Norw. J. Entomol. 49, 51–58. 2002

Spiders (Araneae) in organically managed ley and pasture, Tingvoll Farm, Norway

Reidun Pommeresche

Pommeresche, R. 2002. Spiders (Araneae) in organically managed ley and pasture, Tingvoll Farm, Norway. Norw. J. Entomol. 49, 51-58.

This study focusses on the spider fauna in two organically managed leys in different stages of a crop rotation and in one permanent pasture, all on the Tingvoll Farm in northwestern Norway. Spiders were collected by means of pitfall traps; the sampling period lasted from 28 April to 23 June 2000. Altogether 2415 specimens, representing 48 species, were found. A DCA-analysis shows differences in the spider populations found in the leys compared with the pasture, but less difference between the young and older ley. However, the number of species and the dominance pattern of the spider populations differ between the young and older ley. A total of 16 species were found in the young ley, 26 species in the older ley and 34 species in the pasture. *Bathyphantes gracilis*, *Erigone atra*, *Oedothorax fuscus* and *Savignia frontata* were the most abundant species in the leys, with *Pardosa amentata* and *Silometopus elegans* the most abundant in the pasture. *Collinsia inerrans* was represented by 83 specimens in the leys. This species is previously recorded only twice in Norway, and has been placed on the national Red List proposal.

Key words: Araneae, spider, ley, grass, organic farming, DCA

Reidun Pommeresche, Norwegian Centre for Ecological Agriculture (NORSØK), NO–6630 Tingvoll, Norway. E-mail: Reidun.Pommeresche@norsok.no

INTRODUCTION

A recent review on spiders in agricultural areas focussed on spiders as natural control agents of crop pest insects and on diversification of habitats and land use effects on species and populations of spiders (Sunderland & Samu 2000). Organic agriculture produces food and other products in a sustainable system, without the use of artificial fertiliser or pesticides, and includes a focus on maintenance of biodiversity. Even though ploughing, harvesting and grazing reduce the total number of spiders (Thomas & Jepson 1997), several studies have shown that organic farming has positive effects on the diversity of species of spiders and other invertebrates compared with conventional farming (Azeez 2000, Glück & Ingrisch 1990, Feber et al. 1998, Stoltze et al. 2000).

In Norway most studies of the diversity of insects and spiders in agricultural landscapes are from conventionally managed field margins and semi-natural biotopes, indicating the importance of these habitats for biodiversity (Dennis et al. 2000). No studies of spiders in organically managed leys or cereal fields have previously been conducted in Norway. *Erigone atra, E. dentipalpis* and *Oedothorax apicatus* were the most abundant species in a Norwegian study of spiders in conventionally grown barley fields (Andersen 1990). The same three species dominated in conventionally grown barley fields in Denmark (Toft 1989). The present study focusses on the spider fauna in two organically managed leys in different stages of a crop rotation, and in one permanent pasture. The aim is to see how management of the fields is reflected in the composition of the resident spider populations. The lack of comparable studies in Norway and the lack of arachnological investigations in the region contribute to the importance of this study. The northwestern location of the study area is

especially important, as it contributes to completing the distribution ranges of spider species in Europe.

SITE DESCRIPTION

The three investigated fields are on the Tingvoll Farm at the Norwegian Centre for Ecological Agriculture (NORSØK), (EIS 85, MRY, Tingvoll) northwestern Norway (Figure 1). The fields have been organically managed at least since 1991. The spiders were collected in 2000. **Young ley (YL)**: The young ley was established after spring ploughing in 1999, by growing barley undersown with a mixture of timothy (*Phelum pratense* L.), fescue grass (*Festuca pratensis* Huds.), red clover (*Trifolium pratense* L.) and white clover (*Trifolium repens* L.). This grass and clover species continued to grow after the harvesting of the barley and made up the young ley of the sampling year. No manure was used in 2000. The first of two harvests for silage started shortly after the spider sampling period. **Older ley (OL)**: The older ley was established in 1997 in the same way as the young ley, but had had two additional years of grass and clover production. In the year of sampling, there was more red clover in the young ley than in the old ley and more fescue grass in the older ley. On the older ley, 1.5 tons of urine (incl. 30 % water) per da were used as a spring manure. The ley was harvested for silage twice a year; in the sampling year it was first harvested after the spider sampling period. **Pasture (PA)**: The permanent pasture has never been ploughed, but was manured and grazed by cattle. The sample site in the centre of the pasture was quite moist and was dominated by tufted hair grass (*Deschampsia cespitosa* [L.]) and creeping buttercup (*Ranunculus repens* L.). The sampling site nearer the field margin was dominated by meadow grass (*Poa* sp.). A few pines (*Pinus sylvestris* L.) were scattered throughout the pasture.

METHODS AND MATERIAL

Spiders were collected by means of pitfall traps. Glass jars 6.5 cm in diam., one-third filled with 50% propylene glycol and some detergent, were used as traps. Seven traps were placed 2 m apart in a row at each site. In each of the three fields, two rows of traps were used, one centrally located, the other 5 m from the edge of the field. The traps were in use continuously during the trapping period, which lasted from 28 April to 23 June 2000. Catches from each row were added together and treated as one sample. The spider catches from the sites in the middle of the young ley, older ley and pasture are referred to as YLm, OLm and PAm, respectively, and the catches from the sites nearer to the edge as YLe, OLe and PAe, respectively. Only adult spiders were identified to species

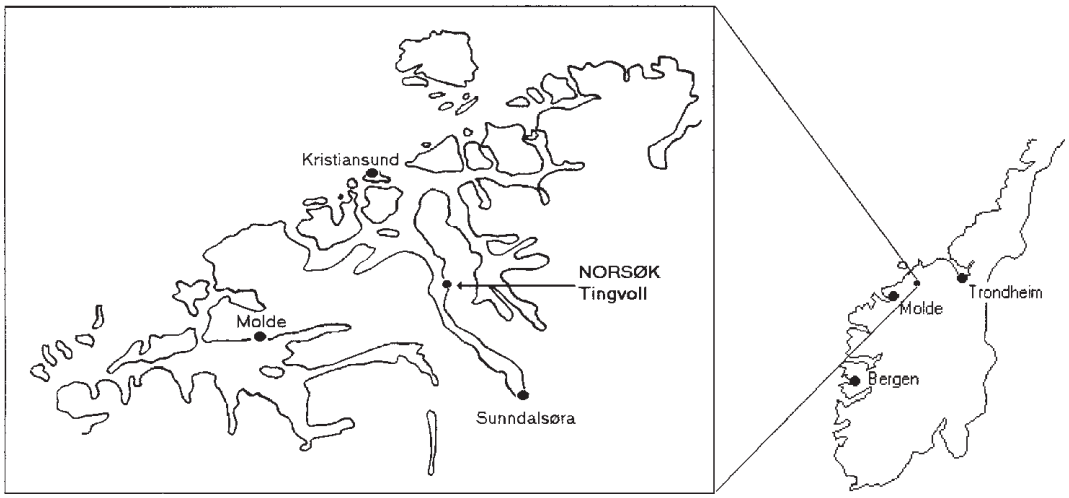

Figure 1. The location of the study area Tingvoll Farm at the Norwegian Centre for Ecological Agriculture (NORSØK), Norway.

level and used in this study. The identification keys of Roberts (1993a, b, 1995) and Nentwig et al. (2001) and nomenclature and taxonomy of Platnick (2001) were used.

To analyse the spider data, an ordination technique of multivariate analysis was used (ter Braak 1995). This detrended canonical analysis (DCA) (Hill & Gauch 1980) of the spider data was run in CANOCO 3.12 (ter Braak 1991). The aim of ordination is to arrange the spider data set so that points close together correspond to sites that are similar in species composition, while those that are far apart correspond to sites that are dissimilar in species composition. The analysis is based on the species and the number of specimens found on each of the six sites.

RESULTS

Altogether 2415 specimens, representing 48 species, were found (Table 1). 67 % of the species belonged to the Linyphiidae (75 % of individuals). A total of 16 different species were found in the young ley, 26 species in the older ley, and 34 species in the pasture.

The spider populations found on the different sites differ in species and dominance pattern. Nine species occurred in all three fields, and 18 of the 48 species were exclusively caught in the pasture. Spider populations of the two leys were represented by many species in common, but with different dominance patterns. The young ley (YLe + YLm) was dominated by *Bathyphantes gracilis* (41 % of the individuals), followed by *Erigone atra* (29 %), whereas *Oedothorax fuscus*, *Savignia frontata*, *E. dentipalpis* and *Collinsia inerrans* were less dominant (Figure 2, Table 1). The older ley (OLe + OLm) was dominated by *E. atra* (27 %), *S. frontata* (16 %), *B. gracilis* (15 %) and *O. fuscus* (15 %) (Figure 2, Table 1). Less dominant were *E. dentipalpis* and *C. inerrans.*

C. inerrans is an interesting species, found on all the four ley sites and represented by 83 specimens. This is a species proposed to be Red-listed in Norway (Aakra & Hauge 2000).

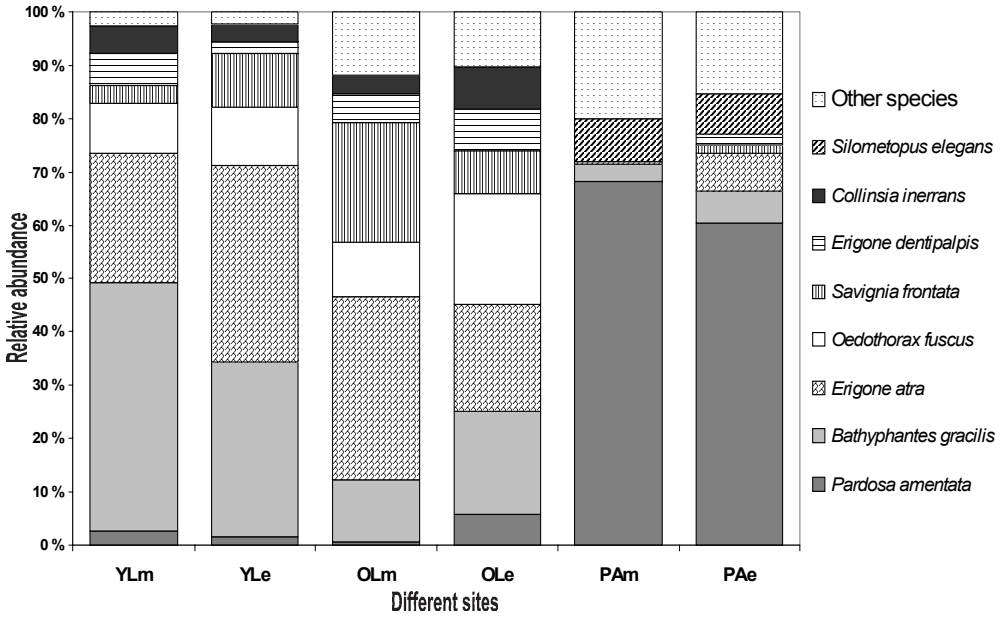

Figure 2. The dominance pattern of the spider populations found in organically managed young ley (YL), older ley (OL) and permanent pasture (PA). One site in the middle (m) and one nearer the edge (e) of each field. Spiders were collected by means of pitfall traps in 2000.

Table 1. Spider species and number of individuals from organically managed fields: young ley (YL), older ley (OL) and pasture (PA), one site in the middle (m) and one nearer the edge (e) of each field. Spiders collected by means of pitfall traps from April to June 2000.

Family / *Species*	YLm	YLe	OLm	OLe	PAm	PAe
Linyphiidae						
Bathyphantes gracilis (Blackwall)	235	113	51	77	15	18
Erigone atra (Blackwall)	122	127	149	80	1	22
Oedothorax fuscus (Blackwall)	48	38	45	82		
Savignia frontata Blackwall	16	34	98	32		5
Erigone dentipalpis (Wider)	31	8	24	31		6
Collinsia inerrans (O.P.-Cambridge)	25	11	15	32		
Silometopus elegans (O.P.-Cambridge)					35	23
Diplocephalus latifrons (O.P.-Cambridge)		2	11	17	5	
Dicymbium nigrum (Blackwall)	7	3	15	6	2	
Tenuiphantes cristatus (Menge)					17	1
Centromerita bicolor (Blackwall)			12	1		2
Erigonella hiemalis (Blackwall)					2	6
Tenuiphantes mengei (Kulczynski)			1		7	
Dicymbium tibiale (Blackwall)		1			5	
Diplostyla concolor (Wider)				1	2	1
Gongylidiellum vivum (O.P.-Cambridge)	2			2		
Meioneta affinis (Kulczynski)						4
Meioneta saxatilis (Blackwall)					4	
Porrhomma sp (egeria) Simon			4			
Tapinacyba pallens (O.P.-Cambridge)					3	1
Tiso vagans (Blackwall)				1		2
Agyneta cauta (O.P.-Cambridge)						1
Bathyphantes parvulus (Westring)					1	
Bolyphantes luteolus? (Blackwall)			1			
Ceratinella brevis (Wider)			1			
Meioneta rurestris (C.L.Koch)			1			
Micrargus apertus (O.P.-Cambridge)				1		
Neriene clathrata (Sundevall)			1			
Oedothorax gibbosus (Blackwall)	1					
Tallusia experta (O.P.-Cambridge)	1					
Tenuiphantes zimmermanni (Bertkau)					1	
Walckenaeria acuminata Blackwall				1		
Lycosidae						
Pardosa amentata (Clerck)	13	5	3	23	290	185
Pardosa pullata (Clerk)	2		2	1	22	2
Trochosa terricola Thorell		2	2	7	8	5
Pardosa nigriceps (Thorell)			1	1	5	2
Pardosa lugubris (Walckenaer)						4
Alopecosa taeniata (C.L.Koch)	1					1
Pardosa palustris (Linnaeus)						1
Haniidae						
Cryphoeca silvicola (C.L.Koch)						6
Hahnia pusilla C.L.Koch					1	
Tetragnathidae						
Pachygnatha degeeri (Sundevall)						3

Table 1. Continued.

Family / *Species*	YLm	YLe	OLm	OLe	PAm	PAe
Pachygnatha listeri (Sundevall)						2
Other families						
Haplodrassus signifer (C.L.Koch)						1
Ozyptila trux (Blackwall)						1
Robertus scoticus Jackson				1		
Segestria senoculata (Linneaus)				1		
Zora spinimana (Sundevall)						1
Number of specimens	504	344	437	398	426	306
Number of species	13	11	19	20	19	26
No. of diff. species in each field type	16		26		34	

Pardosa amentata was the most abundant species in the pasture (PAe + PAm) (65 %), but much less abundant in the leys (Figure 2, Table 1). The second most abundant species in the pasture was *Silometopus elegans*, which only occured there. *Bathyphantes gracilis* and *Erigone atra* were also present in the pasture, but with fewer specimens than in the leys.

When comparing the dominant species found in the centre and nearer the edge of the leys, few differences could be observed. More of the same species and more individuals common to the leys (e.g. *Erigone atra, Savignia frontata* and *E. dentipalpis*) were present in the site near the edge of the pasture (Pae) compared with the site in the centre of the pasture (PAm) (Figure 2, Table 1).

To compare and get an impression of the relationship among the spider populations present at the various sites, a DCA analysis was run on the spider data set. The results of the DCA-analysis are given in Figure 3. The first and second ordination axes respectively explain 70.2 % and 11.4 % of the total variability. The first DCA-axis indicates separation in the spider populations found on the sites in the leys compared with the ones found in the pasture, and shows less separation between the populations in young and older ley. In this analysis little separation was found between the spider populations from the middle of each field compared with those nearer the edge of the same field (Figure 3). The first DCA-axis probably shows a gradient, from left to right, of spider populations in more disturbed habitats to spider populations representing more permanent, less disturbed habitats. The distribution along the second axis cannot be attributed to any obvious gradient.

DISCUSSION

Arable ecosystems worldwide are characterised by instability caused by different disturbances compared with natural ecosystems. Major disruptions such as harvesting and ploughing have negative effects on spider assemblages (Topping & Sunderland 1994, Thomas & Jepson 1997). Compared with the pasture, the leys support more species and more individuals of species that are r-selected, such as *Bathyphantes gracilis, Erigone atra* and *E. dentipalpis*. This higher number amount of pioneer species in the leys is probably due to the more intensive management of the leys compared to the pasture: two harvests compared to differentiated grazing. Only minor differences were found between the young and older leys, such as a higher total number of species and fewer specimens of the pioneer species *Bathyphantes gracilis* in the older ley. This minor differences may indicate that the yearly disturbance of the ley by harvesting has greater effects on the local spider populations than the time period since ploughing. Several species that are restricted to the pasture in this study are known usually to prefer more undisturbed habitats like forest or shrubland, e.g. *Pardosa lugubris, Cryphoeca silvicola, Tapinocyba pallens* and *Thenuiphantes cristatus*. This

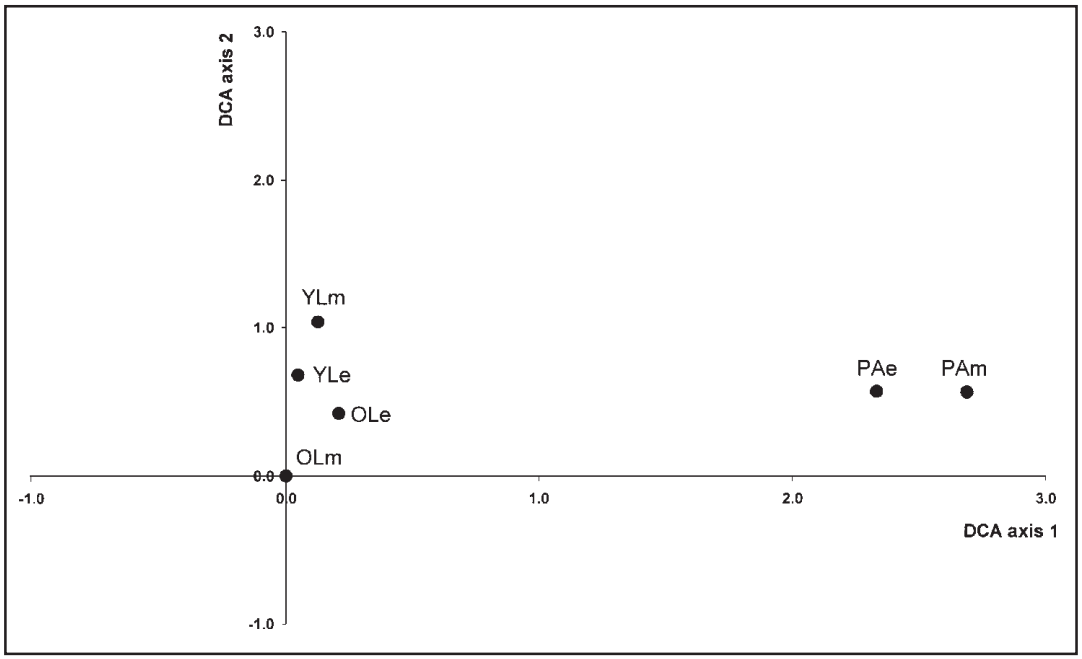

Figure 3. DCA ordination diagram of spider populations found in organically managed young ley (YL), older ley (OL) and permanent pasture (PA). One site is located in the middle (m) and one nearer the edge (e) of each field. Spider species and numbers of specimens are used as the basis of the analysis. Spiders were collected by means of pitfall traps in 2000.

indicates that the less intensive management of the pasture allow other species and more k-selected species to prevail than does the management of the leys.

The higher number of species and individuals of species typical of the leys that are present in PAe compared with PAm in the pasture (Table 1) may be explained by differences in the vegetation structure and grazing pressure on the two sites. PAe had been grazed more than PAm, something which reduced the complexity and height of the vegetation structure on PAe. PAm was dominated by creeping buttercup and tufted hair grass, which are not preferred by the cattle as food. This indicates that indirect or direct effects of grazing have selective effects on the vegetation structure and the resident spider population. A change in composition of spider populations, caused by increasing intensity of grazing management, to a fauna more like those found in cultivated areas, is not unknown (Gibson et al. 1992, Rushton & Eyre 1992).

Some of the most abundant species found in the ley, such as *Erigone atra, Bathyphantes gracilis, Oedothorax* spp. and *E. dentipalpis*, are also found in comparable grass and cereal fields in England and Denmark (Toft 1989, Thomas & Jepson 1997, Feber et al. 1998). *Meioneta rurestris* and *Lepthyphantes tenuis* were abundant in English grass and cereals fields (Thomas & Jepson 1997, Feber et al. 1998), as were *M. rurestris* and *O. apicatus* in Danish barley fields (Toft 1989), but these were all absent in our leys, except for one specimen of *M. rurestris*. In contrast, *Savignia frontata* and *Collinsia inerrans* were found in our leys in quite high numbers compared to the English and Danish studies. The reason for this difference is probably related to biogeography and climate.

The proposed Red-listed species *C. inerrans* (Aakra & Hauge 2000) found in this study has been recorded only twice in Norway (Hauge & Kvamme 1983, Andersen 1990). The species is considered critically endangered in Slovakia (Gajdos et al. 1999). Elsewhere in Europe it is a rarely found

species reported from bogs (Heimer & Nentwig 1991), open land, and forests (Maurer & Hänggi 1990). According to Klapkarek & Riecken (1995), *C. inerrans* is a pioneer species, most often found in agroecosystems and reported from intensively managed grasslands (Rushton & Eyre 1992) and cereal fields (Duffey 1978). The high numbers of *C. inerrans* in the young and older ley in this study suggest that the habitat niche in Norway and the distribution range of *C. inerrans* may be broader.

Acknowledgements. I express my gratitude to Erling Hauge (University of Bergen), Kjetil Aakra (Midt-Troms Museum) and my colleagues at the Norwegian Centre for Ecological Agriculture (NORSØK) for discussions and valuable comments on the manuscript. Many thanks also to Magne Sætersdal (Norwegian Forest Research Institute) for help with DCA-analysis.

REFERENCES

Aakra, K. & Hauge, E. 2000. Provisional list of rare and potentially threatened spiders (Arachnida, Araneae) in Norway including their proposed Red List status. NINA-NIKU, 042 Fagrapport.

Andersen, A. 1990. Spiders in Norwegian spring barley fields and the effects of two insecticides, Norw. J. Agric. Sci. 4, 261-271.

Azeez, G. 2000. The Biodiversity Benefits of Organic Farming. 1-34. The Soil Association, UK.

Dennis, P., Fry, G.L.A. & Andersen, A. 2000. The impact of field boundary habitats on the diversity and abundance of natural enemies in cereals. Pp. 195-214 in Ekbom, B., Irwin, M. & Roberts, Y. (eds), Interchanges of insects. Kluwer Academic Publishers, the Netherlands.

Duffey, E. 1978. Ecological strategies in spider including some characteristics of species in pioneer and mature habitats. Symp. zool. Soc. Lond. 42, 109-123.

Feber, R.E., Bell, J., Johnson, P.J., Firbank, L.G. & Macdonald, D.W. 1998. The effects of organic farming on surface-active spider (Araneae) assemblages in wheat in southern England, UK. J. Arachnol. 26, 190-202.

Gajdos, P., Svaton, J. & Sloboda, K. 1999. Katalog pavukov Slovakia. Catalouge of Slovakian spiders. 337 pp. Bratislava.

Gibson, C.W.D., Hambler, C. & Brown V.K. 1992. Changes in spider (Araneae) assemblages in relation to succession and grazing management. J. Appl. Ecol. 29, 132-142.

Gluck, E. & Ingrisch, S. 1990. The effect of biodynamic and conventional agriculture management on Erigoninae and Lycosidae spiders. J. Appl. Ent. 110, 136-148.

Hauge, E. & Kvamme, T. 1983. Spider from forest-fire areas in southeast Norway. Fauna norv. Ser. B 30, 39-45.

Heimer, S. & Nentwig, W. 1991. Spinnen Mitteleuropas. Ein Bestimmungsbuch. 543 pp. Verlag Paul Parey, Berlin and Hamburg.

Hill, M.O. & Gauch, H.G.J. 1980. Detrended correspondence analysis: An improved ordination technique. Vegetatio 42, 47-58.

Klapkarek, N. & Riecken, U. 1995. Zur Verbreitung und Autökologie von Collinsia submissa (Araneae: Linyphiidae). Arachnol. Mitt. 9, 49-56.

Maurer, R. & Hänggi, A. 1990. Katalog der Schweizerischen Spinnen. Documenta Faunistica Helvetica 12.

Nentwig, W., Hänggi, A., Kropf, C. & Blick, T. 2001. Spinnen Mitteleuropas, Bestimmungsschlüssel. http://www.araneae.unibe.ch/index.html. 20-9-2001.

Platnick, N.I. 2001. The World Spider Catalog, version 2.0. The American Museum of Natural History. http://research.amnh.org/entomology/spiders/catalog81-87/INTRO3.html. 2-5-2001.

Roberts, M. J. 1993a. The spiders of Great Britain and Ireland. Volume 1, Atypidae to Theridiosomtidae. 228 pp. Harley Books, Essex, England.

Roberts, M.J. 1993b. The spiders of Great Britain and Ireland. Volume 2, Linyphiidae and Check List. 229 pp. Harley Books, Essex, England.

Roberts, M.J. 1995. Spiders of Britain and Northern Europe, 5 edn. Collins field guide. 383pp. Harper Collins Publisher, England.

Rushton, S.P. & Eyre, M.D. 1992. Grassland spider habitats in North-East England. J. Biogeogr. 19, 99-108.

Stoltze, M., Piorr, A., Häring, A. & Dabbert, S. 2000. The environmental impacts of organic farming in Europe. Organic Farming in Europe, Economics and Policy 6, 1-127.

Sunderland, K. & Samu, F. 2000. Effects of agricultural diversification on the abundance, distribution, and pest control potential of spiders: a review. Entomol. Exp. Appl. 95, 1-13.

ter Braak, C.J.F. 1991. CANOCO-a FORTRAN program for CONOnical Community Ordination by (partial) (detrended) (canonical) correspondence analysis, principal components analysis and redundancy analysis. 3.12. New York, Microcomputer Power.

ter Braak, C. J. F. 1995. Ordination. Pp. 91-173 in Jongman, R.H.G., ter Braak, C.J.F. & van Tongeren, O.F.R. (eds), Data analysis in community and landscape ecology. Cambridge University Press, UK.

Thomas, C.F.G. & Jepson, P.C. 1997. Field-scale effects of farming practices on linyphiid spider populations in grass and cereals. Entomol. Exp. Appl. 84, 59-69.

Toft, S. 1989. Aspects of the ground-living spider fauna of two barley fields in Denmark: species richness and phenological synchronization. Ent. Meddr. 57, 157-168.

Topping, C.J. & Sunderland, K. 1994. Methods of quantifying spider density and migration in cereal crops. Bull. Br. Arachnol. Soc. 9, 209-213.

Received 21 January 2002,
accepted 6 March 2002