

## SPIDERS (ARANEAE) AND OTHER INVERTEBRATE GROUPS AS ECOLOGICAL INDICATORS IN WETLAND AREAS

EJGIL GRAVESEN

Department of Zoology, University of Århus, Denmark. E-mail: Ejgil.Gravesen@mail.tele.dk

GRAVESEN E.: Spiders (Araneae) and other invertebrate groups as ecological indicators in wetland areas. In GAJDOŠ P., PEKÁR S. (eds): Proceedings of the 18th European Colloquium of Arachnology, Stará Lesná, 1999. Ekológia (Bratislava), Vol. 19, Supplement 4/2000, p. 39-42.

Spiders (Araneae) and other invertebrate groups have successfully been used as ecological indicators of grassland management practices (ERHARDT, 1985; EYRE et al. 1989; GIBSON et al., 1992; RUSHTON et al., 1987, 1989, RUSHTON, 1991; VAN WINGERDEN et al., 1992). DÖBEL et al. (1990) have shown that the composition of spider communities in natural marsh areas is dependent on flooding intensity and vegetation structure.

The species composition of spiders and other invertebrate groups in this investigation were related to a set of environmental variables from 21 wet grassland areas in southwestern Denmark (Fig. 1). The relationships between species composition and environmental variables were analysed with CANOCO (TER BRAAK, 1990), using forward selection and the Monte Carlo permutation technique.

Before the analysis in CANOCO, groups of closely correlated variables were synthesised using Principal Component Analysis (PCA). Use of this procedure reduces the problem of closely correlated environmental variables.



• Sample area

Fig. 1. The study area with sampling localities.

Table 1. The species composition of spiders and other invertebrates in relation to environmental variables. Only significant F-values are shown; \* p<0.05; \*\* p<0.01; \*\*\* p<0.001.

No. of species	Carabidae	Curculionid	Staphylinid	Orthoptera	Lepidoptera	Araneae
	96	71	111	5	19	119
"Clay-silt/sand"	2.95***				2.73**	
Fine sand	2.51**	2.04*			2.01*	
River water level	2.66**	4.66***			2.72**	2.95***
"Former water levels"						
Dyking time	2.61***	2.83***			4.37***	3.16***
Salt concentration	1.97*	2.28**				
N-input						
"Permanent vegetation"		4.09***		3.08*		
Plant species	1.99*	2.06*				
Mowing time					2.95**	2.23**

Table 1 shows the relationships between six invertebrate groups, including spiders, and a set of environmental variables from the 21 wetland areas in southwestern Jutland in Denmark. Quotation marks around the name of an environmental variable indicate a PCA-synthesised variable.

The species composition of spiders is illustrated in relation to significantly important environmental variables (Fig. 2). Only significantly related environmental variables are shown using Canonical Correspondence Analysis (CCA).

During the investigation period, the time since dyking and the height above water level of the nearest river were important factors in relation to spider species composition. The time of mowing or grazing in these grassland areas is also an important factor. This follows roughly the findings of DÖBEL et al. (1990), who showed that vegetation structure in marsh areas is an important factor for the species composition of spiders. Figure 2 is a CCA-diagram showing the relation between the significantly important environmental variables and the species composition of spiders in Southwest Jutland.

Table 1 also shows the relationships between the set of environmental variables tested and the other invertebrate groups. The analysis revealed a pattern for the species compositions of ground beetles, weevils and butterflies that was similar to that found for spiders. These groups are also dependent on the time since the area was dyked as well as the height above water level in the nearest river. In addition to these two factors, the species compositions of these three invertebrate groups were also dependent on the soil type. Ground beetles were particularly dependent on the soil texture. If the area was cultivated earlier, the species composition of weevils seemed to depend on the vegetation succession after ploughing and the establishment of a new vegetation layer.

This study confirms the hypothesis, that a combination of flooding intensity, water levels in the nearest river system and grazing or mowing time are important factors for the species composition of spiders in wet grassland areas, particularly marsh areas.

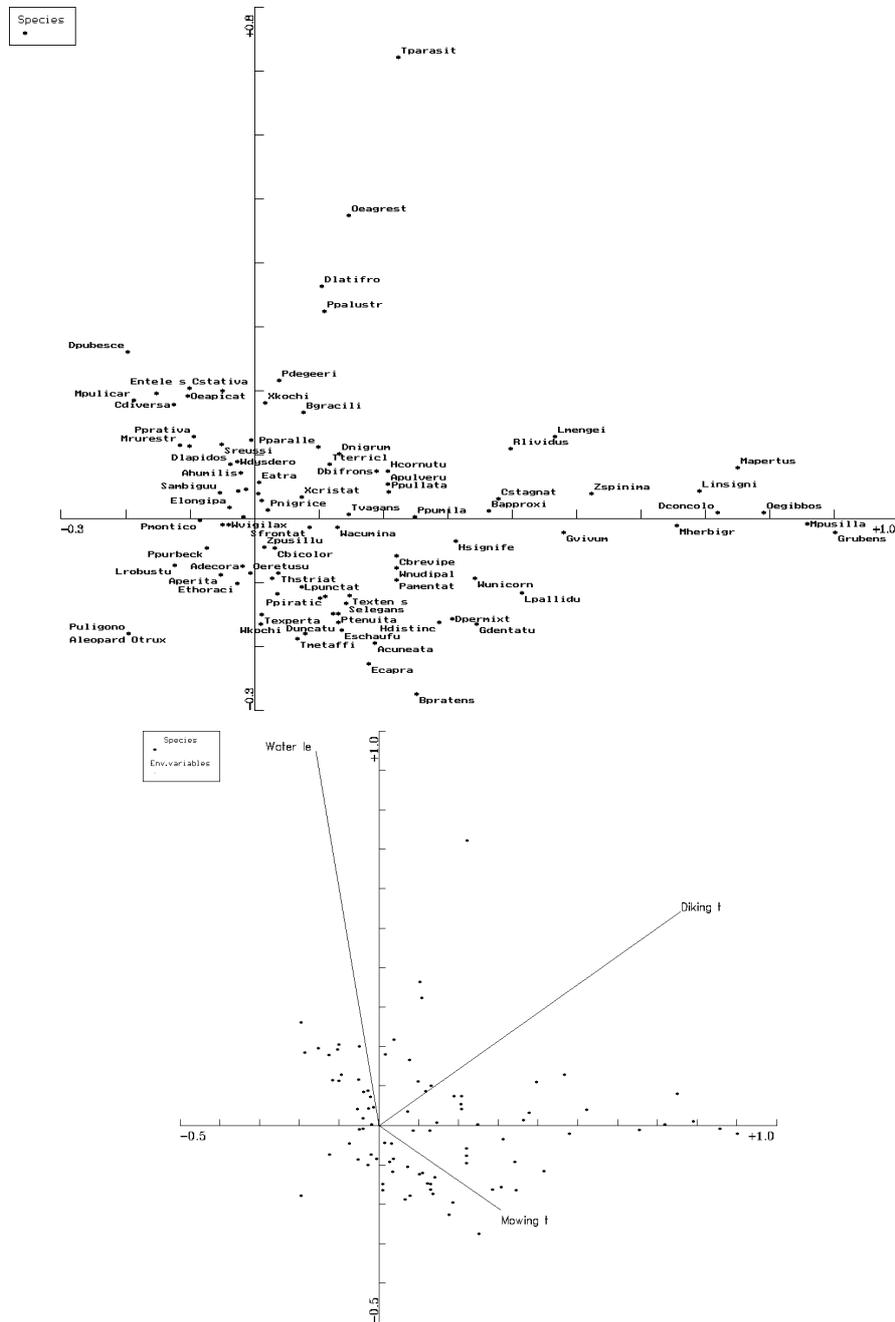


Fig. 2. CCA diagram of the spider species composition in relation to the significant and important environmental variables.

## References

- DÖBEL, H.G., DENNO, R.F., CODDINGTON, J.A., 1990: Spider (Araneae) community structure in an intertidal salt marsh: Effects of vegetation structure and tidal flooding. *Environmental Entomology*, *19*, 5, p. 1356-1370.
- ERHARDT, A., 1985: Diurnal Lepidoptera: Sensitive indicators of cultivated and abandoned grassland. *J. Appl. Ecol.*, *22*, p. 849-861.
- EYRE, M.D., LUFF, M.L., RUSHTON, S.P., TOPPING, C.J., 1989: Ground beetles and weevils (Carabidae and Curculionidae) as indicators of grassland management practices. *J. Appl. Ent.*, *107*, p. 508-517.
- GIBSON, C.W.D., BROWN, V.K., LOSITO, L., MCGAVIN, G.C., 1992: The response of invertebrate assemblies to grazing. *Ecography*, *15*, p. 166-176.
- RUSHTON, S.P., 1991: A discriminant analysis and logistic regression approach to the analysis of *Walckenaeria* habitat characteristics in grassland (Araneae: Linyphiidae). *Bull. Br. arachnol. Soc.*, *8*, 7, p. 201-208.
- RUSHTON, S.P., EYRE, M.D., 1989: The spider fauna of intensively managed agricultural grasslands. *J. Appl. Ent.*, *108*, p. 291-297.
- RUSHTON, S.P., TOPPING, S.P., EYRE, M.D., 1987: The habitat preferences of grassland spiders as identified using Detrended Correspondence Analysis (DECORANA). *Bull. Br. arachnol. Soc.*, *7*, 6, p. 165-170.
- TER BRAAK, C.J.F., 1990: Update notes: CANOCO version 3.10. Agricultural Mathematics Group, Wageningen.
- VAN WINGERDEN, W.K.R.E., VAN KREVELD, A.R., BONGERS, W. 1992: Analysis of species composition and abundance of grasshoppers (Orth., Acrididae) in natural and fertilized grasslands. *J. Appl. Ent.*, *113*, p. 138-152.