

Rare and endangered liverworts: A new area of conservation in New Zealand

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In contrast to the wealth of information available on the vertebrate animal and seed plant groups of New Zealand, the taxonomic diversity, distribution, ecology and reproductive biology of New Zealand liverworts is largely unknown. This is alarming considering the liverwort flora of New Zealand is of worldwide significance and the fact that liverworts form both a conspicuous and important component of many New Zealand ecosystems.

Ecological and biological significance of liverworts

The ecological roles of liverworts in temperate and tropical ecosystems include contributing to nutrient cycles (Coxson, 1992) and canopy humus (Ingram & Nadkarni, 1993), forming microhabitats for insects and microorganisms, and ameliorating the effect of heavy rains (Pócs 1980). The chemical compounds of some liverworts are also particularly noteworthy because they have important biological properties such as activity against certain cancer cell lines, anti-bacterial, anti-microbial, and anti-fungal activities (Asakawa 1995; Asakawa *et al.* 2003).

Global significance of the New Zealand liverwort flora

New Zealand has about 5-10% of the world's liverwort flora including about 300 endemic taxa (Table 1). Of worldwide significance is that greater than 60% of the liverwort families and over 40% of the genera are represented in New Zealand. Furthermore, of the 18 genera endemic to New Zealand, 16 genera are monotypic (a genus with only one species), e.g., *Jubulopsis* and *Xenothallus*.

Table 1. Biodiversity statistics for liverwort families, genera, and species (Number of endemic taxa in brackets).

Region	No. of Families	No. of Genera	Lower Ranks
Worldwide	74	377	6000-8000
New Zealand	49 (2)	155 (18)	642 (304)

The taxonomic and evolutionary significance of the New Zealand liverwort flora also is exemplified by the presence of a high number of taxonomically isolated species-poor families that have disjunct distributions. Examples of taxa occurring in New Zealand and Australia are *Neogrollea*

(Fig. 1,2) (Neogrolleaceae) and *Trichotemnoma* (Trichotemnataceae), both of which are in monotypic families, and the monotypic genus *Chaetophyllopsis*.

Assigning categories of threat

de Lange and Norton (1998) proposed a New Zealand-based risk classification system for uncommon taxa to overcome several shortcomings presented in other systems, e.g., the IUCN threat categories, particularly with regard to insular and narrow-range endemics. Their classification system has been further developed to produce the New Zealand Threat Classification System (Molloy *et al.* 2002), which is used by the New Zealand Department of Conservation.

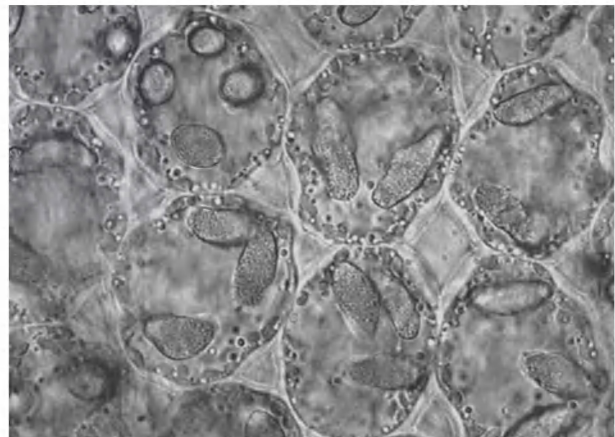


Figure 1. Cellular oil-bodies of *Neogrollea notabilis*.



Figure 2. Habit of *Neogrollea notabilis* with sporophyte as inset, ranked "Nationally Endangered" in New Zealand, but also known from Tasmania, Australia.

Difficulties applying threat classification systems to bryophytes

Data is seldom available to bryologists that makes it possible to conduct population viability analyses, calculate generation time, or estimate the number of mature individuals or total population sizes. Evaluation of species against threat categories is mostly based on numbers of collections and inference from available data. Furthermore, some of the criteria are either not applicable, inappropriate, or present special challenges when dealing with bryophytes. For example, it is difficult to apply the term 'individual' as defined by Molloy *et al.* (2002): 'the number of mature individuals is defined as the number of known, estimated or inferred to be capable of reproduction'. In setting forth guidelines for the application of the revised IUCN threat categories specifically to bryophytes, Hallingbäck *et al.* (1998) noted that it is impossible, without genetic studies of each unit, to determine what constitutes an individual bryophyte. We promote a pragmatic definition of an individual and regard a single discrete 'patch' or 'tuft' as an individual.

Current and perceived threats

Threats to the New Zealand biota are generally well known and include habitat loss, deterioration, fragmentation and invasive plant and animal species. From the bryophyte perspective, the exotic clubmoss *Selaginella kraussiana* is a serious threat to many New Zealand liverworts because of similarity in habitat preference. Moreover, the impact of other pressures on liverworts and bryophyte assemblages, such as micro-habitat loss and habitat fragmentation, has not been previously investigated within a New Zealand context (Braggins *et al.* 2001). Studies elsewhere have concluded that the size and shape of fragments had a significant effect on habitat heterogeneity, and bryophyte and lichen diversity (Gignac & Dale 2005). This is relevant to New Zealand where there are large tracts of forests as well as many fragmented systems. Interestingly, Gignac (2001) concluded that because of the close association of bryophytes with climatically sensitive habitats and ecosystems, bryophytes might serve as potential indicators of large-scale changes before the habitat or ecosystem itself is affected.

Taxonomic knowledge of New Zealand liverworts

Although there have been a considerable number of recent taxonomic publications on the New Zealand liverwort flora, many taxonomic problems still need serious study, and data relevant to distribution ranges and ecology are still incomplete. Hence few regions can be considered extensively inventoried for liverworts. Attesting to this are: recent new records of two genera new to New Zealand, *Brevianthus* (Glenny 1999) and *Mnioloma* (Renner 2003); scores of new species in genera such as *Lepidozia* (Engel & Schuster 2001; Engel 2004); as well as regular new



Figure 3. Habit of *Schistochila nitidissima*, known only from scant collections from North Island, New Zealand, and considered under threat from the invasive weed *Selaginella kraussiana*.

species record with an average of five species per year added to the New Zealand liverwort flora.

In order to help fill gaps in knowledge of New Zealand liverwort biodiversity, a collaborative project between the Field Museum, Chicago and Landcare Research, New Zealand is underway to produce a three-volume Liverwort Flora of New Zealand. The project is the first to be attempted since Hooker's 1855 *Flora of New Zealand*.

Conservation Status of New Zealand Liverworts

An update to the previous threatened bryophyte list (Hitchmough, 2002) is to be published in a forthcoming issue of *Australasian Bryological Newsletter*. In developing the list, the threat classification system outlined by Molloy *et al.* (2002) was applied. The precautionary principle to species conservation advocated by Molloy *et al.* (2002) and the IUCN was also adopted. This emphasizes the importance of attempting to allocate threat status to even poorly known species by estimating and extrapolating the current or potential threats into the future. This has resulted in many undescribed liverworts on the threatened list, particularly in the Data Deficient category, and suggests that much taxonomic work remains to be done. The list thus also indicates priorities for taxonomic research.

The revised list comprises 172 taxa, representing an increase of 82 taxa on the previous listing of Hitchmough (2002). The increase is due in part to the inclusion of some 32 undescribed taxa, ranging from those awaiting publication through to entities whose distinctness has yet to be ascertained. The increase also reflects the renewed efforts to ascertain the New Zealand liverwort flora and, as a consequence, better networking within the bryological community.

Table 2. Number of taxa of New Zealand liverworts assigned to a category of threat.
(Categories as defined by Molloy et al., 2001).

Taxon Status	Nationally Endangered	Nationally Vulnerable	Nationally Critical	Sparse	Restricted Range	Data Deficient
Described	10	1	57	23	22	26
Undescribed	2	—	3	2	8	17

Sixty-eight described taxa are collectively rated as “Acutely Threatened” (comprising the categories “Nationally Endangered”, “Nationally Vulnerable”, and “Nationally Critical”) and 26 described taxa and 17 undescribed entities are assigned to the Data Deficient category (Table 2). There are also species on the list that are apparently uncommon in New Zealand but common outside of New Zealand, e.g., *Dumortiera hirsuta*, and these have been qualified with “Secure Overseas.”

Conclusions and priority areas for investigation

A benefit of listing has been that this has stimulated fieldworkers to search for threatened liverworts, and a considerable effort has gone into searching for many species in the last decade. Although this has helped the current listing, it is clear that future priorities now include: 1) identify distributions more completely as well as accumulate ecological data; 2) identify and research further both present and potential threats to liverworts, such as forest fragmentation; 3) taxonomic revision of critical taxa; 4) accumulate data on reproductive biology; and 5) assess poorly investigated habitats and ecological regions, including the many offshore islands that have not been well inventoried. These avenues of research and investigation will lead to new insights in the study of New Zealand liverwort diversity, geography and conservation. As stressed in the preamble to the IUCN threat categories (2001), Red List threat categories alone are not sufficient to determine priorities for conservation. A system of assessing priorities for action should also include other factors, such as international responsibilities, taxonomic uniqueness, logistics, chances of success and costs (Hallingbäck *et al.* 1998).

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