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A NEW INDEX MEASURING EVENNESS

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(Text-figs. 1–2)

A new evenness index based on the Shannon–Wiener information function H is defined as $(e^H - 1)/(S - 1)$. This index is theoretically superior to other evenness indices and has a better statistical behaviour.

INTRODUCTION

The use of diversity and evenness indices is well established in recent ecological literature. Many indices have been proposed, to such an extent that the choice of a suitable index became somewhat of a problem. Recently, however, Hill (1973) introduced a unifying notation where diversity numbers are defined in relation to Rényi's definition of a generalized entropy. Hill showed that his diversity numbers N_a of the 0th, 1st and 2nd order coincide with three important diversity measures which have been frequently used, $N_0 = S$, $N_1 = e^H$ and $N_2 = 1/SI$, where S is the number of species, H is the Shannon–Wiener information function $-\Sigma p_i \ln p_i$ and SI is Simpson's index Σp_i^2. According to this notation, evenness should be calculated by dividing two of Hill's diversity numbers, e.g. $N_2/N_1 = e^H/S$. This index was proposed by Sheldon (1969), but its use in ecological literature has been negligible. The most commonly used evenness index has been the one proposed by Pielou (1966), $e = H/H_{max}$, with $H_{max} = \ln S$. Contrary to Hill's (1973) statement, it shares with Hill's continuum of evenness measures the property of remaining constant when the number of individuals of all species is multiplied with a constant factor. Intuitively, this seems to be a necessary property of an evenness index.

THE NEW INDEX

Theoretically, Sheldon's index e^H/S should be used as one of the alternatives based on Hill's diversity numbers. It has, however, a serious disadvantage: when in a community diversity is low ($e^H \rightarrow 1$), the number of species will generally be low also ($S \rightarrow 1$). In these communities, Sheldon's index will tend to $1/S$, and this limit will be higher when S decreases. This is clearly an undesirable property of an evenness index. This trend can be corrected when introducing $(e^H - 1)/(S - 1)$; the numerator of this ratio will tend to 0 when H decreases. Its maximum value is 1, when $H = \ln S$.

In Fig. 1 the values of three evenness indices are compared when a two-species community shows increasing dominance of one of the species (10–1; 100–1; 1000–1, etc.). It is clear that Pielou's index and the new index go to 0, Sheldon's index to 0·5, a quite ridiculous value for a community where 999999 individuals belong to one species and 1 individual to the second.

In Fig. 2 the values of these evenness indices are compared for a community where the number of individuals of the different species differs by a factor 10; diversity stabilizes on 0·52, evenness continues to decrease over the whole range as species are added, but the picture is the same for the three indices.

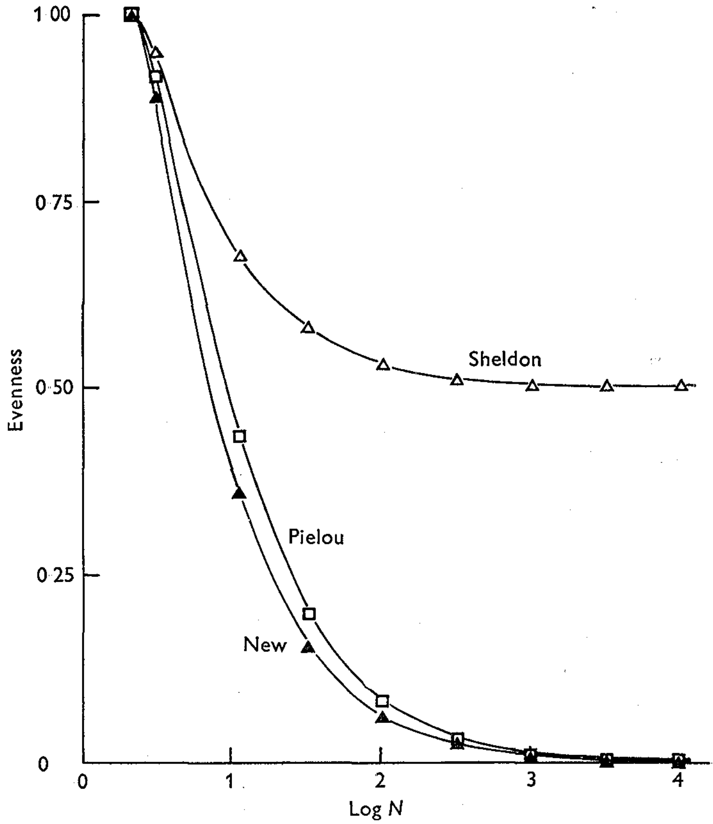

Fig. 1. Evenness in a two-species community, where one species is represented with one individual and the other species shows an increasing number of individuals $N-1$, as a function of log N.

Heip & Engels (1974) have shown that in a low-diversity community of copepods in the benthos of a shallow brackish water habitat the proposed new index has a superior statistical behaviour in comparison to six other evenness indices; it was the only index which showed no significant departure from normality.

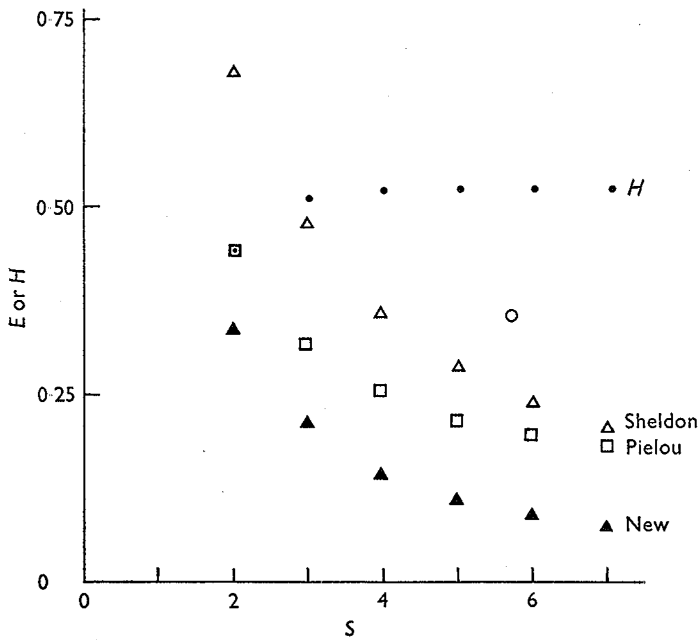

Fig. 2. Evenness E and diversity H in a community where the number of individuals of different species differs by a factor 10 (10–1; 100–10–1; 1000–100–10–1; etc.) as a function of the number of species S.

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