COENOSES 8(1): 25-26, 1993

WHAT CAN BE INFERRED FROM SPECIES DIVERSITY INDICES?

V. Novotný

Institute of Entomology, Czech Academy of Sciences, Branišovská 31, 370 České Budějovice, Czech Republic.

Keywords: Community indices; Diversity indices; Species diversity.

Abstract. Species diversity indices, wich describe distribution of individuals among species into a single value, are at best questionable tools for community functional analysis. As shown in the article, they cannot be safely used either deductively for the testing of hypotheses, or inductively for the sorting of communities into different functional types.

Since the pioneering papers of Fisher *et al.* (1943) and Simpson (1949), many species diversity indices have been proposed (see Peet 1974, Washington 1984 for rewiews, recently *e.g.*, Kvalseth 1991). Essentially, these indices are all designated to describe community dominance structure, that is the distribution of individuals among species in any sample (Fig. 1), into a single value. Construction of indices is performed in various ways, all converting initial information to a presumptive more workable form by inevitably reducing them. The substantial effort devoted to the mathematical perfection of indices, and their routine usage as an important community characteristic, strongly implies that dominance structure is valuable for under-

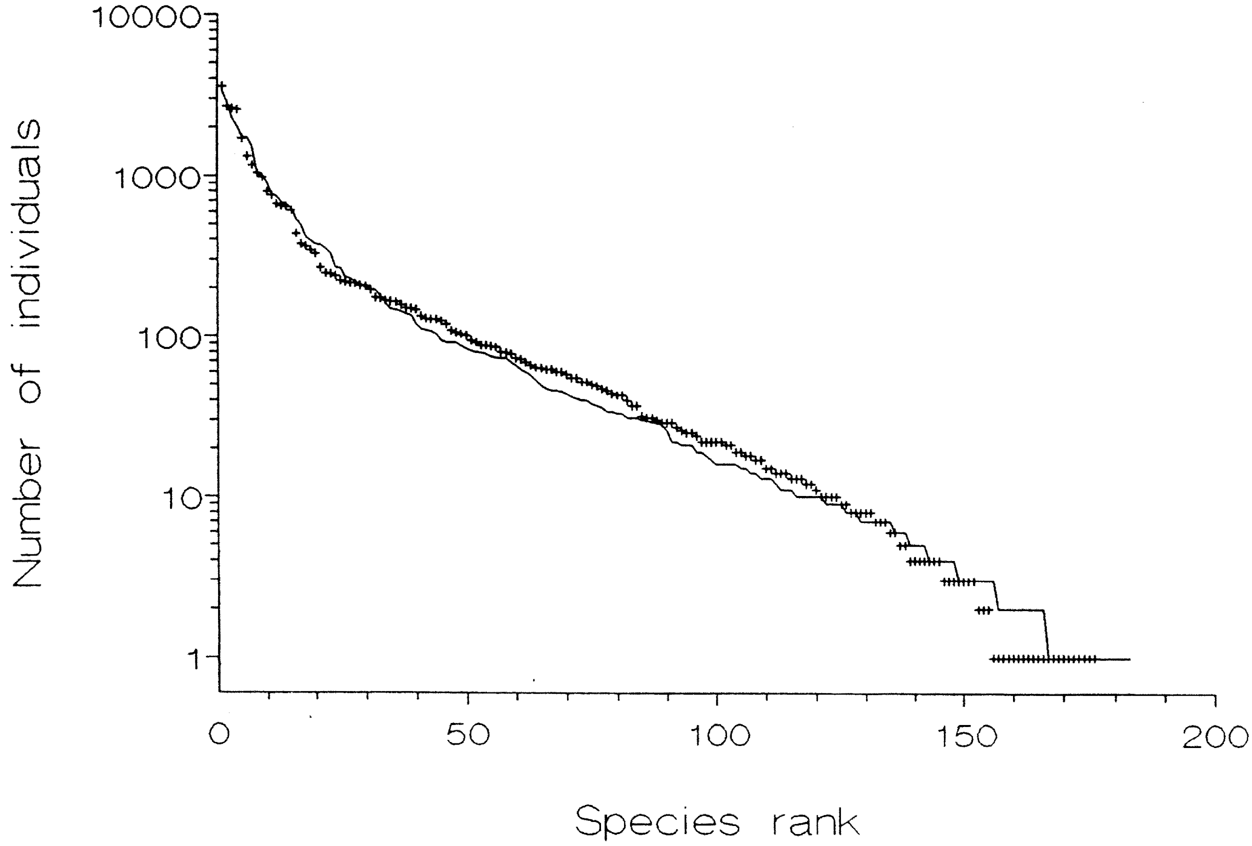

Figure 1. Dominance structure of two moth communities (Lepitoptera, Noctuidae) near Ceske Budejovice, South Bohemia. Total number of individuals of each species in a sample is depicted; for each community, species are ordered in a descending order. Solid line: agriculture landscape, 183 species, 31 937 individuals. Crosses: climax alder carr, 176 species, 31 834 individuals. Each community was sampled daily during the vegetative seasons 1981 - 1989 by a light trap.

standing community organization and function, a major goal of community research. Contrary to this expectation, it is practically impossible to draw any significant conclusions concerning the dynamic processes of a community from its dominance structure, and vice versa.

Various theoretical models that differ widely in their premises concerning community assemblage rules predict the same dominance structure. The log normal distribution of individuals among species may be merely a consequence of the central limit theorem (MacArthur 1960, May 1975), or the result of the sequential breakage of a community niche space (Sugihara 1980), the summation of several species groups with normal distributions (Ugland and Gray 1982), or the hierarchical habitat model (Kolasa and Biesiadka 1984). Similarly, there are several explanations for other distributions, including the broken-stick distribution (MacArthur 1957, Webb 1974, Cohen 1968). Consequently, the dominance structure of real communities cannot be used to test the validity of niche division models even in the case of a perfect agreement between predicted and real data.

This point is illustrated by two species assemblages of Noctuidae (Lepidoptera) from two neighbouring sites in South Bohemia. One is from temporally highly variable agricultural landscape, and the other from the climax ecosystem of an alder carr with constant composition of vegetation (Spitzer and Lepš 1988, Jaroš and Spitzer 1987). The data sets presented in Fig. 1 are based on nine years of continuous sampling. They are fully comparable one to another in the sampling method, time, location, sample size, and species number. The communities differ significantly in the prevailing bionomic strategy of constituent species, but in terms of dominance structure they are indistinguishable. The agricultural landscape community is an assemblage of mainly polyphagous species with population sizes widely fluctuating in time, the community of the alder carr is more habitat specific and temporally constant in composition (Rejmánek and Spitzer 1982, Spitzer *et al.* 1984, Spitzer and Leps 1988, Wolda *et al.* 1992).

Obviously, as descriptors of community dominance structure, indices of diversity are at best questionable tools for community functional analysis. They cannot be safely used either deductively for the formulation and testing of hypotheses of community assembly rules, or inductively when applied to sorting of sampled communities into functional types according to their dominance structure. Consequently, the causal interpretation of diversity values is very difficult so that their measurement adds a little to the understanding of community organization. Calculations of diversity values so represent a case where perfection of mathematical descriptors is not followed by an adequate progress in our understanding of biological reality wich is being described.

Acknowledgements. I wish to thank R. H. T. Mattoni for his valuable comments on the manuscript.

References

Cohen, J. E. 1980. Alternate derivations of a species- abundance relation. Am. Nat. 102: 165-172.

Fisher, R. A., A. S. Corbet and C. B. Williams. 1943. The relation between the number of species and the number of individuals in a random sample of an animal population. J. Anim. Ecol. 12: 42-58.

Jaroš, J. and K. Spitzer. 1987. *The Lepidoptera of Cernis wetland in South Bohemia.* Jihoceske Muzeum, Ceske Budejovice.

Kolasa, J. and E. Biesiadka. 1984. Diversity concept in ecology. Acta Biotheor. 33: 145-162.

Kvalseth, T. O. 1991. Note on biological diversity, evenness, and homogeneity measures. Oikos 62: 123-127.

MacArthur, R. 1957. On the relative abundance of bird species. Proc. Natl. Acad. USA 43: 293-295.

MacArthur, R. 1960. On the relative abundance of species. Am. Nat. 94: 25-36.

May, R. M. 1975. Patterns of species abundance and diversity. In: Cody, M. L. and J. M. Diamond (eds.). *Ecology and Evolution of Communities.* Belknap Press, Harvard, pp. 81-120.

Peet, R. K. 1974. The measurement of species diversity. Annu. Rev. Ecol. Syst. 5: 285-307.

Rejmánek, M. and K. Spitzer. 1982. Bionomic strategies and longterm fluctuations in abundance of Noctuidae (Lepidoptera). Acta Entomol. Bohemoslov. 79: 81-96.

Simpson, E. H. 1949. Measurement of diversity. Nature 163: 688.

Spitzer, K., M. Rejmánek and T. Soldan. 1984. The fecundity and long-term variablity in abundance of noctuid moths (Lepidoptera, Noctuidae). Oecologia (Berl.) 62: 1-93.

Spitzer, K. and J. Lepš. 1988. Determinats of temporal variation in moth abundance. Oikos 53: 31-36.

Sugihara, G. 1980. Minimal community structure: an explanation of species abundance patterns. Am. Nat. 116: 770-787.

Ugland, K. I. and J. S. Gray. 1982. Lognormal distributions and the concept of community equilibrium. Oikos 39: 171-178.

Washington, H. G. 1984. Review: Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosystems. Water Res. 18: 653-694.

Webb, D. J. 1974. The statistics of relative abundance and diversity. J. theor. biol. 43: 277-291.

Wolda, H., K. Spitzer and J. Leps. 1992. Stability of environment and of insect populations. Res. Popul. Ecol. [in press].

Manuscript received: September 1992