

Spiders (*Araneae*) from Nordmarken on the island of Læsø in Denmark. Faunistic notes, habitat description, and comparison of sampling methods

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Clausen, I.H.S.: Spiders (*Araneae*) from Nordmarken on the island of Læsø in Denmark. Faunistic notes, habitat description, and comparison of sampling methods. Ent. Meddr 55: 7-20. Copenhagen, Denmark, 1987. ISSN 0013-8851.

The flora and invertebrate fauna of Nordmarken, a dune-heath association on Læsø, an island in the Danish part of the Kattegat Sea, were sampled in June-July 1976 at 12 stations along a 450 m transect from the north coast inland. One station was sampled each day; seven sampling methods were used at each station. Analysis of the spider fauna is compared with analysis of the flora; the species composition of spiders giving similar ecological information as the species composition of the vascular plants. The 12 stations are briefly characterized and Sørensen's indices of similarity (QS) between stations are given. Shannon-Wiener diversity indices (H) for the sampling methods are discussed. The spiders are listed and notes on other Danish records are given. The different sampling methods gave widely different results with almost no overlap, and neither the quantitative nor the qualitative data based on the different methods were comparable.

A total of 82 species of spiders (78 identified to species) were collected. Of these, 56 are first records from Læsø; 18 of the 82 were previously known from at most 5 localities in Denmark. *Drassodes cupreus* (Blackwall 1834) is recorded from Denmark for the first time. The species is common here but has been mistaken for *D. lapidosus* (Walckenaer 1802), which is rare.

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Introduction

In June-July 1976 a group of biologists, »Læsøgruppen af 1976«, collected plants and invertebrates in a dune-heath area, »Nordmarken«, on the island of Læsø in the Kattegat Sea, Denmark (UTM: 32V PJ25). Supplementary collections were made in the years 1978 and 1980. The investigation made it possible to compare results obtained with plants and animals, as well as to compare different sampling techniques.

This paper deals with the spider fauna, focusing on habitat description by means of

the spider fauna as compared to habitat description by means of the flora and on the effectiveness of the different sampling techniques.

Materials and Methods

Sampling was made in the period 27/6 - 10/7 1976 in 12 different plant associations, stations (st.), along a transect perpendicular to the coast extending from the north coast and about 450 m inland. Invertebrates were only sampled at 10 of the stations as there were certain sampling difficulties at st. 6 and st. 10. A list of plant species is given in Ap-

pendix 1. The plant associations are described below with distance from the shore (bar-nacle level) indicated:

St. 1 (18-21 m). *Ammophila* dune. Mosaic vegetation consisting mainly of *Ammophila arenaria* (L.). Link, lichens, and small depressed clusters of *Empetrum nigrum* L. with bare sand in between.

St. 2 (49-56 m). *Ammophila* dune. Slope of the hollow facing south. Vegetation of *Ammophila arenaria* and *Coelocaulon* sp.

St. 3 (58-112 m). Lichen-rich *Empetrum* heath. Dominated by *Empetrum nigrum* and branched *Cladonia* spp., especially *C. portentosa* (Dufour) Cöem.

St. 4 (114-129 m). Deflation area. Dominated by *Corynephorus canescens* (L.) Beauv. and *Coelocaulon* sp. A few spots with some *Empetrum nigrum*.

St. 5 (155-165 m). South-facing slope with dry *Empetrum* heath at the top, and moist ground with *Juniperus* and some *Myrica* below. Rather heterogeneous.

St. 7 (204-212 m). Lichen-rich *Calluna-Empetrum* heath. Low vegetation in a hollow dominated by *Calluna vulgaris* (L.) Hull and *Empetrum nigrum*.

St. 8 (235-259 m). *Calluna-Empetrum* heath. Vegetation dominated by *Calluna vulgaris* and *Empetrum nigrum* with scattered individuals of *Vaccinium uliginosum* L. and *Myrica gale* L., and with a fairly dense lichen vegetation in open spots. Height of heath vegetation generally 40-50 cm.

St. 9 (323-373 m). A wet *Molinia* fen. Dominated by *Molinia coerulea* (L.) Moench and some *Myrica gale*. Height of vegetation c. 50 cm.

St. 11 (390-419 m). *Molinia* fen. A little less wet than st. 9. Dominated by low vegetation

of *Molinia coerulea*, *Myrica gale*, and some tussocks of *Deschampsia setacea* (Huds.) Hack.

St. 12 (439-450 m). *Calluna-Empetrum* heath. Dominated by *Calluna vulgaris* and *Empetrum nigrum* with rather dense cover of moss. Height of vegetation generally 30-40 cm.

Spiders were sampled at one station each day using the following methods:

Sweep-net (01): Net sampling was made with 50 strokes in the vegetation at each station. Net diameter was 35 cm, and mesh size was 1 mm.

Pooter (02): Pooter, or aspirator (Southwood 1978), was used to sample within 10 x 1/10 m² quadrat at each station except at st. 9 where 16 x 1/10 m² was used.

Quadrat (03-05): A quadrat of 1/10 m² or 1/4 m² was used: 5 x 1/10 m² at st. 1; 3 x 1/10 m² at st. 2 and 3; 4 x 1/10 m² at st. 4; 2 x 1/4 m² at st. 5-11; 3 x 1/4 m² at st. 12. The quadrats were wooden frames with one side removable. Where possible, samples were divided into vegetation (03), litter (04), and earth (05).

Pitfalls (08): 6 pitfalls were placed for 24 hours at st. 1 and 2, and 3 pitfalls at each of the other stations. The pitfalls were emptied at 8 a.m. and 8 p.m. The traps consisted of small plastic buckets with a diameter of 11.5 cm at the opening. No fluid was added.

»Searching« (07): General collecting using any sampling technique at hand. This »method« was used in Nordmarken in general.

The field work was carried out between 8-12 a.m., and samples were then hand sorted in the laboratory.

Annelida: Lumbricidae; Arachnida: Araneae; Insecta: Psocoptera, Heteroptera, Carabidae, Sphecidae, and Formicidae have

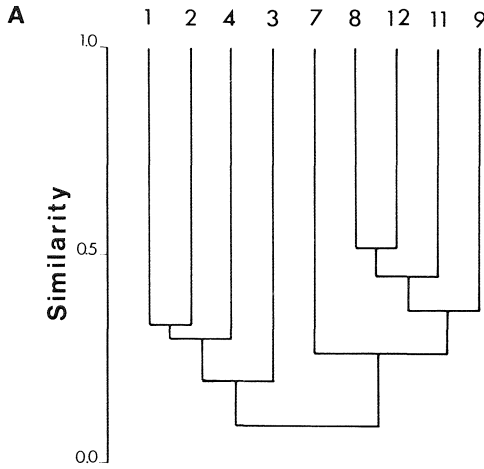


Fig. 1. Cluster-analyser baseret på lighedstal (QS) beregnet på grundlag af edderkopper (A) og karplanter (B). Tallene over hvert dendrogram angiver stationerne.

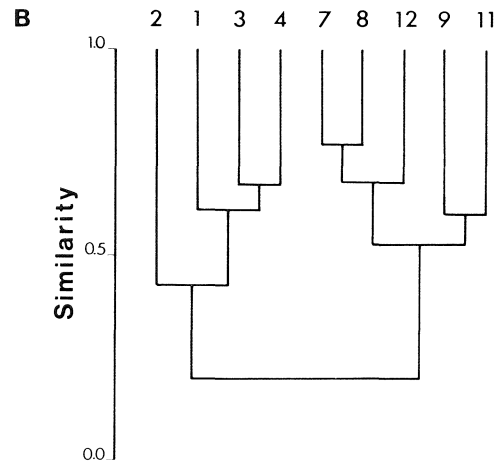


Fig. 1. Cluster analyses using similarity indices (QS) based on spiders (A) and vascular plants (B). Numbers at the top of each dendrogram indicate stations.

been identified at the species level. The rest of the material was sorted to order.

The plant material was dealt with by the botanists of the group, and the calculations based on the plant data were done by Steen N. Christensen and Susanne Rehder.

Data on the vascular plants have been used as »reference data« as the ecology of that group is especially well known; moreover, our samples of vascular plants are generally much greater (statistically) than are samples of the remaining organism groups.

The weather was remarkably constant throughout the sampling period in 1976 with clear sky and little wind most of the time.

Nordmarken was revisited in 1978 and 1980 and supplementary sampling was done by searching (07).

Systematics and taxonomy follow Locket & Millidge (1951 and 1953) and Locket, Millidge & Merrett (1974).

Statistical methods are according to Zar (1974).

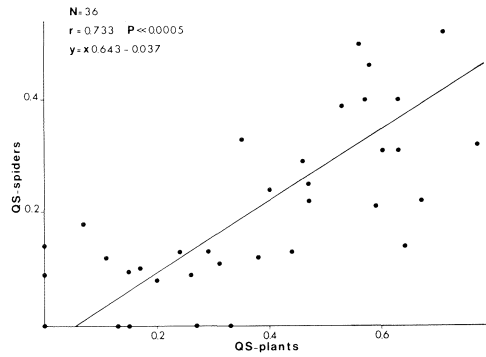


Fig. 2. Similarity indices based on spiders (QS-spiders) as a function of similarity indices based on vascular plants (QS-plants). The line is the functional regression (Ricker 1973). N = number of data points, r = product-moment correlation coefficient, P = probability of r if there is no correlation.

Fig. 2. Lighedstal baseret på edderkopper (QS-spiders) som funktion af lighedstal baseret på karplanter (QS-plants). Linjen er den funktionelle regression (Ricker 1973). N = antal datapunkter, r = product-moment korrelationskoefficienten, P = sandsynligheden af r hvis der ingen sammenhæng er.

Table 1. Identified species of spiders. A) Spiders found on the line in 1976. The species are ordered according to distribution on the plant associations (stations). x designates the presence of a species (specimens from 1976 only). B) Spiders found outside the line (station 0) in 1976 (the first 7 species), and caught in 1978 and 1980 only. x designates presence. C) Spiders from Nordmarken collected prior to 1976, and recorded by other authors. x: as in B). In B) and C) the species are ordered systematically. Numbers in the column next to the species names refer to the following notes: 1. First record from Denmark. 2. First record from Læsø. 3. Previously noted only from northern Jutland. 4. Previously noted only from Tisvilde, Hasle, Grenå, and Hansted Reservatet. 5. Not recorded since 1904. 6. Previously not noted north of Gribskov in North Zealand. 7. Previously noted only from Danstrup Hegn, Orehoved and Resle woods, near Løgstor, and Mols. 8. Previously recorded only from Melby Overdrev in North Zealand, Stignæs at Skælskør, Jægerspris, and south-west of Løgstor. 9. Previously noted only from Herlufsholms Kohave, Nørreskoven på Als, Tranum Klit, and Bommerlund Plantage. 10. Previously not recorded north of Limfjorden. 11. Previously recorded only from Melby Overdrev, Hasle, Fjellerup Strand, by Himmelbjerget, and Mols. 12. Previously recorded only from the surroundings of Copenhagen, at Ryget Skov, Holmegårds Mose, and Bommerlund Plantage. 13. Previously noted only from Saltholm, Tranum Klit, and Bommerlund Plantage. 14. Previously noted only from Tranum Klit, Northern Zealand, Anholt, and »Denmark«. 15. Previously noted only from Gribskov in North Zealand, Bommerlund Plantage, and Anholt. 16. First Danish record of females. 17. Previously noted only from Asserbo Plantage, Bommerlund Plantage, and Strandkær on Mols. 18. According to Bøggild (1962), *Episinus angulatus* (Blackwall) noted by Brændegård (1928) from Asserbo Plantage has been mistaken for *E. truncorum* Latreille. 19. First record north of Mols. 20. Previously noted only from Teglstруп Hegn, Tisvilde Strand, Tisvilde Hegn, and Tornbakke Rimme near Hulsig. 21. Previously recorded only from Lolland-Falster. 22. Previously noted only from Asserbo and Thorning. 23. Previously noted only from Gribskov in North Zealand, Broholm, Holmegårds Mose, Bommerlund Plantage, and Anholt. 24. Previously not recorded north of Nykøbing in North Zealand. 25. Previously recorded only from Tornbakke Rimme near Hulsig, and Højsande on Læsø. 26. Previously recorded only from Tisvilde, Rude Skov, Gribskov, Hestehaven at Rønde, and Anholt. 27. Identified with caution according to Locket, Millidge & Merrett (1974). 28. Had its last molt in the laboratory.

Tabel 1. Bestemte edderkoppearter. A) Edderkopper fra prøvelinjen i 1976. Arterne er ordnet efter deres fordeling på plantesamfundene (stationer). x angiver tilstedeværelse af en art (kun for dyr fra 1976). B) Edderkopper fundet uden for linjen (station 0) i 1976 (de første 7 arter), og edderkopper kun fanget i 1978 og 1980. x angiver tilstedeværelse. C) Edderkopper fra Nordmarken indsamlet før 1976 samt noteret af andre forfattere. x: som under B). I B) og C) er arterne ordnet systematisk. Tallene lige ud for artsnavnene hentyder til følgende noter: 1. Ikke tidligere noteret fra Danmark. 2. Ikke tidligere noteret fra Læsø. 3. Tidligere kun noteret fra det nordlige Jylland. 4. Kun noteret fra Tisvilde, Hasle, Grenå og Hansted Reservatet. 5. Alle tidligere registreringer fra før 1904. 6. Tidligere ikke noteret nordligere end Gribskov i Nordsjælland. 7. Tidligere kun noteret fra Danstrup Hegn, Orehoved og Resle skove, nær Løgstor og på Mols. 8. Tidligere kun registreret fra Melby Overdrev i Nordsjælland, Stignæs ved Skælskør, Jægerspris og sydvest for Løgstor. 9. Tidligere kun noteret fra Herlufsholms Kohave, Nørreskoven på Als, Tranum Klit og Bommerlund Plantage. 10. Tidligere ikke noteret nord for Limfjorden. 11. Tidligere kun noteret fra Melby Overdrev, Hasle, Fjellerup Strand, ved Himmelbjerget og på Mols. 12. Tidligere kun noteret fra Københavns omegn, ved Ryget Skov, Holmegårds Mose og Bommerlund Plantage. 13. Tidligere kun noteret fra Saltholm, Tranum Klit og Bommerlund Plantage. 14. Tidligere kun registreret fra Tranum Klit, Nordsjælland, Anholt og »Danmark«. 15. Tidligere kun noteret fra Gribskov i Nordsjælland, Bommerlund Plantage og Anholt. 16. Alle tidligere danske fund har været hanner. 17. Tidligere kun noteret fra Asserbo Plantage, Bommerlund Plantage og Strandkær på Mols. 18. Ifølge Bøggild (1962) er Brændegårds (1928) *Episinus truncorum* fra Asserbo Plantage forkert bestemt *E. angulatus*. 19. Ikke tidligere noteret nordligere end Mols. 20. Tidligere kun noteret fra Teglstруп Hegn, Tisvilde Strand, Tisvilde Hegn og Tornbakke Rimme nær Hulsig. 21. Tidligere kun noteret fra Lolland-Falster. 22. Tidligere kun noteret fra Asserbo og Thorning. 23. Tidligere kun noteret fra Gribskov, Broholm, Holmegårds Mose, Bommerlund Plantage og Anholt. 24. Tidligere ikke noteret nord for Nykøbing Sjælland. 25. Tidligere kun noteret fra Tornbakke Rimme nær Hulsig og Højsande på Læsø. 26. Tidligere kun noteret fra Tisvilde, Rude Skov, Gribskov, Hestehaven ved Rønde og Anholt. 27. Bestemt med et vist forbehold, jævnfør Locket, Millidge & Merrett (1974). 28. Sidste hamskifte fandt sted i laboratoriet.

	Stations												Total catch incl. 1978 & 1980		
	0	1	2	3	4	5	7	8	9	11	12	♀♀	♂♂	juv.	
A.															
<i>Hahnia nava</i> (Bl.)											x	1			
<i>Robertus lividus</i> (Bl.)	10							x	x		x	9	2	1	
<i>Xysticus cristatus</i> (Cl.)							x				x	2		3	
<i>Clubiona trivialis</i> C.L.K.					x						x	1			
<i>Maso sundevalli</i> (Westr.)	14							x	x	x	x	4	3		
<i>Euryopis flavomaculata</i> (C.L.K.)	9						x	x		x	x	2	2	1	
<i>Lepthyphantes mengei</i> Kulcz.	13								x		x	3	1		
<i>Minyriolus pusillus</i> (Wider)	15,16								x		x	5	1		
<i>Peponocranium ludicrum</i> (O.P.-C.)				x			x				x	14			
<i>Theridion impressum</i> L.K.	2	x			x			x	x	x	x	5	7	>15	
<i>Dictyna arundinacea</i> (L.)									x	x	x	12		4	
<i>Drassodes lapidosus</i> (Walck.)											x	2		1	
<i>Lepthyphantes ericaeus</i> (Bl.)											x	1			
<i>Sitticus caricis</i> (Westr.)	6										x		1		
<i>Philodromus caespitum</i> (Walck.)	2					x					x	6	1		
<i>Araneus adiantus</i> (Walck.)						x	x	x	x	x	x	3	2	21	
<i>Pardosa pullata</i> (Cl.)	2							x		x		8	12	>25	
<i>Hycitia nivoyi</i> (Lucas)		x				x			x	x		2	1	2	
<i>Zelotes laireillei</i> (Sim.)						x	x			x		4	1		
<i>Walckenaera malanocephala</i> O.P.-C.								x		x		1	1		
<i>Thanatus striatus</i> C.L.K.									x					1	
<i>Clubiona diversa</i> O.P.-C.	3									x		2			
<i>C. reclusa</i> O.P.-C.	2									x		1	1		
<i>Pocadicnemis pumila</i> (Bl.)											x		1		
<i>Oreonetides abnormis</i> (Bl.)	2										x		1		
<i>Poecilonea globosa</i> (Wider)	2										x	1			
<i>Pholcomma gibbum</i> (Westr.)											x	1			
<i>Hypsosinga pygmaea</i> (Sund.)	12			x			x	x	x			3	1	1	
<i>Pardosa nigriceps</i> (Thor.)	2							x	x			6	4		
<i>Zora spinimana</i> (Sund.)	2						x		x				1	1	
<i>Tibellus maritimus</i> (Menge)			x								x	2	2	2	
<i>Theridion bimaculatum</i> (L.)	2							x		x		6			
<i>Tapinocyba praecox</i> (O.P.-C.)						x	x	x				10	2	1	
<i>Araneus quadratus</i> (Cl.)	2							x				4	2	4	
<i>Hypsosinga albovitata</i> (Westr.)	11							x				1			
<i>Drassodes cupreus</i> (Bl.)	1							x				1			
<i>Alopecosa fabrilis</i> (Cl.)	2	x			x			x				3		2	
<i>Stemonyphantes lineatus</i> (L.)	2						x	x					1	4	
<i>Marpissa muscosa</i> (Cl.)								x				2			
<i>Walckenaera dysderoides</i> (Wider)								x				2			
<i>Scotina gracilipes</i> (Bl.)				x		x						1	1	3	
<i>Xysticus sabulosus</i> (Hahn)	4				x							1		1	
<i>Aelurillus v-insignitus</i> (Cl.)	2	x	x	x	x							1	4	4	
<i>Alopecosa cuneata</i> (Cl.)	7			x								1			
<i>Attulus saltator</i> (Sim.)	5	x	x									3	1	3	
<i>Tapinopa longidens</i> (Wider)	2	x										1		2	
<i>Pardosa agricola</i> forma <i>arenicola</i> (O.P.-C.)	8	x										3		>40	
<i>Metopobactrus prominulus</i> (O.P.-C.)		x										1			
<i>Arctosa perita</i> (Latr.)	2	x										1		8	

	Stations												Total catch incl. 1978 & 1980		
	0	1	2	3	4	5	7	8	9	11	12	♀♀	♂♂	juv.	
B.															
<i>Misumena vatia</i> (Cl.)	10	x										1		2	
<i>Pisaura mirabilis</i> (Cl.)	10	x										x		x	
<i>Achaearanea riparia</i> (Bl.)	2	x										1			
<i>Episinus angulatus</i> (Bl.)	17,18	x											1		
<i>Theridion sisyphium</i> (Cl.)	2	x										1	1		
<i>Cercidia prominens</i> (Westr.)	2	x										1		1	
<i>Linyphia peltata</i> Wider	19	x													
<i>Phaeoedus braccatus</i> (L.K.)	20	x											1		
<i>Zelotes serotinus</i> (L.K.)	2	x										2	2		
<i>Agroeca proxima</i> (O.P.-C.)	2	x											2		
<i>Cheiracantium erraticum</i> (Walck.)									x	x		4		3	
<i>Chubiona subtilis</i> L.K.	21				x							1			
<i>Phlegra fasciata</i> (Hahn)	2	x												1	
<i>Pardosa monticola</i> (Cl.)	2			x								1		7	
<i>Trochosa spinipalpis</i> (F.O.P.-C.)	22,27						x					1			
<i>Araneus diadematus</i> Cl.	2	x										2	1		
<i>Zygiella atrica</i> C.L.K.	2	x	x									3		1	
<i>Drapetisca socialis</i> (Sund.)	2	x										1			
<i>Erigone arctica</i> (Wh)	28,2	1												1	
<i>E. dentipalpis</i> (Wider)	2	x											1		
<i>Gonatium rubens</i> (Bl.)	23	x										1	1		
<i>Lepthyphantes minutus</i> (Bl.)	2	x										1			
<i>L. flavipes</i> (Bl.)	2	x										1	1		
<i>Linyphia tenuipalpis</i> Simon	2	x										1			
<i>Meioneta rurestris</i> (C.L.K.)	24	x										1			
<i>Trichoncus hackmani</i> Millidge	25				x							1			
<i>Walckenaera antica</i> (Wider)											x	1			
<i>W. cuculata</i> (C.L.K.)	26	x											1		
C.															
<i>Agelena labyrinthica</i> (Cl.)		x										x	1		
<i>Centromerus expertus</i> (O.P.-C.) (Larsen & Bøggild 1970)		x										3			
<i>Walckenaera unicornis</i> O.P.-C. (Larsen & Bøggild 1970)		x										1			

Results

Faunistic notes

A total of 82 species (78 identified) of spiders have been sampled from Nordmarken by the group, and of these 56 are first records from Læsø, while 18 species were previously recorded from at most 5 localities in Denmark.

Drassodes cupreus (Blackwall 1834) is recorded from Denmark for the first time.

The identified species are listed in Table 1; the numbers next to the species names refer to the notes given in the legend.

A list of total catches including information on sex, habitats, dates, and sampling methods is available upon request to the author.

The spider specimens are stored at the home of the author.

In connection with the faunistic notes the following literature has been consulted: Brændegård (1928, 1972), Bøggild (1961, 1962), Cloudsley-Thompson (1955), Larsen & Bøggild (1970), Nielsen (1932), Nørgård (1945), Schjøtz-Christensen (1966), and Toft (1976, 1977).

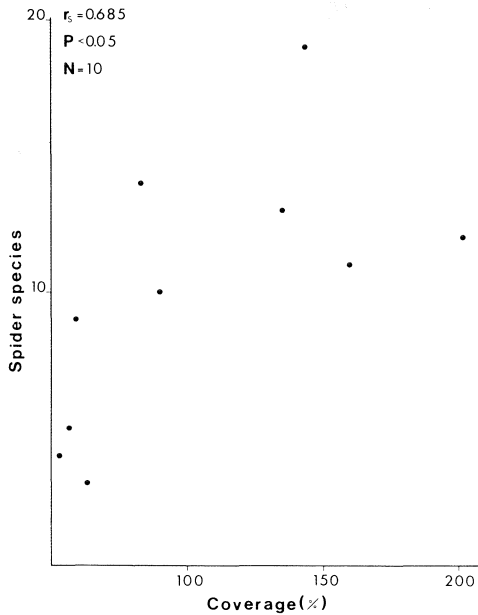


Fig. 3. Number of spider species as a function of the percentage of coverage (pin-point analysis) of vascular plants. r_s = Spearman's rank correlation coefficient. N and P, see Fig. 2.

Fig. 3. Antal edderkoppearter som funktion af karplanternes procentvise dækningsgrad (punkt-kvadrat analyse). r_s = Spearmans rank korrelationskoefficient. N og P, se Fig. 2.

Habitat description

The Shannon-Wiener diversity indices (H) for each sampling method at each station are shown in Table 2. The indices for methods (02) and (03-05) were significantly correlated with H based on vascular plants (Spearman's rank correlation = r_s = 0.624 and 0.748, respectively, $P < 0.05$ and $P < 0.01$, respectively (one-sided), $N = 10$ in both cases), while H for methods (01) and (08) did not correlate significantly ($P < 0.05$) with Hplants.

In Table 3, Sørensen's indices of similarity, QS (Southwood 1978) between stations are listed, and in Fig. 1A is shown the dendrogram of a cluster analysis (»Unweighted pair-group method using arithmetic average« (Sneath & Sokal 1973)) based on QS. Also shown is the dendrogram based on the plant data (Fig. 1B). QSSpiders is clearly

correlated with QSplants, the product-moment correlation coefficient = $r = 0,733$, $P < < 0.0005$ (one-sided), $N = 36$ (Fig. 2). In the cluster analysis and the correlation analysis st. 5 has been omitted because of deviations between botanists and zoologists with respect to the precise delineation of st. 5.

The number of spider species was not significantly correlated with the number of vascular plant species ($r_s = 0.049$, $P > 0.25$, $N = 10$), whereas the correlation with percentage coverage of vascular plants was significant ($r_s = 0.685$, $P < 0.05$ (two-sided), $N = 10$) (Fig. 3).

Sampling methods

There are no significant differences between sampling methods with respect to number of species caught (chi-square test: $X^2 = 2.267$, $P > 0.95$), whereas the species composition varies greatly between methods, as can be seen from Fig. 4, which show the species obtained with each sampling method, and Table 4 where the mean frequencies of the more common families are shown.

Discussion

Faunistic notes

The great number of species new to Læsø is due to previous lack of sampling and publishing on the subject.

Although *Drassodes cupreus* has not previously been recorded from Denmark, the species probably is not rare in this country, but has been mistaken for *D. lapidosus* (Walckenaer 1802). Søren Langemark at the Zoological Museum in Copenhagen has checked the »*D. lapidosus*« material of the museum and found that only one individual (a female labelled: 28/6 1929, Melsted, North Zealand, Denmark: collected by E. Nielsen) safely could be identified as *D. lapidosus*, the rest of the material (81 females, 23 males) being *D. cupreus*. Thus it seems that in Denmark *D. cupreus* is common while *D. lapidosus* is rare.

Table 2. Shannon-Wiener diversity indices based on spiders (a) and on vascular plants (b). -(01): sweep-net; -(02): pooter; -(03-05): quadrat; -(08): pitfalls.

Tabel 2. Shannon-Wiener diversitetsindeks baseret på edderkopper (a) og karplanter (b). -(01): ketcher; -(02): sugeglas; -(03-05): rammeprover; -(08): faldfælder.

Methods	a) Spiders				b) Plants
	-(01)	-(02)	-(03-05)	-(08)	
St. 1	0.95	1.04	0.69	0.13	0.12
St. 2	0.69	1.10	0	0	0.36
St. 3	1.27	1.83	1.61	0.69	1.42
St. 4	0.63	0	0.63	0.69	0.24
St. 5	1.57	1.70	1.88	0.69	1.33
St. 7	1.93	2.14	1.63	1.05	0.99
St. 8	1.74	1.39	2.15	1.61	1.24
St. 9	1.97	1.10	1.57	1.82	1.17
St.11	1.28	0	1.04	0.67	1.12
St.12	1.15	1.51	2.45	1.81	1.33

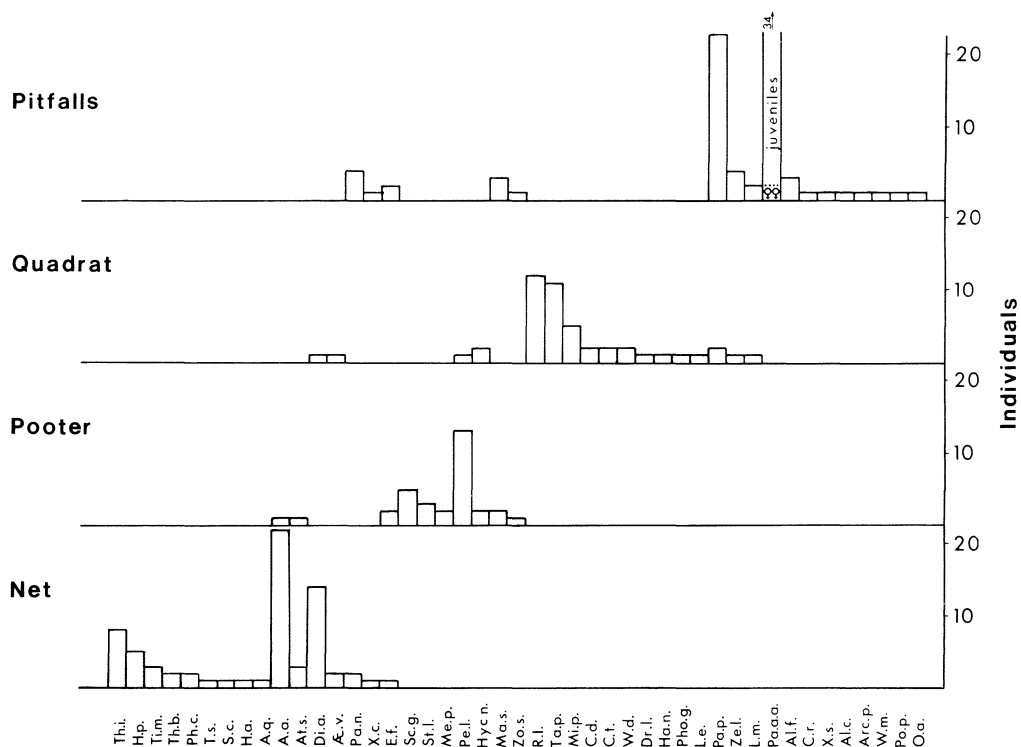


Fig. 4. Distribution of species on sampling methods.

Fig. 4. Arternes fordeling på fangstmetoder. Pitfalls = faldfælder; quadrat = rammeprove; pooter = sugeglas; net = ketcher.

Table 3. Sørensen's index of similarity (QS) between stations based on spider data.

$$QS = \frac{2c}{a + b},$$

c = the number of species in common, a and b are the number of species at each of the two stations compared.

Tabel 3. Sørensens lighedstal (QS) mellem stationerne baseret på edderkoppetal.

$$QS = \frac{2c}{a + b},$$

c = antal fælles arter, a og b er antallet af arter på hver af de to stationer, der sammenlignes.

St.:

1	-										
2	0.33	-									
3	0.14	0.25	-								
4	0.46	0.29	0.22	-							
5	0.11	0	0.13	0	-						
7	0.09	0	0.21	0.11	0.33	-					
8	0.10	0	0.13	0.13	0.19	0.32	-				
9	0.14	0.09	0.08	0.09	0.14	0.24	0.40	-			
11	0.18	0	0	0.12	0.35	0.22	0.50	0.31	-		
12	0.10	0	0.12	0.13	0.18	0.31	0.52	0.39	0.40	-	

St.: 1 2 3 4 5 7 8 9 11 12

Habitat description

With respect to habitat choice spiders constitute a quite unspecialized group, the members of which occupy almost all terrestrial niches. The group is species rich, and spiders are usually abundant.

As can be seen from Table 1, each plant association clearly has a specific spider fauna, even though the spiders are generally not directly related to the plant species, but mainly to factors like spatial structure of the habitat and microclimate (Fig. 3) (e.g., Almqvist 1973, Duffey 1968, Robinson 1981), and the spider fauna analysis thus distinguishes between habitats as does analysis of the flora.

The diversity indices have been calculated simply because they are so widely used. I do, however, find the biological meaning of the indices dubious and wish to note that, if used, the indices based on spider faunas seem to be correlated with indices based on the flora when sampling is made with the pooter or the quadrat. It may be noted that the number of spider species caught with

each of the two methods is not significantly correlated with the number of vascular plant species ($r_s = 0.288$, $P > 0.2$ and $r_s = 0.209$, $P > 0.5$, respectively).

In the cluster analyses (Fig. 1) the dendrograms show the same two main groupings corresponding to dry areas (st. 1-4) and more wet areas (st. 7-9, 11-12). If we look at the spider dendrogram, in the group of dry stations the localities with much bare sand are grouped together, with the more overgrown st. 3 by itself. In the other main group the most dry locality, st. 7, is by itself. The remaining stations are all somewhat damp, and here the two *Calluna* localities, st. 8 and 12, are grouped together. In the plant dendrogram the grouping within the dry group is somewhat puzzling, while in the wet group there are two subgroups corresponding to *Calluna* and *Molinia* localities. However, the subgroupings are probably not significant, as they are altered by small changes in species distributions (as accidentally experienced by the author). Adding to this the very significant correlation between QSspiders and QSplants, it may be conclu-

Table 4. Mean frequency (\bar{x}) of families (in % of individuals) in samples of different methods. N = number of samples (stations); S.E. = standard error; -(03): vegetation part of quadrat; -(04-05): litter and earth part of quadrat; -(01), -(02), -(03-05), and -(08): see Table 2.

Tabel 4. Middel-hyppigheden (\bar{x}) af familierne (i % af individer) i fangster fra forskellige metoder. N = antal »prøver« (antal stationer); S.E. = standard fejl; -(03): vegetationsdelen af rammeprove; -(04-05): forn- og jorddel af rammeprove; -(01), -(02), -(03-05) og -(08): se Tabel 2.

	-(01) (N = 10)		-(02) (N = 9)		-(03-05) (N = 9)		-(03) (N = 9)		-(04-05) (N = 9)		-(08) (N = 9)	
	\bar{x}	S.E.	\bar{x}	S.E.	\bar{x}	S.E.	\bar{x}	S.E.	\bar{x}	S.E.	\bar{x}	S.E.
Dictynidae	8	5.9	0		0.4	0.4	4	3.7	0		0	
Gnaphosidae	2	1.7	3	2.8	10	7.3	11	7.9	8	7.4	14	10.9
Clubionidae	3	1.8	8	3.6	11	4.7	27	12.7	7	3.0	3	2.1
Zoridae	0		1	0.8	0		0		0		1	1.2
Thomisidae	18	5.7	9	4.5	3	2.2	2	2.2	6	5.5	7	5.6
Salticidae	13	6.4	4	3.7	6	3.3	17	11.1	6	5.6	0	
Lycosidae	3	2.9	15	6.2	17	6.7	11	7.4	16	10.9	58	11.7
Agelenidae	0		0		2	1.3	0		2	1.5	0	
Theridiidae	14	6.4	4	2.8	7	3.8	0		9	4.7	4	2.7
Argiopidae	33	7.5	18	11.0	1	0.7	4	3.7	0		0	
Linyphiidae	7	4.4	34	9.7	43	4.0	24	11.0	46	11.0	11	5.4

ded that an analysis of the spider fauna gives the same »picture« of the area as does an analysis of the vascular plant flora. As spiders are generally more short-lived than many of the vascular plants, as well as being mobile, they will probably reflect changes in the environment earlier than the plants, and so there may be situations where spider-fauna analysis can be a useful alternative to floral analysis. However, the influence of seasonal changes in spider populations on the general pattern should be investigated. Are, e.g., the similarity indices fairly constant, or do they vary greatly?

Sampling methods

The results clearly show that care must be taken when choosing sampling methods, and that it may be almost impossible to compare data obtained with different collecting techniques. With qualitative data, however, intensified and prolonged sampling will certainly make methods (02)-(08) quite comparable, while the sweep-net, touching only

the upper vegetation layer, will probably still give results significantly different from those of the other methods. With quantitative data the different methods will not be comparable even with intensified and prolonged sampling.

Conclusions

In Denmark *Drassodes cupreus* has previously been mistaken for *D. lapidosus*.

The descriptive power of the spider fauna seems to be comparable to that of the vascular plant flora, the two groups giving the same general »picture« of the area.

There is almost no overlap between sampling methods with respect to species caught, and quantitative data based on different methods are not comparable.

Sammendrag

Edderkopper fra Nordmarken på Læsø. Faunistiske notater, om habitatsbeskrivelse, og sammenligning af fangstmetoder.

I perioden 27/6 - 10/7 1976 indsamledes hvirvelløse dyr og planter fra 12 forskellige plantebælter, stationer (st.), langs en linje fra nordkysten og ca. 4500 m ind i landet. Der blev dog ikke indsamlet dyr i st. 6 og 10. Supplerende indsamlinger blev foretaget i 1978 og 1980.

Plantesamfundene er beskrevet i Appendix 1 og ovenfor under »Materials and Methods«, hvor også afstanden til kysten er angivet.

Dyrene blev indsamlet én st. pr. dag med følgende fangstmetoder:

Ketcher (01): I hver st. ketchedes vegetationen med 50 strøg. Ketcher diameteren var 35 cm og maskevidden 1 mm.

Sugeglas (02): Der blev suget med sugelas (pooster, Southwood (1978)) inden for 10 x 1/10 m² på alle st. undtagen i st. 9, hvor der indsamledes fra 16 x 1/10 m².

Ramme (03-05): Der blev brugt trærammer med en aftagelig side på 1/10 m² og 1/4 m²: 5 x 1/10 m² i st. 1, 3 x 1/10 m² i st. 2 og 3, 4 x 1/10 m² i st. 4, 2 x 1/4 m² i st. 5-11 og 3 x 1/4 m² i st. 12. Hvor det var muligt, adskiltes lagene i vegetation (03), førn (04) og mineraljord (05).

Faldfælder (08): Små spande med en åbningsdiameter på 11,5 cm blev gravet ned på hver st. i 24 timer. De blev tømt kl. 8 morgen og aften. På st. 1 og 2 placeredes 6 spande, på de øvrige stationer 3 spande. Der blev ikke hældt nogen form for væske i spandene.

»Søgning« (07): Søgning i terrainet med forhåndsbevarende udstyr. Denne »metode« anvendtes i større dele af Nordmarken.

Feltarbejdet foregik mellem kl. 8-12 om formiddagen, og prøverne håndsorteredes i laboratoriet.

Regnorme (Lumbricidae), edderkopper (Araneae), barklus (Psocoptera), tæger (Heteroptera), løbebiller (Carabidae), gravehvepse (Sphecidae) og myrer (Formicidae) blev bestemt til art. Øvrige dyr bestemtes til orden.

Karplanterne er blevet benyttet som en slags referencegruppe, da deres økologi generelt er velundersøgt, og da vores plantemateriale, statistisk set, er større end dyrematerialet.

I alt 82 arter (78 bestemte) edderkopper blev indsamlet i Nordmarken, og af disse er 56 nye for Læsø. *Drassodes cupreus* noteres her for første gang i Danmark. Dette skyldes, at arten er blevet forvekslet med *D. lapidosus*. Søren Langemark på Zoologisk Museum i København har gennemgået »*D. lapidosus*«-materialet på museet og fundet, at kun én hun med rimelig sikkerhed kunne henføres til *D. lapidosus* (etiketteret: Melsted, 28/6 1929, E. Nielsen Leg.), mens resten (81 hunner, 23 hanner) var *D. cupreus*.

De sikkert bestemte arter er vist i Tabel 1, hvor tallene lige ud for artsnavnene hentyder til noterne givet i tabelteksten.

Diversitetsindekserne (Shannon-Wiener = H) er vist i Tabel 2. Indeksene baseret på metoderne (02) og (03-05) viste en statistisk sikker sammenhæng med H baseret på karplanter ($r_s =$ henholdsvis 0,624 og 0,748 og $P <$ henholdsvis 0,05 og 0,01 (ensidet), $N = 10$ i begge tilfælde), mens Hedderkopper for de øvrige metoder ikke viste nogen sikker sammenhæng med Hplanter.

I Tabel 3 ses Sørensens lighedstal (similaritetsindeks, QS) mellem stationerne, og i Fig. 1 er vist det grenede diagram (dendrogram) for en grupperingsanalyse (clusteranalyse) baseret på lighedstallene. Ligeledes ses det tilsvarende dendrogram baseret på karplantedata. Dendrogrammerne er inddelt i de samme to hovedgrupper, og lighedstallene baseret på edderkopper og karplanter udviser en overordentlig sikker sammenhæng (Fig. 2) ($r = 0,733$; $P << 0,0005$; $N = 36$). I grupperingsanalyserne og i sidstnævnte sammenhængsanalyse er st. 5 blevet udeladt pga. uoverensstemmelse mellem botanikere og zoologer med hensyn til afgrænsningen af st. 5.

Der var ingen klar sammenhæng mellem antallet af edderkoppearter og antallet af karplantearter. Derimod var der en statistisk sikker sammenhæng mellem antallet af edderkoppearter og karplanternes dækningsgrad ($r_s = 0,685$; $P < 0,05$ (tosidet), $N = 10$) (Fig. 3).

Alt i alt må det konkluderes, at edderkoppefaunaen giver det samme billede af området, som karplanterne gør. Da edderkopperne generelt har en kortere levetid end planterne, og da de desuden kan bevæge sig omkring, vil de kunne afspejle ændringer i miljøet hurtigere end planterne. I visse tilfælde

vil brug af edderkopper til beskrivelse af områder derfor kunne være et nyttigt alternativ til brugen af planter. Dog bør det bl.a. undersøges, hvor stor betydning svingninger i edderkoppebestande igennem året har for det generelle billede. Er f.eks. lighedstallene stabile, eller varierer de meget?

Der var næsten ingen overlap mellem indsamlingsmetoderne med hensyn til de arter, der blev fanget (Fig. 4, Tabel 4), og resultater baseret på de forskellige metoder er ikke sammenlignelige. Med hensyn til tilstedeværende arter vil metoderne (02)-(08) formodentlig kunne gøres sammenlignelige ved at øge indsamlingsindsatsen og -tiden.

En fuldstændig liste over fangsterne indeholdende oplysninger om bl.a. køn, datoer, habitater og indsamlingsmetoder kan fås ved henvendelse til forfatteren.

Edderkopperne opbevares hos forfatteren.

Acknowledgements

Part of the laboratory work was done at The Zoological Museum, University of Copenhagen.

The field work was done by »Læsøgruppen af 1976«: Lisbeth W. Børgesen, Steen N. Christensen, Martha W. Clausen, I.H.S. Clausen, Birgitte D. Nielsen, Ole Chr. Hansen, Hanne Jeppesen, Rikke B. Jørgensen, Poul B. Madsen, Tommy Nielsen and Susanne Rehder.

The project was supported financially by Böje Benzons Støttefond, Botanisk Rejsefond, and Egmont H. Petersens Fond.

Special thanks are extended to: L.W. Børgesen, M.W. Clausen, O. Chr. Hansen, the late Dr. Niels Haarløv, Poul Jeppesen, Søren Langemark, and the late Dr. S.L. Tuxen.

The repro-photo work was done by Eva Bonde, The Zoological Museum, University of Copenhagen.

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APPENDIX 1

Plant species at the 10 stations

Plantearter på de 10 stationer.

	1	2	3	4	5	7	8	9	11	12
<i>Ammophila arenaria</i> (L.) Link (Sand-Hjælme)	x	x	x		x	x				
<i>Anthoxanthum odoratum</i> L. (Vellugtende Gulaks)										x
<i>Anthyllis vulneraria</i> L. (Rundbælg)	x									
<i>Armeria maritima</i> (Mill.) Willd. (Engelskgræs)	x									
<i>Calluna vulgaris</i> (L.) Hull. (Hedelyng)			x	x	x	x	x	x	x	
<i>Carex arenaria</i> L. (Sand-Star)	x	x	x	x	x	x	x			x
<i>C. nigra</i> (L.) Reich. (Almindelig Star)								x		
<i>C. panicea</i> L. (Hirse Star)									x	
<i>Corynephorus canescens</i> (L.) Beauv. (Sandskæg)	x	x	x	x						
<i>Deschampsia flexuosa</i> (L.) Trin. (Bølget Bunke)									x	
<i>D. setacea</i> (Huds.) Hack. (Fin Bunke)									x	
<i>Dryopteris carthusiana</i> (Vill.) H.P. Fuchs (Smalbladet Mangeløv)								x		
<i>Elymus arenarius</i> L. (Marehalm)		x			x					
<i>Empetrum nigrum</i> L. (Rævling)	x		x	x	x	x	x	x	x	
<i>Erica tetralix</i> L. (Klokkelyng)						x	x	x	x	x
<i>Eriophorum angustifolium</i> Honck. (Smalbladet Kæruld)									x	
<i>Festuca rubra</i> L. (Rød Svingel)	x									
<i>Galium verum</i> L. (Gul Snerre)	x									
<i>Hieracium umbellatum</i> L. (Smalbladet Høgeurt)	x	x	x	x	x					
<i>Hypochoeris radicata</i> L. (Almindelig Kongepen)	x	x	x							
<i>Jasione montana</i> L. (Blåmunke)	x		x	x						
<i>Juniperus communis</i> L. (Ene)					x					
<i>Leontodon autumnalis</i> L. (Høst Borst)	x									
<i>Lotus corniculatus</i> L. (Almindelig Kællingetand)	x		x	x						
<i>Molinia coerulea</i> (L.) Moench (Blåtop)									x	x
<i>Myrica gale</i> L. (Pors)					x		x	x	x	x
<i>Pinus sylvestris</i> L. (Skov Fyr)										x
<i>Plantago maritima</i> L. (Strand Vejbred)	x		x		x					
<i>Potentilla erecta</i> (L.) Räusch. (Tormentil potentil)					x	x	x	x		
<i>Salix repens</i> L. (Krybende Pil)			x		x	x	x	x	x	x
<i>Scirpus caespitosus</i> L. (Tue Kogleaks)										x
<i>Sedum acre</i> L. (Bidende Stenurt)	x									
<i>Taraxacum</i> sp. (Mælkebøtte)	x									
<i>Vaccinium uliginosum</i> L. (Mosebølle)					x	x	x			
<i>Viola tricolor</i> L. (Stedmoderblomst)	x	x								
<i>Aneura pinguis</i> (L.) Dum. (Tyk Nervelø)										x
<i>Dicranum scoparium</i> Hedw. (Kost-Kløvtand)					x		xx			
<i>Hypnum cupressiforme</i> Hedw. (Almindelig Cupresmos)			x		x	x	x	x	x	
<i>Lophocolea heterophylla</i> (Schrad.) Dum. (Forskelligbladet Kamsvøb)					x					
<i>Pleurozium schreberi</i> (Brid.) Mitt. (Trind Fyrremos)					x	x	x	x		
<i>Polytrichum piliferum</i> Hedw. (Hårspidset Jomfruhår)		x	x	x	x					
<i>Ptilidium ciliare</i> (L.) Hampe (Almindelig Frynsemos)					x					x
<i>Sphagnum auriculatum</i> Schimp. (Krumgrenet Tørvemos)										x
<i>Acarospora smaragdula</i> (Wahlenb.) Massal (Liden Småsporelav)	x									
<i>Cetraria islandica</i> (L.) Ach. (Islandsk Kruslav)	x	x	x	x						
<i>C. ericetorum</i> Opiz (??)	x									
<i>Cladonia arbuscula</i> (Wallr.) Rabenh. (Gulhvid Rensdyrlav)	x	x	x	x	x	x				

Plant species at the 10 stations

Plantearter på de 10 stationer.

	1	2	3	4	5	7	8	9	11	12
<i>C. bacillaris</i> Nyl. (Pind Bægerlav)			x	x	x					
<i>C. chlorophaea</i> (Flörke ex. Sommerf.) Sprengel (Brungrøn Bægerlav)	x	x	x	x	x	x	x			
<i>C. coccifera</i> var. <i>coccifera</i> (L.) Willd. (??)										x
<i>C. coccifera</i> var. <i>pleurota</i> (Flörke) Schaer (??)			x		x					
<i>C. coniocraea</i> (Flörke) Spreng. (Træfods Bægerlav)					x	x				
<i>C. floerkeana</i> (Fr.) Flörke (Lakrød Bægerlav)										x
<i>C. foliacea</i> (Huds.) Willd. (Fliget Bægerlav)		x	x			x				
<i>C. furcata</i> (Huds.) Schrad. (Kløftet Bægerlav)		x								
<i>C. glauca</i> Flörke (Grågrøn Bægerlav)					x	x	x			
<i>C. gracilis</i> (L.) Willd. (Slank Bægerlav)		x	x	x	x					
<i>C. mitis</i> Sandst. (Mild Rensdyrlav)		x	x	x	x					
<i>C. pityrea</i> (Flörke) Fr. (Kliddet Bægerlav)										x
<i>C. polydactyla</i> (Flörke) Spreng. (Vifte Bægerlav)										
<i>C. portentosa</i> (Dufour) Coëm (Hede Rensdyrlav)	x	x	x	x	x		x	x		x
<i>C. rangiferina</i> (L.) Wigg. (Askegrå Rensdyrlav)					x	x				
<i>C. rangiformis</i> Hoffm. (Spættet Bægerlav)		x								
<i>C. subcervicornis</i> (Vain.) Kernst. (Kyst Bægerlav)						x				
<i>C. tenuis</i> (Flörke) Harm. (??)						x		x	x	
<i>C. uncialis</i> (L.) Wigg. (Pigget Bægerlav)					x	x				
<i>C. cervicornis</i> subsp. <i>verticillata</i> (Hoffm.) Ahti (Étage Bægerlav)	x	x	x	x						
<i>C. zopfii</i> Vain (Grågul Bægerlav)		x	x	x	x					
<i>Cornicularia aculeata</i> (Schweb.) Ach. (Grubet Tjørnelav)	x	x	x	x	x		x			
<i>C. muricata</i> (Ach.) Ach. (Tue Tjørnelav)					x	x	x			
<i>Hypogymnia physodes</i> (L.) Nyl. (Almindelig Kvistlav)	x	x	x	x	x	x	x	x		
<i>H. tubulosa</i> (Schaer.) Havaas (Finger Kvistlav)	x				x		x		x	
<i>Lecidea granulosa</i> (Hoffm.) Ach. (Forskelligfarvet Skivelav)						x				
<i>Lecanora dispersa</i> (Pers.) Sommerf. (??)		x								
<i>Parmelia saxatilis</i> (L.) Ach. (Farve Skållav)							x			
<i>Peltigera</i> sp. (Skjoldlav)								x		
<i>Platismatia glauca</i> (L.) Culb et C. Culb (Blågrå Papirlav)		x	x	x	x					
<i>Pseudevernia furfuracea</i> (L.) Zopf. (Grå Fyrrelav)					x	x	x	x		
<i>Rhizocarpon constrictum</i> Malme (Strand Landkortlav)		x								
<i>R. obscuratum</i> var. <i>reductum</i> (Th. Fr.) Eitner (Mørk Landkortlav)							x			
<i>Sarcogyne simplex</i> (Dav.) Nyl. (Sort Foldekantlav)							x			
<i>Stereocaulon saxatile</i> H. Magnuss. (Klit Korallav)							x			
<i>Usnea</i> sp. (Skæglav)								x		
<i>Xanthoria parietina</i> (L.) Th. (Almindelig Væggelav)		x								

At st. 6 *Cetraria nivalis* (L.) Ach. was found, and at st. 10 *Juncus conglomeratus* L. and *Sorbus aucuparia* L. were noted.

Further it is noted that in 1978, which was not so dry, and thus close to normal, *Drosera intermedia* Hayne and *Gentiana pneumonanthe* L. were found at st. 11.

I st. 6 blev *Sne Kruslav* (*Cetraria nivalis*) fundet, og i st. 10 *noteredes Knop Siv* (*Juncus conglomeratus*) og *Røn* (*Sorbus aucuparia*).

Det bemærkes yderligere, at i det vådere, mere »normale«, år 1978 blev der fundet *Liden Soldug* (*Drosera intermedia*) og *KlokkeEnsian* (*Gentiana pneumonanthe*) i St. 11.