European Arachnology 2000 (S. Toft & N. Scharff eds.), pp. 171-176.
 ISBN 87 7934 001 6
(Proceedings of the 19th European Colloquium of Arachnology, Århus 17-22 July 2000)

Practical use of a single index to estimate the global range of rarity of spider communities in Western France

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Abstract
A patrimonial index (I_p) was calculated for different habitats of a nature reserve and the relative contribution of each habitat to the global patrimonial value of the reserve is presented. Strong variations can be observed between the different values of the patrimonial index. These variations have to be related to the management of the habitat, to the presence of local habitats, and also to the fragmentation of the shrubby layers. For example, set-asides and local *Juncus maritimus* beds exhibit the highest values, while areas exposed to animal trampling and fragmented areas exhibit the lowest ones; we can notice that the values gradually increase from the lowest to the highest. The variablity of the I_p is linked to the number of species analysed, to the collecting method and varies strongly in the course of the year.

Key words: spider communities, nature reserve, biodiagnostics, Western France

INTRODUCTION

The principle of evaluation of a habitat by analysis of the global range of rarity of spider communities is based on the following concept: an area which has been partly or totally depleted of its living species is immediately colonised by the species living in adjacent areas as soon as the conditions have improved. These early arriving species have a high dispersal potential; they are ubiquitous species and form a community of low conservation (or patrimonial) value. On the contrary, an area which has a high number of rare specialised species (stenoecious species), with a low capacity of recolonisation, is an area which has maintained its original biodiversity. Such a spider community has a high conservation value. Referring to this idea, an index (I_P) based on the relative rarity of the spider species to estimate the conservation value of different communities was elaborated (Canard et al. 1998). To assess how species richness among the communities influence the I_P value, we first present a brief theoretical analysis on the variations of the I_P values. Secondly, we describe an example of the practical use of this index as a contribution to the elaboration of the managing plan of a natural reserve in the west of France.

MATERIALS AND METHODS

Calculation of the index

A reference base indicating the distribution of all the spider species of Western France allows us to evaluate the relative rarity of each species (Fig. 1). The number of stations in the reference base are divided into several groups (group of species known from 1, 2, 3 ….10 stations to group of species known from 200 to 250 stations).

Fig. 2 gives a theoretical example of the

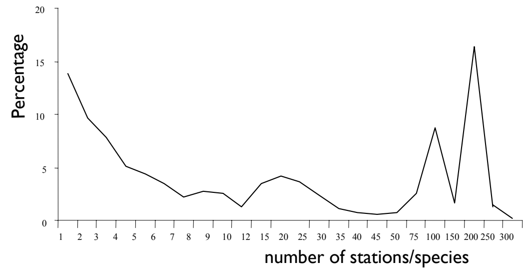

Fig. 1. Reference base curve for the West of France (percentages from 23296 records).

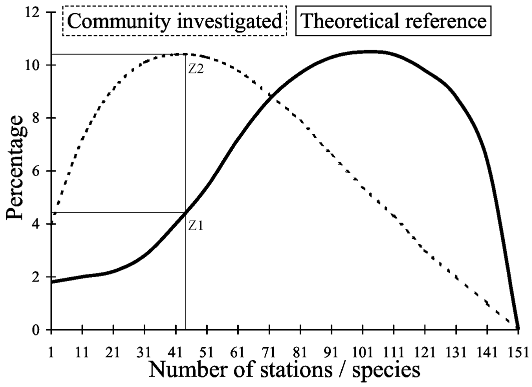

Fig. 2. Theoretical comparison of the investigated biotope curve and the reference base curve for a biotope containing few common species (after Canard et al. 1998).

principle of calculation of the index. The black curve indicates the percentage of species known from different groups in reference base; the doted line indicates the percentage of species of a hypothetical community investigated known from different groups. At point Z1 there are 4% of the total species of the theoretical reference base known from 41-50 stations. At point Z2 there are 10.4% of the species in the community investigated known from 41-50 stations. The patrimonial index (I_P) is calculated in a computer program which sums all the differences between Z1 and Z2 for each group of stations. Thus the global range of rarity of the community investigated is given by a single value: the patrimonial value (I_P). By referring to the database of the west of France, the patrimonial index may vary from -27 when there are only very common species in the community, to +75 when there are only rare species in the community (known from only one station). These values are different from those in Canard & al. (1998); they agree with new data on species distribution. Another noticeable value is 'zero' which corresponds to a theoretical community composed of all the species of the reference base.

To examine how both the species richness and the overall rarity of the community affect the I_P values, we used simulated I_P values for several theoretical communities. These communities were composed of species known from 10, 40, 70, or 100 stations in the reference base. We then introduced one or two unknown species (not listed in the reference base) for each theoretical community to explore the range of variation of the I_P values.

Field analysis

The nature reserve investigated ('Réserve Ornithologique de Séné') is a coastal area of Western France (47°36'N, 2°42'W) consisting of a complex of salt-marshes, rush meadows, pastures, mowed and non-mowed meadows, fallow land, surrounded by hedges and thickets. The first aim of this nature reserve is to serve as a stop-over area for migrating birds on major flyways. For a few years, arthropods have been taken into account to develop a managing plan for the terrestrial areas of this nature reserve. Spiders were collected by nine series of pitfall traps (2 pitfall traps per plot) from 15 March 1998 to 30 October 1998. Results from a second period of pitfall trapping (15/02/99—30/03/99) were added. In both periods, spiders were removed from the traps every two weeks. Additional sampling was made by visual searches and beating of branches throughout this period. Eighteen plots have been investigated (Table 1) representing the different vegetation types found in the nature reserve. Special attention was paid to edge effects, and we considered the spider community of a field margin separately from that found in the center of the plot. We also considered the communities

Table 1. List of the 18 investigated plots ordered according to their patrimonial index (I_p). N: number of species; Es.: percentage of exclusive species found only in one habitat.

Areas investigated	N	Es. (%)	I_p
Fallow land (center)	46	11	-21.43
Mesophilous grassland	36	0	-22.94
Humid meadow (margin)	44	4.5	-23.37
Juncus maritimus beds	41	9.8	-23.64
Tree foliage	56	25.8	-24.24
Upper shore communities	49	4	-24.66
Salt-marshes	19	10.5	-24.85
Mowed humid meadow	41	14.5	-25.16
Blackthorn-bramble scrubs (ground-layer)	37	13.5	-25.12
Sub-Halophytic humid pasture	56	5.3	-25.28
Halophytic humid pasture	54	11	-25.60
Fallow land (margin)	73	22	-25.82
Mesophile grassland	40	22.5	-26.08
Non-mowed humid meadows	40	10	-26.53
Small deciduous woods (ground-layer)	43	23	-26.71
Mesophile pasture	43	0	-26.96
Gorse clumps	39	20.5	-27.43
Banked edge of salt basins	33	6	-27.55

found at the center and margin of the fallow land separately.

I_p values were also calculated both for all species collected by each method (pitfall traps, visual searches, beating of branches) and for the species that were caught exclusively by each method. For this purpose, data from all 18 habitats and all seasonal samples are combined.

RESULTS

Theoretical variations of I_p

If the I_p value does not vary for a community composed of species known from the same number of stations, whatever this number of species is, the integration of a new species (an unknown species in the reference base) induces a strong increase of the I_p value (from –26.1 to –9.95) for the community which has from 5 to 250 species (Fig. 3a). When the species diversity is high (from 50 to 250 species) the I_p value increases very slowly (from –25.82 to –22.36). The highest values of the I_p can be observed for the community with two new species what-ever the number of species of the community is (Fig. 3b). When the number of species in the investigated community is low, we can notice strong differences between the values of I_p. When the number of species in the commun-ities is high, the I_p values are very close. Thus the difference between two I_p values depends on the number of species and the communities must be composed of at least 25-30 species for a reliable comparison.

I_p values for the nature reserve

247 spider species were identified in the whole nature reserve and the values of the species richness of the different plots allows the direct comparison of the I_p values. However, the salt-marshes exhibited the lowest diversity (19 species) while the maximal diversity (73 species) was found in the margin of a fallow field.

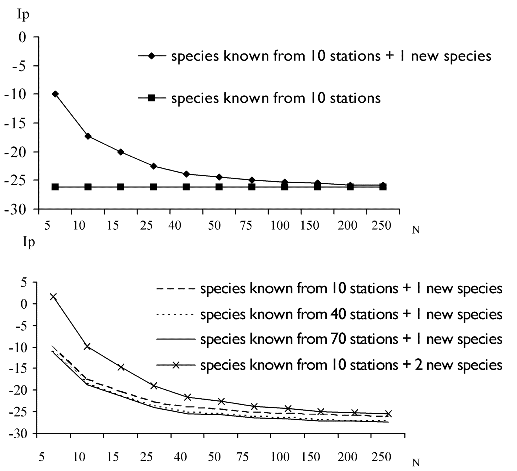

Fig. 3. Simulation of the patrimonial index (I_p) in relation to species richness (N)

Thus it can be underlined that, compared to other habitats, the I_p value of salt marshes is probably overestimated while the I_p value of the margin of a fallow field is probably underestimated. Table 1 lists these 18 plots according to their patrimonial index. The fallow land exhibited the highest patrimonial index whereas the banked edge of salt basins exibited the lowest, and the values gradually increased from the lowest one to the highest one. We can distinguish two groups among the different areas investigated. The low patrimonial value group consists of stations subjected to human trampling (small deciduous wood), animal trampling (banked edge of salt basins) or animal grazing (mesophile pasture). These areas have a negative effect on the global patrimonial value of the reserve. The low patrimonial value of the gorse clumps must also be related to the fragmentation of the investigated clumps. The high patrimonial values group have to be related to the specific orientation of biotopes (warm microclimate of the old fallow land) or to unusual and only locally occurring habitats in the region (e.g. salt-marshes or *Juncus maritimus* beds). It is also due to the presence of species which have seldom been recorded in France, or which are new to the French fauna (as for instance *Haplodrassus minor*). Concerning the spider communities, these areas have retained their own specificity without any disturbance. They have a positive effect on the overall patrimonial value of the reserve. However, whatever the patrimonial value of the different plots, their species richness have a positive effect on the richness of the spider fauna of the whole nature reserve.

The comparison between the patrimonial index of each habitat plot and the whole nature reserve with other values in the same biogeographic area (Fig. 4) clearly indicates that the spider community of fallow land is distinguish-able from other communities composed of 25 to 80 species because of its high patrimonial value. The I_p value of the whole nature reserve is higher than those of dry heathlands and atlantic heathlands but lower than those of

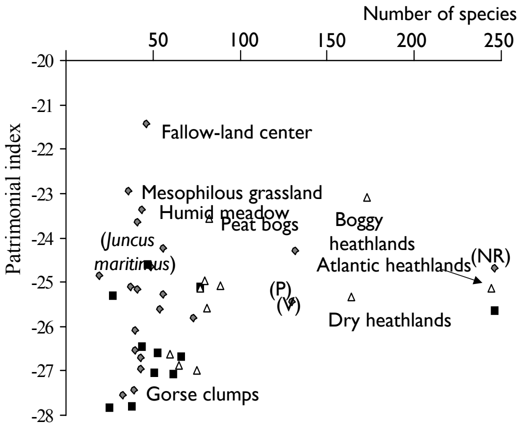

Fig. 4. Overview of the patrimonial index of different areas of the west of France including the nature reserve investigated. ◊ : habitats of the nature reserve; ■ : other habitats of Western France; △ : other habitats within the coastal area.
(Data from all 18 habitats and all seasonal samples: P : I_p value for species collected by pitfall traps; V : I_p value for species collected by visual-search; NR : I_p value of the whole nature reserve).

peat bogs and boggy heathlands. Fig. 5 shows the variation in the patrimonial index during the year (from March to October) for the samples from the 18 plots of the reserve. This variation is due to the staggered occurrence of adults of different species. Table 2 gives the patrimonial index values for the three different sampling methods used. More than 60% of the species were collected by only one method. Thus, a single sampling method cannot give a representative value of the patrimonial index. It is noticeable that the two values are very close, but considering the number of species collected, this small variation can be taken into account. Another remark concerns the high patrimonial value of the species exclusively caught by pitfall-traps. This may indicate that more rare species have been caught by pitfall traps. However, it may also indicate that there is a lack of data in the reference base concerning the distribution of species caught by pitfall traps.

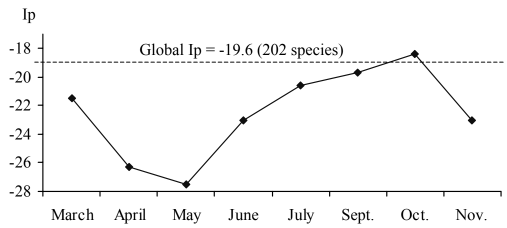

Fig. 5. Variation of the patrimonial index in the course of the sampling period, data from all plots combined.

Table 2. Patrimonial index (I_p) according to the sampling methods (data from the 18 habitats of the nature reserve surveyed through one year combined). N: total number of species collected; Es.: number of species ecxlusively caught by one sampling method.

Sampling method	N	I_p	Es.	Ip Es.
Pitfall trapping	135	-24.32	80	-19.90
Hand collecting	130	-25.44	71	-26.10
Branch beating	69	-24.24	40	-21.13

DISCUSSION

These results are consistent with previous studies demonstrating that the heterogeneity in mosaic landscape and the incidence of mowing or trampling typically affect the species richness (Duelli 1997; Dupont & Lumaret 1997); this short study provides a response, not only in terms of analysis of species richness but also in terms of evaluation of the conservation value of human management. Because the index is very sensitive to the presence/absence, and to the number of species collected, standardized methods have to be strictly followed when comparing several plots during the same periods. The index does not take into account the species density and only refers to the presence/absence criterion. One may object that the distribution of abundance among species can be important in the evaluation of the patrimonial value of localities. Unfortunately, the number of spiders collected strongly depends on the sampling effort (visual search), the sampling period, the design of the pitfall traps and the microenvironment around them. Thus we suggest that it is inadequate to integrate quantitative data on spider densities to compare habitat conservation values at the community level from available data sets. Use of density is most appropriate to assess the different forms of rarity (Rabinowitz et al. 1986) when a study focuses on a particular species. However, in order to minimize the 'sampling effect' on the I_p values, the reference base can be split into several units according to the sampling method or to sampling seasons.

The originality of the patrimonial value of the different listed communities comes from the integration of the rarity degree on all the species of the community. This approach can complete other approaches based on the research of the so-called 'rare species' and whose status in Europe (Van Helsdingen 2000) still needs to be studied. Other kinds of single index have been proposed to evaluate the patrimonial value of the habitats. Ruzicka and Bohac (1994) have proposed a single index based on the percentage of representation of three species groups in the investigated community: spiders associated with protected territories (group I), with managed territories (group III) and others species (group II). Other indices based on the occurrence of species in geographic units (method of square mapping) have been pointed out to estimate the global range of rarity of insect communities (Eyre & Rushton 1989) or of spider communities (Gadjos & Sloboda 1996). In France the so-called 'indice biotique global de rareté' first proposed by Favet & Bigot (1993) (which is nowadays used to define the French status categories for invertebrate species) is the result of a rather subjective attribution for each species of a rarity index varying from 1 (endangered species) to 8 (very common species). Although the reference base still needs to be completed, the method we are working on presents a base which systematically integrates all the data on the species distribution, and the patrimonial index can be quickly up-dated with new data on the species distribution.

Whatever definition of rarity one uses, the results will be influenced by the spatial scale at which it is applied (Gaston 1994). In order to explore rarity at different range size, the reference base can also be split into several units from the geographic point of view (example presented here), to a smaller natural complex (as for instance a complex of littoral areas), to a particular type of biotope (heathlands, dunes ...), to a particular macroclimatic area within the geographic zone or the administrative district. The possibility of using different indices at different scales within a geographic area to assess the global range of rarity of spider communities is presently being analysed.

REFERENCES

Canard, A., Marc, P. & Ysnel, F. 1998. Comparative value of habitat biodiversity: an experimental system based on spider community analysis. In: *Proceedings of the 17th European Colloquium of Arachnology, Edinburgh 1997* (P.A. Selden ed.), pp. 319-323. British Arachnological Society, Burnham Beeches, Bucks.

Duelli, P. 1997. Biodiversity evaluation in agricultural landscapes: An approach at two different scales. *Agriculture, Ecosystems & Environment* 62, 81-91.

Dupont, P. & Lumaret, J.P. 1997. *Intégration des invertébrés continentaux dans la gestion et la conservation des espaces naturels. Analyse bibliographique et propositions.* (P. Dupont & J.P Lumaret eds.), pp. 35-53. Ministère de l'Environnement.

Eyre, M.D. & Rushton, S.P.1989. Quantification of conservation criteria using invertebrates. *Journal of Applied Ecology* 26, 159-171.

Gadjos, P. & Sloboda, K. 1996. Present knowledge of the arachnofauna of Slovakia and its utilization for biota quality evaluation and monitoring. *Revue Suisse de Zoologie* hors série 2, 235-244.

Gaston, K.J. 1994. *Rarity.* Chapman & Hall.

Favet, C. & Bigot, L. 1993. Expertise des milieux naturels: une méthode originale par cotation des populations d'insectes. *Insectes OPIE* 90, 25-28.

Ruzicka, V. & Bohac, J. 1994. The utilization of epigeic invertebrate communities as bioindicators of terrestrial environmental quality. In: *Biological monitoring of the environment: a manual of methods* (J. Salanki, D. Jeffrey & G.M. Hughes eds.), pp. 79-86. CAB International, Wallingford.

Rabinowitz, D.,Cairns, S. & Dillin,T. 1986. Seven forms of rarity and their frequency in the flora of the British Isles. In: *Conservation biology: The science of scarcity and diversity* (M.E. Soulé ed.), pp. 182-204. Sinauer, Associates, Sunderland, Massachusetts.

Van Helsdingen, P.J. 2000. Spider (Araneae) protection measures and the required level of knowledge. *Ekológia (Bratislava)* 19 Suppl. 4, 43-50.