The distribution and probable importance of linyphiid spiders living on the soil surface of sugar-beet fields

W. A. Thornhill
Broom's Barn Experimental Station,
Higham, Bury St. Edmunds,
Suffolk IP28 6NP

Summary

The most abundant species of linyphiid spiders living on or close to the soil surface of sugar-beet fields were determined by searching and pitfall trapping. The seasonal and diurnal activity, habitat preferences within the crop, and web sizes of these species were investigated.

The effects of agricultural operations on linyphiid spider populations and the role of linyphiids as predators of sugar-beet pests are discussed.

Introduction

Linyphiid spiders are amongst the most numerous arthropod predators on arable land (Geiler, 1963; Pietraszko & De Clercq, 1980), and may have an important role in controlling pests of arable crops. Unlike other predators on arable land they catch much of their prey in horizontal sheet webs so there is some justification for regarding them as a distinct ecological group, as Łuczak (1979) does in her classification of spiders on arable land. However the extent to which they rely on hunting to obtain their prey is unknown. The life styles of some species may more closely resemble those of predators such as lycosid spiders or carabid beetles, which rely solely on hunting to catch prey, than of spiders highly dependent on webs.

For small creatures living on or just below the soil surface, life on arable land is in some respects harsher than in more stable habitats. For much of the year the land is devoid of tall vegetation, and therefore temperatures at the soil surface are more variable (Oke, 1978) and wind speeds greater. Because weather is an important factor influencing spider populations (Dondale & Binns, 1977) their maximum attainable rate of population increase is probably reduced on arable land.

Many spiders, and much of their prey, are killed by stubble burning (Roesgaard & Lindhardt, 1979) and insecticides (Hossfeld, 1976; Vickerman & Sunderland, 1977). The soil is frequently disturbed during soil cultivations, physical weed removal, seed sowing, etc., although Duffey (1978) showed that some linyphiid spiders survived normal soil cultivations (ploughing and harrowing) in the autumn. Nyffeler & Benz (1979) state that most spider eggs of species inhabiting the vegetation layer are destroyed during cereal harvest and the fields are repopulated later by immigrant spiders from less disturbed areas. Duffey (1978) caught 2-3 times fewer linyphiid spiders from October to January on cultivated land on plots caged to prevent immigration than on uncaged plots.

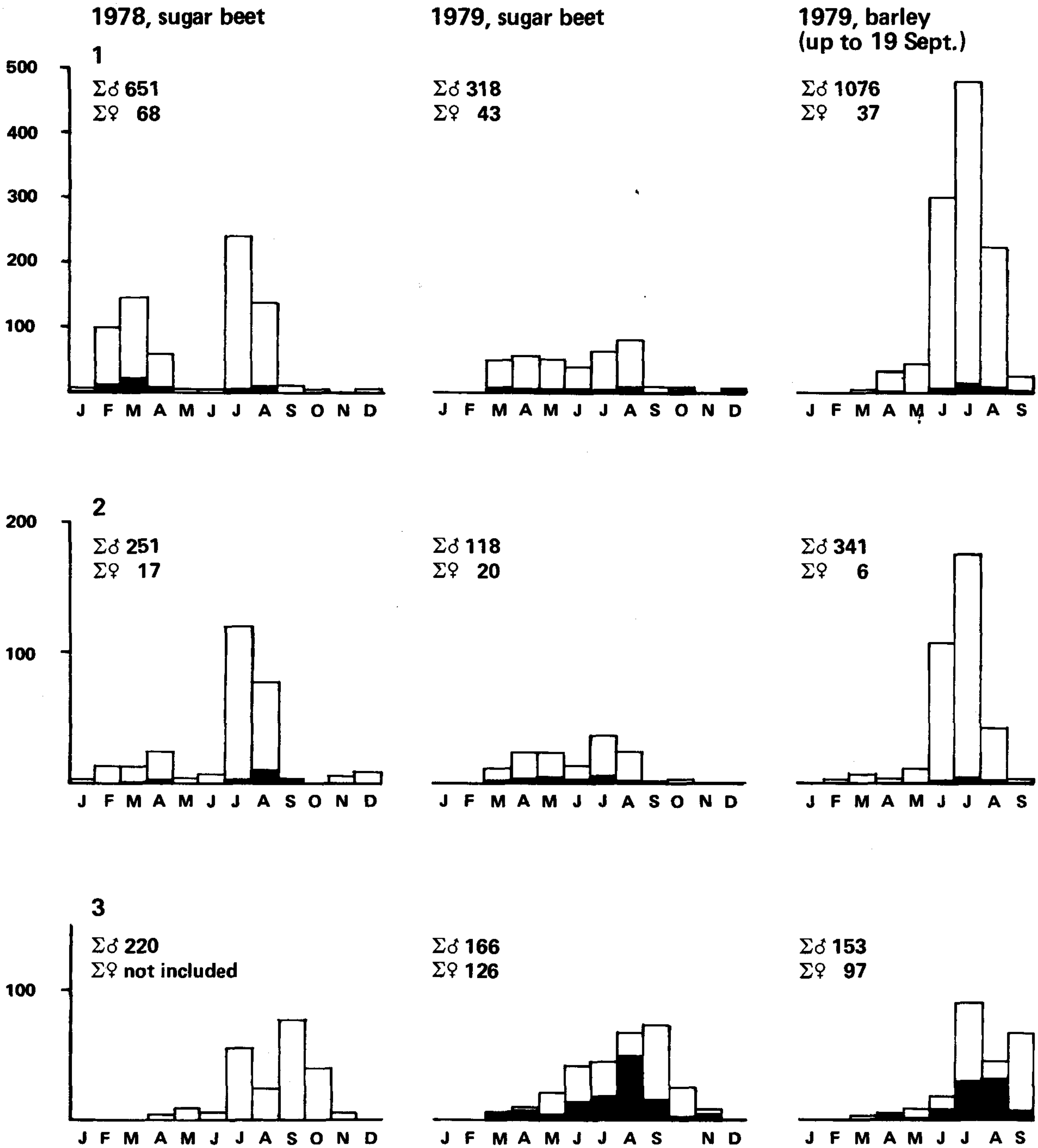
As the crop grows, and older leaves touch the ground, the habitat at the soil surface becomes structurally more complex. Although increased structural diversity discourages a few spider species (Edwards *et al.*, 1976) in general it permits a larger number of spiders and of spider species (Duffey, 1978). Kajak (1962) and Edwards *et al.* (1976) observed, for example, that in grassland mowing led to a reduction in the total number of spiders and to elimination of some species. On arable land the habitat is continually modified by agricultural operations which will affect the size and composition of the spider population.

Lists of linyphiid spiders caught in pitfall traps on arable land in N.W. Europe are dominated by the same few species (Geiler, 1963; Cottenie & De Clercq, 1977; Łuczak, 1979; Czajka & Goos, 1976). This study investigated the life styles, the seasonal and diurnal activity and the niche preferences of these species. The effects of agricultural operations on linyphiid spider populations, and of linyphiids on the populations of sugar-beet pests, are discussed.

Methods

All field work was done at Broom's Barn Experimental Station. In 1978 the pitfall trapping was done on sandy loam soil but all other field work, in 1979, 1980 and 1982, was done on calcareous clay loam soil. The station is in a predominantly arable-farming area within which are several small woods and mature hedgerows.

Spiders active on the soil surface were caught in pitfall traps – cylindrical aluminium cans, 11.5 cm



Figs. 1-3: Total monthly catches of 1 *Erigone atra* (Blackwall), 2 *Erigone dentipalpis* (Wider), and 3 *Oedothorax apicatus* (Blackwall) in five pitfall traps (*Oedothorax* spp. females were not identified to species in 1978). Open bars = males, solid bars = females.

deep and with a 5 cm diameter aperture, sunk into the soil. The cans contained water and detergent, and were held within plastic sleeves to minimise disturbance to the soil when changing the traps.

Throughout 1978 five pitfall traps, spaced 10 m apart in a line, operated in an 8 ha sugar-beet field (sown 19 April; harvested late October). In 1979 five traps, arranged as in 1978, operated throughout the year in a 4 ha sugar-beet field (sown 14 April; harvested late October), and another five operated up to ploughing on 19 September in a 5 ha spring-barley field (sown 14 April; harvested 27 August). The sugar-beet seed was treated with methiocarb and the barley seed with gamma-HCH; no other insecticides were applied to the crops. The traps were changed at the end of every month, and during warm weather as often as necessary for the spiders to be in fresh condition and easily identified. They were removed at seedbed preparation, sowing and harvesting, but replaced as soon as possible, always within two days.

In 1978, from 13 to 25 August, five pitfall traps in another 5 ha sugar-beet field were changed at 4.00, 7.00, 19.00 and 22.00 hrs to compare diurnal activity on the soil surface. From 13 to 18 August five traps in a 0.5 ha fallow area harrowed on 19 June and 11 July after sugar-beet seedling-growth experiments, were changed similarly.

When searching for webs, on bare soil or amongst fallen sugar-beet leaves, an area of several square metres was sprayed with water droplets from an atomiser to render all webs conspicuous; this reduced observer bias towards larger and more obvious webs.

The area of a horizontal sheet web was determined by placing a transparent plastic sheet slightly above it and tracing the outline of the web on the sheet. If a web was largely overhung by soil or covered by vegetation its area could not be determined. For some observations the area was recorded only if an adult spider was present; if the spider was not immediately visible it was sought by disturbing the soil around the web. The plastic sheet was placed on millimetre graph paper and the area enclosed by the tracing calculated.

Using a cylindrical auger, 25 pits approximately 10.5 cm across and 10 cm deep were made in bare patches of soil between sugar-beet plants on 1 August 1982. This was to determine whether species building large webs would readily occupy sites away from vegetation and whether species which normally build webs much smaller than the aperture of the pits would build larger webs if suitable sites were available. The pits were inspected at irregular intervals, but on average once every 2 days, at approximately 10.00 hrs, for 4 weeks. To discourage web-building at the bottom of the pits loose soil was removed when the pits were made and, if necessary owing to the crumbling of the pit walls, on subsequent inspections. Deep cracks and holes which developed in the sides of the pits were filled with damp soil. All spiders with webs inside the pits were collected, and all webs destroyed after each inspection.

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Oedothorax fuscus (Blackwall) males	1		2	2	1	1	9	2	2	2	1		23
O. retusus (Westring) males		2	1				5	7	5	2			22
**Oedothorax* spp. females		1		8	10	9	35	32	3	2			100
Milleriana inerrans (O. P.-Cambridge) males			2	4	2	2	3	7	5				25
Milleriana inerrans (O. P.-Cambridge) females						1	2	4	2		1		10
Porrhomma microphthalmum (O. P.-Cambridge) males			2	8	9	6	5		2	2	6		40
Porrhomma microphthalmum (O. P.-Cambridge) females				2	3	3	3		1				12
Centromerita bicolor (Blackwall) males										1	14	8	23
Centromerita bicolor (Blackwall) females												2	2
immatures, all species		12	21	5	2	5	3	8	24	10	4		94

Table 1: Total monthly catches of the less abundant species of linyphiid spiders in five pitfall traps in sugar beet, 1978. Total catches of other species were; *Pelecopsis parallela* (Wider) male (1), *Mioxena blanda* (Simon) males (3), *Micrargus herbigradus* (Blackwall) male (1), *M. subaequalis* (Westring) male (1), *Erigonella hiemalis* (Blackwall) male (1), *Savignya frontata* (Blackwall) male (1), *Diplocephalus latifrons* (O. P.-Cambridge) male (1), *Araeoncus humilis* (Blackwall) males (2), *Ostearius melanopygius* (O. P.-Cambridge) males (3) females (5).
**Oedothorax* females not identified to species in 1978. Scientific names as in Locket *et al.* (1974).

Results

Pitfall trapping

a) *Species abundance and seasonal activity*

The traps caught large numbers of spiders and, thus, were an efficient aid in determining the most abundant species active on the soil surface and in comparing their seasonal activity. Figures 1-6 and Tables 1-3 record all linyphiid spiders caught in the traps in each field. The most abundant species (shown in Figs. 1-6) were *Erigone atra* (Blackwall), *E. dentipalpis* (Wider), *Oedothorax apicatus* (Blackwall), *Meioneta rurestris* (C. L. Koch), *Lepthyphantes tenuis* (Blackwall) and *Bathyphantes gracilis* (Blackwall). These species were also those most commonly found by searching (Tables 5 and 6).

In 1978 peaks in the numbers of adults of the two *Erigone* species in the traps were recorded in spring (Feb-April) and late summer (July-August). In 1979 in the sugar-beet field there was no distinct peak throughout a main period of activity from March to August. Many more of both species were caught in June, July and August in the barley than in the sugar-beet. Adults of *L. tenuis* and *B. gracilis* were commonly caught throughout the second half of 1978 and 1979, whereas for *M. rurestris* adults a peak of numbers from May to July/August was recorded and none was caught in sugar-beet fields after August. *O. apicatus* males were commonly caught up to October in sugar-beet, and up to harvest in September in spring barley, whereas the number of females caught declined after August.

Walckenaera capito (Westring), *Mioxena blanda* (Simon), *Centromerus capucinus* (Simon) and *C. incilium* (L. Koch) are species recorded only rarely in the British Isles (Locket *et al.,* 1974). Probably these species live at low densities on arable land but may be widely distributed. The paucity of records probably reflects the lack of attention paid to arable land by arachnologists until recent years.

b) *Diurnal activity*

The results of the pitfall trapping to compare diurnal activities of spider species are shown in Table 4. *Oedothorax apicatus* appeared to be markedly more active at night; other *Oedothorax* species were also caught principally at night but only in small numbers. *Erigone* females were caught principally at night, and the males mainly during the day. Other species were caught in smaller numbers, allowing no distinct preference for activity at a certain time of the day to be determined.

Relative frequency of species in different habitats in sugar-beet fields

i) *Summer 1980.* During the period 24 July-2 September 1980 adult spiders were sought below sugar-beet leaves, often yellow with senescence, which were touching the soil (grounded) although still attached to the plant; they were not sought

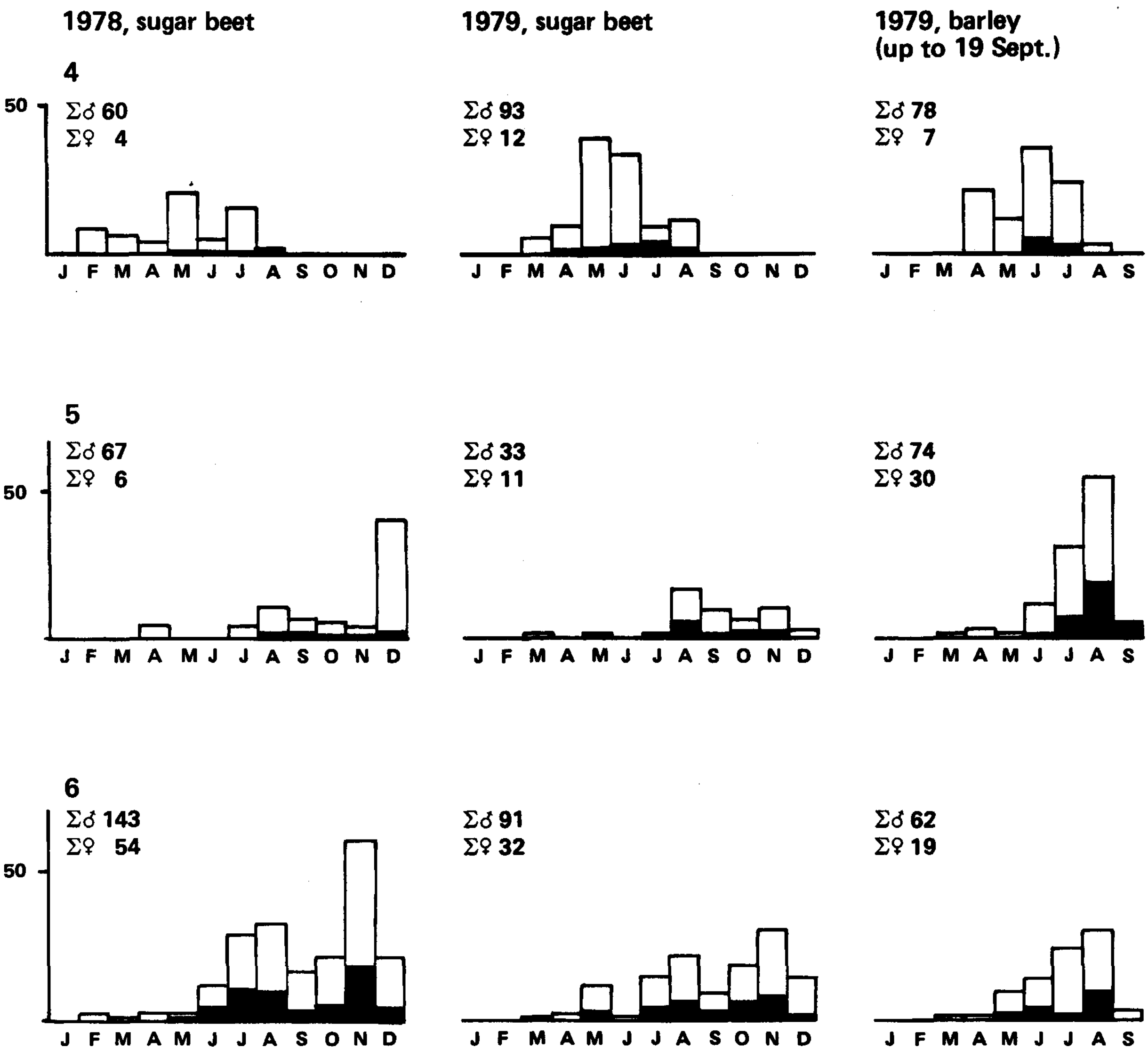
	J	F	M	A	M	J	J	A	S	O	N	D	Total
Oedothorax fuscus (Blackwall) males					2	3		1	2				8
Oedothorax fuscus (Blackwall) females			3	5	2	1		3	3				17
O. retusus (Westring) males					5			2	4	1			12
O. retusus (Westring) females				2	1	1		4					8
Milleriana inerrans (O. P.-Cambridge) males					5	11							16
Milleriana inerrans (O. P.-Cambridge) females					1	4		2					7
Porrhomma microphthalmum (O. P.-Cambridge) males										2	3		5
Porrhomma microphthalmum (O. P.-Cambridge) females						1			1		1		3
Centromerita bicolor (Blackwall) males											6	15	21
Centromerita bicolor (Blackwall) females											1		1
immatures, all species				3	5	19		11	31	3			72

Table 2: Total monthly catches of the less abundant species of linyphiid spiders in five pitfall traps in sugar beet, 1979. Total catches of other species were; *Walckenaera cucullata* (C. L. Koch) male (1), *W. capito* (Westring) males (3), *W. antica* (Wider) male (1), *W. nudipalpis* (Westring) male (1), *Troxochrus scabriculus* (Westring) female (1), *Micrargus herbigradus* (Blackwall) female (1), *Ostearius melanopygius* (O. P.-Cambridge) female (1), *Centromerus capucinus* (Simon) males (5) females (2), *Kaestneria pullata* (O. P.-Cambridge) male (1), *Diplostyla concolor* (Wider) male (1) females (3), *Lepthyphantes ericaeus* (Blackwall) males (2) females (2), *Helophora insignis* (Blackwall) male (1).

below brown, decaying leaves. During the period 18 June-2 September adult spiders which had soil-surface webs not attached to living vegetation were also sought; these webs were often below the crop canopy but not covered by leaves touching the ground. Results are shown in Table 5.

M. rurestris comprised 60% of the spiders found with webs over bare soil but only 9% of those found below grounded leaves. The relative numbers of this species found in the two situations differed significantly from those of *L. tenuis* (χ^2 = 14.8, $p < 0.001$) and of *B. gracilis* (χ^2 = 34.4, $p < 0.001$), which were rarely found with webs over bare soil. This suggests that the distribution of these three species within the crop is influenced by the amount and distribution of vegetation close to the ground. *O. apicatus* was also found frequently, but only below grounded leaves.

ii) *Summer 1982.* From 6 July to 10 August 1982



Figs. 4-6: Total monthly catches of **4** *Meioneta rurestris* (C. L. Koch), **5** *Bathyphantes gracilis* (Blackwall), and **6** *Lepthyphantes tenuis* (Blackwall) in five pitfall traps. Open bars = males, solid bars = females.

adult spiders were sought with webs on bare soil, as in the previous comparison. They were also sought with webs which were close to the soil but wholly or partly supported by the sugar-beet plants, either between the petioles of grounded leaves (Fig. 7) or against the crown of the root. Results are shown in Table 5.

As in the first comparison *M. rurestris* comprised a large majority (72%) of spiders found with webs on bare soil; it was rarely found with webs supported by sugar-beet plants. The relative numbers of this species in the two situations were significantly different from those of *L. tenuis* and *B. gracilis*, which were the most common species found with webs supported by sugar-beet plants ($\chi^2 = 29.4$, $p < 0.001$; $\chi^2 = 17.7$, $p < 0.001$ respectively).

Measurements were made of the areas of the webs of adult spiders found on bare soil in the two series of observations described above. The mean web areas of each species are shown in Table 6.

Area of soil covered by webs

The percentage of the soil surface covered by the webs of linyphiid spiders was determined on three dates in 1978 in the sugar-beet field in which pitfall trapping was done. On each date ten 0.5 x 0.5 m squares on the soil surface were randomly selected and the areas of the webs within them measured. The mean % cover on 12 May, 3 June and 1 July was 0.35%, 0.25% and 2.83% respectively; these values reflect differences in the total numbers of linyphiid spiders (63, 60, 523) caught in pitfall traps in those months.

After early July the percentage ground cover could not be determined because the outer leaves of sugar-beet plants began to touch the ground and many spiders built their webs wholly or partly below these leaves; the areas of these webs could not be determined.

Occupation of artificial pits

Table 7 records the spiders found with webs in 25 auger-made pits in the soil. Most webs spanned the pits, at various depths within them, attached only to the side walls. Occasionally some webs were built wholly or partly on soil at the bottom of the pits. Often no spider was found with a web and some webs were found in disrepair, particularly if the pits were not inspected for two or more days. *L. tenuis* and *B. gracilis*, species which frequently attach their webs to vegetation, were the most common occupants of the pits. *M. rurestris*, which normally builds a web much smaller in area (Table 6) than the aperture of the pits (approx. 85 cm^2), rarely occupied them.

On nine occasions the pits were examined one day after the previous examination and the destruction of the webs. On these days on average 10.1 pits (40%) had new webs spanning them, 55% of which were attended by spiders.

	J	F	M	A	M	J	J	A	S	Total
Oedothorax fuscus (Blackwall) males						2	10	3	10	25
Oedothorax fuscus (Blackwall) females				2		2	8	9		21
O. retusus (Westring) males					2	7	4	3	3	19
O. retusus (Westring) females								1		1
Milleriana inerrans (O. P.-Cambridge) males					1	4	3	12	3	23
Milleriana inerrans (O. P.-Cambridge) females						2	1	1	1	5
Porrhomma microphthalmum (O. P.-Cambridge) males				1	5	1			1	8
Porrhomma microphthalmum (O. P.-Cambridge) females					2		1	2	1	6
immatures, all species				2	5	7	10	7	12	43

Table 3: Total monthly catches of the less abundant species of linyphiid spiders in five pitfall traps in barley, 1979 (to 19th Sept.)

Total catches of other species were; *Walckenaera cucullata* (C. L. Koch) male (1), *W. dysderoides* (Wider) males (2), *W. nudipalpis* (Westring) male (1), *Dismodicus bifrons* (Blackwall) male (1), *Pocadicnemis pumila* (Blackwall) males (2), *Monocephalus fuscipes* (Blackwall) male (1), *Micrargus subaequalis* (Westring) males (2), *Erigonella hiemalis* (Blackwall) male (1), *Savignya frontata* (Blackwall) male (1), *Araeoncus humilis* (Blackwall) males (3), *Centromerus capucinus* (Simon) male (1), *Diplostyla concolor* (Wider) males (2) female (1), *Lepthyphantes ericaeus* (Blackwall) male (1).

Discussion

Łuczak (1979) suggests that few, if any, spider species are capable of surviving on land growing annual crops without immigration from less disturbed areas because agricultural operations prevent most spiders from passing through a complete life cycle. However, she mentioned that *O. apicatus* is more numerous on arable land than other habitats, and suggested that this is perhaps due to decreased competition from other species. In the present study it was not found to build webs, although it was as numerous in the pitfall traps as species that do; it is probably better adapted to survive on bare land than species which frequently attach their webs to plants. *O. apicatus* is reclusive, appearing to move about chiefly at night, and in the fields it was found only below stones or grounded leaves.

The ratio of male to female adults caught in the pitfall traps varied greatly between species; of the species caught in large numbers in this study, and those of Geiler (1963), Cottenie & De Clercq (1977), and Thaler *et al.* (1977), the ratio is highest for *Erigone* spp. (approximately 15:1) and lowest for *Oedothorax* spp. (approximately 2:1). Edwards *et al.* (1976) suggest that females of most linyphiid species are outnumbered in pitfall traps because they remain with the web whilst being sought by the males. Possibly, therefore, *Oedothorax* females are less dependent on webs and rely more on hunting than females of other species. Alternatively, the ratios may reflect differences in the actual population, a suggestion reinforced by the lower male to female ratio of *O. apicatus* adults found below leaves than for other common species, or pitfall traps may be more biased towards catching female than male *Oedothorax* spp. if, for example, the females walk more rapidly.

M. rurestris, *L. tenuis* and *B. gracilis* walk on the undersides of their thin sheet webs, which trap prey falling on them from above. The webs require support to raise the central portion above the soil, to allow for downward movements caused by strong winds or the weight of rain or dew. *M. rurestris* is a smaller, shorter-legged species than *L. tenuis* (Locket & Millidge, 1953) and builds smaller webs (Table 6), which therefore require less clearance. *M. rurestris* was the commonest species found with webs over bare soil and, to gain the necessary clearance, it builds its webs against stones or over depressions in the soil surface (Fig. 7). *L. tenuis* readily built webs across the mouths of auger-made pits, 85 cm^2 in cross-

	Sugar beet field 13-25 Aug.		Fallow area 13-18 Aug.	
	Day 7.00-19.00	Night 19.00-7.00 (Numbers in brackets are catches in 19.00-22.00, 22.00-4.00, 4.00-7.00)	Day 7.00-19.00	Night 19.00-7.00 (Numbers in brackets are catches in 19.00-22.00, 22.00-4.00, 4.00-7.00)
O. apicatus male	1 *	26 (1, 16, 9)	0	2 (0, 2, 0)
O. fuscus male	0	3 (0, 2, 1)	0	0
O. retusus male	1	5 (1, 2, 2)	0	0
Oedothorax spp. female	10 *	35 (5, 28, 2)	0	15 (2, 11, 2)
M. inerrans male	2	2 (0, 2, 0)	0	0
M. inerrans female	1	1 (1, 0, 0)	0	2 (0, 2, 0)
E. dentipalpis male	24	14 (0, 8, 6)	1	0
E. dentipalpis female	4	5 (0, 3, 2)	1	4 (0, 4, 0)
E. atra male	41	22 (0, 13, 9)	2	2 (0, 2, 0)
E. atra female	1	6 (0, 3, 3)	0	3 (0, 3, 0)
M. rurestris male	2	0	3	10 (0, 7, 3)
M. rurestris female	1	0	3	2 (0, 2, 0)
B. gracilis male	0	4 (0, 3, 1)	1	0
B. gracilis female	0	1 (0, 1, 0)	0	0
L. tenuis male	4	4 (0, 4, 0)	2	4 (1, 2, 1)
L. tenuis female	2	1 (0, 1, 0)	2	2 (0, 2, 0)

Table 4: Diurnal variation in catch of linyphiid spiders, 1978: total numbers in 5 pitfall traps.
*Significant difference ($p < 0.05$) between day and night totals by Wilcoxon test, using totals in each day and each following night as matched pairs.

sectional area, but was less often found with webs over bare soil than *M. rurestris.* This suggests that there are few natural depressions in the soil surface sufficiently large for the webs of *L. tenuis,* and explains why it is often found in association with vegetation, which supports its webs above the soil. *B. graçilis* appears to occupy a similar ecological niche to *L. tenuis* in sugar-beet fields. It frequently built webs amongst grounded leaves, and adults of the two species were caught in pitfall traps at the same time of the year.

Time appears not to be a factor contributing to the ecological segregation of closely related species. Adults of both *Erigone* species were trapped in large numbers in the same months and at the same time of day, as were those of the three *Oedothorax* species. It is not known how, or if, the two *Erigone* species reduce competition for resources on arable land. Wiehle (1960) states that *E. dentipalpis* prefers drier habitats than does *E. atra,* and it may therefore tend to build its web in more exposed places.. These species occupy a variety of habitats, e.g. below leaves and with webs over bare soil or in small cracks or pits in the soil. They build small webs which, unlike the much larger webs of *L. tenuis* and *B. gracilis,* are unable to span the large expanses between the petioles of grounded sugar-beet leaves.

The percentage ground cover by linyphiid webs in July 1978 in a sugar-beet crop was much less than

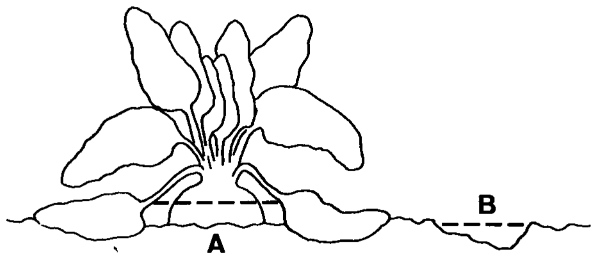


Fig. 7: Typical positions of webs of **A** *Lepthyphantes tenuis* and *Bathyphantes gracilis,* and **B** *Meioneta rurestris.*

that determined by Carter *et al.* (1982) in cereals in July. Furthermore, in 1979 the number of *Erigone* species caught in pitfall traps in spring barley from June to August was much higher than in sugar-beet, whereas earlier in the year similar numbers were caught. If this reflects a higher population in the barley then the layer of dead leaves on the soil surface of barley fields is probably structurally more suitable for *Erigone* webs than that in beet fields and, furthermore, is deposited earlier. The peak of leaf production of the spring barley (Gallagher *et al.,* 1977) was approximately six weeks earlier than that of the sugar-beet (Scott *et al.,* 1973). The *Erigone* species were perhaps encouraged to stay by the greater structural diversity at the soil surface of the

	1980		**6 July-10 August, 1982**	
	Below grounded leaves 24 July-2 Sept.	**With web over bare soil 18 June-2nd Sept.**	**With webs close to the soil and supported by sugar-beet plants**	**With web over bare soil**
***O. apicatus* male**	3	0	0	0
***O. apicatus* female**	19	0	0	0
***O. fuscus* male**	4	1	1	0
***E. atra* male**	2	0	0	1
***E. atra* female**	10	3	0	4
***E. dentipalpis* male**	1	0	0	0
***E. dentipalpis* female**	4	2	0	1
***M. rurestris* male**	4	6	1	4
***M. rurestris* female**	6	22	1	14
***L. tenuis* male**	16	0	0	0
***L. tenuis* female**	13	11	23	1
***B. gracilis* male**	11	1	1	0
***B. gracilis* female**	14	1	8	0

Table 5: Numbers of linyphiid spiders found by visual searching in different situations in sugar-beet fields at Broom's Barn (immatures not recorded).

barley field, just as species building larger webs readily occupied auger-made pits in sugar-beet fields. Without frequent disturbance of the soil the fissures and minor undulations in exposed soil surfaces rapidly disappear owing to weathering.

Linyphiid spiders probably have little direct effect on the populations of major soil-inhabiting pests. Their principal potential importance in sugar-beet fields is as predators of aphids in May and June, before the arrival of aphid-specific predators. Linyphiid spiders in sugar-beet fields were observed eating aphids of the three species most commonly found on the crop, *Myzus persicae* (Sulz.), *Aphis fabae* Scop. and *Macrosiphum euphorbiae* (Thos.), during the present study, and Łuczak (1979) found dead aphids in the webs of linyphiid spiders in potato fields early in the season. However, Nyffeler (1982) considers that their importance as aphid predators on arable land remains to be determined, there being no quantitative information on the influence of spiders on aphid numbers. The aphid *M. persicae* is the principal vector of the two yellowing viruses of sugar-beet in England. Ribbands (1963) suggests that much of the spread of the viruses is done by apterous aphids walking across the soil surface. The viruses severely decrease the yield of the crop if plants are infected early in the season, in May and June, but in 1978 the webs of linyphiid spiders covered less than 1% of the soil surface in these months, and many appeared to be unattended. It therefore appears unlikely that in sugar-beet in 1978 the population of linyphiids would have been high enough to affect the numbers of aphids, and hence virus spread, significantly. However, for their importance as aphid predators to be determined the proportion of aphids caught by hunting must be known. The cover increased greatly in July but, by then, aphid-specific predators had arrived and these are probably more effective in controlling aphid populations.

		Number (n) of webs found	Mean area, cm^2 (± s.e. where $n > 10$)
O. fuscus	♀	1	23.0
E. atra	♂	1	30.4
E. atra	♀	7	11.5
E. dentipalpis	♀	3	13.2
M. rurestris	♂	10	32.7
M. rurestris	♀	36	26.2 ± 1.58
B. gracilis	♀	1	40.3
L. tenuis	♀	12	61.7 ± 6.44

Table 6: Mean areas of webs found on bare soil, July-August 1978-9.
By the Mann-Whitney U test the webs of female *L. tenuis* were significantly larger than those of female *M. rurestris* ($p < 0.001$). The webs of female *L. tenuis* and female *M. rurestris* were significantly larger than those of female *Erigone* sp. (*E. atra* + *E. dentipalpis*), ($p < 0.001$ in both cases).

	Number of webs spanning the pits	Number of webs attached at least partly to bottom of pits
L. tenuis male	2	0
L. tenuis female	26	1
L. tenuis immature	9	1
B. gracilis male	3	0
B. gracilis female	32	3
M. rurestris female	3	0

Table 7: Spiders with webs in 25 circular pits (with 85-90 cm^2 aperture) in bare ground between sugar-beet plants on 14 inspections, 1-28 Aug. 1982.

Riechert (1974) makes the general suggestion that spiders are ineffectual in controlling the sporadic pest outbreaks which occur in crops because they have not evolved the capacity to live at sufficiently high densities, although they may restrict the rate of increase in pest populations before the arrival of more specific predators. In sugar-beet fields the density of linyphiid spiders during aphid immigration is far lower than later in the year and, therefore, far below the level at which cannibalism and their unwillingness to live in close proximity act to restrict increases in their population. There is therefore considerable scope for increasing the numbers of linyphiid spiders in sugar-beet fields in late spring. Probably a large proportion of the spider population at this time consists of recently-arrived immigrants, and consequently it is difficult to estimate the effect on the population of autumn, winter and early spring farming operations. Nevertheless linyphiid numbers in May-June could be increased by increasing the structural diversity of the habitat at the soil surface. This could be achieved by covering the soil with a layer of dead vegetation or by roughening the soil surface itself. Linyphiid spiders might then become a more useful component in aphid-control strategies, particularly where pesticide usage is minimised.

References

CARTER, N., GARDNER, S., FRASER, A. M. & ADAMS, T. H. L. 1982: The role of natural enemies in cereal aphid population dynamics. Proceedings of the Entomology Group of the Association of Applied Biologists – Natural Enemies and Insect Pest Dynamics. *Ann.appl.Biol.* **101**: 190-195.

COTTENIE, P. & DE CLERCQ, R. 1977: Studie van de arachnofauna in wintertarwevelden. *Parasitica* **33**: 138-147.

CZAJKA, M. & GOOS, M. 1976: The spiders (Aranei) of sugar-beet fields in Pawlowice Wielkie near Wroclaw. *Polskie Pismo ent.* **46**: 179-185.

DONDALE, C. D. & BINNS, M. R. 1977: Effect of weather factors on spiders (Araneida) in an Ontario meadow. *Can.J.Zool.* **55**: 1336-1341.

DUFFEY, E. 1978: Ecological strategies in spiders including some characteristics of spiders in pioneer and mature habitats. *Symp.zool.Soc.Lond.* **42**: 109-123.

EDWARDS, C. A., BUTLER, C. G. & LOFTY, J. R. 1976: The invertebrate fauna of the Park Grass Plots. II, Surface fauna. *Rep.Rothamsted exp.Stn* **1975**(2): 63-89.

GALLAGHER, J. N., BISCOE, P. V., SCOTT, R. K. & DENNIS-JONES, R. 1977: Barley physiology and its relation to farming practice. In *The Yield of Cereals.* Cereal Unit, National Agricultural Centre, Kenilworth: 11-17.

GEILER, J. 1963: Die Spinnen- und Weberknechtfauna nordwestsächsischer Felder. *Z.angew.Zool.* **50**: 257-272.

HOSSFELD, R. 1976: The effects on some groups of the fauna of sugar-beet fields of the application to the soil of insecticides containing lindane. *NachrBl.dt.Pfl-Schutzdienst.LandschPflege* **28**: 97-100.

KAJAK, A. 1962: A comparison of spider fauna in artificial and natural meadows. *Ekol.pol.* (A) **10**: 1-20.

LOCKET, G. H. & MILLIDGE, A. F. 1953: *British Spiders* **2**: 1-449. Ray Society, London.

LOCKET, G. H., MILLIDGE, A. F. & MERRETT, P. 1974: *British Spiders* **3**: 1-314. Ray Society, London.

ŁUCZAK, J. 1979: Spiders in agrocoenoses. *Pol.ecol.Stud.* **5**: 151-200.

NYFFELER, M. 1982: *Field studies on the ecological role of the spiders as insect predators in agroecosystems (abandoned grassland, meadows and cereals fields).* Ph.D. thesis, ETH Zurich.

NYFFELER, M. & BENZ, G. 1979: Zur ökologischen Bedeutung der Spinnen der Vegetationsschicht von Getreide- und Rapsfeldern bei Zürich (Schweiz). *Z.angew.Ent.* **87**: 348-376.

OKE, T. R. 1978: *Boundary layer climates.* Methuen, London.

PIETRASZKO, R. & DE CLERCQ, R. 1980: Étude de la population d'arthropodes épigés dans la culture agricoles au cours de la période 1974-1978. *Revue Agric., Brux.* **33**: 719-733.

RIBBANDS, C. R. 1963: The spread of apterae of *Myzus persicae* (Sulz.) and of yellows viruses within the sugar-beet crop. *Bull.ent.Res.* **53**: 267-283.

RIECHERT, S. E. 1974: Thoughts on the ecological significance of spiders. *Bioscience* **24**: 352-356.

ROESGAARD, H. & LINDHARDT, K. 1979: The effect of straw burning on predaceous arthropods on the soil surface. *Tidsskr.PlAvl* **83**: 305-323.

SCOTT, R. K., ENGLISH, S. D., WOOD, D. W. & UNSWORTH, M. H. 1973: The yield of sugar beet in relation to weather and length of growing season. *J.agric.Sci., Camb.* **81**: 339-347.

THALER, K., AUSSERLECHNER, J. & MUNGENAST, F. 1977: Vergleichende Fallenfänge von Spinnen und Käfern auf Acker- und Grunlandparzellen bei Innsbruck, Österreich. *Pedobiologia* **17**: 389-399.

VICKERMAN, G. P. & SUNDERLAND, K. D. 1977: Some effects of dimethoate on arthropods in winter wheat. *J.appl.Ecol.* **14**: 767-777.

WIEHLE, H. 1960: Spinnentiere oder Arachnoidea (Araneae) XI: Micryphantidae – Zwergspinnen. *Tierwelt Dtl.* **47**: 562-573.