Species Lists in Ecology and Conservation: Abundances Matter

OLIVER BALMER

Department of Ecology and Evolutionary Biology, Osborn Memorial Laboratory, Yale University, P.O. Box 208106, New Haven, CT 06520–8106, U.S.A., email oliver.balmer@yale.edu, and Departement für Integrative Biologie, Universität Basel, Rheinsprung 9, 4051 Basel, Switzerland

In a paper in the October 2001 issue of *Conservation Biology*, Gómez de Silva and Medellín (2001) studied the problem of incomplete species lists in conservation and macroecology. They based their study on the observation that "studies of species diversity, macroecology, and conservation are usually based on lists of species, but lists found in the scientific literature vary in completeness." They concluded that "realistic results may be produced in macroecological and conservation studies only if they are based on reasonably complete species lists." Here, I make the point that there is an even more fundamental issue with respect to species lists that is in fact known, but whose effects are increasingly underestimated, especially in conservation: even complete species lists may fail to produce realistic results, and thus lead to wrong decisions, if they do not include estimates of the relative abundances of the species.

In ecology and conservation, conclusions or management decisions are often based on comparisons of species occurrences in different habitats or locations. These comparisons, in turn, are based on the assumption that species lists reflect the ecological character and value of different places and that such comparisons thus reveal real similarity or distinctness. Using data from Balmer (1999) and Balmer and Erhardt (2000), I demonstrate that these assumptions may not hold if species frequencies are not accounted for.

I compared butterfly assemblages in 12 pastures that were classified into three groups (1–3 in Fig. 1) based on vegetation type. I surveyed one standardized plot on each pasture over an entire season. On two pastures (1B and 1N), I also surveyed a second plot close to the first one. Thus, 14 plots were surveyed. Because all pastures were homogeneous units, it is a safe assumption that two plots on the same pasture were ecologically similar. To perform unweighted pair-group method using arith-

metic averages (UPGMA) cluster analyses, I used both a similarity index that accounts for relative species abundances (Renkonen index) and one based only on the presence or absence of species (Sørensen index).

The Renkonen (percentage) similarity index is calculated as

$$S_R = \sum_1^i \text{minimum } (p_{1i}, p_{2i}),$$

where p_{1i} is frequency of species i in collection 1 and p_{2i} is frequency of species i in collection 2. The Sørensen similarity index is calculated as

$$S_S = \frac{2a}{(2a + b + c)},$$

where a is the number of shared species, b is the number of species only in collection 1, and c is the number of species only in collection 2. See Krebs (1998) for methods and indices. Only the first analysis recovered the similarities of plots within 1B and 1N (Fig. 1). Comparisons of other available indices gave the same results. The most straightforward conclusion is that analyses that do not include the species' relative abundances do not reveal the real ecological patterns in the data.

The following hypothetical example may help strengthen the point. Figure 2 shows three species distributions. Of these three, which two are most similar? If we look only at which species are present, as is done with a presence-absence species list, A and B are identical and C is different. If we include the information on relative abundances, however, we see a clear pattern. It is obvious that, from an ecological perspective, A and C are the most similar to each other. If we are to make ecologically meaningful comparisons of sites, therefore, we have to include the abundance information in this example. Only if the relative abundance distributions were equal across the plots would both analyses yield the same conclusions. It is clear that species lists are better
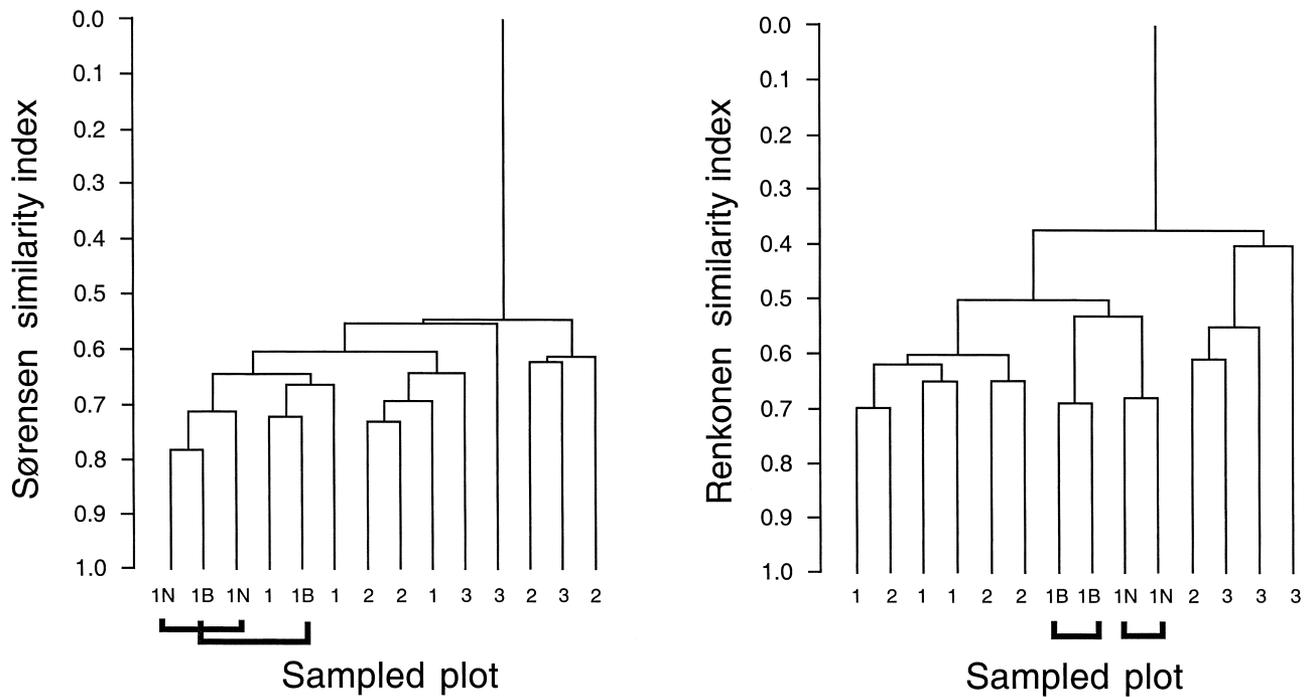
Figure 1. Dendrograms of UPGMA cluster analysis using Sørensen similarity index (left) and Renkonen (= percentage) similarity index (right). The Sørensen index works with presence-absence data, whereas the Renkonen index is calculated from abundance data. Plots of sites 1B and 1N are highlighted. Numbers 1–3 are vegetation types, and plot identities are omitted (adapted from Balmer 1999).
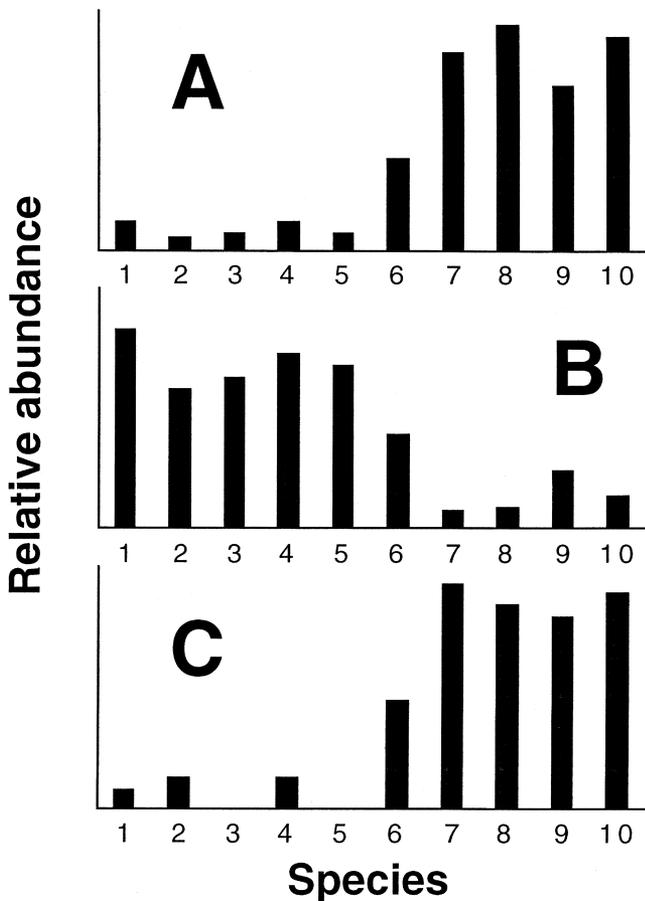
than no lists and that relative abundances are better than simple lists (and that frequency dynamics are better than relative abundances). The question is, when can we afford to neglect a level of information?

Estimates of abundance may not be available from the literature. But if we want to claim that conclusions and decisions reflect real ecological patterns, we have to include at least rough estimates of species frequencies. Without estimation of relative abundances, even results based on complete species lists may have little ecological meaning and may lead to inappropriate conclusions and management decisions.

Literature Cited

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Figure 2. Hypothetical abundance distributions for 10 species on three different sites, A–C.