Bryophytes and the morphospecies concept: a comparison of novice and expert sorting

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INTRODUCTION

THE exclusion of bryophytes (mosses, liverworts and hornworts) from the majority of impact assessment and monitoring studies is probably due to key characters being microscopic and difficult to work with given limited resources. Coarse morphological groups have been used in rangeland monitoring where a level of identification accessible to amateurs successfully separated different soil crust groups (Eldridge and Rosentreter 1999). However, there has been only one study of the feasibility of using a morphospecies approach for bryophytes. Oliver and Beattie (1993) included mosses in their study of the comparison of the results of "biodiversity technicians" and expert taxonomists. They found that novices split and lump many moss species. The bryoflora they investigated was species-rich with 86 species found in 220 specimens. In this study, I investigate a different environment with a level of species richness that is more typical of many dry sclerophyll forests (Pharo and Beattie 1997). Novices collected the specimens as well as sorted, which is a realistic replication of the task facing biologists when undertaking biodiversity surveys or establishing monitoring studies. Here I compare the efforts of 65 novices (second-year biogeography students) and myself in sampling an area of sub-alpine Tasmania. I was interested quantifying the abilities of this group rather than a smaller, more experienced group because a range of interests and abilities were represented. The results are informative as to the feasibility of including bryophytes in monitoring projects where the focus of the project may be on other groups and the field officer has little experience with bryophytes.

The variation in topography and vegetation was maximized to provide a diversity of habitats to sample. Fifty-five quadrats (5 m × 5 m) were evenly spaced along a 800 m transect laid across a small valley, near Bronte Park (42°14'S, 146°49'E) in the geographical centre of Tasmania. Elevation ranged from 630 to 700 metres. Valley slopes were forested with a sparse shrub understorey and dominated by *Eucalyptus rodwayi*, *E. dalrympleana*, and *E. pauciflora*. The valley floor was sedgeland dominated by *Carex gaudichaudiana*. The background of the novices varied from no formal botanical training, to completion of first-year botany that included a treatment of bryophytes.

Immediately prior to field sampling, novices were given a one-hour lecture on the key characters and the type of variability that was important in determining species. The importance of lifeform, leaf arrangement, leaf detail, and texture (cell type) was emphasized. Colour was identified as being variable and therefore a poor character for determining morphospecies. Bryophyte samples were taken from each quadrat for later inspection and sorting. Novices were provided with dissecting microscopes (× 7–45) and a compound microscope (× 40–100). The novices sorted each quadrat for what they perceived to be different species and any remaining material was put back into the sample bag so that I could determine whether any species had been overlooked. Pearson product moment correlation was used to relate the species richness results for morphospecies and species.

RESULTS AND DISCUSSION

I identified a total of 18 species from 184 specimens (Table 1). Although the novices detected all 18 species, many overlooked species present in low abundances. A relatively weak correlation was found between the number of morphospecies and species at the plot level ($r = 0.67$, $P < 0.001$), which is likely to be an unacceptable basis for monitoring at the species level. The two species most often missed were a liverwort (*Chiloscyphus semiteres*) and a rosette moss (*Rosulabryum billardieri*), which are common and easily identified species (Scott and Stone 1976). However, in this study, these species were uncommon and often present in the sample as a single individual or strand. I found the liverwort in 10 plots versus the novices finding it four times, and I found the moss in nine quadrats versus the novices finding it four times. The species most commonly split into more than one species in this study was *Breutelia affinis*, which changes from having a rope-like appearance and a dull colour when dry to being bright and open when fully hydrated. However, cell detail is diagnostic. Emphasizing the importance of both sorting under the dissecting

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Table 1. Species present and their percentage occurrence in the 55 quadrats. L denotes liverwort.

	Species	% frequency
1	*Acrocladium chlamydophyllum*	7.1
2	*Barbula calycina*	1.8
3	*Breutelia affinis*	62.5
4	*Campylopus introflexus*	5.4
5	*Ceratodon purpureus*	16.1
6	*Chamberlania salebrosum*	35.7
7	*Chiloscyphus muricatus (L)*	1.8
8	*Chiloscyphus semiteres (L)*	10.7
9	*Eurhynchium asperipes*	3.6
10	*Fissidens asplenioides*	1.8
11	*Grimmia laevigata*	3.6
12	*Heteroscyphus coalitus (L)*	16.1
13	*Hypnum cuppressiforme*	35.7
14	*Polytrichum juniperinum*	19.6
15	*Racomitrium crispulum*	3.6
16	*Rosulabryum billardieri*	17.9
17	*Thuidium furfurosum*	83.9
18	*Triquetrella papillata*	1.8

microscope, as well as closely examining cell detail, may have made a difference to the results.

Overall, the proportion of quadrats in which species were missed or lumped was much higher than quadrats where species were split (Fig. 1). Species richness was relatively low in each quadrat ($\bar{\chi}$ = 2.7 species, stdev = 1.1), and underestimates of three species constituted

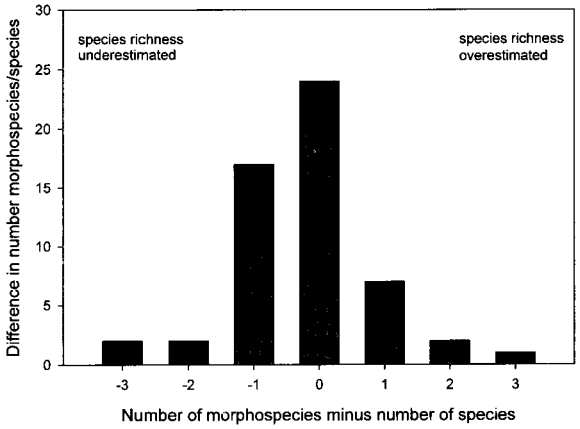

Fig. 1. Number of morphospecies minus the number of species in each of the 55 quadrats (5 m × 5 m).

missing half the species present. Unlike the Oliver and Beattie (1993) study, there was only one example of lumping and the remaining richness underestimates were due to missed species. The species list of Oliver and Beattie included multiple species in difficult to separate genera (such as 11 species in the genus *Bryum*, Downing *et al.* 1991) which presents a fairly intractable problem for novices.

Intensive training over weeks or identification to genus level only may be needed when dealing with species-rich areas. In studies such as this where time restrictions meant it was not possible to intensively train novices, a reduction in the number of quadrats studied and a double-observer approach (Nichols *et al.* 2000) may substantially improve the coincidence of novice and expert results.

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