Spider Studies on Fair Isle (Shetland) over a three year period: distribution, phenology and the zoogeographical context

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Summary

Spiders have been studied on Fair Isle over a three-year period with regular pitfall trapping during that time together with general collecting in all parts of the island.

The species list has been increased from 46 to 78 with several species new to Shetland. A total of 4998 spiders were taken in the traps and the results have been analysed under the following headings: (a) Overall results; numbers and species, (b) New records, (c) Variation between sites, (d) Effects of diversity, (g) Linyphiids as a proportion of the catch. An annotated list of the newly recorded species is included with phenological information (where available) and known regional distributions.

Keywords: Fair Isle, Shetland, spiders, pit-fall trapping, diversity, altitude, phenology.

Introduction

Fair Isle (VC 112, Shetland) is a 3km^2 rocky island lying in an isolated position at nearly 60°N, almost midway between North Ronaldsay (Orkney) and Sumburgh at the southern tip of the mainland of Shetland. The spiders of Fair Isle have previously been reported by Lindroth (1955), Cloudsley-Thompson (1956), Carpenter (1962), and Milner (1987): in total these writers reported a list of 46 species from the island. Most of these records were from visits made during summer months as the winter is rather harsh; prior to the present study little or nothing was known about the occurrence of spiders of Fair Isle during the winter months.

Spiders are not well-known from the northern islands of Orkney, Fair Isle or Shetland. There are scattered records by a number of authors principally Bristowe (1931), Duffey (1955), Hillyard (1977) and Surtees (1976). Ashmole (1979) made a number of studies on the mainland of Shetland over several years. As a result of these studies, and by reference to other authors such as Holm (1967 etc), Brandegaard (1928, 1946 and 1958) and Bengtson & Hauge (1976, 1979), he was able to put

the spiders of Shetland (including Fair Isle) in a regional zoogeographic context – that is within the triangle of Greenland, Scotland and Scandinavia. A proportion of the species recorded for Shetland and Fair Isle exhibit a geographical distribution and occurrence at high altitudes which indicate a tolerance of extreme conditions. These "northern" or "montane" species make up a substantial proportion of the spider fauna on both Shetland and Fair Isle, while another group of species appears to reach the northernmost limit of its range on Fair Isle or Shetland; that is they are not found on islands further north. This situation may change in the coming years under global warming.

Fair Isle

Fair Isle is a hilly island, surrounded on most sides by precipitous cliffs. The main part of the island consists of a sloping plateau, while near the northernmost point the ground rises steeply to the summit of Ward Hill (217m) the highest point on the island. Geologically it consists almost entirely of sediments of the Middle Devonian (Old Red Sandstone) with some peat deposits: the soils are generally acid.

The island lies in the north temperate zone, but its climate is often described as hyper-oceanic (Birce 1974). Conditions are greatly influenced by the island's size, its location in the path of a warm water current (the North Atlantic Drift), and its position in relation to the weather systems tracking eastwards across the northern part of the Atlantic Ocean. While temperatures are never extreme, they are rarely high, the mean temperatures for the coldest month (February) being 4.2°C and for the warmest month (August) only 11.9°C, however the mean number of days with frost are 59 (ground) but only 18 (air). Fair Isle is a very windy place, with a high wind chill factor in the air especially on the higher ground; mean number of days per annum with a wind speed of >34 knots is 58. Mean annual rainfall is 918mm, there being on average 242 days with measurable rain per annum. (D. Wheeler (Fair Isle Meteorological Station) *pers. comm.*)

Fair Isle has been an island since before the Ice Ages two million years ago, but the peat deposits and present flora and fauna date from around 10,000 years ago when the ice retreated at the end of the last Ice Age.

Before human settlement around 4000 years ago, most of the island was probably covered with deciduous scrub (Scott & Palmer 1987) but the current vegetation and landscape reflect a long history of human

influence, in particular the introduction of grazing animals such as sheep. Peat has also been removed in some places down to the bedrock, and the result is a patchwork of moorland, coastal grassland, arable fields, "improved" pasture and boggy areas. The study area of Ward Hill and the area near The Gulley, is now year-round common unimproved sheep-grazing. Much of the vegetation of Fair Isle today hugs the ground reflecting the combined pressures of grazing, wind and salt-spray.

The Fair Isle Study: Introduction

Since1987 the authors have made collections of spiders in different parts of Fair Isle, and conducted pitfall-trapping over an extended period at a number of sites at different altitudes on Ward Hill. Traps were also set for limited periods around the Finniquoy Gulley (referred to hereafter as The Gulley), a small, sheltered, steep-sided valley near the north-east coast of the island. Trapping at the sites on Ward Hill continued for over three years and the catches for three complete 12-month periods (January 1988 through to January 1991) have been examined.

As the trap sites differed in altitude, vegetation density and dampness, differences observed in the spider catches were interpreted as being related to these factors, although precise assessment of the relative importance of each factor would need more detailed study.

As a result of this study a total of 33 species not previously recorded on Fair Isle were found (of which 11 were also new to Shetland) and the total list for the island now stands at 78. Of these 54 (68%) are Linyphiids and 25 (43%) other families.

Materials and Methods

Searching, sweep-netting, turning stones, beating low vegetation and sorting of vegetation was done at several places and times. Pitfall-trapping was conducted using trios of standard polythene pitfall traps (of diameter 75mm and depth 104mm) set in a triangular configuration at each site and the catch aggregated at each emptying. A small amount of ethylene glycol with some washing-up liquid as a wetting agent was used in each trap as a medium to hold the specimens and to prevent carnivorous beetles damaging or consuming the catch. Small zinc roofs were used to help keep out the rain, and the traps were emptied at approximately monthly intervals (with some irregularities) for a period of three years from December 1987 to February 1991.

The trap-sites were:

Site A: 215m above sea level (asl). Near the exposed summit of Ward Hill, in short-turf coastal grassland with *Festuca rubra* dominant and *Armeria maritima, Holcus lanatus* and the lichen *Peltigera canina* frequent. Other relatively frequent components of the diverse vegetative community included acid-soil indicators *Festuca vivipara, Nardus stricta* and *Potentilla erecta,* while *Plantago maritima* and *Armeria maritima* demonstrated the influence of salt-laden winds even at 215m asl. Arctic-alpine elements included some *Polygonum viviparum* and just ten metres from the trap site, broken ground with very thin soil supporting a vegetative community dominated by the tiny *Salix herbacea*. The traps were set on the west side of the summit and within two metres of the highest point, on a free-draining slope of around 10°. The soil was thin (5-9cm deep) and the vegetation height did not exceed 0.5cm apart from tufts of *N. stricta* up to 4cm.

Site B: 205m asl. (Fig. 1). On the north side of Ward Hill just below the summit in damp unimproved grassland on acid soil with *N. stricta* dominant and frequent *F. vivipara, Agrotis stolonifolium, Luzula sylvatica* and *Potentilla erecta*. Other components of the vegetation included *Carex binervis, Eriophorum angustifolium,* and an "understorey" of the moss *Hypnum cupressiforme* evidence of partly impeded drainage. The traps were set immediately below the west site of the summit, at around 205m asl, on a slope of approximately 10° with a westerly aspect. The soil was peaty clay with a depth of around 35cm. The vegetation height was around 10cm.

Site C: 155m asl. At the base of the steep summit of Ward Hill in a patch of dry heath on acid peaty soil. The site was chosen as being typical of a major vegetation type on higher ground within the Fair Isle hill grazings. The restricted plant community comprised dominant low, dense *Calluna vulgaris* interspersed with frequent swatches of *Empetrum nigrum,* some *Erica cinerea* and occasional plants of a few other species such as: *Festuca rubra, Luzula multiflora, Eriophorum angustifolium*. Immediately south of this patch was an eroding bank of exposed peat, partly colonised by the lichens *Cladonia* spp. The traps were set on a patch of level ground, in generally south-east facing moorland of variable slope. The soil was a shallow peaty podzol with a depth of around 30cm.

Site D: 110m asl. This was set in a very damp boggy area, but as it soon became regularly flooded in the early part of the study it was abandoned.

Fig. 1. The view over west cliffs of ward Hill showing vegetation at site B in the foreground.

Site E: 70m asl. (Fig. 2). Near the centre of an extensive (350m x 250m) area of flushed valley mire (Sukka Mire) just west of the airstrip, on a moderately deep peat substrate. The vegetation at the trap site was typical for the mire as a whole, with *Eriophorum angustifolium* and the moss *Sphagnum subnitens* dominant, and with *N. stricta, Carex flacca* and *Hydrocotyle vulgaris* frequent. The vegetation at the trap-site was relatively diverse with a number of other grasses present. The traps were set on level ground at around 70m asl. The soil type was blanket peat with a depth of about 90cm, permanently waterlogged with limited through-flow of water and the water-table close to but rarely exceeding the surface. Vegetation height, though low by national standards, was greater than at the other sites, ranging from three to 15cms with some much taller stems.

This site was affected by the digging of a drainage ditch in October 1988 which started to affect the water-table of the area in the dry summer of 1989, but whose full effect was probably not felt until the second summer (1990).

Site F: about 125m asl. Within a small, heavily vegetated peat pool in transition to a basin mire. The moss *Sphagnum cuspidatum* was dominant and in much of the pool formed a single-species carpet,

gradually being colonised by *Hydrocotyle palustris*. Other plants present were *N. stricta, Juncus articulatus* with the mosses *Aulacomnium palustre* and *Sphagnum auriculatum*. The water table was near or above the surface of the vegetation at all times and the traps though set in the driest part were frequently flooded, resulting in erratic and incomplete results from this site. The vegetation height adjacent to the traps was up to 10cm.

Pitfall traps were also set for limited periods around The Gulley, at about three metres and about 12 metres altitude.

Fig. 2. A view of Sukka Mire also looking west with site E in the foreground.

Results and interpretation

(a) Overall results: numbers and species

As a result of the general collecting in various parts of the island, and the pitfall-trapping, the total list of species recorded from Fair Isle has been increased from 46 to 78, and that for Shetland (including Fair Isle) to 110. This has recently been raised to 112 (Milner 1996.)

The pitfall-trapping at the four main sites (A, B, C and E) over the three year study period producing a total of 4997 spiders (13140 trap nights) representing 56 species, while another 22 species were found at other sites or by searching *etc.*, or had been previously reported but were not found during this study. The overall results of the trapping are given in tables 1 and 2.

Table 1. Total catch at each site for the three years from 4.1.88 to 4.1.91. ** = Linyphiidae spp. as % of species.

Year	A	B	Site C	E
1 Total catch	317	482	633	640
spp. & % linyphiids	20 (95%)	18 (94%)	23 (70%)	34 (68%)
2 Total catch	299	477	416	452
spp. & % linyphiids	13 (100%)	18 (94%)	17 (71%)	31 (74%)
3 Total catch	264	429	352	236
spp. & % linyphiids	12 (83%)	16 (94%)	16 (75%)	25 (72%)
3 years combined	880	1388	1403	1327
spp. & % linyphiids	24 (96%)	26 (96%)	25 (68%)	39 (72%)
overall mean				
spp. & % linyphiids	15 (95.6%)	17.3 (94.2%)	18.7 (71.7%)	30.3 (71.5%)

Spider catches from pitfall-traps like other field observations of animal communities are obviously affected by weather conditions during the study period. Fair Isle's weather is carefully monitored and has been recorded continuously since 1974 (D. Wheeler, *pers. comm.*). The study period was within a period (1988-93) of consistently slightly higher than average temperatures. 1988 was slightly (but not significantly) wetter than average, while 1989 was marginally the warmest, driest and sunniest year since 1974.

In the study both total numbers and species richness were highest in the first year and declined somewhat in the two subsequent years. The reduced numbers could have been partly caused by the weather, but in addition the catches for the second and particularly the third year were much reduced for Site E which had dried out considerably. The results for this site in Year three especially are therefore probably untypical as the habitat had changed. As Table 2 shows, several species present in years one and two were absent from year three.

The most abundant species in year one, *Pirata piraticus,* a marshland species declined dramatically from 331 individuals in year one to zero in year three. *Lepthyphantes ericaeus, L. zimmermanni, Robertus arundineti* and *Gongylidiellum vivum* were also present in years one and two but absent in year three. *Agyneta decora* also declined markedly but as this decline occurred at Sites A and B too, it cannot be attributed to the drying out of Site E alone. However, the substantial decline in numbers and species richness at Site E does suggest that damage can be caused in these sensitive habitats by simple physical operations such as minor drainage works.

Table 2. Catches for sites A-E in each 12-month period: all species with aggregate of 10 or more in the three year study period. Species are arranged according to apparent altitude preferences, descending from the highest (site A).

Site	A			B			C			E			Total			
Year	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
E. promiscua	60	133	20	2	2	9	–	–	–	–	1	–	62	136	29	227
L. hardyi	24	16	31	–	–	1	5	3	2	–	–	–	29	19	34	82
T. digitatus	19	4	11	1	–	2	3	4	2	1	–	–	24	8	15	47
Rh. morulus	4	6	1	1	1	–	4	–	–	1	–	–	10	7	1	18
W. antica	7	1	–	–	–	–	1	1	–	–	–	–	8	2	0	10
A. decora	22	7	–	74	118	19	1	–	–	16	5	–	113	130	19	262
C. concinna	156	123	178	204	216	174	462	322	264	39	17	30	861	678	646	2185
C. bicolor	1	1	9	–	–	162	1	–	–	4	33	43	6	34	214	254
M. castaneipes	4	–	–	64	31	6	–	–	–	–	–	–	68	31	6	105
W. clavicornis	–	1	5	25	15	15	–	–	–	–	–	–	25	16	20	61
G. rubens	7	–	–	46	39	15	1	2	6	5	1	2	59	42	23	124
S. elegans	1	–	1	14	16	5	–	–	–	5	7	12	20	23	18	61
R. lividus	1	–	3	2	3	–	–	–	–	1	–	–	4	3	3	10
D. brevisetosum	–	–	–	5	12	4	–	–	–	–	–	–	5	12	4	21
L. ericaeus	4	–	–	21	9	11	29	16	15	3	3	1	57	28	27	112
W. acuminata	1	1	2	16	8	1	48	31	22	3	3	3	68	43	28	139
C. brevipes	–	–	–	–	–	–	20	8	9	–	1	3	20	9	12	41
C. prudens	–	1	–	–	1	–	7	2	2	–	–	–	7	3	3	13
L. zimmermanni	–	–	–	2	–	1	2	8	5	2	2	–	6	10	6	22
X. cristatus	–	–	–	–	–	1	6	4	1	1	9	5	7	13	7	27

cont . .

L. mengei	–	–	–	1	–	–	3	–	4	5	3	3	9	3	7	19
B. luteolus	–	–	–	–	–	–	3	5	8	15	18	14	18	23	22	63
T. terricola	–	–	–	–	–	–	6	3	6	14	5	13	20	8	19	47
P. pullata	–	–	–	–	–	–	24	6	2	83	88	24	107	94	26	227
P. piraticus	–	–	–	–	–	–	–	–	–	331	76	–	331	76	0	407
P. degeeri	–	–	–	–	–	–	–	–	–	27	34	24	27	34	24	85
O. trux	–	–	–	–	–	–	–	–	–	24	44	4	24	44	4	72
H. bituberculatum	–	–	–	1	–	–	–	–	–	3	19	8	4	19	8	31
T. thorelli	–	–	–	–	–	–	–	–	–	3	20	7	3	20	7	30
X. miniata	–	–	–	–	–	–	–	–	–	1	–	26	1	0	26	27
M. mossica	–	–	–	–	–	–	–	–	–	4	14	3	4	14	3	21
A. pulverulenta	–	–	–	–	–	–	–	–	–	16	3	2	16	3	2	21
L. tenuis	–	–	–	–	–	–	–	–	–	11	7	1	11	7	1	19
D. permixtus	–	–	–	–	–	–	–	–	–	7	9	2	7	9	2	18
G. vivum	1	–	–	–	–	–	–	–	–	2	7	–	3	7	0	10
C. obscurus	–	–	–	–	–	–	–	–	–	3	4	3	3	4	3	10
others (nos)	5	5	3	3	6	3	7	3	4	9	19	3	24	33	13	70
total (nos)	317	299	264	482	477	429	633	418	352	639	452	236	2071	1645	1282	4998
Three years combined:		880			1388			1403			1327					
total (spp.)	5	2	2	2	5	1	5	3	2	6	5	3				
aggregate (spp.)	20	13	12	18	18	16	23	17	16	34	31	25				
		(24)			(26)			(25)			(39)					

(b) New records

As might be expected, systematic study also led to a number of new species being recorded for the island, several also being new records for Shetland. A number of these are of particular interest because according to Ashmole (1979) they could have been expected to be present on Shetland from their wider distribution. *Cnephalocotes obscurus* occurs on Iceland and similar latitudes in Fennoscandia, and recently on Orkney (Snazell, *pers. comm.*). *Gongylidiellum vivum* is known from the Faeroes and Fennoscandia, and only in 1994 from Orkney (Snazell, *pers. comm.*); *Walckenaeria cuspidata* is known from Orkney, Faeroes, Iceland, Fennoscandia and even Greenland but had not previously been recorded from Shetland.

Some of the newly recorded species notably *Xerolycosa miniata* and *Trichopterna thorelli* do not come into the same category. Neither has been recorded from further north; these new records for Fair Isle are the most northerly records so far for these species. *T. thorelli* has subsequently been recorded from Orkney (Snazzell, *pers. comm.*).

It is most unlikely that the complete spider fauna for Fair Isle is yet known, and in any case this is likely to be a dynamic feature of the island with changes due to global warming anticipated. In other words more southern species are likely to become established in these northern islands in coming years, although the speed at which this may happen is not known.

(c) Variation between sites

Eight species were recorded at all four main pitfall sites, although in very different numbers. These were *Centromerita concinna, C. bicolor, Typhochrestus digitatus, Agyneta decora, Walckenaeria acuminata, Rhaebothorax morulus, Gonatium rubens* and *Lepthyphantes ericaeus.* The distribution of all the species in relation to altitude is shown in Table 2.

Over the three year period as a whole the three higher sites produced smaller total numbers, lower species richness, and higher proportions of Linyphiids (see Table 1) than Site E which was more sheltered and damper as well as being lower. The aggregate numbers of individuals for the different sites were largely influenced by the extraordinary abundance of the commonest species *Centromerita concinna,* which as Table 2 shows, dominated the catch at the three higher sites (A, B and C) where it made up a substantial or overwhelming proportion of the total annual catch (42% to 77% of the

total numbers). This single species made up 43.7% of the total catch at all sites. On the other hand six species including *Hilaira frigida, Porrhomma montanum* and the pioneer species *Savignia frontata* all occurred at minimal frequencies, that is, a single specimen over a three year period.

As Table 3 shows, a small group of species made up a very large proportion of the catch at all sites. In addition to *C. concina,* three species *Erigone promiscua, Monocephalus castaneipes* and *Agyneta decora* made up a large proportion of the catch at Sites A and B, while at Site E *Pirata piraticus* and *Pullata palustris* dominated the catch in the first two years. The total numbers were greater at Site E and the proportion of Linyphiids lower reflecting the more sheltered and structurally diverse nature of the habitat. Three specimens common in rough grassland throughout the British Isles were among the most abundant six species at Site E (*Pachygnatha degeeri, Pardosa pullata* and *Ozyptila trux*) and this site also produced several of the new records for Shetland.

The boggy Site F is not included in the main results; this is because when precipitation was high the traps at this site rapidly flooded and did not function. From the limited data obtained it was clear that the site was dominated by three wetland species *Drepanotylus uncatus, Diplocephalus permixtus* and *Pirata piraticus* which together made up well over 50% of the (incomplete) catch in all three years, while the new record *Lophomma punctatum* (another wetland specialist) was taken frequently.

Table 3. Most abundant species: proportion (% of total catch) of the most abundant species, by site and year.

Site	A			B			C			E		
Year	1	2	3	1	2	3	1	2	3	1	2	3
C. concinna	49	45	67	42	45	41	73	77	76	–	–	13
E. promiscua	19	41	8	–	–	–	–	–	–	–	–	–
A. decora	–	–	–	15	25	4	–	–	–	–	–	–
P. piraticus	–	–	–	–	–	–	–	–	–	52	17	0
P. pullata	–	–	–	–	–	–	–	–	–	13	19	0
C. bicolor	–	–	–	–	–	38	–	–	–	–	–	19

(d) Effects of altitude

From the distribution at different sites, some apparent ecological differences between the species can be seen which are probably

affected directly or indirectly by altitude. In Table 2 the species are arranged according to apparent altitude preferences, showing that there are apparently groups of species particularly associated with specific sites.

Table 4 lists all species found at or above 100m on Fair Isle, with the corresponding altitude ranges recorded in other studies. One group of species occurs on the upper slopes of Ward Hill but not lower down. In this respect although the summit is only about 215m it shows similarities with other high altitude sites both on the Shetland mainland (such as Ronas Hill) and the hills of the Scottish mainland.

Fourteen species referred to by Ashmole (1979) as "obligate montane" or "facultative montane" species are found near the summit of Ward Hill at sites A or B. Some of these such as *Scotinotylus evansi, Rhaebothorax morulus, Hilaira frigida* and *Porrhomma montanum* have been taken on Fair Isle at lower altitudes than in other studies. This can be attributed to the peculiar conditions on Fair Isle where the effects of altitude appear to be magnified. The total area of the summit of Ward Hill is very limited and the populations of some of these species may be very small – possibly as low as a few hundred individuals – which are effectively isolated from other populations.

Table 4. Lists of species recorded from over 100m on Fair Isle or Shetland mainland (as of 1.1.96).

1 = "obligate montane" species.
2 = "facultative montane" species.
3 = "occasional montane" species (as defined by Ashmole, 1979).

FI = Fair Isle; SH = Shetland mainland (Ashmole); BH = Ben Hope (Merrett); CM = Craig Meagadh (D. Horsfield, *pers. comm.*).

Altitudes in metres.

	FI	SH	BH	CM
LINYPHIIDAE				
3 *Ceratinella brevipes*	10-155	200-290	457	290-895
3 *W. acuminata*	5-215	200-410	488-610	280-790
W. antica	70-215	–	–	280-760
2 *W. nudipalpis*	150-215	200-290	274-777	290-1000
1 *W. clavicornis*	200-215	230-390	–	760-1000
W. vigilax	70-215	–	–	290-450
D. brevisetosum	5-205	–	–	290
H. bituberculatum	10-205	–	–	280-1000
3 *Gonatium rubens*	10-205	200-290	152-610	280-790
Oedothorax fuscus	10-215	–	–	–
Silometopus elegans	20-215	–	274-610	280-1000

cont . .

Table 4 cont . .

	FI	SH	BH	CM
Cneph. obscurus	70-150	–	–	280-610
M. castaneipes	50-215	–	–	510-885
Lophomma punctatum	70-150	–	–	–
Gongylidiellum vivum	20-215	–	457	280-450
Erigonella hiemalis	10-205	<30	–	280-1000
Savignia frontata	10-215	–	914	885
D. permixtus	20-160	–	610	450-790
1 *Scotinotylus evansi*	155-215	200-410	77-914	885
T. digitatus	20-215	–	–	–
Erigone atra	10-155	0-180	–	–
E. promiscua	5-215	0-115	274-914	790-1000
2 *Rhaebothorax morulus*	70-215	200-410	610-762	885-1000
Drepanotylus uncatus	20-150	–	–	375
Leptothrix hardyi	150-215	–	–	–
1 *Hilaira frigida*	40-215	200-450	274-914	790-1000
2 *Porrhomma montanum*	180-205	400-450	–	–
Agyneta decora	5-215	–	541-762	610-790
2 *Centromerus prudens*	150-215	200-450	610-762	1000
Centromerita bicolor	15-215	–	–	790-975
2 *C. concinna*	5-215	200-450	274-610	375-1000
Bathyphantes parvulus	10-150	–	–	–
2 *Poeciloneta variegata*	5-215	200-290	–	280-450
2 *Bolyphantes luteolus*	5-200	–	–	450-510
Lepthyphantes tenuis	5-150	–	9	–
2 *L. zimmermanni*	5-215	200-410	274-762	280-760
L. mengei	10-150	–	9-914	280-1000
3 *L. ericaeus*	5-215	200-390	152-914	280-885
Allomengea scopigera	30-150	–	–	–
OTHER FAMILIES				
1 *Clubiona trivialis*	15-160	200-290	152	375-510
Xysticus cristatus	15-180	?	152-457	315-885
1 *Pardosa palustris*	20-155	200-390	914	885
1 *P. pullata*	5-155	200-390	152-610	280-790
2 *A. pulverulenta*	5-70	200-290	488	280-1000
2 *Robertus lividus*	5-215	200-450	152-610	280-975
2 *R. arundineti*	10-160	200-390	556-762	290
Pachygnatha degeeri	10-205	–	–	280-450

(e) Seasonal differences

Seasonal differences have been analysed by separating the catches for each month (Table 5). However, the monthly analysis is somewhat distorted by irregularities in the trapping periods as trap emptying depended on suitable weather and pressure of other work on the resident author. To compensate for these irregularities, the month of the midpoint of the trapping period for each sample is used. Even so unfortunately some months therefore had more samples than others, but figures 3 and 4 show the basic trends. In general the peak of numbers signals the main breeding season as numbers are (usually for a relatively short time) augmented by large numbers of adult males.

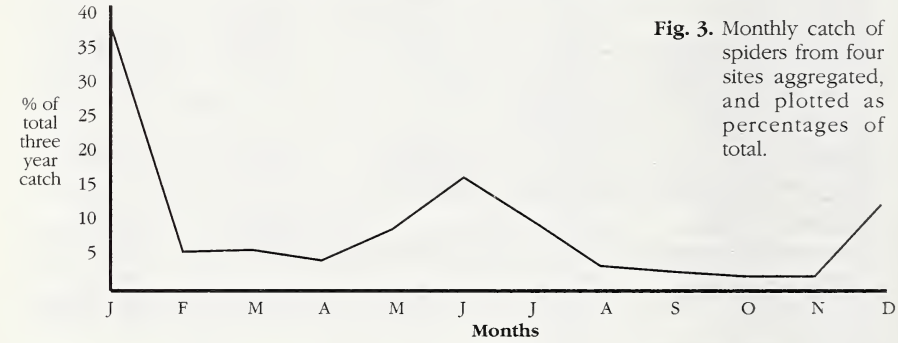

Fig. 3. Monthly catch of spiders from four sites aggregated, and plotted as percentages of total.

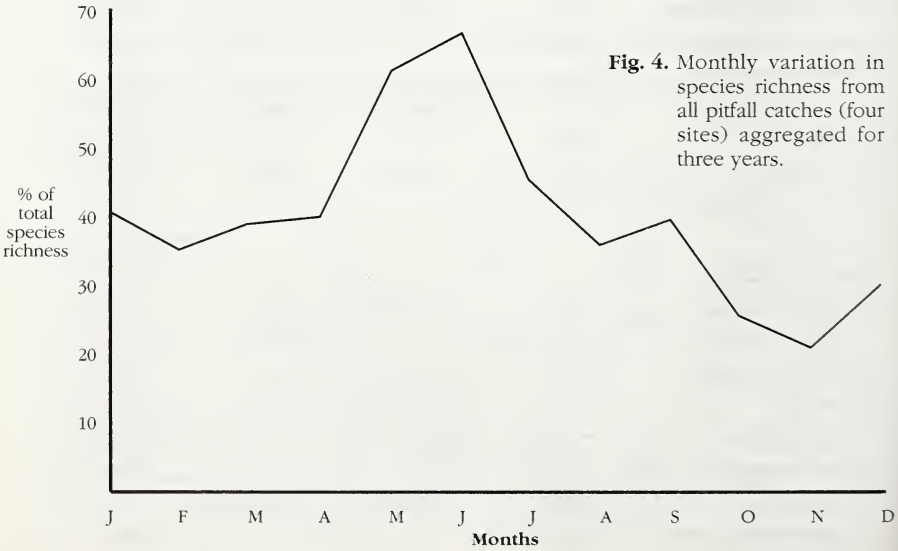

Fig. 4. Monthly variation in species richness from all pitfall catches (four sites) aggregated for three years.

One of the most surprising findings was the marked winter peak in total spider numbers. This was largely due to the high numbers of three winter-active (and winter-breeding) species *Centromerita concinna, C. bicolor* and *Erigone promiscua* in each of the three years. As a result, when the figures for all three years are aggregated, two of the highest monthly totals were for December and January (537 and 1737 respectively), while the highest aggregate for a summer month was 749 for June.

From the monthly totals (Table 5) it is clear that only a few species showed a peak in numbers in mid-summer, and several species show peaks in the winter months. The two summer months May and June had the highest totals for species richness with nearly twice the average number of species recorded for the two mid-winter months January and February. However even the June aggregate was only 38 species (68%) out of a total of 56 trapped species, and the average figure for June was only 30 (just over 50% of the total species list). Both peaks and absences of individual species are well distributed through the year (Fig. 4).

Taking the overall findings the major seasonal changes in the spider fauna were as follows. In December and January the catches were dominated at sites A to E by *Centromerita concinna* and *C. bicolor* which together made up over 75% of the catch. At the two highest sites some other species made up a substantial proportion of the catch, notably *Leptothrix hardyi* and *Typhochrestus digitatus* and at Site C *Walckenaeria acuminata* and at lower altitudes *Bolyphantes luteolus*. By March the numbers of *C. concinna* had fallen and *Erigone promiscua* numbers reached their peak at the two highest sites. From March to June *Drepanotylus uncatus* reached a peak in the wet areas, followed at Site E by the peak for *Pachygnatha degeeri*. By May many of the summer-active Lycosids, Thomisids and some Linyphiids such as *Agyneta decora* reach their peaks. At the same time at the highest sites other species such as *Walckenaeria clavicornis* (an arctic species), *Monocephalus castaneipes* and *Silometopus elegens* all reach their peak. *Gonatium rubens* is unusual in reaching a clear peak in numbers in September and October when it was the most abundant spider at Site B.

The only species trapped as adults throughout the whole year was *C. concinna* although *Lepthyphantes ericaeus* and *G. rubens* both appeared in all but one month. Less than half the total species were restricted to the months of March to September, but this group of species included most of the larger species such as *Pardosa pullata* and *Alopecosa pulverulenta* and the two Thomisids *Xysticus cristatus* and *Ozyptila trux*. Several winter-active species were virtually absent as adults during the summer including *T. digitatus, L. hardyi* and *Bolyphantes luteolus*.

Table 5. Three years catches, aggregated by month (taken as the mid-point of the trapping period for each catch), from 4.1.88 to 4.1.91, sites A-E only.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
C. concinna	1295	133	109	66	47	16	9	1	22	37	51	399	2185	43.7
P. piraticus	–	–	–	1	–	135	240	28	3	–	–	–	407	8.1
A. decora	–	–	–	–	1	214	42	4	1	–	–	–	262	5.2
C. bicolor	219	1	7	–	1	–	–	–	–	–	–	26	254	5.1
P. pullata	–	–	–	1	63	116	30	15	2	–	–	–	227	4.5
E. promiscua	9	35	63	11	19	38	27	8	11	6	–	–	227	4.5
W. acuminata	55	6	11	8	15	4	3	1	–	–	8	28	139	2.8
G. rubens	10	8	10	14	3	1	–	12	40	14	10	2	123	2.5
L. ericaeus	24	12	10	6	16	11	10	12	1	–	2	8	112	2.2
M. castaneipes	1	7	8	16	24	27	10	7	4	1	–	–	105	2.1
P. degeeri	2	2	7	11	37	17	–	1	5	3	–	–	85	
L. hardyi	39	5	3	1	–	–	–	–	3	9	11	11	82	
O. trux	–	–	–	–	6	15	14	31	6	–	–	–	72	
B. luteolus	26	6	7	–	–	–	–	–	1	2	2	19	63	
W. clavicornis	–	–	1	25	32	1	2	–	–	–	–	–	61	
S. elegans	–	–	–	–	23	33	4	1	–	–	–	–	61	
T. terricola	–	–	6	3	15	4	14	1	3	1	–	–	47	
T. digitatus	29	4	2	–	–	–	–	–	–	–	3	9	47	
C. brevipes	4	3	6	15	6	3	–	–	3	1	–	–	41	
H. bituberculatum	–	–	–	2	23	6	–	–	–	–	–	–	31	
T. thorelli	–	–	–	–	9	19	2	–	–	–	–	–	30	
X. cristatus	–	–	–	1	9	10	4	1	2	–	–	–	27	
X. miniata	–	–	–	–	1	1	25	–	–	–	–	–	27	
L. zimmermanni	2	–	–	–	1	2	2	1	4	1	4	5	22	
A. pulverulenta	–	–	–	–	–	20	1	–	–	–	–	–	21	
M. mossica	–	–	–	–	2	16	3	–	–	–	–	–	21	

cont . .

Table 5 cont . .

D. brevisetosem	–	1	–	5	10	4	–	–	–	–	1	–	21
L. tenius	–	–	1	–	5	3	1	2	–	1	1	5	19
L. mengei	6	1	2	–	–	2	2	1	1	–	2	2	19
D. permixtus	5	2	–	1	2	3	–	1	–	–	–	4	18
Rh. morulus	1	10	5	2	–	–	–	–	–	–	–	–	18
C. prudens	2	–	1	1	2	–	–	–	–	2	1	4	13
R. lividus	1	1	–	–	3	3	1	–	–	–	–	1	10
G. vivum	–	1	–	1	2	4	–	2	–	–	–	–	10
C. obscurus	–	–	–	–	5	4	1	–	–	–	–	–	10
W. antica	–	–	–	–	–	2	1	1	3	1	1	1	10
W. nudipalpis	3	–	–	2	–	–	–	–	–	–	–	4	9
B. gracilis	1	–	–	–	–	1	2	2	1	–	–	2	9
M. prominulus	–	–	–	–	4	2	–	–	–	–	–	–	6
E. hiemalis	–	–	1	2	2	1	–	–	–	–	–	–	6
H. signifer	–	–	–	–	–	5	1	–	–	–	–	–	6
W. vigilax	–	–	–	–	3	1	1	–	–	–	–	–	5
D. uncatus	1	1	2	–	–	–	–	–	–	1	–	–	5
R. arundineti	–	–	–	–	1	–	–	–	2	–	–	1	4
Oe. fuscus	–	1	–	–	–	–	–	–	1	1	–	–	3
P. variegata	–	–	–	–	1	–	–	–	2	–	–	–	3
A. crassiceps	–	–	–	–	–	3	–	–	–	–	–	–	3
S. evansi	–	–	2	1	–	–	–	–	–	–	–	–	3
C. trivialis	–	–	1	–	–	–	–	–	1	–	–	–	2
P. montanum	–	–	–	–	–	1	–	–	–	–	–	–	1
P. palustris	–	–	–	–	1	–	–	–	–	–	–	–	1
P. nigriceps	–	–	–	–	–	1	–	–	–	–	–	–	1
P. ludicrum	–	–	–	–	1	–	–	–	–	–	–	–	1
H. frigida	1	–	–	–	–	–	–	–	–	–	–	–	1
S. frontata	1	–	–	–	–	–	–	–	–	–	–	–	1
Total spp.	23	20	22	23	35	38	26	21	23	15	13	18	56
nos.	1737	240	265	196	395	749	452	133	122	81	97	531	4624

(f) Fair Isle and species richness

Approximately 70% of known Shetland spiders have now been recorded on Fair Isle. It may be premature to draw detailed conclusions from this as the Shetland list is probably far from being complete. Nowhere in Shetland has a similar concentrated trapping programme been undertaken so far; indeed some Shetland habitats such as the fragments of relic natural scrub woodland, have yet to be investigated at all.

However comparison with well-researched groups, including vertebrates and plants show similar figures for Fair Isle compared with the Shetland mainland. Scott & Palmer (1979) gave the established flora of Shetland as 568 species – a total which excluded those thought to be extinct, casuals, plants of garden or agricultural origin and unconfirmed or dubious records. Using the same criteria, Riddiford (1992) gave the established flora for Fair Isle as 225 species increasing to 233 if those species that had been reliably reported but not seen by the author were included. Thus around 41% of the known Shetland flora occurs on Fair Isle – a figure which would be expected from the Theory of Island Biogeography which holds that a reduction of 90% of area should be associated with a 50% drop in species. In comparison the spider fauna of Fair Isle appears to be richer than would be expected since the island is 40km from the nearest land and has a more limited range of geological substrates and available habitats than the mainland.

(g) Linyphiids as a proportion of the total catch

Spiders of the family Linyphiidae are characteristic of northern latitudes generally making up a large proportion of the total fauna. Table 1 gives the linyphiid numbers in relation to the total catch at the four main sites for each year. Linyphiids made up over 90% of the catch at both sites A and B while the percentage dropped to just over 70% at the lower sites.

Taking the island as a whole the proportion of linyphiids (53 out of 78 or 68%) is below that for Iceland (70%) but higher than that for Greenland (64%) and much higher than that for the Scottish mainland (53%) or for the UK as a whole (44%).

(h) Concluding remarks

This study attempts to contribute to knowledge of spiders of the northern isles. It allows comparisons to be made with previous Fair Isle studies and with results from elsewhere in Shetland. The continuous, long-term nature of the study hopes to shed some detailed light on a number of areas: it relates spider communities both temporally and

spatially to the harsh Fair Isle environment; it reveals high numbers of winter active species, even at the highest and most exposed locations; and gives information of altitude and habitat preferences. The three-year span of data also give first evidence of annual variations.

Fair Isle offers a number of different habitats but it remains almost entirely a harsh northern environment and the spider fauna reflects the fact that in some ways it is more an outpost of the Arctic than an extension of the Scottish mainland.

Conclusions

The fauna of Fair Isle is now known to be considerably richer than was previously thought; and there are probably a number of species awaiting discovery. At present there are 32 species recorded elsewhere in Shetland that have yet to be found on the island. Systematic collecting or trapping has yet to be done at the lower altitudes especially in damp areas or under heather. Sea-bird burrows and nests may well harbour previously unrecorded species especially in the summer months when collecting in such places would be difficult to do without undue disturbance to the nesting birds. Additional synanthropic species may occur in and around buildings on the island; *Pholcus phalangioides* was recently reported from a garage near Sumburgh, and *Tegenaria gigantea* has been introduced on a number of occasions without apparently becoming established. A specimen of *T. gigantea* was found on Fair Isle in 1995 but it had arrived in a case of wine! There may be other species established in buildings or in gardens or fields in the island; the ubiquitous *Diplocephalus cristatus* could be expected to be one of these.

This is the first systematic study of spiders through all seasons in the northern isles. The continuous, long-term nature of the study provides a clearer overall picture than was hitherto available in a number of areas. It relates spider assemblages both temporally and spatially to the harsh Fair Isle environment; it reveals high numbers of winter-active species, even at the highest and most exposed locations; and provides evidence of the altitude and habitat preferences. The three-year span of data gives the first evidence of annual variations.

Comparisons with seasonal data for some of the species has been possible. For winter-active species the patterns are generally similar to those found for the same species in Dorset (Merrett 1969). However for stenochronous species (summer-active) peaks in male activity (taken to indicate the main breeding period), are at least a month or more later in Fair Isle than that reported for Dorset.

From this study it is clear that while Fair Isle offers a number of different habitats, allowing a number of southern species to extend their range, it remains almost entirely a harsh northern environment and the spider fauna largely reflects the fact that in some ways it is more an outpost of the Arctic than an extension of the Scottish mainland.

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