Numerical Estimation of the Impact of Terrestrial Ecosystems by Using the Staphylinid Beetles Communities

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Staphylinid beetles are an insect family very rich in species. They comprise species with diverse ecological demands, whose imagos and larvae are abundant in all types of biotopes, often with close ties to some of them. Man-made environmental changes frequently result in changes in the structure of staphylinid communities /BOHÁC, 1986, 1988/. In view of this, staphylinids can serve as suitable indicators of anthropogenous environmental changes.

The aim of the present work is to propose an index expressing the degree to which staphylinid communities are influenced by the activities of man.

Materials and methods

Various mathematical indices are used for evaluating material from ecologico-faunistic investigations with respect to the naturalness of the locality under study or the degree to which it is affected by the activities of man /ODUM, 1983/. These indices are calculated from the numbers of species and individuals in a sample of the community and do not include the ecological properties of the species, including their sensitivity to the activities of man. Thus, although applicable for bioindication purposes, they are not a really objective indication of the degree of landscape disturbance /RUZICKA, 1987/.

The percentage abundances of species from various ecological groups are employed for the evaluation of the site conditions, thus contributing to our knowledge of the ecological demands of the species. A convenient method for the evaluation of the degree of anthropogenous disturbance is the classification of species occurrence relictness. This classification was initially worked out for spiders /BUCHAR, 1983/ and, more recently, for staphylinids /BOHAC, 1988/, and its elaboration for other groups of invertebrates is feasible. The fauna of staphylinid beetles in Czechoslovakia was classed in three groups: 1. species occurring predominantly in protected territories and territories unaffected by man; 2. species occurring in man-made forest ecosystems and not proliferating into non-forest ecosystems /2nd rank relicts/; 3. ubiquitous species occurring mainly in open agricultural landscapes and urban ecosystems /fields, meadows, ruderals/.

The percentage abundances for the individuals of expansive species proved useful in assessing the degree of site deterioration. This value increases from localities little affected by man to anthropogenous localities. However, as pointed out by KURKA /1987/, all three components of the community must be taken into account, rather than a single one. The index proposed here is a simple mathematical index covering all three components. Referred to as the index of staphylinid communities /ISC/ /BOHÁC, 1988/, it is defined as

$$ISC = 100 - \left(\sum_{i=1}^{n} U_i + 0.5 \sum_{i=1}^{n} RII \right)$$

where the first right-hand sum comprises the percentage abundances of individuals of ubiquitous species, and the second the abundances of individuals of 2nd rank relicts.

The value of this index ranges from 0 /only ubiquitous species are present, the community is highly affected by man/ to 100 /only 1st rank relicts are present, the community is virtually unaffected by man/. After establishing the index values for different biotopes it is possible to characterize the degree of anthropogenous influence in the examined communities by a single figure, thus avoiding dubious comparisons with sparse controls.

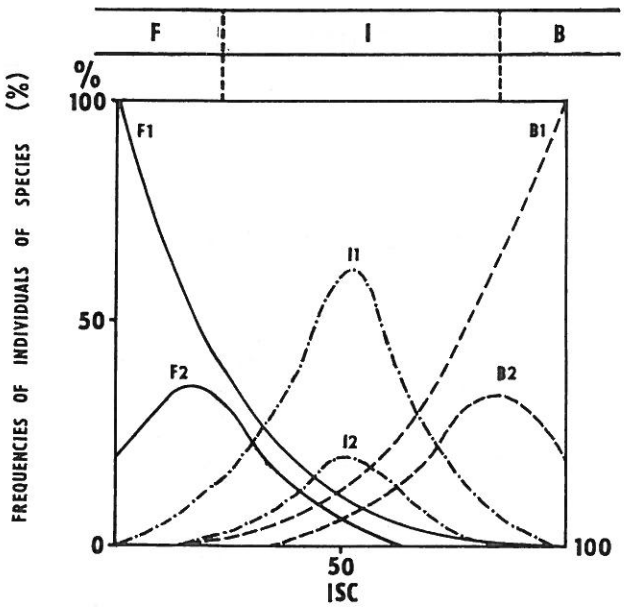

Fig. 1

Species distribution as a function of the relation between the index of staphylinid communities /ISC/ value and the frequencies of individuals of the species in the community. F = anthropophilic species; I = anthropoindifferent species, B = anthropophobic species; 1 = subgroups with high frequencies in the community; 2 = subgroups with low frequencies in the community

Conversely, the relation between the ISC value for a given biotope and the species abundances within the communities can be employed as an index of the sensitivity of various species to anthropogenous stress; it can also serve for a refinement of the classification /Fig. 1/. A graphical representation of this relation was obtained for 155 communities and 70 species of staphylinid beetles.

Results

The index of staphylinid communities appears to be well suited for characterizing the anthropogenous effect on the biotopes examined. Its value increases from highly affected biotopes /ruderals, agrocoenoses,

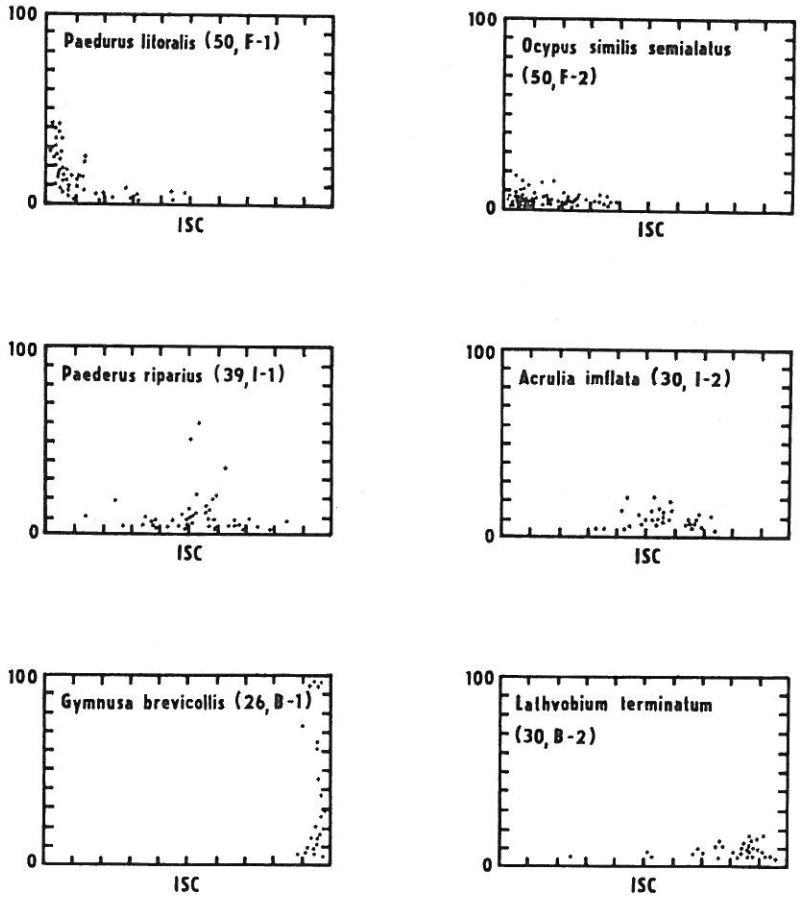

Fig. 2
Examples of evaluations of the relation between the index of staphylinid communities /ISC/ and the frequencies of species occurrence in the community for anthropophilic, anthropoindifferent and anthropophobic staphylinid beetles. The numbers of biotopes evaluated and the corresponding groups are given in parentheses, using the designations given in Fig. 1

pastures: ISC = 0 - 10; man-made forest ecosystems: ISC = 0 - 31/ to less affected biotopes /oak-hornbeam forests, acidophilic oak groves, beech forests, alder forests, steppe-forests, managed meadows: ISC = 25 - 59/ to biotopes where the communities are nearly natural /oak groves, mountain forests with firs, shores of unregulated brooks and rivers, peat bogs, dunes, saline meadows, subalpine meadows.

With respect to the relation between the index of staphylinid communities and the frequency of the numbers of individuals in the community, we divided the staphylinid beetles into three groups, namely anthropophilic, anthropoindifferent and anthropophobic species. Each, group was further divided into two subgroups, frequencies, respectively /Figs. 1, 2/. These groups were characterized with respect to life strategies and life forms, the corresponding size groups, and groups classed by their thermopreference and hydropreference and by their zoogeographic occurrence /BOHÁC, 1988/.

The method described for the evaluation of the response of species to anthropogenous effects enables us to determine the response of all staphylinid beetle species. The evaluation of communities is a tool for characterizing ecosystems by a single index, which may be of value, for example for nature conservancy purposes. This approach can also be applied to other groups of invertebrates.

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