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Community Characterization for Purposes of Habitat Evaluation: Assessing the Influence of Winter Tourism on some Insect Assemblages*

by

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Zusammenfassung

Charakterisierung von Zönosen für eine Habitatbewertung: Erfassung des Einflusses von Winter-Tourismus auf einzelne Insektengemeinschaften.

Ski-Tourismus kann in Gebirgslebensräumen zu erheblichen Schäden führen. Auswirkungen auf Insektengemeinschaften *(Diptera: Syrphidae, Coleoptera: Carabidae, Orthoptera)* in solchen belasteten Gebieten werden vorgestellt und diskutiert. Die Untersuchungen belegen den Nachteil von Diversitätsmessungen beim Vergleich von Lebensräumen, sie zeigen hingegen den Vorteil eines mehr „mechanistischen" Ansatzes auf. Auf diese Weise sollte es möglich sein, dem Problem der Habitatsabgrenzung näher zu kommen. Eine Möglichkeit, die sich anbietet, besteht in einem Datenverarbeitungssystem (Geographisches Informationssystem), wie es beispielsweise gegenwärtig im Nationalpark Berchtesgaden angewendet wird („Arc-Info").

Abstract

Skiing can cause serious damage to mountain habitats. The changes which occur within the insect communities of affected areas are discussed by reference to studies of assemblages of *Syrphidae (Diptera)*, *Carabidae (Coleoptera)* and *Orthoptera*, undertaken in the Austrian and Bavarian Alps. These studies expose the weaknesses of using diversity measures to compare communities, while illustrating the advantages of a more mechanistic approach to such research. It is suggested that the mechanistic outlook should be extended to include the problem of habitat definition, and that one way of achieving this would be through the use of computer based Geographical Information Systems, as exemplified by the 'Arc-Info' package presently in use at the Berchtesgaden National Park.

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Introduction

Deterioration of mountain habitats through skiing has recently become a serious problem in certain parts of the Alps. Ultimately the process leads to destruction of vegetation and then erosion, but before these stages are reached the structure of the animal and plant communities is considerably changed. The present paper considers some of the difficulties of detecting and measuring such variations within selected insect communities.

Diversity as a parameter of community description

Over the past 15 years or so, diversity has been used as a convenient means of evaluating the ecological quality of an area. Whether expressed in terms of simply the total number of species (species richness), or as the number of species in relation to the total number of individuals, or whether an index is used which includes a measure of the 'equitability' (evenness) of the distribution, the validity of using a single statistic to describe and compare communities is now open to question. This can be illustrated by the following three examples:

1. The Hoverflies *(Syrphidae, Diptera)* of the Gastein Valley, Austria.

In a comparative study of the syrphid faunas of skied and unskied sub-alpine meadows I have previously demonstrated that despite obvious habitat deterioration, ski slopes can have just as 'diverse' a community as unskied control meadows (HASLETT 1988).

2. The *Carabidae (Coleoptera)* of the Berchtesgaden Alps, FRG.

In a study of the carabid beetless on the Jenner mountain, HAMMELBACHER & MÜHLENBERG (1986) conclude that diversity measures can be very misleading when investigating ski slope faunas. Here again the ski slope was shown to be just as diverse as the control.

3. The *Orthoptera* of the Gastein valley, Austria

The sub-alpine grasshopper community studied by ILLICH (1985) consists of only 5 species. Although some differences in species richness were noted between ski slope and control meadow communities, a reliance on diversity measures would in this case be meaningless, as it is impossible to say whether the variations within such a small pool of species are a result of anything other than random processes.

The above examples clearly illustrate the limitations of using diversity as an all-embracing statistic for characterizing alpine meadow insect communities. Indeed, the value of such community based 'megaparameters' is presently being questioned throughout ecology, and many workers are now looking towards a more reductionist 'mechanistic' approach.

The mechanistic approach

Here, the community is no longer looked upon as a 'superorganism' with characteristics peculiar to itself. Rather, communities are made up of populations of individuals and it is the 'individual based' properties which account for the workings of the community as a whole. Using this idea to re-examine the three examples given above, differences between the ski slope and control meadow insect communities become clear.

Adult hoverflies may be divided into a number of foraging groups, for present purposes it is enough to say three, – pollen generalists, pollen specialists, and grass pollen feeders. (This can be done by analysing the pollen contained in the guts of individual flies. See HASLETT, in press). When the proportions of species within each of these groups are compared between the two meadow habitats, it is immediately apparent that the specialists are lost from the ski slopes (HASLETT 1988).

Similarly, among the carabid beetles, the feeding specialists (known from the literature) disappear from the ski slopes, and the fauna becomes comparable to that of an agricultural landscape (HAMMELBACHER & MÜHLENBERG 1986).

With the *Orthoptera*, a clear pattern emerges in which it is not so much feeding requirements, but physical aspects of the micro-habitat which are important. Low vegetation interspersed with patches of bare ground on the ski slope mean that grasshoppers which tend to sit relatively high above the ground surface are not accommodated in this habitat and are thus of infrequent occurence in such areas.

It appears then, that the mechanistic approach can be helpful when undertaking comparative community studies. This being the case it would seem sensible to apply a similar logic to the definition of the habitats within which the communities exist. Presently, it is common practice to define terrestrial habitats as discrete units, taking little account of the degree of heterogeneity or of the presence of neighbouring biotopes. Such a definition has only limited relevance to the natural world. To take the ski slope example, most skiing areas are in reality a mosaic of patches at different stages of degradation, from 'healthy' unskied meadow to areas of eroded bare ground. This mosaic may be thought of as similar to the one described by REMMERT (1985) for supposedly 'climax' woodlands. Further, common sense suggests that a ski slope which is surrounded by one type of habitat (such as woodland) is likely to support assemblages of organisms at least slightly different to those found in an equivalent situation where the surroundings are different (such as open meadow).

Seen in these terms, a habitat becomes a collection of 'patches', each of which may have associations with neighbouring patches and each of which offers a different combination of 'resources' to the exploiting organisms. To be able to make comparative studies of such systems, it is crucial that the worker is able to delimit the patches of the mosaic on a map, and that he be able to attach large amounts of information to each patch.

One way in which this may be achieved is through the use of a computerized Geographical Information System (G.I.S.). A good example of such a system is 'Arc-Info' (available from Environmental Systems Research Institute, Ringstr. 7, D-8051 Kranzberg, FRG). This computer package is presently being used in the Berchtesgaden National Park as an aid to research designed to investigate the 'Impact of Human Activities on Mountain Ecosystems', undertaken as part of the Man and Biosphere Project 6. The general principle under which Arc-Info operates is quite straightforward. A number of maps, each giving some different information about the area in question, are superimposed upon one another in a manner analogous to the way one can stack transparent sheets on an overhead projector. In Berchtesgaden, maps giving details of contour lines, gradients of slopes, aspects of slopes (exposition), and ground cover types provide the working basis for the system, but any number of variables may be included. When these maps are 'laid on top of each other' by the computer, the result is a complicated pattern of shapes – called polygons – each of which is accurately defined in terms of the variables mentioned. Add to this a means of identifying each individual polygon (simply a number), and an information system which allows any amount of data to be appended to that number, and we have a system capable of defining areas according to specific criteria and storing all sorts of extra information associated with those areas. (For a more detailed account of GIS see SCHALLER & SPANDAU 1987).

Now, substitute the word 'polygon' for the word 'patch' in the previous discussion of habitat definition, and we have a practical framework on which to base mechanistically orientated studies of habitats and the communities of organisms they contain. As well as offering the obvious advantage of allowing the selection of standardized sites for field experiments, this framework makes it possible to explore the constancy of community structure in relation to the characteristics of particular habitats and their surroundings. The work in this direction is still in its infancy, but the achievements of the Berchtesgaden National Park to date indicate an exciting future.

In conclusion, it may be suggested that a mechanistic approach to the study of both communities and habitats could lead to a much more exact understanding of ecological systems, certainly a desirable goal if we are to be successful in managing our environment.

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