive evolution of bryophytes in relation to environmental factors. There are three major sections in chapter seven. The first section, "Global ecology," is directed towards interpretations of climatic changes ascertained from the distribution of macrofossils of *Sphagnum* and *Racomitrium langenosum* in peat profiles. The second section, "Landscape ecology," calls attention to a case study of the liverwort *Calypogeia fissa* in discontinuous forest habitats within an agricultural landscape located in Belgium. A positive relationship between species richness and forest cover indicated that species distributions of forest bryophytes are controlled by the overstory. Section three, "Population ecology," treats the concepts of the ecological niche and interactions of taxa with an emphasis on selected epiphytic communities. However, some terrestrial bryophyte communities are discussed with respect to competitive exclusion. The final portion of this section provides insights on how particular features of life histories of bryophyte species might enhance their survival. For example, fugitive and pioneer species tend to be more reproductive in spore and/or gemmae production than later seral species. In general, chapter seven can be considered in the arena of ecologic plant geography as discussed by Daubenmire (1978). Also in this area, we recommend the related review chapters, written by experts and brought together in the volume Bryophyte Ecology edited by Smith (1982).

Extant bryophytes have adapted to a range of abiotic and biotic factors of their environments (habitats). Some bryophyte species appear to have relatively narrow ecological ranges (ecological amplitudes) whereas other species have broad ecological ranges. Chapter eight, "Physiological ecology," explores the adaptive features of bryophytes to abiotic environmental factors especially water, light, mineral nutrition, and temperature. Here, we will mention some aspects concerning the water and temperature factors. Water relations are discussed in some detail with a focus on desiccation tolerance (very low cellular water content) of the gametophytes. Desiccation tolerance is a recognized physiological feature of most bryophytes and is most likely a feature that contributed to their adaptation to terrestrial habitats. Temperature affects all metabolic processes, but is commonly evaluated from measurements of photosynthetic, respiratory, and growth rates. Hence, among bryophyte species there are ranges of metabolic responses to the three car-

nal temperatures: minimum, optimum, and maximum (Daubenmire, 1974). Generally, bryophytes have a capacity to endure freezing temperatures and it is unlikely that they require or exist continuously in their natural habitats at their optimal temperatures; therefore their maximal temperatures are likely to be the critical factor in habitat selection, provided other environment factors are suitable. Chapter eight can be considered a subdiscipline of ecology referred to as autecology. Daubenmire's (1974) textbook is an excellent introduction to the subject, and there are chapters on the autecology of bryophytes in Smith's (1982) tome mentioned previously. Furthermore, students of bryology need to appreciate that many bryophytes are not the only organisms that can survive extreme cellular water losses and low temperatures. A recent fascinating book by Wharton (2002) discusses numerous organisms that deal with extreme environments. Also, new students to bryology need to explore Dyer and Duckett's (1984) multi-authored volume containing ecologically related reviews and Glime's (Cited in IB) progressing treatise on a broad range of ecological topics.

"Bryophytes in a changing world" (Chp. 9) concerns the effects of pollutants on bryophyte communities and physiological features of bryophytes with respect to acidification and eutrophication of water resources. In addition, the chapter covers the use of bryophyte taxa as references for bio-monitoring. And a brief discussion on adaption to a changing environment is included. In the book's final chapter (Chp. 10) "Conservation biology" the authors point out that bryophytes are often overlooked in land conservation, biological diversity, and restoration projects. On the other hand, it now appears that bryophytes and other cryptogams are now recognized as significant components of plant communities. With this in mind, the authors provide an overview of methods for assessing the status of bryophyte taxa in plant communities in reference to their endangered survival, and needs for conservation and restoration.

In closing, we recommend Introduction to Bryophytes to all students of bryology, new and advanced. Also, college and university libraries need to add this monograph to their botanical collections.

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