J. Cons. int. Explor. Mer, 36(2): 183–184. Mai 1975.

Short notes

A method for the calculation of ordinate values of the cumulative species - area curve

TORLEIF HOLTHE

University of Trondheim, Royal Norwegian Society of Sciences and Letters
The Museum, N-7000 Trondheim, Norway

Downloaded from https://academic.oup.com/icesjms/article/36/2/183/746368 by guest on 20 April 2024

Introduction

To understand the nature of the dependency of number of species of an association upon area, it is necessary to study the cumulative curve of species number. If a series of N samples is taken, N points of the curve can be found, one point for each area of n, where n is a multiple of the sample unit area.

The easiest way of producing the curve is to accumulate the samples in the order they were taken; or one may first randomize the samples as done by Holme (1953). The curve produced in this way will not be smooth, and only a part of the information of the N samples is used in calculating the number of species of any n area.

Ursin (1960) obtains his semi-cumulative curve by taking the samples n by n, thus getting $(N - r)/n$ parallel samples of size n. If N/n is not an integer there will be a number (r) of samples which will not count in the calculation of the ordinate value, and the weight given to the number of species in a sample will depend on which other samples it is grouped with.

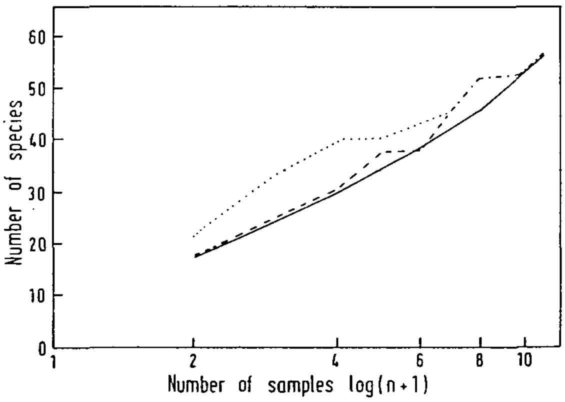

Figure 1. Simple cumulative curve (dotted line), semi-cumulative curve (broken line), and curve of S_n (unbroken line) for the macrobenthos of a station in Trondheimsfjorden.

The method of calculating the mean number of species per area, described below, will give equal weight to all samples.

Method

Consider a series of N samples containing s different species, the frequency of any species is fx_i, the number of species in any particular samples is s_j. Thus:

Species	Samples 1 2 . . . . j . . . . N	Frequencies
x_1		fx_1
x_2		fx_2
.		.
.		.
.		.
x_i		fx_i
.		.
.		.
.		.
x_s		fx_s
Number of species s	s_1 s_2 . . . . s_j . . . . s_N	

Viewing the species as elements of the sets $s_1, \ldots, s_N$, one may treat the mean number of species per area of n, s_n, as the mean of all different unions of n sets of different s_j. There are $\binom{N}{n}$ such different unions:

$$s_n = \frac{\sum\limits_{i_1 \leq \ldots \leq i_N} \bigcup\limits_{j=1}^{n} s_{i_j}}{\binom{N}{n}}$$

Now

$$\bigcup_{j=1}^{n} s_j = \sum_{b=1}^{n}\left[(-1)^{b+1}\sum_{a=1}^{\binom{n}{b}}\bigcap_{j=a}^{b} s_j\right]$$

In the sum of sections each set s_j will appear $\binom{n}{b}\binom{N}{n}\Big/\binom{N}{b}$ times, and the number of elements of a section of b sets is

$$\sum_{i=1}^{s}\binom{Nfx_i}{b}$$

thus

$$\bar{s}_n = \sum_{b=1}^{n}\left[\frac{\binom{n}{b}}{\binom{N}{b}}(-1)^{b+1}\sum_{i=1}^{s}\binom{Nfx_i}{b}\right]$$

Example

The following example is taken from a quantitative investigation of the level-bottom macrofauna of Trondheimsfjorden, Central Norway, in June 1972 (Holthe, 1974). The material consists of 10 replicate samples taken at one station at a depth of 50 m by means of a 0·1 m^2 Petersen grab. The mean number of individuals per sample was 54·9 with a variance of 116·5. A total of 56 taxa (mostly species) occurred in the series.

To calculate s_n one needs the frequencies of the species which are the number of occurrences of the species divided by 10, thus ranging from 0·1 to 1·0; S_n is then calculated for all values of n:

n	1	2	3	4	5	6	7	8	9	10
$\bar{s}_n$	17·10	24·69	30·23	34·87	39·02	42·86	46·45	49·82	53·00	56·00

Species - area curves constructed by the simple cumulative method, the semi-cumulative method of Ursin (1960), and the method described above are shown in Figure 1.

Conclusions

The method described may be used to find empirically the relations between species number and area; it is the only method which for the calculation of the ordinate of any point takes into consideration all the information present in the data. It will produce a smooth curve, the course of which can be judged from a relatively small number of samples.

In practical work the calculation of $\bar{s}_n$ demands the use of a computer. The calculation is easily programmed, but execution time will increase rapidly with increasing values of N.

References

Holme, N. A. 1953. The biomass of the bottom fauna in the English Channel off Plymouth fishing grounds. J. Mar. Biol. Ass. U.K., 29: 267–80.

Holthe, T. 1974. Bunndyrundersökelser i Trondheimsfjorden 1972–1973. Preliminærrapport. K. norske Vidensk. Selsk. Mus. Rapport Zool. Ser. 1974–7: 45 pp.

Ursin, E. 1960. A quantitative investigation of the echinoderm fauna of the central North Sea. Meddr Danm. Fisk. Havunders. N.S., 2(24): 1–204.

J. Cons. int. Explor. Mer, 36(2): 184–187. Mai 1975.

Stereoscan observations of a plaice otolith

R. W. BLACKER

Fisheries Laboratory, Lowestoft, Suffolk, England

The Cambridge Stereoscan Mark IIA electron microscope in the Department of Environmental Sciences at the University of East Anglia has been used in attempts to study the structure of the sagittal otoliths of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and plaice (*Pleuronectes platessa*). The best results, so far, have been obtained from plaice otoliths.

The Stereoscan accepts objects up to 12·5 mm in diameter and about 5 mm thick, so that whole otoliths, broken pieces or cut sections of otoliths can be examined. Initially a whole plaice otolith was examined but the surface showed nothing that could be related to the hyaline and opaque zones which are the basis of the use of otoliths for age-determination. The surface of a fracture showed mainly the radiat-

Downloaded from https://academic.oup.com/icesjms/article/36/2/183/746368 by guest on 20 April 2024