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PREDICTION OF SPIDER SPECIES OCCURRENCE: AN EXAMPLE USING THERIDIID SPIDERS (ARANEAE)

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Abstract

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An attempt to predict spider species occurrence is described, using theridiid spiders as an example. Data from the database of Middle European spiders was evaluated to describe the relationships among the occurrence of spider species using the Jaccard coefficient and cluster analysis. Common "non-specific neighbour" species are eliminated in this way – they are often found with a spider in question but have a minimum indication value. The result of such an analysis is a list of the species occurring regularly with the given spider without any other relation to the features of the habitat. A possible use of such knowledge could be, for instance, the search for a certain species in the given place on the basis of the neighbour's occurrence discovered by previous collection.

Introduction

Numerous authors have described the relation between specific spider fauna and different biotopes. In this connection various efforts exist to classify the relations between species and phytocenosis, or even to define the spider community (Luczak, 1954; Šmaha, Pěnička, 1989; van Helsdingen, 1997; Gajdoš, 1995). However, the same spider species are often found in different plant associations. Factors characterising plant ecological demands are often different from the factors affecting spider occurrence. In fact, the number of spider species is not strongly correlated with the plant species, but to a greater extent, depends on the spatial structure and microclimate of the environment (Duffey, 1966; Clausen, 1986). The physical structure of the habitat also has a profound effect on habitat selection

(Robinson, 1981; Merkens, 1997). Thus these distributions may also reflect responses of the populations to competition for prey, or mates, rather than a pure preference for microhabitat or microclimate (Snazell, 1982).

The main problem is that the factors influencing occurrence are very complex. For this reason it is very difficult to predict the presence of a species in a specific locality. The species typical for the appropriate habitat may or may not be present in such a locality. Finding a peatbog species in a peatbog is not surprising. On the other hand, a forecast of existence of a given species entirely in a particular peatbog is not at all certain to be true.

To solve the given question from this point of view, spider groups occurring together without a necessary relation with habitat features can be evaluated. The intention of the paper is the verification of the method of estimation of such groups. Possible use of the obtained knowledge could be, for instance, the forecast of the presence of a certain species according to the presence of other species of the mentioned group after previous collection in the given locality.

Material and methods

For solving the described problem, the evaluation of the theridiid spiders was performed using the database published in Hänggi et al. (1995). This database contains a list with the most abundant species collected together with the presented species. For brevity, we introduce the term „neighbour“ for such species. However, the problem is that this list contains mostly common species, which we can call „non-specific neighbours“. For example, *Trochosa terricola* (Thorell) is a very frequent species collected along with many different spiders. However, we search for specific neighbours, i.e. species that occur most frequently together with the spider in question but occur independently in few cases.

To search for a specific neighbour we used the Jaccard coefficient. Given two spiders, when A is an independent occurrence of the 1st spider, B an independent occurrence of the 2nd and C the occurrence of both together, then the Jaccard coefficient is equal to C/(A + B + C). Cluster analysis was used to create dendrograms.

Results

An example of the result of Jaccard coefficient computing is shown in Fig. 1. The left part of the figure shows the most abundant species published in Hänggi et al. (1995), the right part is the result of computing (the rank order of spiders with highest Jaccard coefficients). The comparison shows that specific neighbours are species mostly different from the non-specific neighbours.

The co-occurrence of theridiids was evaluated by cluster analysis using all habitats in the database. In Fig. 2, discrimination into several groups was demonstrated: 1- Species living in trees and shrubs, 2- xerophilic spiders, 3- steppe spiders, 4- synanthropic species. Studying the first group, we can see large differences in terms of co-occurrence. For instance *Theridion pinastri* L. Koch and *Theridion tinctum* (Walckenaer), typical of pine forests, are very close. On the other hand, *Theridion pictum* (Walckenaer), which is found regularly on the banks of ponds, is distant from all others.

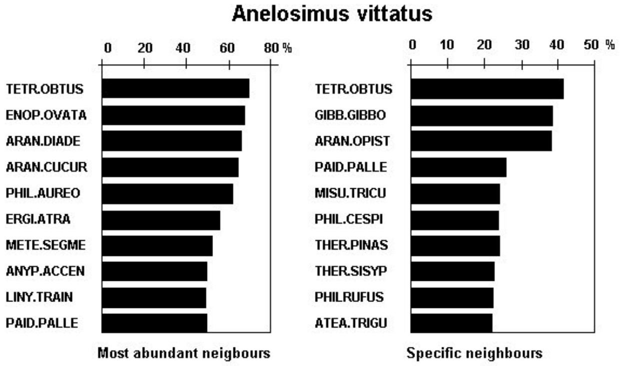

Fig. 1. Comparison of most abundant neighbours and specific neighbours.

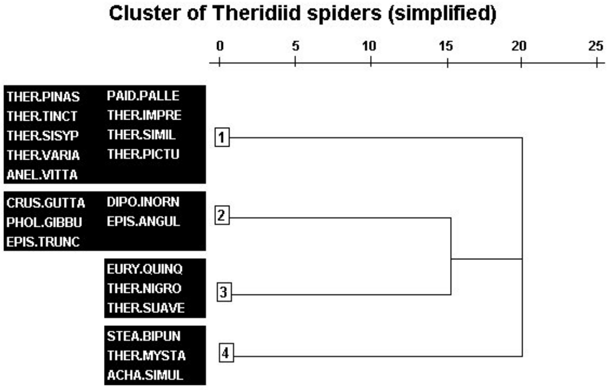

Fig. 2. Clusters of theridiid spiders (simplified).

To determine the specific neighbours of theridiid spiders living in trees and shrubs among all other spiders, it was necessary to eliminate those species that are common everywhere. For this purpose the specific neighbours were estimated by means of the Jaccard coefficient. In the second step, the first group from Fig. 2, with their specific neighbours, was evaluated using cluster analysis. These are the different spider communities characteristic of taller vegetation. Individual groups delimited in such a way are demonstrated in Fig. 3.

On the basis of evaluation of specific neighbours, an opportunity to estimate the probability of theridiid spider occurrence is presented. This probability is estimated as the highest frequency of combination of a given species with specific neighbours found in the database. We can see in Fig. 1 that there are several subgroups existing among specific neighbours of *Anelosimus vitatus* C. L. Koch.

Example: By data processing in the database, *A. vittatus* was found in combination with its specific neighbours (*Araniella opisthographa* (Kulczyński) and *Misumenops tricuspidatus* (Fabricius) in 95% of cases. The interpretation of this result: when we find *A. opistographa* and *M. tricuspidatus*, then *A. vitatus* should be expected in 95% of cases.

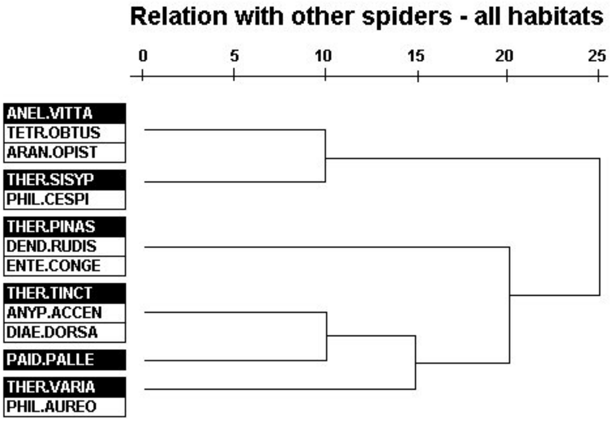

Fig. 3. Relations of theridiid spiders with other spiders in all habitats.

To verify the efficiency of predictions, the test of relevance was performed. To predict the occurrence of the species, the following sources were used: Czech faunal list Růžička et al. (1996) and the data from the Swiss database Hänggi et al. (1995). The Swiss database was used as a training set of data for computing Jaccard coefficients. Czech species lists were used as a test set of data. We have tried to predict the presence of theridiid spiders (supposed to be unknown) according to the rest of the species in the lists. First, particular combinations of occurrence of individual theridiids in relation to a specific locality were inputted. Then we searched for the actual presence of the predicted species. In other words, using specific neighbours, the estimation was performed to ascertain if the present species could be really expected. The preliminary results of the test are as follows: in 13 localities 14 theridiid species were present. A successful prediction on the basis of computed combinations was 10 species, i.e. 71%. In all cases the list has to contain more than 30 species, because a lover number of species could influence the efficiency of computing probabilities.

Discussion

A spider community is a group of species which are often found together. Such a species group is usually composed of different kinds of species: Some species are found very frequently together in the specific type of habitat studied, but it is also possible to find them in other habitat types. Other species are found quite rarely, but exclusively in this particular habitat type and nowhere else MERKENS (1997). The supposed reason for this fact is the very complex effect of individual ecological factors. In this connection MARTIN (1991) does not evaluate spider habitat preferences in relation to phytocenoses, but with more general features of habitat, which is similar to our concept. If phytocenosis is used in the last case for this purpose, then it is more often as the complex feature of habitat, for instance by means Ellenberg's method (KROPF, 1993).

Cluster analysis (in our paper in additional combination with the Jaccard coefficient) is actually often used for the evaluation of the complex relations between species and environment. Many papers evaluating occurrence of spider communities use multi-dimensional methods, which express the complexity of the factors in question more precisely – FINCH (1997), CANARD (1997). BOSMANS (1986) created dendrograms based on the differences between individual habitats. The distinction into vegetation belts here is not necessarily coincident with the occurrence of spider communities. Similarly, according to multi-dimensional evaluation of heather arachnocenoses, the microclimate conditions are of the higher importance (KLEINMANS, 1997).

Efforts to make a prediction of occurrence optimum, as described in RUSHTON (1991), are not so frequent. On the other hand, our preliminary results concerning prediction possibility show some positive facts, supporting the development of this approach using the described methods.

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