VERHANDELINGEN VAN HET SYMPOSIUM "INVERTEBRATEN VAN BELGIE", 1989, p. 437-442
COMPTES RENDUS DU SYMPOSIUM "INVERTEBRES DE BELGIQUE", 1989, p. 437-442

Some examples of the practical use of spiders and carabid beetles as ecological indicators

by Jean-Pierre MAELFAIT, Konjev DESENDER and Léon BAERT

Summary

Spiders and carabids are good ecological indicators. In order to make that property more operative within the framework of site assessment for nature conservation, we investigated the possibilities for using shorter pitfall sampling periods in the study of communities of these animals. It is known that a three month sampling period during spring and summer already allows to discern the carabid and spider communities of as well grassland as woodland habitats that only differ slightly between each other. Autumn also seems to be suited but a larger sampling effort (a larger number of sampling units) is required during that period for spiders and carabids of grasslands and for spiders of woodlands. If one only has the opportunity of one month sampling, this should preferentially be done during spring and in the beginning of the summer for grassland as well as for woodland spiders. For grassland carabids the optimal periods for such a short term sampling seem to be May, August and September. For woodland carabids the complete year with the exception of the winter months and the end of the summer seems suitable.
Key-words: Araneae, Carabidae, Ecological indicators.

Samenvatting

Spinnen en loopkevers zijn goede ecologische indicatoren. Teneinde deze eigenschap operationeler te maken voor toegepast ecologisch onderzoek in het kader van natuurbehoud, hebben we de mogelijkheden onderzocht om gemeenschappen van deze dieren gedurende slechts kortere perioden met bodemvallen te bemonsteren. Het blijkt dat een bemonsteringsperiode van drie maanden uitgevoerd gedurende de lente en de zomer reeds volstaat om zowel sterk gelijkende graslanden als sterk gelijkende bospercelen via hun spinnen- of loopkeverfauna van elkaar te onderscheiden. De herfstperiode is ook geschikt, maar dan is er wel een grote vangstinspanning (een groter aantal staaleenheden) nodig voor spinnen en loopkevers van graslanden en voor spinnen van bossen. Als men slechts de mogelijkheid heeft om één maand te bemonsteren, dan wordt dit voor spinnen van zowel graslanden als van bossen bij voorkeur gedaan gedurende de lente of de vroege zomer. Voor loopkevers van graslanden zijn de optimale periodes voor een dergelijke korte bemonstering de maanden mei, augustus en september. Voor loopkevers van bossen kan dit met uitzondering van de winter en het einde van de zomer gedurende het ganse jaar gebeuren.
Sleutelwoorden: Araneae, Carabidae, Oecologische indicatoren.

Introduction

There is a general consensus that spiders and carabid beetles are good ecological indicators (MAELFAIT & BAERT, 1987, RUSHTON, 1987; SPEIGHT, 1986). That is in the first instance because populations and communities of these animals are highly influenced by large and more importantly by small scale changes in environmental conditions. Moreover, these groups possess properties that make them good ecological indicators not only in theory but also in practice. These features can be summarized as follows :

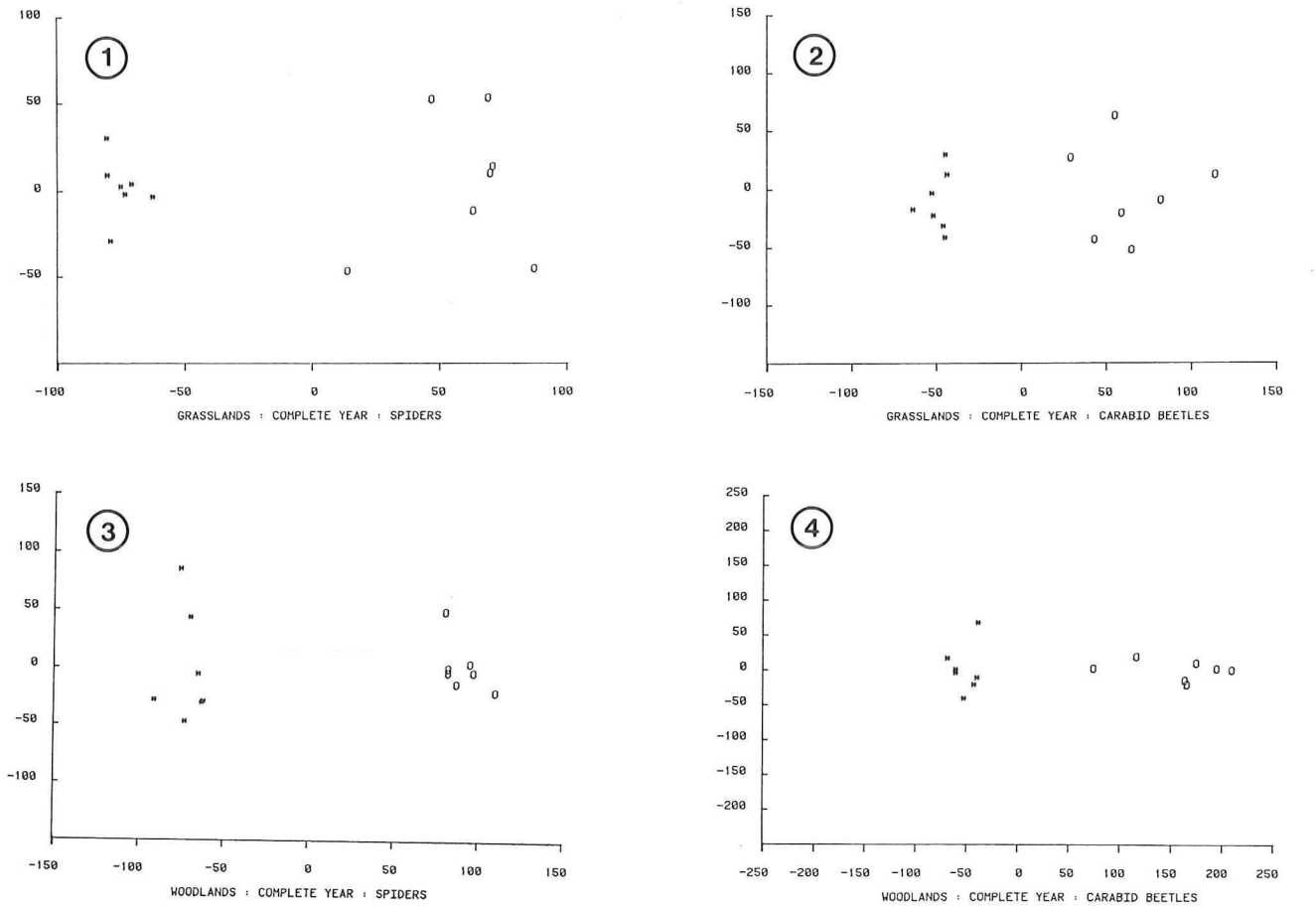
- they have a stable taxonomy and are rather easily identified.
- they are distributed over the total range of terrestrial habitats (MAELFAIT & BAERT, l.c.; THIELE, 1977).
- they can be sampled with standardized techniques.

One of the applications of ecological indicators is their use in nature conservation research. This consists in the assessment of the ecological value of different sites within the framework of environmental planning or in the assessment of the changes that take place on a site subjected to nature conservation management. Unfortunately, severe limitations in resources and personnel reduce the global research effort, and in particular the length of the sampling period when using these invertebrates in nature conservation research.

A first step in site assessment is the detection of differences among comparable sites. The aim of the present communication is to demonstrate that we can shorten the sampling period needed to assess the ecological value of differing sites, in other words that we can shorten the period needed to inspect for differences among comparable sites. We will therefore compare the composition of spiders and carabid communities for habitats that are only slightly different.

Material and methods

A comparison will be made between on the one hand two grassland sites and on the other hand two woodland sites. In each site we used the numbers of animals trapped in each of seven pitfalls. Only the most abundantly caught species were used in the analysis, in other words the species whose total catch is larger than or equal to the total number of sampling units (14) in the two compared habitats. This was done to avoid the large random variation on small numbers. Each of these abundant species was given equal weight by



Figs. 1-4. Scores on the first and second axis of a detrended correspondence analysis for the data gathered during a complete year cycle.

expressing their numbers caught per sampling unit as a percentage of the total catch per species. Differences between the faunas of the compared sites were searched for by means of a detrended correspondence analysis. This was done by means of the programme CANOCO (TER BRAAK, 1987) run on a personal computer.

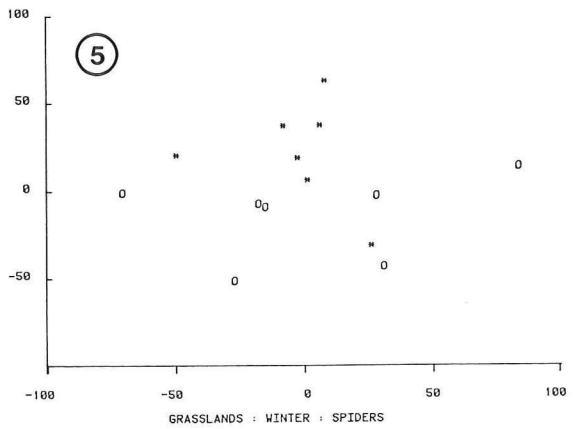
The first grassland site was situated in the centre of an intensively grazed pasture of the Experimental Farm of the State University of Ghent (*cfr.* MAELFAIT *et al.*, 1988). Its grass sward is almost exclusively composed of perennial ryegrass (*Lolium perenne*). The spider and carabid faunas of that site were compared with those occurring in the narrow border zone of the same pasture along its fence between the pasture and a drainage ditch (*cfr.* DESENDER *et. al.*, 1981). The pitfalls were installed here on the pasture side which was grazed but like the rest of the border zone not trampled. The vegetation of the border zone is richer as compared to the pasture and composed mainly of four grass and five herb species. In contrast to the pasture there is a well developed litter layer. The two grassland sites were sampled with plastic vials having a diameter of 6,5 cm and a depth of 18cm, partially filled with a 4% formaldehyd solution. They were emptied each week from February 1982 till January 1983.

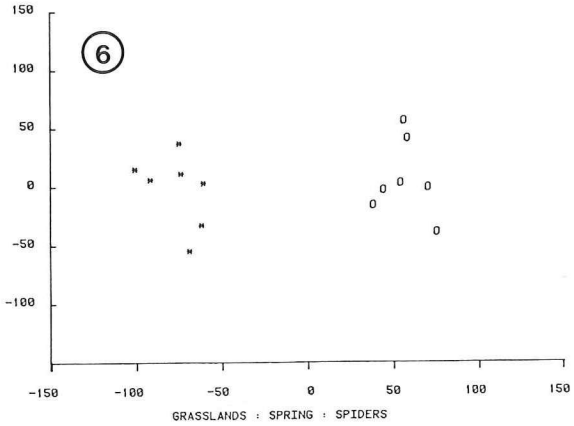
Both woodland habitats for which we analyzed the carabid and spider communities are situated in the forest of Zonien (52°N). The first site is a relatively open stand with standards of oak (*Quercus robur*) and a mixed low tree and shrub layer. The loamy soil on this site is deep and without surface compaction. The second site is a very closed stand. It also consists of standards of old oaks, but it has a dense low tree layer of beech and hornbeam. There is no compaction at the soil surface, but a highly compacted fragipan is present at a depth of 30 cm only. The woodland sites were sampled with glas jars having a diameter of 9,5 cm and a depth of 10 cm, again partially filled with a 4% formaldehyd solution. They were emptied at fortnightly intervals from June 1986 to May 1987.

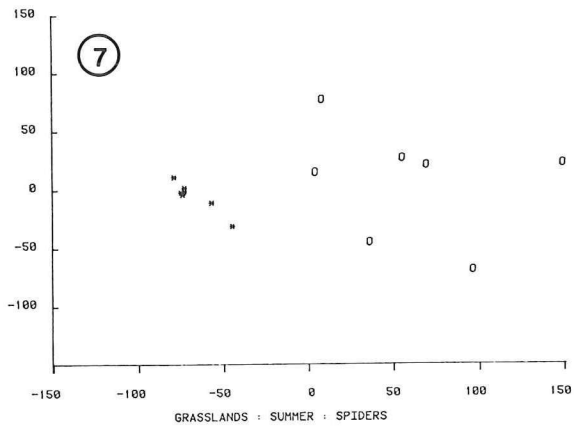
Results and discussion

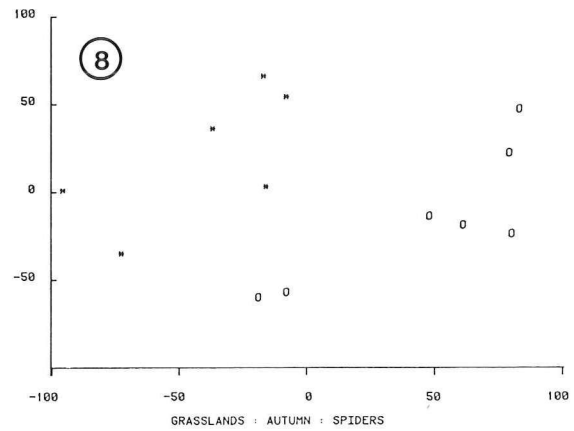
Based on the captures of a complete year cycle, the fourteen sampling units of the grasslands as well as of the woodlands clearly break down into two groups (Figs. 1-4). This is the case for the spiders as well as for the carabids. Both groups are separated along the first ordination axis.

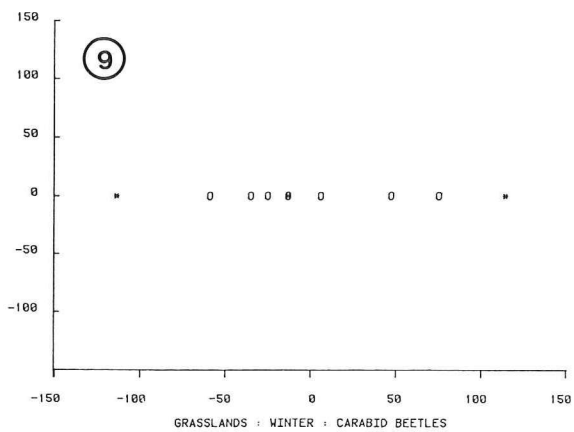
Without going much into detail these differences can for example for the spiders be understood as follows (MAELFAIT & DE KEER, *in prep.*). In the pasture there

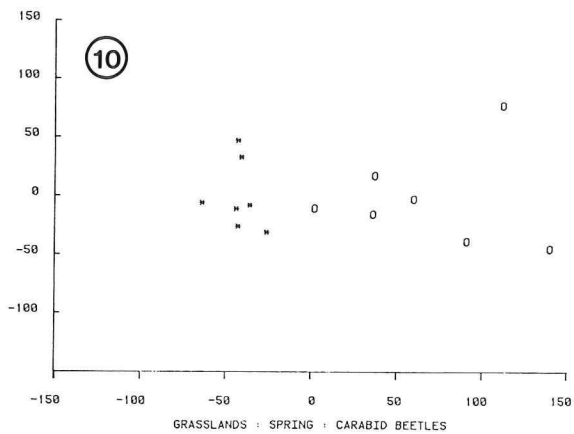

5
GRASSLANDS : WINTER : SPIDERS

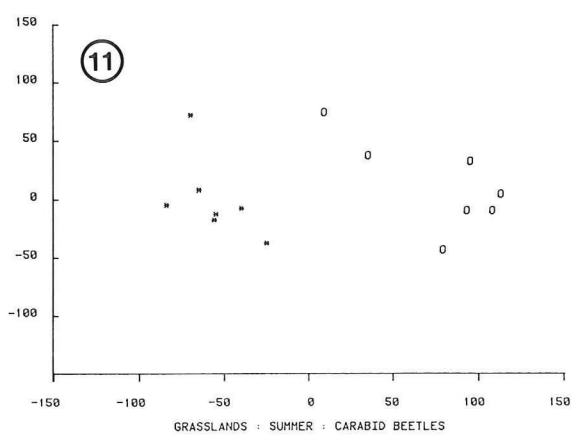

6
GRASSLANDS : SPRING : SPIDERS

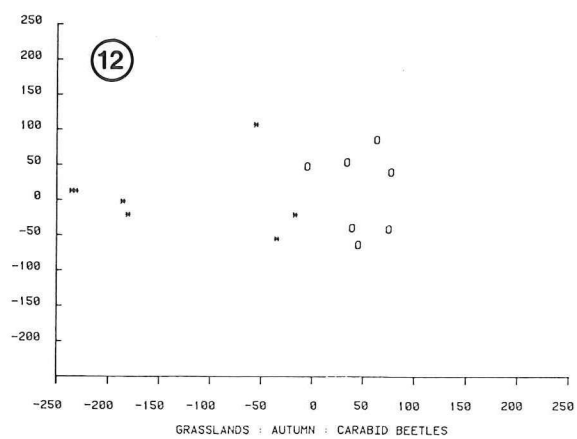

7
GRASSLANDS : SUMMER : SPIDERS

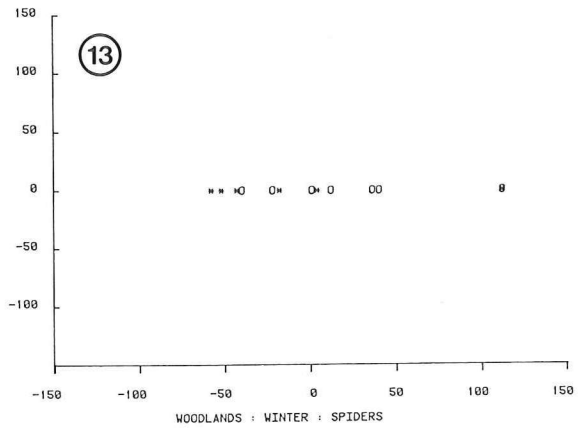

8
GRASSLANDS : AUTUMN : SPIDERS

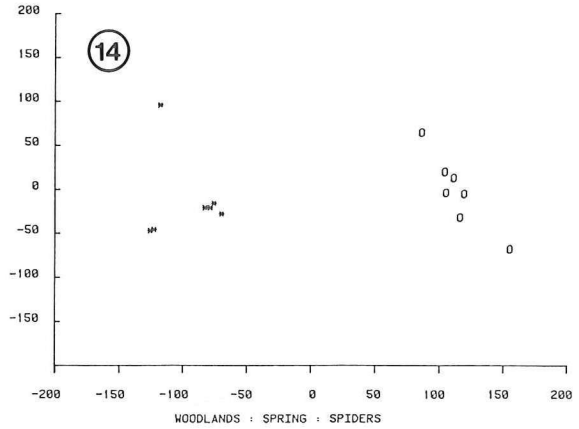

9
GRASSLANDS : WINTER : CARABID BEETLES

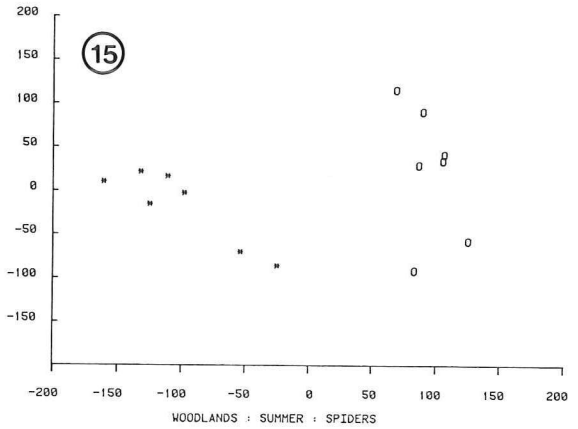

10
GRASSLANDS : SPRING : CARABID BEETLES

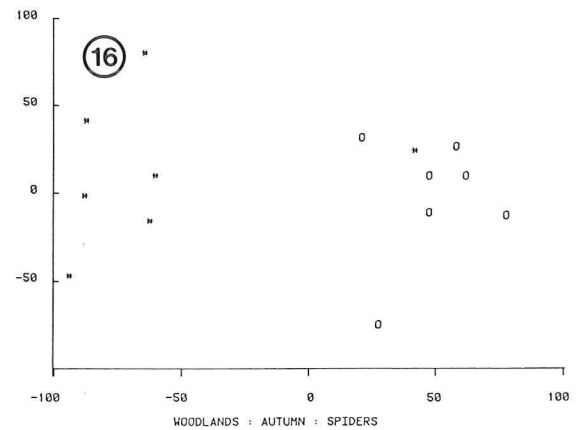

11
GRASSLANDS : SUMMER : CARABID BEETLES

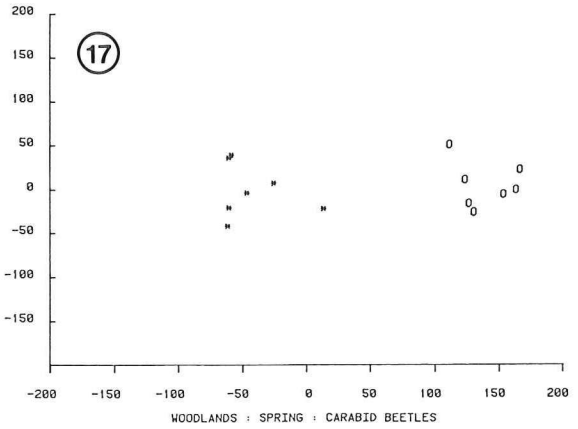

12
GRASSLANDS : AUTUMN : CARABID BEETLES

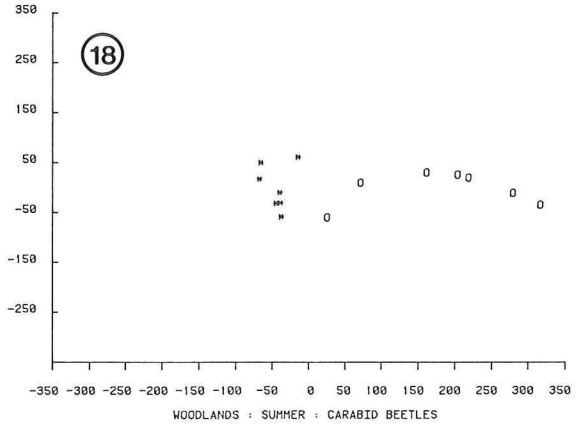


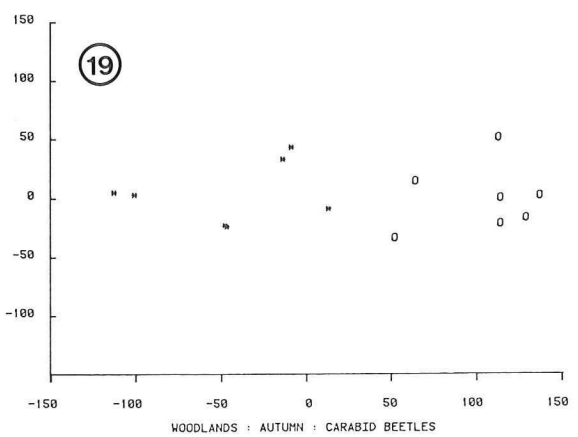












Figs. 5-19. Scores on the first and second axis of a detrended correspondence analysis for the data gathered per meteorological season.

is a preponderance of small spider species, which hibernate as adults and reproduce during spring and summer. They have two generations per year. The spiders preferring the border zone overwinter as juveniles. They have one generation per year only. A lot of these species need the high grasses and herbs to build their webs. The accumulated litter offers shelter for their hibernation.

An important difference between the spider faunas of the two woodland habitats is that the more open stand spiders associated with a fast litter breakdown during spring and summer are much more abundant as compared to the closed stand (*cfr.* SEGERS & MAELFAIT, in press).

We will now investigate the possibilities of using shorter sampling periods to assess differences between both pairs of study sites.

In a first step we ordinated the fourteen sampling units of the grasslands as well as of the woodlands based on the captures made per meteorological season. The results for the grassland spiders are shown in figs. 5 to 8. A clear distinction between the two habitats is observed for both spring and summer sampling. For winter sampling on the other hand the sampling units are not discriminated. Autumnal sampling gives a good separation but not so clearcut as during spring and summer. Quite comparable results are obtained for the carabids and for the woodlands (Figs. 9-19). For the carabid beetles no detrended correspondence analysis could be applied to captures of the winter sampling.

In a next step we investigated whether still shorter periods, namely of one month only, would allow to discern between the two communities of the grasslands and the woodlands respectively.

For the spiders of the grasslands, we therefore plotted the scores for each of the sampling units obtained on the first axis for each sampling period of one month (Fig. 20). Those for the site with the higher scores at the left and those for the site with the lower scores at the right. The vertical line between both groups of scores shows the difference between the median values. The same was done for the carabids of the grasslands and for both taxonomical groups of the woodland sites (Figs. 21-23).

For the grasslands no detrended correspondence analysis can be applied for the low captures of carabids made during the winter months. For the spiders an ordination is possible for those months but the resulting separation is poor. On the contrary, we get a clear distinction for these animals for the monthly samplings form April till July. For carabid beetles the separation is very good for May, August and September.

For the woodlands neither of both animal groups yields enough information during the winter months. Spiders give a clear separation during spring and at the beginning of summer. Monthly captures of carabids seem to be well suited for this purpose during spring, the beginning of summer and again during autumn.

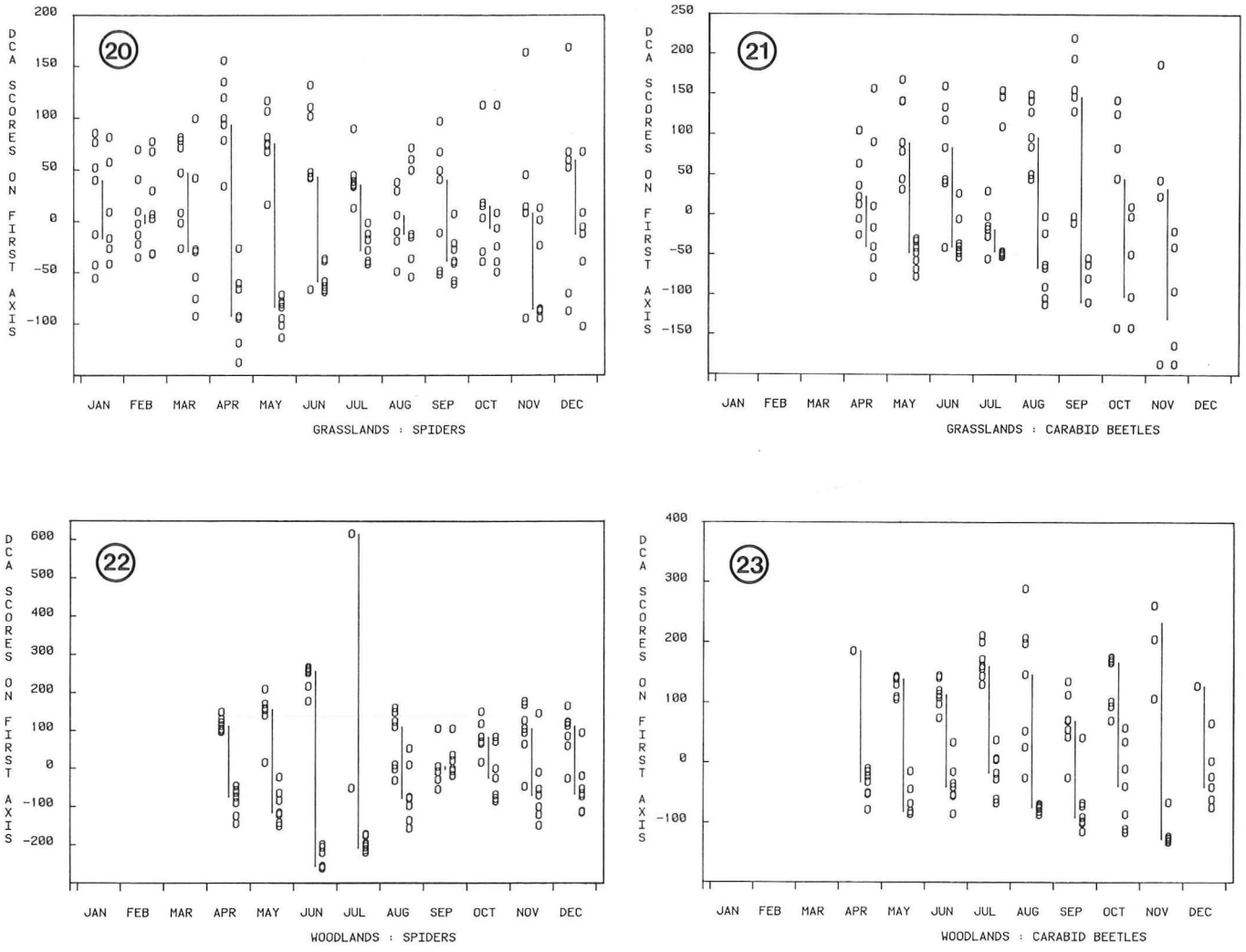
From the results presented here we can conclude that a three month sampling period in spring and summer allows to discriminate the carabid and spider communities of grassland and woodland habitats. During autumn a larger sampling effort is required in grasslands and for spiders in woodlands, in other words a larger number of sampling units is needed during that season.

If one only has the opportunity of one month of sampling, this should preferentially be done during spring and the beginning of summer for grassland as well as for woodland spiders. For grassland carabids the optimal periods for such a short term sampling seem to be May, August and September, while for woodland carabids the complete year with the exception of the winter months and the end of summer seem suitable. If one would have to make an assessment of grassland habitats within a short time span one would preferentially do that with spiders during spring and the beginning of summer, if it has to be done by the end of summer carabids beetles would be better used. Of course, these conclusions can only be generalized to site assessment studies in regions with the same seasonal pattern as Belgium.

A final remark we would like to make is the following. Argumentation for the special protection of a certain site is often documented with a list of invertebrates that at the best mentions the rare species occurring at that site. This procedure is sometimes rewarding in that it leads to an immediate success, to a better protection of the site. It is, however, bad for our scientific reputation. If site assessment based on invertebrates is to be taken seriously in the future, more formal methods will have to be adopted. The purpose of this communication is to contribute to the development of such more objective methods. In our opinion, such an approach will be beneficial to nature conservation in the long run. It will most probably lead to the preservation of many more sites of special natural interest.

Acknowledgements

We wish to thank our collegue H. SEGERS for letting us use the spider data of two woodland sites.



Figs. 20-23. Scores on the first axis of a detrended correspondence analysis for the data gathered per month.

References

DESENDER, K., MAELFAIT, J.-P., D'HULSTER, M. & VANHERCKE, L., 1981. Ecological and faunal studies on Coleoptera in agricultural land. I. Seasonal occurrence of Carabidae in the grassy edge of a pasture. *Pedobiologia,* 22: 379-384.

MAELFAIT, J.-P. & BAERT, L., 1987. Het gebruik van spinnen bij ecologische indicatie. *Nieuwsbrief Belgische Arachnologische Vereniging,* 6: 24-27.

MAELFAIT, J.-P. & BAERT, L., 1988. Les araignées sont-elles de bons indicateurs écologiques? *Comptes Rendus Xème Colloque d'Arachnologie, Bulletin de la Société scientifique de Bretagne,* 59, n° h.s. I: 155-160.

MAELFAIT, J.-P. & DE KEER, R., in prep. The border zone of an intensively grazed pasture as a corridor for spiders.

MAELFAIT, J.-P., DESENDER, K., DE KEER, R. & POLLET, M., 1988. Investigations on the Arthropod fauna of grasslands. In: PARK, J.R. (Editor). *Environmental Management in Agriculture. European Perspectives.* Belhaven Press, London, pp. 170-177.

RUSHTON, S.P., 1987. A multivariate approach to assessment of terrestrial sites for conservation. In: LUFF, M.L. (Editor). *The use of Invertebrates in site assessment for conservation.* University of Newcastle upon Tyne, Newcastle upon Tyne, pp. 62-79.

SEGERS, H. & MAELFAIT, J.P., 1988. A comparative study of the spider communities of different woodland habitats. *Comptes Rendus du XIème Colloque d'Arachnologie (Colloque international européen), Berlin, TUB-Dokumentation Kongresse und Tagungen,* 38: 154-160.

SPEIGHT, M.C.D., 1986. Criteria for the selection of insects to be used as bio-indicators in nature conservation research. *Proceedings of the third European Congress of Entomology, Amsterdam:* 485-488.

TER BRAAK, C.J.F., 1987. CANOCO - a FORTRAN program for canonical ordination by (partial) (detrended) (canonical) correspondence analysis, principal components analysis and redundancy analysis (version 2.1.). ITI-TNO, Wageningen, The Netherlands, 95 pp.

THIELE, H.-U., 1977. *Carabid beetles in their environments.* Springer Verlag, New York, USA, 369 pp.

Jean-Pierre MAELFAIT
Instituut voor Natuurbehoud
Kiewitdreef, B-3500 Hasselt

Konjev DESENDER
Laboratorium voor Ecologie,
Zoögeografie en Natuurbehoud
K.L. Ledeganckstraat 35,
B-9000 Gent

Léon BAERT
Koninklijk Belgisch Instituut
voor Natuurwetenschappen
Vautierstraat 29, B-1040 Brussel