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Abundance and species richness of field-margin and pasture spiders (Araneae) in Canterbury, New Zealand

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Abstract The density and species composition of ground-dwelling spiders were assessed using suction sampling from August 1994 to July 1995 at various distances from a field edge into a single grazed pasture, and from March 1996 to March 1997 in the same and three additional grazed pastures and adjacent fenced shelterbelts on the Canterbury Plains, New Zealand. Spider density declined rapidly with distance from the shelterbelt (mean 241 m^{-2}) into the pasture (means 72.5 m^{-2} at 2.5 m, and 10.3 m^{-2} at 5 m). Mean spider densities in the four pastures were 53.0 m^{-2} while in the shelterbelts they reached 316 m^{-2}. The fauna in both habitats was dominated by the European linyphiid, *Tenuiphantes tenuis* (Blackwall). An unidentified theridiid was common only in the shelterbelt, while unidentified immature linyphiids and theridiids were common in both habitats. Of the c. 28 species collected, 25 were found in shelterbelts, and 13 in pasture. Thirteen endemic, one native, and one introduced species were found only in shelterbelts, while from pasture all but two endemic species were also recognised from shelterbelts. There was little evidence that the shelterbelts acted as refuges for spiders which could subsequently disperse to the adjacent paddocks.

Keywords shelterbelt; suction sampling; Linyphiidae; *Tenuiphantes tenuis*; Lycosidae

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INTRODUCTION

Spiders are often the most abundant predators in agro-ecosystems (Turnbull 1973; Wise 1993). Their communities have been well studied in agro-ecosystems outside New Zealand, including in the United States (Howell & Pienkowski 1971; Dean et al. 1982; Plagens 1983; Agnew & Smith 1989), Canada (Turnbull 1966; Putman 1967; Wheeler 1973; Doane & Dondale 1979), Belgium (Alderweireldt 1987, 1989; Maelfait & De Keer 1990), Austria (Kromp & Steinberger 1992), Switzerland (Nyffeler & Benz 1988a,b), Ireland (Feeney & Kennedy 1988), the United Kingdom (Thornhill 1983; Luff & Rushton 1989), and Australia (Bishop 1980). Most of these studies examined fauna and phenology; however, until recently, virtually nothing was known of the spider fauna in New Zealand farmland. Forster (1975) noted that the New Zealand spider fauna as a whole included both native and introduced species, and Martin (1983) recorded species from 15 families from pitfall traps in a Nelson pasture. Topping & Lövei (1997) provided the first density estimates and faunal lists from North Island, New Zealand, agricultural habitats. Still unknown in New Zealand is the actual or potential contribution made by spiders to biological control, the value of paddock-margin refuges for this group, and the extent to which spiders move from these refuges to the open field.

A knowledge of the densities, species-composition and dispersal of spiders has helped improve the contribution made by spiders to the biological control of pests. For example, in Europe, weed strips planted in an apple orchard (Wyss et al. 1995) led to an increase in the numbers of aphidophagous predators, including spiders, which in spring reduced aphid numbers on trees near the weed strips. Also in Europe, within-field overwintering refuges have been established for polyphagous predatory invertebrates (Thomas et al. 1992), some of which disperse widely from the refuge in spring, colonising the adjacent field, and potentially contributing to enhanced levels of biological control. The faunal groups studied were mainly Coleoptera (Carabidae and Staphylinidae) and European spiders from a range of families. Beetles from both families dispersed into the field, but the spiders either remained in the refuge (Lycosidae) or dispersed widely aerially (Linyphiidae) (Thomas et al. 1992).

In New Zealand, the margins of fields are commonly planted with trees to provide shelter for livestock. These shelterbelts may be fenced off from the pasture so that livestock cannot enter them. In this study, we examined the effect of distance from a shelterbelt on species richness and abundance of spiders, based on sampling extending over 11 months. Over a further 13-month sampling period, we also analysed species richness and abundance in these and three additional pastures and in their adjacent fenced-off shelterbelts.

METHODS

Spider densities in relation to distance from field margin

We sampled a 6 ha paddock referred to as the "Shands Road site" (see Site descriptions below), on the Lincoln University Sheep Breeding Unit, every 3–5 months from August 1994 to July 1995 using a vacuum sampler (Arnold 1994). The sampler was powered by a 21 cc McCulloch Super AirStream IV Gas Blower/Vac motor (McCulloch Corporation, United States). Sample dates were: 4 August 1994, 22 October 1994, 27 March 1995, and 7 July 1995. Suction samples of the invertebrate fauna were taken in the shelterbelt (within 0.5 m of the fence) and at 2.5, 5, 10, 25, and 50 m into the pasture. Ten samples were taken at each of the six distances (see Sampling procedures).

Spider densities in four pastures and shelterbelts

We sampled four pastures near Lincoln University (see Site descriptions below) at 1–3 month intervals from March 1996 to March 1997. At each site, we took five suction samples from the shelterbelt (within 1 m of the fence separating the shelterbelt and pasture) and five samples from the pasture (25 m away from the fence).

Site descriptions

The four sites were within 4 km of each other, near Lincoln University, Canterbury, New Zealand (43°39′S, 172°28′E). The area receives an average of 55 cm of rainfall per year. Daily mean temperatures range from 6.1°C in July to 17.0°C in January.

Shands Road: This was a sheep pasture (Lincoln University Sheep Breeding Unit paddock S2, 6.0 ha) dominated by ryegrass *Lolium perenne* L. (Gramineae) with some clover *Trifolium* spp. (Fabaceae), rotationally grazed by sheep for 10 months of the year, then set-stocked for 2 months (September–October) at an average stocking rate of 15 stock units ha^{-1}. The paddock had been in pasture for 8 years at the start of sampling, and was cultivated and sown in *L. perenne* and white clover *Trifolium repens* L. in March 1995. The shelterbelt comprised *Pinus radiata* (D. Don) G. Don (Pinaceae) trees c. 25 years old, trimmed to c. 9 m in height, planted 2 m apart in two rows 4 m apart. Inside the fence at its base was an almost-continuous stand of cocksfoot *Dactylis glomerata* L. (Gramineae) whereas underneath the trees only pine needles covered the ground.

Weedons Road: This was sheep pasture (Lincoln University Research Farm paddock R 28, 7.3 ha) of mainly ryegrass and white clover grazed from April–December at an average stocking rate of 12 stock units ha^{-1}. The field had been in pasture for 12 years at the beginning of sampling. The shelterbelt was *Cedrus deodara* (D. Don) G. Don (Pinaceae) trees 6–8 m tall, planted 6 years previously, 2–3 m apart c. 3 m from the fence. *D. glomerata* was the main grass species present, with some yarrow *Achillea millefolium* L., thistle *Cirsium vulgare* (Savi) Ten. (Asteraceae), and broom *Cytisus scoparius* (L.) Link (Fabaceae).

Boundary Road: This was dairy pasture (privately owned, 0.6 ha, adjacent to Lincoln University Mixed Cropping Farm paddock A18) sown in permanent pasture (ryegrass and clover) 5 years previously, and irrigated in summer. The shelterbelt comprised poplar trees *Populus* sp. (Salicaceae) and willow trees *Salix* sp. (Salicaceae) 6–8 m tall, c. 5 years old. The roadside fence had gorse *Ulex europaeus* L. and broom *C. scoparius* growing in it. Ground cover consisted of the grasses *D. glomerata* and *Arrhenatherum elatius* (L.) J. Presl et C. Presl, some yarrow *A. millefolium*, clover *Trifolium* sp., with occasional vetch *Vicia sativa* L. (Fabaceae).

Dairy Farm: This was dairy pasture (Lincoln University Dairy Farm paddock 12, 3.2 ha) sown in permanent pasture (ryegrass and clover) c. 30 years previously, and irrigated in summer. The shelterbelt

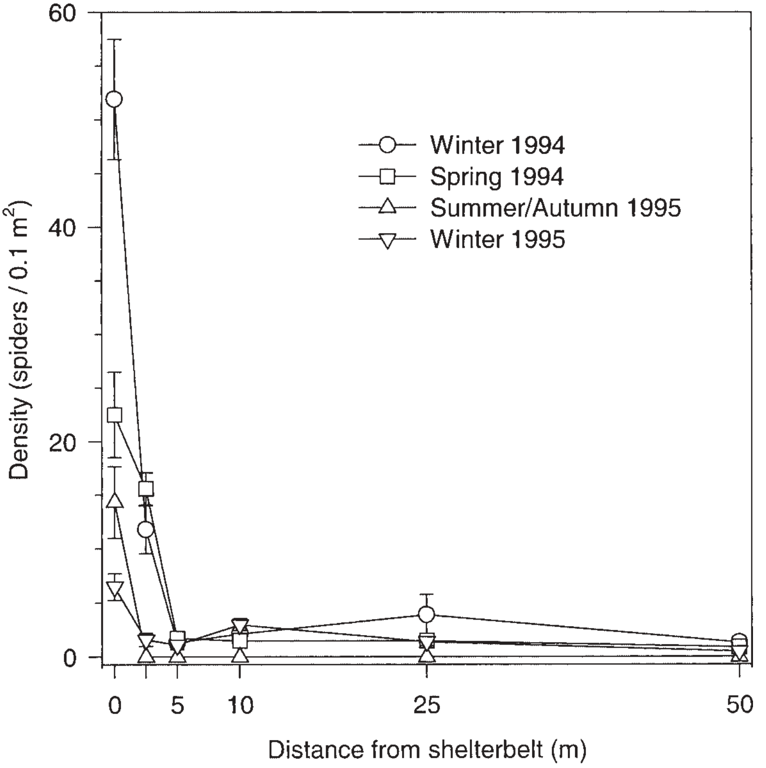


Fig. 1 Density of spiders (mean/ 0.1 m^2 ± SE) within a fenced-off *Pinus radiata* shelterbelt and in an adjacent sheep pasture in four seasons in Canterbury, New Zealand.

comprised poplar trees *Populus* sp. c. 30 years old, trimmed to c. 7 m, planted c. 1 m apart in two rows c. 3 m apart. Ground cover was mainly *Phalaris aquatica* L. with some *D. glomerata*, *Holcus lanatus* L., and *A. elatius* (Gramineae) and *Rumex obtusifolius* L. (Polygonaceae), *Plantago lanceolata* L. (Plantaginaceae), *Cirsium vulgare*, and *C. arvense* (L.) Scop. (Asteraceae).

Plant names follow Webb et al. (1988), Vidaković (1991), and Edgar & Connor (2000).

Sampling procedures

Each 0.1 m^2 suction sample consisted of five, 5-s suctions taken c. 1 m apart. Ethanol (70%) was added to the sample container to kill and preserve the specimens. The samples often contained soil and plant debris, so they were sieved through 2 mm mesh in the laboratory. The debris trapped on the sieve was then searched for any spiders attached to it. The material that had passed through the sieve was sieved again, this time with 250 µm mesh. Samples from one pasture that had recently been cultivated (Shands Road, 27 March 1997) were processed differently. Owing to the large amount of soil in the samples, flotation separation (Southwood 1978) was used instead of sieving to sort the spiders from the debris.

The individual spiders were transferred to 70% ethanol and examined under a dissecting microscope (up to 125× magnification). Identification was usually to family or species, and the names followed Forster (1970), Forster & Wilton (1973), Forster & Blest (1979), Millidge (1984), Forster et al. (1988), Saaristo & Tanasevitch (1996), Vink & Sirvid (1998), and Forster & Forster (1999). Some species could not be named because of limitations of the current taxonomic literature, or because of the absence of adult specimens. Medium-sized and larger immatures of *Tenuiphantes tenuis* (Blackwall) (formerly *Lepthyphantes tenuis*, see Saaristo & Tanasevitch 1996) were identified by the presence of a prolateral femoral spine on leg I (Forster et al. 1988). We determined the number of species at a site as the minimum number of species present, calculated by counting the number of recognised species plus the minimum number of species that were present as immatures only. For example, if a family is represented only by immatures (possibly from several species that could not be distinguished) we counted a minimum of one species.

RESULTS

Spider densities in relation to distance from field margin

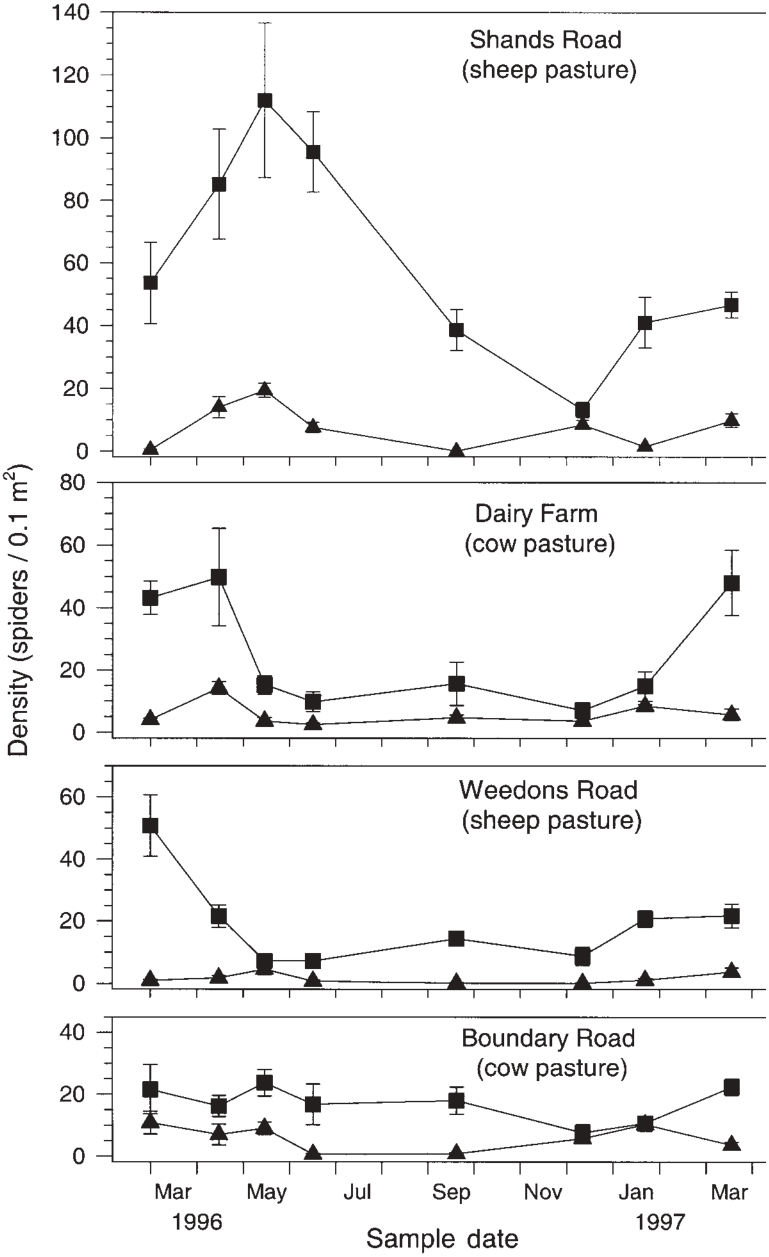
Spider density declined rapidly with distance into the pasture from the shelterbelt (Fig. 1). There was little effect of season on this pattern of decline, although the densities in the shelterbelt did vary from season to season. The mean density/0.1 m^2 (±SE) of spiders was 24.1 ± 3.38 in the shelterbelt (four sample dates combined), and 1.3 ± 0.21 in the pasture away from the shelterbelt (samples from 10, 25, and 50 m combined from four sample dates). Thirteen species of spider from seven families were recognisable (Table 1), with 10 species and six families in the shelterbelt, and eight and four, respectively, in the pasture. Of the seven taxonomic groups found in both the pasture and the shelterbelt, three were species of European Linyphiidae, while the others were an unidentified species of Theridiidae (species 'a'), one unidentified Lycosidae species (only immatures were present, but it was probably *Lycosa hilaris* L. Koch: C. J. Vink pers. comm.), immature Mynogleninae (Linyphiidae), and immature Araneoidea (*sensu* Coddington & Levi 1991). Of these, *Tenuiphantes tenuis* (Blackwall) and immature Araneoidea dominated the fauna shared between the two habitats, and *T. tenuis* was the most abundant identified species overall.

Table 1 Spider fauna in a grazed sheep pasture at various distances from an adjacent fenced-off *Pinus radiata* shelterbelt in Canterbury, New Zealand. Data are pooled from four sample dates in 1994 and 1995.

	Distance from shelterbelt (m)						
Species	0	2.5	5	10	25	50	Total
LINYPHIIDAE							
Tenuiphantes tenuis (Blackwall)*	31	77	4	11	11	1	135
T. tenuis immatures*	231	96	12	33	30	10	412
Microctenonyx subitaneus (O.P. Cambridge)*	28	2	0	0	0	0	30
Erigone wiltoni Locket^n	0	5	3	6	2	8	24
Araeoncus humilis (Blackwall)*	1	3	0	0	0	0	4
Haplinis fucatina (Urquhart)	0	0	0	0	1	2	3
Pseudafroneta incerta (Bryant)	2	0	0	0	0	0	2
Unidentified Mynogleninae immatures	39	2	1	0	0	0	42
THERIDIIDAE							
Unidentified sp. 'a'	172	0	0	0	2	0	174
Unidentified sp. 'b'	3	0	0	0	0	0	3
ARANEOIDEA†							
Unidentified immatures	274	103	18	12	18	4	429
LYCOSIDAE							
Unidentified immatures	4	1	3	2	4	1	15
AGELENIDAE							
Unidentified immatures	1	0	0	0	0	0	1
SYNOTAXIDAE							
Pahora sp.	1	0	0	0	0	0	1
SALTICIDAE							
Unidentified immatures	97	0	0	0	0	0	97
MICROPHOLCOMMATIDAE							
Parapua punctata Forster	0	1	0	0	0	0	1
UNKNOWN FAMILY							
Unidentified immatures	54	0	0	0	0	1	55
Total	938	290	41	64	68	27	1428
Density, spiders/0.1 m^2	24.1	7.25	1.03	1.64	1.70	0.68	6.00
Minimum number of species	10	7	4	3	5	4	13
Sampled area (m^2)	3.9	4.0	4.0	3.9	4.0	4.0	23.8

* = introduced species; ^{n} = native, all others are endemic; † = immatures from the superfamily Araneoidea (*sensu* Coddington & Levi 1991) comprise Linyphiidae and Theridiidae in this case.

Fig. 2 Density of spiders (mean/ 0.1 m^2 ± SE) in four pastures and adjacent fenced-off shelterbelts. See Methods section for site descriptions. ■ = shelterbelt; ▲ = pasture.



Spider densities in four pastures and shelterbelts

At least 28 species of spider were collected from the four sites, 13 from pasture and 25 from shelterbelts (Table 2). At all four sites, the shelterbelt had higher species richness (3–10 spp. more), and higher density of spiders (average 6.7 times more) than the adjacent pasture. Introduced species contributed 41% of numbers in pasture, and 29% in shelterbelts (Table 2).

Over all the sites, the most abundant species were *T. tenuis*, theridiid sp. 'a', and Araneoidea immatures (which may have included both these species, but also other linyphiids and theridiids). Much of the variation in spider numbers at the four sites (Fig. 2) can be attributed to these three groups. Much of the variation in the shelterbelt spider densities at Shands Road can be attributed to changes in numbers of Araneoidea immatures, *T. tenuis* immatures, and to

Table 2 Spider fauna from suction samples in four grazed pastures and their adjacent fenced-off shelterbelts (S/belt). Data are pooled from eight sample dates (Mar 1996–Mar 1997).

	Site										
	Shands		Weedons		Boundary		Dairy		Total		
Species Habitat type:	Pasture	S/belt	Pasture	S/belt	Pasture	S/belt	Pasture	S/belt	Pasture	S/belt	Both
LINYPHIIDAE											
Tenuiphantes tenuis (Blackwall)*	27	250	3	122	24	23	24	10	78	405	483
L. tenuis immatures	56	763	31	52	108	38	41	38	236	891	1127
Microctenonyx subitaneus (O.P. Cambridge)*	2	74	1	21	0	0	0	1	3	96	99
Erigone wiltoni Locket[n]	17	1	8	0	7	1	67	1	99	3	102
Erigone prominens Bösenberg & Strand*	19	1	2	0	2	0	1	0	24	1	25
Araeoncus humilis (Blackwall)	2	0	0	1	2	2	0	0	4	3	7
Diplocephalus cristatus (Blackwall)*	0	0	0	0	0	0	0	4	0	4	4
Diploplecta sp.	1	0	0	0	3	1	5	0	9	1	10
Haplinis mundenia (Urquhart)	0	0	0	0	0	0	1	0	1	0	1
Haplinis titan (Blest)	1	0	0	0	0	0	0	0	1	0	1
Laetesia minor Millidge	0	1	0	0	0	0	0	0	0	1	1
Maorineta tumida Millidge	0	2	0	0	0	0	0	0	0	2	2
Maorineta sp.	0	1	0	0	0	0	0	0	0	1	1
THERIDIIDAE											
Unidentified sp. 'a'	15	247	4	243	3	194	0	525	22	1209	1231
Unidentified sp. 'b'	2	12	2	1	0	16	1	28	5	57	62
Argyrodes sp.†	0	0	0	0	0	1	0	17	0	18	18
ARANEIDAE											
Unidentified immatures	0	0	0	1	0	1	0	1	0	3	3
ARANEOIDEA											
Unidentified immatures	140	1012	12	241	68	108	93	317	313	1678	1991
LYCOSIDAE											
Lycosa hilaris L. Koch	4	0	0	0	2	0	0	0	6	0	6
Unidentified immatures	12	1	3	1	6	117	3	1	24	120	144
OXYOPIDAE											
Oxyopes gracilipes (White)[n]	0	0	0	4	0	1	0	0	0	5	5
AGELENIDAE											
Unidentified immature	0	0	0	1	0	0	0	0	0	1	1
SYNOTAXIDAE											
Pahora sp.	0	2	0	0	0	11	0	1	0	14	14
PSECHRIDAE											
Poaka graminicola Forster & Wilton	1	23	1	7	0	57	0	14	2	101	103
CLUBIONIDAE											
Clubiona contrita Forster	0	0	0	0	0	2	0	0	0	2	2
Unidentified immatures	0	1	0	1	0	7	0	3	0	12	12

GNAPHOSIDAE											
Unidentified immatures	0	0	0	0	0	2	0	0	0	2	2
SALTICIDAE											
Unidentified sp. 'a'	0	4	0	2	0	0	0	2	0	8	8
Unidentified sp. 'b'	0	2	0	3	0	1	0	0	0	6	6
Unidentified immatures	0	57	1	36	0	26	0	11	1	130	131
MICROPHOLCOMMATIDAE											
Parapua punctata Forster	0	0	0	0	0	4	0	0	0	4	4
HAHNIIDAE											
Rinawa otagoensis Forster	0	0	0	0	0	0	0	1	0	1	1
THOMISIDAE											
Unidentified immatures	0	0	0	0	0	2	0	3	0	5	5
UNKNOWN FAMILY											
Unidentified immatures	9	29	0	5	4	32	2	50	15	116	131
TOTAL	308	2483	68	742	229	647	238	1028	843	4900	5743
Density, spiders/0.1m^2	7.70	63.7	1.70	19.0	5.87	17.5	5.95	25.7	5.30	31.6	18.3
Minimum no. of spp.	11	14	9	13	7	17	7	15	13	25	28
Sampled area (m^2)	4.0	3.9	4.0	3.9	3.9	3.7	4.0	4.0	15.9	15.5	31.4

* = introduced species; ^{n} = native, all others are endemic; † = *sensu* Forster & Forster 1999.

a lesser extent theridiid sp. 'a', while Shands Road pasture spider numbers were mainly Araneoidea immatures. The high numbers of spiders in the Weedons Road shelterbelt in March 1996 comprised mainly *T. tenuis* adults, Araneoidea immatures, and theridiid sp. 'a' in similar proportions, while the March 1997 numbers comprised Araneoidea immatures, and theridiid sp. 'a' only. Weedons Road pasture numbers fluctuated little during the year. At the Dairy Farm shelterbelt, numbers were highest in April 1996 and April 1997, and were dominated by theridiid sp. 'a', followed by Araneoidea immatures as the second-most dominant group. An April 1996 peak in numbers in pasture was due mainly to a high number of *Erigone wiltoni* Locket adults (40 out of 71 spiders collected).

With the exception of *Oxyopes gracilipes* (White) (Oxyopidae) and the occasional lycosid or salticid, all the spiders collected were small enough to pass through 2 mm mesh. Sample numbers differed slightly between sites (Tables 1, 2) because some samples dried out in storage and the material could not then be identified.

DISCUSSION

The density of spiders in the grazed pasture was similar to that reported in similar habitat in mainland Europe (Delchev & Kajak 1974), the United Kingdom (Salt et al. 1948; Cherrett 1964; Holland et al. 1999), North America (Wolcott 1937; Turnbull 1966), and New Zealand (Topping & Lövei 1997), and in hay meadows in Europe (Kajak 1978; Alderweireldt 1987); however, the species richness found in this study was much lower than that found in other countries. Pasture spider density varied little during the year, but there was more variation in numbers in the adjacent shelterbelts (Fig. 2). Spider density in the Shands Road shelterbelt declined by 90% from winter 1994 to winter 1995 (Fig. 1). This could have been due to differences in the shelterbelt understorey or to differences in the winter weather between years.

Studies of species richness showed that as many as 45 species of spider from 15 families may be present in pasture (Wolcott 1937; Salt et al. 1948; Cherrett 1964; Turnbull 1966; Delchev & Kajak 1974; Peck & Whitcomb 1978; Martin 1983; Maelfait & De Keer 1990; Topping & Lövei 1997) and meadows (Kajak 1978; Alderweireldt 1987; Nyffeler & Benz 1988b). Because the sampling effort and method varied between these studies, only general comparisons of species numbers can be made with the data in this study. However, Topping & Lövei (1997) used vacuum-sampling followed by hand-searching (Sunderland & Topping 1995) and recorded fewer species in grazed pasture in the North Island, New Zealand than were found in the current study (4–5 cf. 7–11). While these authors sampled only during 1 month (November) they sampled a larger total area (5 m^2 cf. 4 m^2) per site. In North Island pastures, *T. tenuis* is also a commonly encountered species.

Densities of linyphiid spiders declined with increasing distance from shelterbelts. This result contrasts with a number of studies in Europe (reviewed in Sunderland & Samu 2000) that showed high densities of cursorial lycosids at close proximity to field edges, but a reverse pattern for Linyphiidae. It should be noted that Europe has a large linyphiid fauna with diverse ecologies (Roberts (1987) listed 267 species in Britain), whereas in this study one European species, *T. tenuis*, was numerically dominant. Linyphiid spiders may overwinter in diverse edge habitats and subsequently distribute themselves by ballooning (Maelfait & De Keer 1990). Holland et al. (1999) found that Linyphiidae were homogenously distributed in wheat fields, but that lycosids showed higher densities at field margins. A model for the spatial dynamics of Linyphiidae in farmland showed that the potential for large-scale dispersal offered by ballooning reduces the effect of field size (up to 4 km^2) on population density (Halley et al. 1996). However, if field margin habitats are optimal, spiders may remain there, rather than attempt long range dispersal (Sunderland & Samu 2000), thereby resulting in a steep gradient of spider density at close proximity to these habitats.

In the present study, the ratio of spider density in pasture to that in shelterbelts was highest (0.32) in the Linyphiidae and lower for other families (0.25 for Lycosidae, 0.02 for Theridiidae, and 0.007 for Salticidae). This greater homogeneity in linyphiid distribution relative to other families is in broad accordance with the above observations by Holland et al. (1999). Differences in relative spider densities (across families) between the pasture and shelterbelt understorey, where present, could be caused by differences in vegetation structure (Greenstone 1984) and height (although not recorded, ground vegetation inside the shelterbelts could reach 60 cm or more compared with pasture of c. 10–20 cm), disturbance by grazing (Delchev & Kajak 1974; Thomas & Jepson 1997; Topping & Lövei 1997), or differences in prey abundance. Delchev & Kajak (1974) found that sheep grazing reduced numbers of web-building spiders in Polish pasture, and Topping & Lövei (1997) found that spider numbers decreased with increasing disturbance to the agricultural habitats (wheat, pasture, and roadside verge) in the North Island, New Zealand. Numbers of possible prey were not recorded in this study. Suction sampling can underestimate spider densities (Sunderland et al. 1987; MacLeod et al. 1994; Sunderland & Topping 1995; Sunderland et al. 1995) (but see Samu et al. 1997 for an exception). Tests of collection efficiency showed that the vacuum sampler collected 97% of pasture spiders from the Dairy Farm site (McLachlan 2000). Collection efficiency in the shelterbelt was not measured because of difficulties sampling the taller ground vegetation. Vegetation density (Hand 1986; Sunderland & Topping 1995) and height (Henderson & Whitaker 1977; Hossain et al. 1999) can also reduce arthropod collection efficiency. Density estimates from the taller herbaceous vegetation in the shelterbelts may have been underestimated more than those from the pasture. Therefore, the relative difference in densities between these two habitats may be even more extreme than this study shows.

The Canterbury Plains region of New Zealand was largely covered in trees and shrubs before European settlement in the 19th century (Molloy 1969). Little of this vegetation remains today, as most of the available land is used for agriculture. This extremely modified habitat is occupied by a largely non-native pasture spider fauna. The most common species found in this study, *T. tenuis*, is also dominant in European fields (Sunderland 1996). The ballooning habit (Forster & Forster 1973) of linyphiid spiders probably explains their prevalence in disturbed agro-ecosystems, because this high dispersal ability would allow re-colonisation from distant undisturbed habitat (Meijer 1977; Thomas & Jepson 1997). In contrast, endemic species are more common in the relatively undisturbed field margin.

According to Chapman (1984) the main pests of pasture in New Zealand are Argentine stem weevil *Listronotus bonariensis* (Kuschel) (Coleoptera: Curculionidae) and grass grub *Costelytra zealandica* (White) (Coleoptera: Scarabaeidae). Neither of these Coleoptera are likely to be important prey items of spiders. Grass grub adults are too large, and their larvae are subterranean. Argentine stem weevil larvae feed within grass stems, while the adults are probably too robust to be attacked by the mostly small spiders found in this study. However, other pasture types include legumes on which aphid pests can be abundant (Chapman 1984), therefore, the spider population and faunal data presented in this paper may be of value in helping interpret spiders' potential for controlling pests in other pasture types.

Bishop & Riechert (1990) showed that spiders colonising a vegetable garden came not from nearby woodland sources, but from further away. While most of the pasture species listed in the four study sites here were also present in the shelterbelt, a few were not, and probably came from further away to colonise newly cultivated fields. They may, however, have already been present as unidentified immatures (either in the shelterbelt or pasture or both). The possibility of manipulating the density of spiders in a pasture by creating habitat for them in the field or in the margin seems remote, because spider density declined rapidly away from the shelterbelt (Fig. 1), and the fauna was dominated by highly-mobile Linyphiidae.

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