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Distribution, seasonal abundance and emergence of stoneflies (Plecoptera) in the Øvre Heimdal area of the Norwegian Jotunheimen Mountains [1]

ALBERT LILLEHAMMER

Lillehammer, A. 1984. Distribution, seasonal abundance and emergence of stoneflies (Plecoptera) in the Øvre Heimdal area of the Norwegian Jotunheimen Mountains. *Fauna norv. Ser. B. 31*, 1–7.

At Øvre Heimdalsvatn, situated in the Jotunheimen mountains of middle Norway, a study of the distributions, biotopes, occurrences, emergences and flight periods of stoneflies was carried out for a number of species occurring at high altitudes. In the subalpine vegetation belt a large number of closely related species occurs while at the high altitudes only a few less related species were recorded. The reduction in species with altitude was more pronounced among herbivorous than among predatory species. In the middle alpine areas outlets from lakes containing a larger number of species than the lakes and streams, while the opposite was the case in the subalpine.

In the subalpine belt herbivorous species were the most abundant, while in the middle alpine belt the predatory species dominated in abundance.

In the Øvre Heimdalen area closely related species were mainly separated, either in biotope occurrences or in emergence periods. The emergence time of summergrowing species *Isoperla obscura* and *Amphinemura standfussi* was influenced by the altitude.

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INTRODUCTION

Several authors such as Dodds and Hishaw (1925), Hynes (1941), Illies (1955), Illies and Botosaneanu (1969) have stressed the different distribution and the zonation of stonefly species. They have explained this as a result of factors such as altitude, latitude, temperature and substratum.

In Norway Lillehammer (1974) has compared the species zonation of stoneflies to the boreal, subalpine, low-alpine, middle-alpine and high alpine vegetation belts described by Sjørs (1963). From these and subsequent studies by Lillehammer & Brittain (1978) it seems that at high altitudes the presence or absence of willow (*Salix* spp.) along the streams is a very important factor in the distribution of stonefly species. In the absence of willow vegetation only a small number of species are present. These are *Nemurella picteti* Klapalék, *Nemoura cinerea* (Retzius), *N. arctica* Esben-Petersen, *Amphinemura standfussi* (Ris), *Capnia atra* Morton, *Diura bicaudata* (L.), *Arcynopteryx compacta* (McLachland) and occasionally *Diura nanseni* (Kempny) and *Isoperla obscura* (Zetterstedt).

Among the high altitude populations of stoneflies there are indications of an isolation and a selection process which influence the life cycle and distribution more sharply than at lower altitudes (Lillehammer 1975, 1976). This might to a large degree depend on the actual temperature and quantity of nutrients.

In the Øvre Heimdalen area we can find altitudinal marginal areas for several stonefly species. A study of distribution, biotope occurrence, and flight period can therefore give additional facts to the distribution pattern of Norwegian stoneflies.

AREA DESCRIPTION

The area of Øvre Heimdalen is situated in the Jotunheimen mountains at a latitude of 61°25'32" and longitude 8°52'10". The area is a part of the large Caledonian thrust complex known as the «Jotundekke» (Skjeseth and Kloster 1978). The valley is situated in a mountain region with a subarctic or tundra macroclimate. The northern side have the most favourable climate and with

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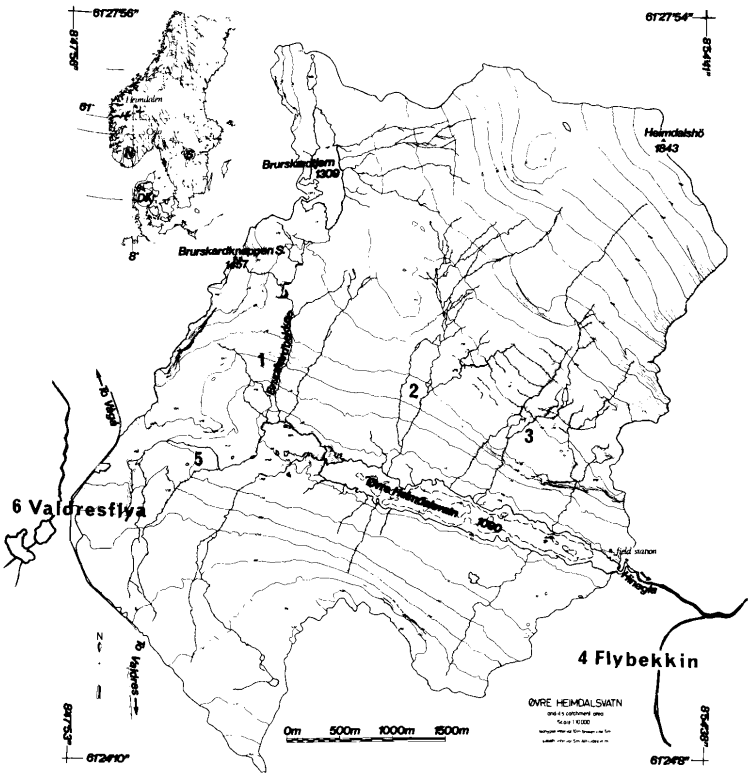

Fig. 1. Øvre Heimdalsvatn, its location and catchment area. The streams studied are given numbers from one to six. Two of them, 4 and 6, are situated outside the catchment area. Height contours in 10 mm intervals. Altitudes in m. The map is from Vik (1978).

a subalpine vegetation and birch trees growing at altitudes of about 1200 m a.s.l., while on the southern side there is only willow growing. The low-alpine vegetation is found between 1200 and 13—1400 m a.s.l. and the middle-alpine up to about 1800 m a.s.l. (Østhagen and Egeli 1978). Throughout the area willow thickets are concentrated along the watercourses (Lillehammer and Brittain 1978).

The climate is rather hard with a long winter. The lake Øvre Heimdalsvatn is mainly ice covered from mid October to early June. The monthly normal in temperature for July in the period 1931—1960 was 9.7°C at the lake level and the temperature was reduced by 1°C for each 100 m altitude (Werner Johannesen 1978). The water temperature of the lake increases rapidly after the ice has disappeared in early June, usually reaching a temperature over 10°C in July. Temperatures up to 17°C occur in the surface water during the summer. The lake begins to cool down in August, reaching the freezing point in middle October (Kloster 1978).

The lake has been the subject of extensive studies (Vik 1978), and the stoneflies have been handled in a number of publications (Lillehammer 1978, Lillehammer and Brittain 1978, and Brittain, 1983.

The present investigation was carried out in six streams (Fig. 1). The stations were chosen to represent different vegetation belts. Two of the streams were situated outside the catchment area of Øvre Heimdalsvatn, Flybekkin at east reaching 1450 m a.s.l. and a tributary to Leirungselva at Valdresflya to the west reaching about 1400 m a.s.l.

Flybekkin which was used for special studies is given a brief description. Station 1 in the subalpine belt situated 1060 m a.s.l. has a dense fringe of willow mixed with birch along the stream. The substratum is unstable with stones of various size mixed in sand and gravel. There is a fair amount of allochthonous organic matter in the stream. Station 2 situated in the low-alpine, upper edge of the *Salix* belt, altitude 1300

Table I. The number of stonefly species, genera, species to genera ratio (s/g), genera to family ratio (g/f), herbivorous to carnivorous ratio (h/c), recorded in five streams and in different vegetation belts in Øvre Heimdalen.

	Total no. of families	Total no. of genera	Total no. of species	Species to genera ratio	Genera to family ratio	Herbivorous to predator ratio
Middle-alpine	3	4	4	1.00	1.33	1.00
Low-alpine	5	10	11	1.10	2.00	1.67
Sub-alpine	6	13	20	1.54	2.17	3.67

m a.s.l. has only low bushes in especially sheltered places. The main vegetation is grass and the substratum is stable and consists of larger stones. There is less allochthonous matter in the stream. The third station in the middle-alpine belt and about 1400 m a.s.l. The terrestrial vegetation consists mainly of grass, the stream substratum is less stable and there are only small amounts of allochthonous matter in the stream. Description of Flybekkin was also given by Lillehammer (1974). The description given here for Flybekkin is much the same as for the other streams in this study.

MATERIAL AND METHODS

Altogether 20 species of stoneflies are recorded in Øvre Heimdalen. In this study the material of stoneflies was collected in the years 1969—1972 and 1977—1979, and consists of 3878 nymphs and 2166 adults. The adult material was collected by hand under stones, and by sweep netting in the vegetation along rivers, streams and lake shores once a month during the ice-free period, and by emergence traps in Øvre Heimdalsvatn and its outlet stream. The nymphal material was sampled by a kicking technique (Brittain and Lillehammer 1978) once a month from June to September and occasionaly in October, i.e. during the ice free period. Usually three samples, duration one min., were taken.

The composition of the sonefly fauna of streams in different vegetation belts was analysed by the number of genera present in each family and species in each genus. The ratio genera/family (g/f) and species/genus (s/g) provides information about the relationship between the species present in the different vegetation belts. High values indicate several closely related species, while values near 1.0 indicate monotypic genera. A factor herbivorous/predators species (h/p) is used to analyse the proportion of the two feeding groups in the same vegetation belt. All the Euholognotha are defined as herbivorous and the predators belong to Systelognatha. In stream Flybekkin the abuncance of the two feeding groups was also recorded.

Table II. Stonefly species and specimens recorded at three stations in different vegetation belts in the stream Flybekkin, Øvre Heimdalen in June, July, August and September 1969—1972.

No of species total	St. 1 Subalpine	St. 2 Low-alpine	St. 3 Middle-alpine
No of species total	14	8	4
No of herbivorous species	11	5	2
No of predatory species	3	3	2
No of specimens	267	482	44
% of herbivorous specimens	82	64	10
% of predatory specimens	18	36	90

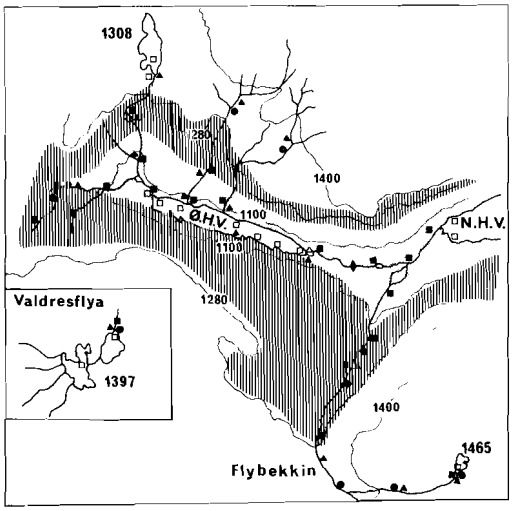

Fig. 2. The distribution of Systelognatha (predatory) stoneflies in the Øvre Heimdalen area. Dotted areas — subalpine, shaded — low-alpine and white — middle-alpine.
□ *Diura bicaudata*
● *Arcynopteryx compacta*
△ *Isoperla grammatica*
■ *Diura nanseni*
◊ *Dinocras cephalotes*
▲ *Isoperla obscura*
O.H.V. = Øvre Heimdalsvatn. N.H.V. = Nedre Heimdalsvatn.

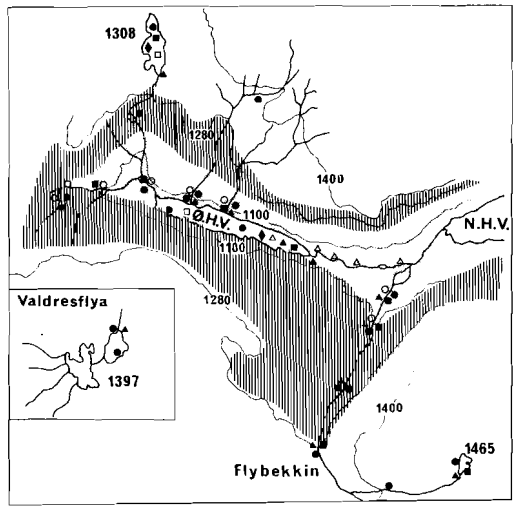

Fig. 3. The distribution of Nemouridae and Capniidae species in The Øvre Heimdalen area.
□ *Nemourella picteti*
◊ *Nemoura avicularis*
▲ *Amphinemura standfussi*
● *Capnia atra*
■ *Nemoura cinerea*
△ *Amphinemura sulcicollis*
○ *Capnia bifrons*

RESULTS

Distribution

In the subalpine vegetation belt occures 20 species from 13 genera. In the upper part of the low-alpine belt at about 1200 m a.s.l. the number of species has decreased to 11, representing 10 genera. Four species of stoneflies from four genera representing three families occur in the middle-alpine vegetation belt above 1300 m. They are *Capnia atra, Amphinemura standfussi, Isoperla obscura* and *Arcynopteryx compacta*. The ratio of species to genera from the subalpine localities to the middle-alpine decreased from 1.54 to 1.00 and the genera to family ratio from 2.17 to 1.33 The herbivorous to predatory species ratio from 3.67 to 1.0. In Flybekkin (Tab. 2) the predatory specimens by far are the most abundant in the middle-alpine vegetation belt and made up for about 90% of the stonefly fauna, the herbivorous only 10%. In the subalpine belt the opposite situation exists with about 20% predators and 80% herbivorous specimens. In the low-alpine belt two species dominate the composition. They are *Capnia atra* and *Amphinemura standfussi*, which make up for 90% of the fauna. Predators such as *Dinocras cephalotes, Arcynopteryx compacta, Diura bicaudata, D. nanseni, Isoperla grammatica* and *I. obscura* did not usually occur in the same habitats (Fig. 2). *Dinocras cephalotes*, the rarest, was only taken in a stream locality below Øvre Heimdalsvatn, where the substratum consisted of large rocks. *Diura bicaudata* occurred mainly in lakes, but of all altitudes. *Diura nanseni* occurred only in streams, mainly in the low-alpine belt, but might be numerous at certain localities above such as in lake outlets. *Arcynopteryx compacta* was the most abundant species in streams above the low-alpine belt, and it occurs also in lake outflows. *Isoperla grammatica* was only recorded in the outlet stream from Lake Øvre Heimdalsvatn, while *I. obscura* is recorded both in lakes and streams also above the low-alpine belt. *Isoperla obscura, D. nanseni* and *A. compacta* are sometimes recorded together, and all three species may be abundant, such as in the outlet of a small lake at Valdresflya.

	Nymphs	Adults	Year
Lake Øvre Heimdalsvatn 1090 m a.s.l.			
Diura bicaudata	400	120	1969-1973
Nemoura cinerea	176	227	1971-1972
Nemoura avicularis	1612	299	1971-1972
Nemourella picteti	105	5	1971-1972
Capnia atra	200	140	1971-1972
Outlet stream from Øvre Heimdalsvatn			
Isoperla grammatica	22	18	1971-1972
Isoperla obscura	19	14	1971-1972
Amphinemura standfussi	21	127	1971-1972
Amphinemura sulcicollis	225	170	1971-1972
Tributary streams to Øvre Heimdalsvatn 1100 m a.s.l.			
Argynopteryx compacta	175	26	1969-1973
Diura nanseni	26	13	1969-1973
Amphinemura standfussi	37	115	1971-1972
Capnia atra	25	78	1971-1972
Capnia bifrons	63	17	1970-1972
Outlet stream at Valdresflya 1400 m a.s.l.			
Diura bicaudata	6	8	1979
Diura nanseni	175	56	1976-1980
Arcynopteryx compacta	218	12	1976-1980
Isoperla obscura	167	12	1976-1980
Amphinemura standfussi	68	150	1976-1979
Capnia atra	18	60	1978-1980

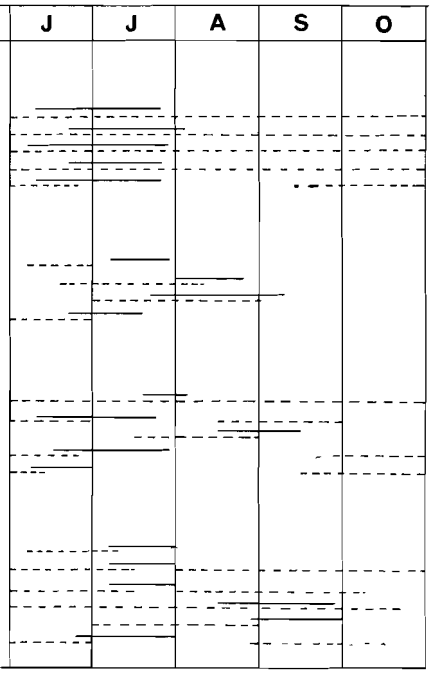

Fig. 4. The occurrence of stonefly nymphs ------- and the flight period _____ of adults in four localities in the Øvre Heimdalen area.

The herbivorous species show the same differences in distribution as the predators. In the subalpine belt of Øvre Heimdalen genera such as *Amphinemura, Nemoura* and *Capnia* are represented by two species each. In the middle-alpine belt only one species of each of these genera is present.

Both *Amphinemura sulcicollis* and *A. standfussi* occur in the subalpine belt while only *A. standfussi* occurs in streams and outlets in the low-alpine and middle-alpine belts and is there numerous in lake outflows such as Valdresflya (Fig. 4 and Tab. 3).

Among the nemourids, *Nemoura avicularis* only occurs in lakes and outlets, while *Nemoura cinerea* and *Nemurella picteti* also occur in streams and lakes. *N. avicularis* is absent in the middle-alpine belt. *C. atra* occurs in streams, lakes and outlets in all the vegetation belts, while *C. bifrons* is restricted to streams in the subalpine and the low-alpine belts where willow is plentiful along the streams. *Capnia bifrons* and *C. atra* occur in separate localities if they occur in the same stream, *C. bifrons* preferring gravel and small stones, while *C. atra* occurs where the substratum consists of larger stones.

Nymphal occurrence and emergence

Nymphs of *Diura bicaudata, Arcynopteryx compacta* and *Isoperla obscura* were recorded in all the ice free months while nymphs of *D. nanseni* were not recorded in July. *Isoperla grammatica* is only recorded as nymphs in June and July (Fig. 4). *Nemoura cinerea, N. avicularis* and *N. picteti* are recorded in all the months, while *A. sulcicollis* was recorded as nymphs only in June and July. *A. standfussi* was recorded as nymphs in June, July, August and September. *C. atra* and *C. bifrons* were recorded as nymphs in June and September.

D. nanseni and *D. bicaudata* which do not occur together emerge at about the same time, i.e. from the middle of June to the end of July. *A. compacta,* which can occur together with *D. nanseni* emerge at different time in the tributary streams. At the Valdresflya locality, however, the emergence of *A. compacta* and *Diura nanseni* and *D. bicaudata* takes place at much the same time (Fig. 4).

The emergence time of *I. obscura* seems influenced by the altitude. In the outlet of Øvre Heimdalsvatn and in the surrounding streams the

main emergence takes place at the first part of August and at 1400 m a.s.l. mainly during September. The emergence of *A. standfussi* is also later at Valdresflya than in the outlet from Øvre Heimdalsvatn (Fig. 4). *A sulcicollis* and *A. standfussi,* which may occur at the same locality, emerge at different times. At Øvre Heimdalsvatn *Nemoura avicularis* emerges earlier than the two other Nemouridae species which can occur in the same lake habitats.

DISCUSSION

The distribution of stoneflies in the Øvre Heimdalen area seems to be related to temperature and food. The mean temperature in Øvre Heimdal in July decreas by 1°C per 100 m altitude (Werner Johannessen 1978) and is during July about 3°C lower at Valdresflya (1400 m a.s.l.) than at Øvre Heimdalsvatn. From other studies we know that a decrease in temperature lengthens the life cycle of a number of stonefly species (Lillehammer 1975, Brittain 1978 and Saltveit 1976). The effect of temperature is, however, difficult to separate from that of food because temperature influences both the autochthonous and allochthonous production as well as the animals themselves. The reduction in number of species with altitude probably is a combined result of both food and temperature.

The high ratio of herbivorous species to predators h/c in the subalpine belt indicates that food for herbivorous such as plant fragments and detritus are more plentiful.

The differences in the fauna composition of herbivorous and predator species in habitats at different altitudes may be explained by two facts. Firstly, the predatory species are perhaps better adapted to a longer winter at higher altitude, because they have a diapause in the egg during the first winter (Khoo 1968, Lillehammer 1976, Saltveit & Lillehammer 1984). The two predatory species with summer egg, *Isoperla grammatica* and *Dinocras cephalotes* (Lillehammer unpubl. data) do not occur above the subalpine vegetation belt. Secondly, the herbivore stoneflies are mainly shredders and detritus feeders.

Above the low-alpine, plant material suitable for herbirorous stoneflies is scarce. In contrast to grazers on periphyton such as *Baetis macani, B. subalpinus* and chironomid larvae which might be numerous at localities such as at the lake outlet at Valdresflya (Lillehammer, unpubl. data). Food therefore seems more plentiful for predatory stoneflies than for shredders above the low-alpine.

The «Monardsche Prinzip» discussed by Illies (1952) states that in the same habitat species in the same genera do not occur at the same time. If they occur in the same habitat they emerge at different times. This in order to avoid competition. The distribution of the stonefly species in Øvre Heimdalen area, seems mainly in agreement with this principle.

Closely related species are mainly distributed in separate localities, such as *Diura bicaudata* and *D. nanseni,* or emerge at different times such as *Amphinemura standfussi* and *A. sulcicollis.* However, at certain localities, such as outlet from lakes, three predatory species can occur together in large numbers and even have a fairly parallel growth and emergence. How these species can exist in the same biotope, their growth, food uptake and possible dietary overlap will be considered in a separate paper.

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Insect pests in forests of the Nordic countries 1977—1981

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During the present five-year period, the spruce bark beetle *Ips typographus* L. continued to be the most serious pest problem in Norway and Sweden. — Aggressive strains of the Dutch Elm Disease were discovered in Denmark, Norway and Sweden. — In Finland, Norway and Sweden extensive outbreaks of the European Pine Sawfly *Neodiprion sertifer* Geoffroy occurred throughout the five-year period. — Other important pests are discussed, and pests of minor importance are listed in tabular form.

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INTRODUCTION

The present five-year report is the fourth one in the series published by the Nordic Forest Entomologists' research group. The three previous reports cover the periods 1961—66, 1967—71 and 1972—76 (Christiansen 1969, Ehnström et al. 1974 and Löyttyniemi et al. 1979).

In the first two reports there are short introductory notes on the tree species composition of the nordic forests, on changes in silvicultural, logging and transporting methods, and on the continuous process of legislative appraisal and adjustment with regard to insecticides. All these factors have a bearing upon the pest status of the insects, and also determine, to a certain extent, the research problems to be encountered.

During the present five-year period, synthetic pyrethroids have been tested in the laboratory and in the field against *Hylobius* (Eidmann 1979), and were approved and registered as substitutes for DDT. In Finland, lindan is used, while in Denmark and Norway DDT has still been permitted for treatment of plants in forest nurseries.

We have found it of rather questionable value to present a general view of the climatic conditions in the nordic region as a whole. The latitudinal extension of the region reaches from approx. 54.5°N in Denmark to 71°N in Norway, and encompasses both the typical atlantic climate of the coastal regions of Norway and the continental climatic type in parts of Norway, Sweden and Finland. The climatic conditions are therefore discussed in connection with the specific insect problems in each country when assumed that the climate has been a main factor regarding the development of the pest.

MAJOR PROBLEMS

Scolytids

During the present five-year period the spruce bark beetle *Ips typographus* L. has been the most serious pest problem in the south-eastern parts of Norway and the southern parts of Central Sweden. In Table 1 the annual volume losses of spruce trees are listed for the period, and the total outbreak areas are shown in Fig. 1.

In 1981 the amount of killed trees was reduced to approximately 1/3 compared to 1980 (Tab. 1). Several factors may have contributed to the reduction:
The precipitation during the years 1979—81 was back to normal, with ample rainfall during the growing seasons. Trees and stands of a physical condition enabling them to react on the favourable growing conditions, may have strengthened their resistance to bark beetle attacks. The bark beetle attacks may thus have been restricted to trees so badly stressed during the former drought period that the trees would hardly be capable of recovering. Therefore, in the years

Table 1. Total amount of beetle killed spruce trees in south-eastern Norway and in Sweden through the years 1977—1981. Cubic meters.

Country	1977	1978	1979	1980	1981	Total
Norway	1 500 000	1 108 000	1 057 000	949 000	329 000	4 943 000
Sweden	189 000	267 000	193 000	123 000	54 000	826 000

to come, the forests may gradually become dominated by fairly beetle resistant trees.

Furthermore, an extensive control campaign based on the results of the pheromone research programme (Bakke & Riege 1982) largely contributed to the reduction of the beetle populations (Bakke 1982). Annually, through the years 1979—1981 approximately 600.000 pheromone baited traps were used in Norway (NOU 1979, 1980) and 300.000 in Sweden (Regnander 1982). In addition, the Forestry Authorities encouraged a comprehensive, rapid extraction of attacked and killed trees before the emergence of the new brood, thereby reducing the population density in the forest.

In Norway attacks by *I. typographus* were also recorded on living *Pinus contorta*. In a small 50 year-old stand 17 trees were killed in 1979. Also *Pityogenes chalcographus* L. and *Polygraphus poligraphus* L. were recorded from the same trees.

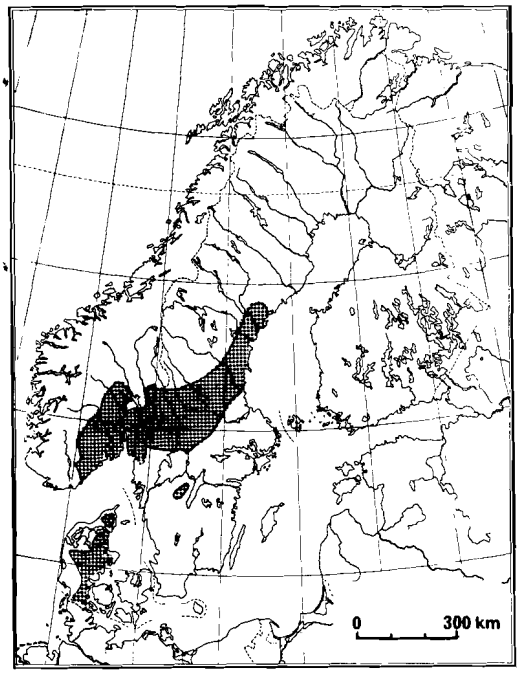

Fig. 1. Outbreak areas of *Ips typographus* during the period 1977—81.

In Denmark *I. typographus, P. chalcographus* and *P. poligraphus* caused the death of approximately 800.000 Norway spruce trees in 1977, and also a great many in the following years, mainly in Jutland (Fig. 1). The trees were weakened by drought in the former period.

In Finland no serious outbreaks of *I. typographus* have been reported. However, in 1980 and 1981 single trees or small groups of Norway spruce were attacked.

Considerable infestations by *P. chalcographus* in young Norway spruce stands have been recorded both in Norway and Sweden. Especially in 1981, the attacks mainly occurred in areas where the trees were weakened due to extreme climatic conditions: an exceptional warm period in March while the soil was still frozen caused a partly suffocation of the trees. — In Sweden *P. chalcographus* was also recorded in young stands of *P. contorta*.

In South Norway considerable infestations of Norway spruce by *P. poligraphus* occurred during the early years of the period, probably caused by the extreme rainfall deficit in the latter part of the former 5-year period.

In Denmark, Norway and Sweden aggressive strains of the Dutch Elm Disease were discovered in 1978, 1981 and the late 1970's respectively. Formerly known incidents of infestations were from 1955 in Denmark, 1963 in Norway and the early 1950's in Sweden. In Denmark and Norway *Scolytus laevis* Chapuis has been found to be the only or main vector of the disease. In Sweden both *S. laevis* and *S. scolytus* Fabricius are considered as vectors.

Extensive surveys in Denmark has shown *S. laevis* to be common all over the country. *S. multistriatus* Marsham has been found in two very southern localities. *S. scolytus* is recorded from several localities east of the Great Belt, but so far only in one district of Jutland (Harding & Ravn 1982).

Pine shoot damage by *Tomicus* spp. seems now to be more restricted to forests adjacent to logging terminals. There is a tendency of reduced infestations in the forests, probably due to improved forest sanitation.

Defoliators

Hymenoptera

Heavy infestations of the European pine sawfly *Neodiprion sertifer* Geoffroy has continued throughout the five-year period both in Finland, Norway and Sweden. The total outbreak areas are shown in Fig. 2. In the northern parts of central Finland the outbreaks, which started during the former five-year period, decreased gradually from 30.000 ha in 1975 to 2.000 ha in 1978. In southern Finland the first evidence of increasing populations was observed in the summer of 1978. In the next year (1979) moderate defoliation of some hundred hectares was recorded in three different localities. In 1980 the outbreaks expanded to 25.000 ha, and the following year moderate to severe defoliation occurred on 70.000 ha, the outbreak area extending from southwestern Finland throughout the lake district to the eastern part of central Finland.

Aerial spraying with polyhedrosis virus was conducted on 1.300 ha in 1980 and on 2.300 ha in 1981. No appreciable defoliation occurred in 1981 in the stands sprayed with virus in 1980.

In Norway heavy infestations were recorded in two different localities in the south-eastern parts of South Norway. During the following years the infestations expanded. In 1981 the total acreage being exposed to attacks was estimated to be between 20.000 and 30.000 ha. — In 1981, polyhedrosis was recorded in larval populations in areas which had been attacked since 1979. In such areas the populations were clearly on a decline.

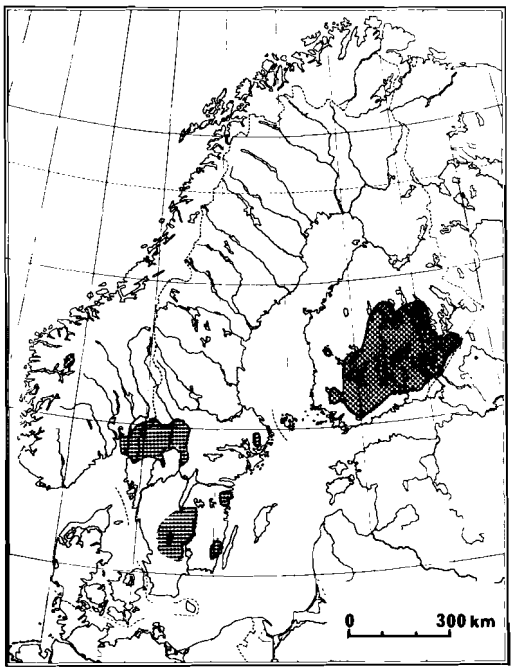

Fig. 2. Outbreak areas of *Neodiprion sertifer* during the period 1977—81.

No large scale control measures were undertaken. However, a few private forest owners sprayed small areas of young pines with polyhedral virus with good results.

In an experimental plantation, also *Pinus contorta* was heavily attacked.

In West-Norway heavy attacks developed in 1980 in three localities in one district. Altogheter 300—400 ha were defoliated. In this district the majority of the *N. sertifer* population is known to have a prolonged diapause of one or more years in the cocoon stage. Accordingly, no further infestations were observed in 1981.

In Sweden heavy infestations were reported in 1977 from many localities in the southern part of the country (Larsson & Tenow 1983). In 1978 the attacks extended over more than 10.000 ha. Through the years of 1979—81 the infestation spread towards north-west resulting in very extensive and partly very heavy outbreaks. In several districts *P. contorta* was strongly attacked. No serious tree mortality has been reported from any of the countries.

Also in Denmark *N. sertifer* is recorded on *P. contorta* and other pines. Defoliation has been moderate this period.

Local infestations of *Diprion pini* L. on young pines occurred in Sweden in 1977, in Finland in 1980 and 1981 and in Norway in 1979, 1980 and 1981. In one district of Norway *D. pini* attacked young plantations of *P. sylvestris, P. mugo* and *P. contorta,* resulting in the death of several trees.

Attacks by *Diprion butovitschi* Hedquist have been recorded locally from northern Sweden.

Microdiprion pallipes (Fallén) caused considerable damage to young pine regenerations in three localities in east Norway and occurred on one locality in southern Sweden. In Norway damage was also done to small plants of *P. contorta.*

Pristiphora abietina (Christ) was common in young spruce stands in southern and central Finland from 1978 to 1980, resulting in top dying of young trees. Also in the southern parts of Sweden *P. abietina* has caused considerable damage from 1977 to 1980. In this region approximately 1.300 ha of young spruce regenerations

have been infested. — In Denmark the sawfly is recorded on both *Picea abies* and *P. sitchensis* in 1980 and 1981, especially damaging the leading shoots (Bejer 1980, 1981). In Norway the species has been recorded only occasionally from single trees.

Pristiphora erichsonii (Hartig) was common on *Larix sibirica* in central Finland in 1979 and throughout the country in 1981. 70% defoliation was reported in an experimental area of a few hectares in northern Finland.

Lepidoptera

Considerable defoliation by various Lepidoptera has occurred during the period, both on softwoods and hardwoods.

In Denmark various lymantriids showed an unusual activity throughout the period, probably due to the preceeding warm years. Smaller outbreaks of *Orgyia antiqua* L. took place over some hectares, mainly on *P. abies*, in 1980 and 1981 (Bejer 1981, 1982). During the same two years *Dasychira pudibunda* L. defoliated some 100—200 ha of *Fagus silvatica* (Bejer 1981, 1982).

From 1978 and onwards, heavy outbreaks of the nun moth *Lymantria monacha* L. occurred, mainly on *P. abies*. Control measures were undertaken on approximately 1.000 ha, using endosulfane and diflubenzuron. In 1981 a new locality was infested (Bejer 1978, 1979, 1980, 1981, 1982). Here attacks were recorded also on *Picea sitchensis, Pinus sylvestris, P. contorta* and *P. mugo*.

Also in South Sweden *L. monacha* occurred in massoutbreaks during the years 1978—80. Between 200 and 300 ha of pine forests were attacked. Aerial control with fenitrothion and Dimilin was undertaken over an area of approximately 50 ha.

Coleophora laricella (Hübner) caused extensive defoliation of *Larix* sp. all over Denmark (Bejer 1977) and in South Sweden in 1977.

Extensive outbreaks of *Epirrita (Oporinia) autumnata* (Borkhausen) and *Operophtera* sp. were recorded on birch forests in North-Norway and the mountainous regions of South-Norway during the years 1977—80. Also in Mid Sweden birch forests were heavily defoliated by *Operophtera* sp.

Operophtera brumata L. caused local defoliation of *Quercus* sp. in Denmark, especially in 1979 (Bejer 1980), but also during other years in the period except 1977. In northern Finland blueberry *(Vaccinium myrtillus)* was heavily defoliated by *O. brumata* in 1980 over an area of 4 ha. The outbreak extended to 10 ha the following year, and new attacks were reported from several localities. High mortality of blueberry was observed after two—year defoliation. Damage to blueberry by *O. brumata* has not been recorded formerly (Saarenmaa & Jalkanen, 1981).

Hybernia defoliaria (Clerck) caused widespread damage to *Quercus* sp., *Betula* sp. and *Acer pseudoplatanus* in Denmark in 1979, 1980 and 1981 (Bejer 1980, 1981, 1982). In South Norway the moth defoliated considerable areas of several hardwood species in 1977 and 1978. Also *Fraxinus excelsior* suffered heavy defoliation. In 1977 heavy outbreaks of *Tortrix viridana* L. were recorded in oak forests in the southern parts of Norway and Sweden.

As during the period 1968 to 1971 *Epinotia nanana* (Treitscke) again occurred in massoutbreaks in the mountainous regions of Mid Sweden adjacent to the Norwegian border. Heavy infestations covering an area of approximately 100 ha were recorded in 1980. In 1981 the attacks extended to several thousands of hectars.

Widespread heavy infestations by *Yponomeuta* spp. occurred in all the Nordic countries during this five-year period. Attacks were confined mainly to *Prunus padus*, but several other hardwood species were also defoliated.

Other important pests

Hylobius abietis L. continued to be one of the most destructive forest pests in Sweden due to the ban of DDT and the absence of an approval of a substitute. However, following comprehensive tests of several insecticides, which were taken into use in 1979.

In southwestern Finland considerable damage was done by *H. abietis* to pine and spruce plants in 1977 despite pretreatment with lindane (Zilliacus 1978). Moderate to heavy damage on treated plants was also recorded locally in other years. In Mid Norway most of the plants were killed by *H. abietis* and *Hylastes* sp. in a 10 ha spruce regeneration were the plants were pretreated with DDT. Extensive damage by *Hylastes* sp. has also been reported from northern Sweden especially in the years 1977 and 1978. The main reason for the attacks is supposed to be insufficient treatment of the plants.

Heavy attacks by *Strophosoma capitatum* (Degeer) in pine and spruce plantations were reported from South and Mid Sweden. In Norway the species has defoliated both *Pinus sylvestris* and *P. contorta* in research plots. In Denmark *S.*

melanogrammum (Forster) has been fairly common throughout the period defoliating several conifers.

In the short rotation hardwood plantations several defoliators have caused serious damage to various tree species. In central Finland *Phyllobius pyri* L. and *P. maculicornis* Germar infested young birch in 1981. The warm weather in the previous summer was evidently favourable for egg laying and larval survival (Annila 1979, Löyttyniemi & Rousi 1979). *P. pyri* also caused slight damage to birch in southeast Norway. In Finland *Melolontha hippocastani* Fabricius totally defoliated birch and aspen over a small area. In Denmark *M. melolontha* (L.) severly damaged plantations of *Abies nordmanniana* in 1979 (Bejer 1980). In Mid and South Sweden *Chrysomela populi* L. and *Phratora (Phyllodecta)* spp. caused heavy defoliation of *Populus*. *Phratora* and *Galerucella lineola* (Fabricius) also attacked *Salix* (Larsson & Wirén 1982). In West-Norway *G. lineola* caused extensive defoliation of *Alnus* in 1977. One plantation of *Salix purpurea* was infested by *Cryptorhynchus lapathi* L., and the cecidomyiid species *Rhabdophaga terminalis* (Loew) has heavily damaged certain *Salix* clones.

With the exception of Denmark, aphids on conifers have in general been of less concern this five-year period compared to the previous one. In Denmark the production of decoration greenery is of considerable importance. Therefore, economic losses are easily incurred by insect pests, especially on *Abies nordmanniana* and *A. procera* (Münster-Svendsen 1978a, 1978b). In the beginning of the five-year period *Dreyfusia nordmannianae* Eckstein was abundant and was controlled with insecticides. In northeastern Finland infestations by *Pineus pini* (Macquart) in young pine plantations killed about 10% of the plants in 1979 and 1980. Locally, heavy attacks by *Elatobium abietinum* (Walker) on *Picea sitchensis* occurred in Denmark and in Mid and South Norway. Extensive infestations of *Populus tremulae* by *Pachypapella lactea* Tullgren were recorded from Norway and Sweden especially during the later half of the five-year period.

The beech scale, *Cryptococcus fagi* (Bärensprung), was fairly abundant in *Fagus silvatica* stands in some parts of Denmark, especially in 1977, but also through the rest of the period (Bejer 1977). In 1977 *C. fagi* was also discovered in a beech stand in a southern locality in Norway.

Aradus cinnamomeus Panzer continued to damage young pine stands on poor sandy soils in southern Finland and in South-Sweden.

Thecodiplosis brachyntera (Schwägerichen) caused severe losses of needles in *Pinus silvestris* over hundreds of km^2 in northern Sweden in 1979 and 1981. In 1980 attacks were reported from many places in the south and middle part of the country. Also from Denmark local heavy infestations on *Pinus mugo* were reported in 1979 and 1980.

MISCELLANEOUS

In 1981 serious violations of the import regulations on timber occurred in Norway and Sweden. Shipments of insufficiently debarked softwood timbers from Canada were arrested by the plant inspection authorities in one harbour in Norway and one in Sweden. Following the inspection by forest entomologists, several bark and wood living canadian insects were found. In Sweden living adults were recorded of *Dendroctonus rufipennis* Kirby, *Polygraphus rufipennis* (Kirby), *Drycoetes affaber* (Mannerheim), *Ips borealis* Swaine, *Rhagium* and *Buprestidae*. Living larvae were found of *Monochamus notatus* (Drury), *Tetropium* and probably *Sirex*. In Norway, unidentified specimens of dead bark beetles and living larvae of longhorn beetles were found. The unloading of the timber had already begun before inspection. After careful considerations, and because the shipments arrived in wintertime, it was desided to allow the unloading to be continued provided the timber was taken directly into the pulping process in the factories. Strict sanitation measures were undertaken, i.e. burning of all loose bark and spraying of the hold of the vessels with insecticides.

Two similar incidents occurred in Sweden also in 1977. Imported spruce timber with bark from Russia contained living adults of *Ips amitinus* (Eichhoff), which so far is not established in the Swedish forests. A shipment of *Abies balsamea* and *Picea glauca* from Maine, U.S.A., contained living adults of *Pityokteines sparsus* (LeConte), larvae of *Monochamus notatus* (Drury) and also numerous *Polygraphus rufipennis* (Kirby). In rotinfested parts of logs, nests of *Camponotus pennsylvanicus* (Degeer) were found.

OTHER ATTACKS REPORTED

The reported occurrences of other forest insect pests during the five-year period are listed in Table 2.

Table 2. Forest pest insects of minor importance reported in the Nordic countries 1977-81.

Insect species	Host	Country	Remarks	Year	References
HEMIPTERA					
Adelges sp.	*Picea abies*	Denmark, Norway	Plantations and shade trees	1977-78	Bejer, 1977, 1979
Aphrastasia pectinatae (Cholodkovsky)	*Abies* spp.	Norway	Plantations and shade trees	1977-83	
Aphrophora sp.	*Alnus, Salix*	Denmark	Severe attacks, locally	1981	Bejer, 1982
Chionaspis salicis L.	*Fraxinus excelsior, Salix*	Denmark	Numerous	1980	Bejer, 1981
Cinara sp.	*Pinus sylvestris*	Norway	Shade trees	1980	
Cinara picea (Panzer)	*Picea abies, P. sitchensis*	Norway	Shade trees	1980	
Cinaropsis sp.	*Picea abies*	Denmark	Attacks reported	1977-78	Bejer, 1977
Dreyfusia sp.	*Abies* sp.	Norway, Finland	Plantation	1977	
Dreyfusia nordmannianae Eckstein	*Abies* sp.	Norway	Shade trees	1977	
Dreyfusia picea (Ratzeburg)	*Abies lasiocarpa*	Norway	Shade trees	1977	
Lachnidae sp.	*Picea abies, Pinus sylvestris*	Sweden, Finland	Plantations	1980-81	
Phyllaphis fagi L.	*Fagus silvatica*	Norway	Attacks reported	1977	
COLEOPTERA					
Anthonomus phyllocola (Herbst)	*Pinus sylvestris, P. contorta*	Norway, Sweden	Considerable infestations	1977-81	
Brachyderes incanus (L.)	*Pinus sylvestris, P. contorta, P. mugo*	Norway	Nursery and trial plots	1977-79	
Dendroctonus micans (Kugelann)	*Pinus sylvestris*	Norway	Ornamental trees	1977	
Altica quercetorum Foudras (= *Haltica saliceti* Weise)	*Quercus*	Sweden	Local defoliation	1981	
Lochmaea caprea (L.)	*Betula, Salix*	Sweden	Extensive defoliation	1978-81	
Magdalis frontalis (Gyllenhal)	*Pinus sylvestris*	Sweden	Local attack on plants	1977	
Magdalis violacea (L.)	*Pinus sylvestris*	Sweden	Local attack on shoots	1979	
Otiorhynchus sp.	*Picea abies*	Norway	Nursery	1980	
Otiorhynchus nodosus (Müller) (=*O. dubius* Strøm)	*Pinus sylvestris*	Sweden	Local attack	1981	
Pissodes validirostris Gyllenhal	*Pinus contorta*	Sweden	Considerable attacks on cones	1977	
Rynchaenus fagi (L.)	*Fagus silvatica*	Denmark	Widespread defoliation	1980-81	Bejer, 1981, 1982
		Norway	Local infestation	1977	
Scolytus ratzeburgi Janson	*Betula*	Norway	Shade trees	1977	

contd.

Table 2 (contd.)

Insect species	Host	Country	Remarks	Year	References
LEPIDOPTERA					
Cidaria juniperata L.	*Juniperus* sp.	Sweden	Heavy defoliation on nursery stock	1980	
Cossus cossus L.	*Betula, Populus*	Sweden	Local attacks	1981	
Cydia (Laspeyresia) illutana (Herrich-Schäffer)	*Conifers*	Sweden	Attacks on cones	1980	
Cydia strobilella L.	*Picea abies*	Sweden	Considerable attacks on cones	1980	
Dioryctria mutatella Fuchs	*Pinus contorta*	Sweden	Attacks on buds and shoots	1980-81	
Dioryctria sp.	*Pinus sylvestris*	Sweden	Heavy attacks on shoots	1977, 1980	
Epinotia proximana (Herrich-Schäffer)	*Abis nordmanniana*	Denmark	Attacks and control operations	1977, 1979	Bejer, 1980, Münster-Swendsen 1978 b.
Eriocrania sp.	*Betula*	Finland, Norway, Sweden	Extensive infestations	1977-79	
Ocnerostoma piniariella Zeller	*Pinus sylvestris*	Norway	Attacks reported	1980	
Rhyacionia buoliana (Denis & Schiffermüller)	*Pinus contorta* *Pinus* spp.	Denmark, Sweden	Considerable infestations	1977, 1978	Bejer, 1977
DIPTERA					
Syndiplosis petioli Kieffer	*Populus*	Sweden	Locally numerous	1980	
HYMENOPTERA					
Acantholyda sp.	*Pinus peuce*	Finland	Ornamental trees	1979	
Acantholyda hieroglyphica (Christ)	*Pinus sylvestris*	Sweden	Moderate attacks on young plants	1977	
Arge pullata (Zaddach)	*Betula*	Denmark	Very heavy defoliation	1977-81	Bejer 1977,1979, 1980,1981,1982.
Cimbex sp.	*Betula*	Norway	Local moderate attack	1979	
Macrophya punctumalbum L.	*Fraxinus*	Sweden	Local heavy defoliation	1980-81	
Xyela sp.	*Pinus sylvestris*	Sweden	Considerable attacks in plantation	1978	
ACARINA					
Oligonychus ununguis Jacobi	*Picea* sp.	Denmark	Moderate infestations on newplantings	1978,1980	Bejer 1979,1981
Phyllocoptes populi Nalepa	*Populus* sp.	Sweden	Local heavy infestation	1980	

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Effects of water regulations on beetle fauna of open shores of mountain lakes in Scandinavia

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Open shores of regulated mountain lakes of central Scandinavia and inner southern Norway were investigated. The composition of the beetle fauna seems to differ from what normally characterizes similar localities of not regulated lakes in some respects. 1. Species normally preferring higher levels or cold localities seem to be favoured through the gathering of cold water in the regulated lakes (*Bembidion hasti* Sahlberg, 1827; *Nebria rufescens* Ström, 1768; *Psephidonus longipes* Mannerheim, 1830). 2. Species usually living on lower levels have become less important (f.i. *Bembidion prasinum* Duftschmied, 1812). 3. Eurytopic species seem to be furthered because of detritus deposit on the shores (*Bembidion bipunctatum* L., 1761, *B. bruxellense* Wesmaël, 1835). 4. The last mentioned fact, on the other hand, may result in worsened conditions to certain species (*Bembidion prasinum* Duftschmied, 1812; *Gnypeta caerulea* Sahlberg, 1831). 5. Rapid fluctuations of the water line and moisture could be fateful to species as *Bembidion difficile* Motschulsky, 1844 and *Pelophila borealis* Paykull, 1790 (strikingly few finds). 6. Several finds of *Trechus rubens* Fabricius, 1792 might indicate some affinity of shady shores to open shores of regulated lakes. 7. *Bembidion femoratum* Sturm, 1825 and *B. grapii* Gyllenhal, 1827, usually living on open culture influenced habitats, found in several places, may give additional evidence to show that regulations favour eurytopic species.

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INTRODUCTION

The aim was initiated through previous rather intensive investigations which were carried out before regulations took place (Fridén 1956). Similar studies were also made by other scientists (f.i. Brundin 1934). The mentioned habitats were chosen since they are easy to survey and no doubt have species which normally are restricted to such localities. However, the number of species might be small and the habitat unstable as a consequence of the water level fluctuations. Furthermore, the animals are mostly able to move. Nevertheless, the fauna of habitats in southern Swedish Lapland, influenced by water fluctuations, could be compared to the same ones previous to the influence. The collected material is rather large but because of the related circumstances farreaching conclusions cannot be expected. The vegetation was as far as possible studied after the regulations and some parallels are drawn.

The investigations were carried out during parts of several summers of the last ten years.

The site of investigated lakes

The site of the lakes where shores have been investigated are indicated (Fig. 1). The lakes are situated in the uppermost part of the regio conferina, on different levels of the regio betulina and, in central southern Norway, in the lowest part of the regio alpina. The last-mentioned, however, is rather little investigated. Temperature conditions of some weather stations can be found in Table 1.

Investigation methods

One aim should be to try to objectively compare my collected materials from uninfluenced and influenced shores. Difficulties have already been discussed above. My own previous investigations have formed a base (Fridén 1956, 1978). Several visited localities at that time have in recent years been investigated, about 30—35 years afterwards and 10—15 years after the regulations. In other areas of the Scandinavian mountains completing collections and studies

Table 1. Height above sea level and mean annual air temperature at weather stations neaarby investigated lakes (Localities shown in Fig. 1).

Station	m.a.s.l.	mean temp. °C
Tärnaby	450	−0.4
Gäddade	315	1.2
Storlien	595	0.7
Røros	630	0.5
Grindaheim	470	3.0
Haugastøl (10)	995	−0.1

have been performed (Fig. 1). While the vascular plants rather easily can be surveyed, a good quantitative evaluation of invertebrates is more difficult to obtain. The weather f.i. plays a rather important part, especially as to species of the in this case well represented genus *Bembidion* Latreille 1802. The animals were caught through pouring water over the shores, furthermore through collecting under stones. Traps were not applied, because they, on the localities in question, could have been wrecked. The application of strict quantitative collecting methods seems to be of dubious value (Bombasch 1962, Strickland 1961).

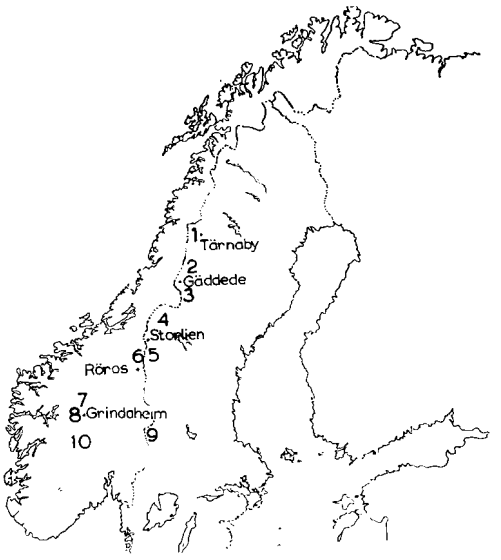

Fig. 1. Map of Scandinavia showing the areas of the investigated lakes (1—10) and six weather stations. — 1, Överuman, Gäutan, Ajaure, Björkvattnet, Abelvattnet, Bleriken, Gardiken. — 2, Ransaren, Kultsjön. — 3, Stora Blåsjön, Jormvattnet, Kvarnbergsvattnet, Hetögeln. — 4, Juvuln, Kallsjön, Anjan. — 5, Sylsjön (regio alpina). — 6, Stugusjöen. — 7, Bydin (regio alpina). — 8, Otrövatn. — 9, Höljessjön. — 10, Ustevatn.

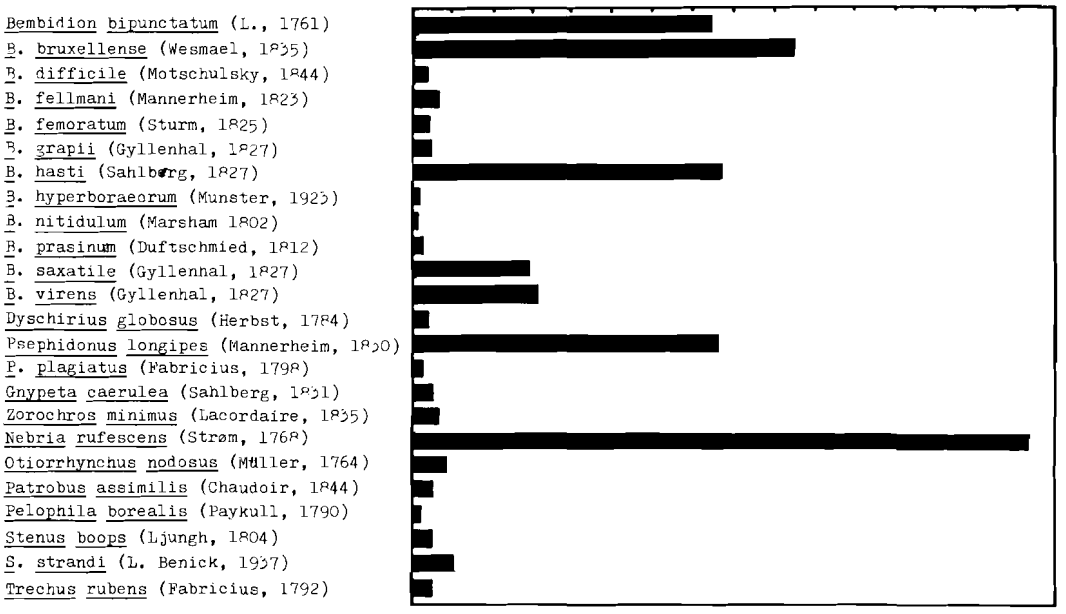

Fig. 2. Relative occurrence of selected species of beetles on open barren shores of regulated Scandinavian mountain lakes. Several sporadic and weather-driven species omitted. In all 2492 specimens of the 24 species were recorded.

A number of noted species are no doubt accidental, usually weather-driven, so they have no value as evidence.

RESULTS

Species of special interest

In a diagram the relative occurrence of a number of species is illustrated (Fig. 2).

Comments to various species.

True shore species

Bembidion bipunctatum (L., 1761)
Ecology and distribution: Common, varying shore basis. As *B. bruxellense* one of few *Bembidion* in the Faroes (Bengtson 1981).
Comments: The ecology may explain the great number found.

B. difficile (Motschulsky, 1844).
Ecology and distribution: Rather varying demands as to the shore quality.
Comments: Appears to be insignificant, possibly due to such as fluctuations of water line and moisture.

B. fellmani (Mannerheim, 1823).
Ecology and distribution: Was not found in southern Lapland by Fridén (1956). In central Scandinavian mountains at higher levels. Ecology as *B. hasti*.
Comments: No good background. One record in northern Jämtland.

B. hasti (Sahlberg, 1827).
Ecology and distribution: Normally on open barren shores and on average at higher levels.
Comments: The number found is considerable in relation to the middle level of the previously investigated lakes (Fridén 1978). It is possible that species of a more northern character are favoured through the regulations.

B. hyperboraeorum (Munster, 1923).
Ecology and distribution: As *B. hasti*. North Scandinavian.
Comments: Surprisingly few finds compared to *B. hasti*.

B. prasinum (Duftschmied, 1812).
Ecology and distribution: Demands truly barren shores and moist environment, mostly of rivers. Normally not at higher levels.
Comments: Noted only in northern Värmland.

B. saxatile (Gyllenhal, 1827).
Ecology and distribution: Ecology as *B. prasinum*. Mostly at lower levels too.
Comments: Rather well represented south of Lapland. Changes in shore material and climate seem to affect *B. prasinum* more than they do *B. saxatile*.

B. virens (Gyllenhal, 1827).
Ecology and distribution: Usually together with the two preceeding species. Prefers lower levels.
Comments: Several finds in southern Lapland. No clear trend is visible.

Gnypeta caerulea (Sahlberg, 1831).
Ecology and distribution: Usually steady on sand shores.
Comments: Rather few finds what could be seen as a sign of changed shore conditions.

Nebria rufescens (Strøm, 1768).
Ecology and distribution. Rather significant of shady shores of regio silvatica.
Comments: May perhaps be stimulated by the pooling of cold water.

Pelophila borealis (Paykull, 1790).
Ecology and distribution. Various shores, near to the water line.
Comments: Seems to have nearly disappeared. The reason could be to strong changes of the moisture of the habitat.

Species living on different moist habitats

Bembidion bruxellense (Wesmaël, 1835).
Ecology and distribution: Decided eurytopic as *B. bipunctatum*.
Comments: Seems to exist well on shores of regulated lakes and be something of a character species.

B. femoratum (Sturm, 1825), *B. 'grapii* (Gyllenhal, 1827).
Ecology and distribution: Usually on open culture influenced habitats.
Comments: Ecology may elucidate several finds.

Stenus (Latreille, 1796).
Ecology and distribution: Not so well investigated, mostly scarcely real shore species.
Comments: Further species rather rarely noted.

Trechus rubens (Fabricius, 1792).
Ecology and distribution: Particularly on shady shores.
Comments: Several finds indicate that regulations favour eurytopic species.

Accidental or weather driven species

Amara brunnea (Gyllenhal, 1810).
Ecology and distribution: Common in birch forest in mountain valleys.
Comments: Has obviously swarming or flying landed on the shores.

Anthophagus omalinus (Zetterstedt, 1828).
Ecology and distribution: A very common species in the mountains.
Comments: Many flying specimens of course fall on the shores.

Otiorrhynchus nodosus (Müller, 1764).
Ecology and distribution: Can not fly.
Comments: The animals found were dead, perhaps drowned because of rapidly rising water.

Some species of *Dytiscidae* were found close to the water line. Only *Hydroporus palustris* (L., 1761) may be worth noting. *Anthicus flavipes* (Panzer, 1797) and *Bembidion velox* (L., 1761) both demandant for pure sand, were found in

south Lapland before the regulations (Fridén 1956) but not after. They are usually local but use to be in abundance.

The animals here discussed do not show such an obvious trend as certain vascular plants. They are, however, mostly beasts of prey (Tobisch-Dunger 1973).

Vegetation parallels

Unfortunately my field work in the forties did not include methodical notations of the flora on the shores by means of which better parallels could have been drawn in order to support the understanding of the faunistical results. However, in Sweden efforts have been made to study the vegetation of mountain lake and river shores just before the regulations were put in (Wassén 1966, Lundqvist 1970). Furthermore florists have studied the shore vegetation following regulation (Sjörs & Nilsson 1976, Nilsson 1981). Perhaps the vegetation of the original shores usually is very poor, but after the regulations a certain new vegetation can be found there. Its stamp is not doubt that of ubiquistic and weed nature (Sjörs & Nilsson 1976). Some species of this kind should be mentioned: *Alopecurus aequalis, Barbaraea stricta, Callitriche* sp., *Matricaria inodora* and *Rorippa palustris*.

SOME SUMMARIZING CONCLUSIONS AND REFLEXIONS

The consequences of lake regulations will obviously soon affect certain shore organisms. *Bembidion femoratum* and *B. punctulatum* (Drapiez, 1821) have proved to be the only common species on certain strongly polluted localities (Koch 1977).

Some factors are mentioned above which should be considered when estimating the consequences of the regulations. In the higher parts of the mountains gathering of cold water might cause very small changes of the climate such as a little lower summer and perhaps spring temperatures. A higher temperature in autumn when the water is relatively warm also is expected. An increased fog frequency is likely. The changed composition of the shore material through detritus deposit results in worsened conditions to certain organisms, bettered conditions to others. It is a question to which degree rapid oscillations of the water line affect moisture dependent species.

The results show no very distinct uniform trend and the investigations can for the present be seen merely as attempts to analyse complicated problems.

The nomenclature follows Siltverberg (1979).

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The acrocerid flies of Norway (Dipt., Acroceridae)

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Ellefsen, G. E. & Greve, L. 1983. The acrocerid flies of Norway (Dipt., Acroceridae). *Fauna norv. Ser. B. 31*, 20—22.

The distribution of *Ogcodes pallipes* Latreille and *Acrocera orbicula* (Fabricius) is recorded, based on all available material in Norwegian collections.

Several body-measurements of *A. orbicula* are given. The synonymy of *A. orbicula* and *A. globula* auct. is commented on.

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The family Acroceridae (Cyrtidae) has a worldwide distribution. More than 30 species are recognized in Europe (Chvála 1980a). Two genera of acrocerid flies, *Ogcodes* and *Acrocera,* are represented in Scandinavia. Adults are rare and seldom taken in large numbers. The distribution of many species are therefore still incompletely known.

The larvae of acrocerid flies are internal parasitoids of true spiders (Araneae) and develop with hypermetamorphosis. The Scandinavian species deposite their eggs either on dead twigs (*Ogcodes*) or on living grass (*Acrocera*). The young larvae move around in search of their spider hosts (Schlinger 1981).

Adult acrocerid flies are recognized by a relatively small head, large thorax and nearly globose abdomen. Hence the Scandinavian name «kule-fluer», meaning «globe-flies». The three-segmented antennae are either placed at vertex just in front of the ocellar tubercle *(Acrocera)* or just above the mouthparts on the ventral part of the head *(Ogcodes)*. Eyes are holoptic in both sexes. Wings are variable in size and venation. Thoracic calypters are strongly developed. Both *Ogcodes* and *Acrocera* are characterized as poor fliers (Schlinger 1981). They can be caught by sweeping-nets or in window-traps.

The only previous records of Acroceridae in Norway were given by Siebke (1877) as *Acrocera globulus* Panzer, from Enebakk in Akershus, and *Henops marginatus* Meigen, from Oslo and Enebakk. Siebke (1877) also placed *Sphaerogaster arcticus* Zetterstedt, in Acroceridae. This is, however, *Glabellula arctica* (Zetterstedt, 1838), belonging to Bombyliidae. Later Bidenkap (1901) also recorded this species from Norway as belonging to Acroceridae.

The present paper is based on all material of Acroceridae in the collections of Zoological Museum, University of Oslo (ZMO); Zoological Museum, University of Bergen (ZMB) and Tromsø Museum (TM). One specimen from the private collection of Tore R. Nielsen, Sandnes, is also included. Økland's (1981) modification of Strand's (1943) system for locality specifications, is followed.

Genus *Ogcodes*

O. pallipes Latreille, 1811

Syn: *Henops marginatus* Meigen, 1822.

Published material: AK: Oslo (Kristiania), EIS:28, 1 ♀, leg. Esmarck (ZMO) AK: Oslo (Kristiania), EIS:28 1 ♂, leg. Siebke (ZMO)

Unpublished material: VE: Lardal, Bergandammen, EIS:18, UTM: 32VNL482916, 16. VIII. 1980, 1 ♀, leg. G.E. Ellefsen (ZMB).

It seems reasonable to suppose that the specimen taken by Esmarck is the one referred to as collected in Kristiania by Siebke (1877). The specimen taken by Siebke is probably the one referred to as collected in Enebakk (Siebke, op.cit.).

Hackman (1970) recorded the closely related species *Ogcodes borealis* Cole, 1919 from Southern Finland. According to Schlinger (1960) this species has a characteristic dark colour, but can only be separated with certainty from *O. pallipes* on characters of the internal male genitalia. As none of our three specimens are particularly dark, and the only male has parts of the abdomen damaged by insects, the question whether both *O. pallipes* and *O. borealis* are native species of the Norwegian fauna, must remain open until more material has been collected.

The Norwegian distribution of *O. pallipes* is mapped on Fig. 2B.

Other Scandinavian *Ogcodes*-species are *O. nigripes* (Zetterstedt, 1838) described from Swedish Lapland, and *O. gibbosus* (L., 1758), a widespread species in northern and central parts of Europe (Hackman 1980).

Genus *Acrocera*

A. orbicula (Fabricius, 1787).
Syn: *Acrocera globulus* sensu Siebke, 1877.
Published material: AK: Enebakk, EIS:29, 21.VII.1871, 1 ♂, leg Siebke (ZMO). AK: Enebakk, EIS:29 1 ♀, leg. Siebke (ZMO).
Unpublished material: VAY: Flekkefjord, EIS:4, VI.19. 1 ♀, leg. Münster (ZMO). VAY: Mandal, EIS:2, 2.VII. 1935, 1 ♀, leg. Soot-Tyen (TM). VAY: Lindesnes, Jørgenstad, EIS:1, UTM: 32VLK8633, 3.VIII.1978, 1 ♀, leg. T.R. Nielsen. HOl: Granvin, Seim, EIS:41, 1.VI.1936, 1 ♂, leg. N. Knaben (ZMB). VE: Lardal, Bergandammen, EIS:18, UTM: 32VNL482916, 18.VI.1980, 1 ♀, leg. G.E. Ellefsen (ZMB).
Two more females are kept in the collection of Zoological Museum, University of Oslo, but both lack labels. They are seemingly old and might originate from a Swedish collection (J.E. Raastad pers. comm.).

Chvála (1980b) gives an account of the uncertainty concerning the synonymy with *Acrocera globula*. According to him all the Scandinavian records of *A. globula* refers to *A. orbicula* (Fabricius, 1787).

The body-length has been the most used measure in descriptions of the different *Acrocera*-species. This measure appears to us to be unsuitable as the abdomen of pinned specimens very often shrink and can be fixed in various positions. Hence, in addition to body-length (a), we have also measured the length of thorax (b), the wing-length (c) and the length of mid-tibia (d). The exact positions of the measure-points are shown in Fig. 1. The measurements are listed in Table 1.

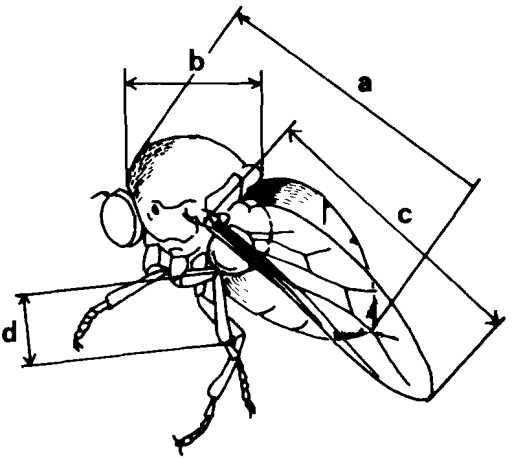

Fig. 1. Measured dimensions in *Acrocera orbicula*: a — total body-length; b — thorax-length; c — wing-length; d — mid-tibia-length.

A possible Central-European species (*A. globula* sensu Sack, 1936; Trojan, 1956; Weinberg, 1966) has a bodylength of 4—6 mm, compared to 3.0—4.4 mm in *A. orbicula* (see Chvála 1980b). The body-length of the Norwegian specimens range from 3.8—5.1 mm. One of our specimens, a female, is thus larger than indicated for *A. orbicula*.

Considering the wing-length, seven specimens have wings longer than indicated for *A. orbicula*, 2.7—4.5 mm (Chvála 1980b). The wing-length for «globula» is not given, and as the ratio wing-length/body-length vary considerably among the specimens, it is impossible to compare these two measurements. Since females probably also in the future will be identified mainly by body-size, we suggest that the measurements shown in Fig. 1 should be used.

Table 1. Measurements of the Norwegian specimens of *Acrocera orbicula*.

	sex	body-length	thorax-length	wing-length	mid-tibia-length
AK: Enebakk 1877	male	4.0	2.0	4.0	1.08
AK: Enebakk	female	4.5	2.6	6.0	1.40
VAY: Flekkefjord	female	5.1	2.2	5.0	1.05
VAY: Mandal 1935	female	5.0	2.3	5.2	1.15
VAY: Lindesnes 1978	female	4.1	2.0	4.8	1.00
HOl: Granvin 1936	male	3.8	1.8	3.6	0.95
VE: Lardal 1980	female	4.0	2.2	—	1.13

Fig. 2. Records of Acroceridae in Norway. A — *Acrocera orbicula* (Fabricius, 1787), B — *Ogcodes pallipes* Latreille, 1811.

The sexes can easily be separated as the males has the scutellum yellow and varying patches of black laterally. Scutellum is black in the females with some yellow at margins. The measurements also indicate size-differences between the sexes, the males being somewhat smaller than the females.

Large intraspecific variation in both colour and body-size seem to be common within Acroceridae. Schlinger (1960) demonstrated the importance of an accurate description of the male genitalia in his revision of the genus *Ogcodes*. A similar revision of the genus *Acrocera* is required.

The Norwegian distribution of *A. orbicula* is mapped in Fig. 2A.

In addition to *A. orbicula* the species *Acrocera borealis* (Zetterstedt, 1838) has been recorded from Scandinavia Hackman (1970).

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The spider fauna of Kristiansand and Setesdalen, S. Norway

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Four clusters of localities in 4 different physical geographic regions were chosen along the 220 kilometers from the southern coastal area near Kristiansand to the northern mountain area near Hovden. The regions were: (1) The nemoral zone (Kristiansand), (2) the boreo-nemoral zone (Evje), (3) the boreal zone (Bygland, Valle, Bykle) and (4) the alpine zone (Hovden). A total of 20 localities were sampled from April to September 1980 by means of pitfall traps, sieving and sweep nets. Altogether 5814 adult specimens and 155 species were collected. The species composition and diversity of the localities, the species distribution in the valley and the coherence between the spider faunas of the different regions are discussed. Four species *Thanatus striatus* (C.L. Koch), *Micaria fulgens* Walckenaer, *M. subopaca* Westring and *Evansia maerens* (O.P.-Cambridge), are reported as new to Norway.

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INTRODUCTION

The geographical situation of Norway together with its shape and topography often results in marked differences in climatic conditions over relatively short distances with a corresponding dramatic change in the spider fauna from one area to an other as revealed through relatively few larger investigations. To map the total spider fauna will thus be a laborious work. Our present investigation in Setesdalen is meant to be a small contribution.

Furthermore being placed in the north western corner of the Palearctic, Norway makes up the northern and western limits of several species justifying thorough zoogeographic and ecological investigations of its spider fauna.

Sampling area

In order to study how the fauna might vary along some gradient we found that Setesdalen would be suitable. The valley has an extraordinary length in this part of the nordic area. It stretches from Kristiansand (50°10'N, 7°59'W) in a distance of about 220 km (Fig. 1). The height above sea level ranges from 0—900 meters (Fig. 2). It runs practically straight in a south-north direction.

Climatic data can be found in reports from The Norwegian Meteorological Institute, Oslo (Table 1). The annual amplitude is defined as the difference in mean temperature between the warmest and the coldest month of the year used as a measure of degree of continentality. Table 1 indicates a moderate continental climate throughout the investigated area (degree of continentality about 18°C). Furthermore, mean annual temperatures (in °C), precipitation (in mm) and number of days with snow cover are given in Table 1.

According to «Naturgeografisk regioninndeling av Norden» (Abrahamsen et al. 1977), Setesdalen runs through four different physical geographical regions: (1) The nemoral zone (Kristiansand), (2) the boreo-nemoral zone (Evje), (3) the boreal zone (Bygland, Valle, Bykle) and (4) the alpine zone (Hovden). This classification is mainly based on a number of reports from different parts of the Nordic area, analysing landscape, geology and vegetation types.

A survey of the different localities within each main area is given in Table 2. Grid reference, plant sociological association (vegetation association), slope and a description of the localities are listed.

METHODS

The field-work was carried out from late April to late September in six main areas — Kristiansand (Zone I), Evje (Zone II), Bygland (Zone III),

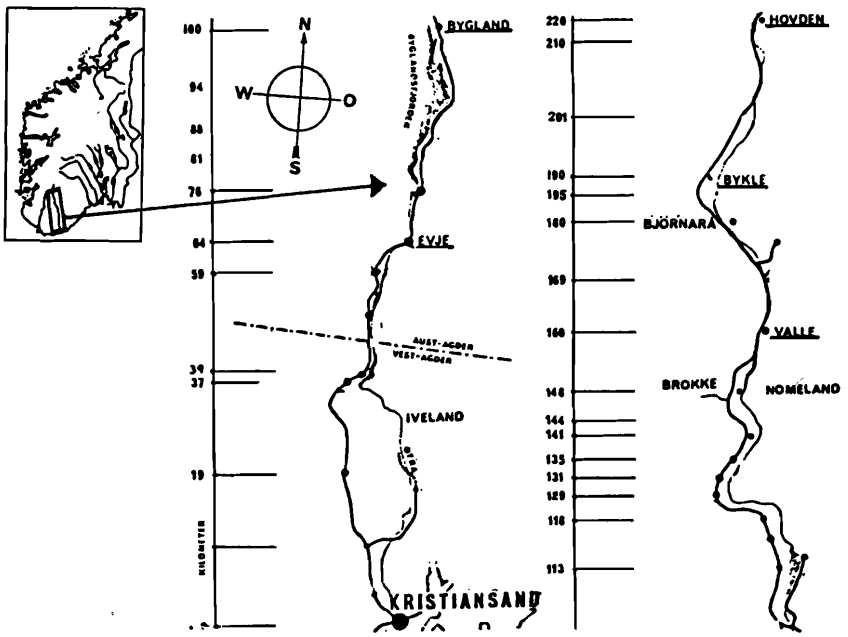

Fig. 1. The situation of Setesdalen, S. Norway. The 20 localities from Kristiansand to Hovden are indicated (black spots) with a kilometer scale to the left.

Valle (Zone IV), Bykle (Zone V) and Hovden (Zone VI). Because of a considerable variation in topography and vegetation throughout the valley it was necessary to examine several localities within each main area. At Zone I, II, III and IV 4 localities were examined. At Zone V and VI only 2 localities were used, primarily because of less heterogeneity, but also because of a heavy snow cover in April and May.

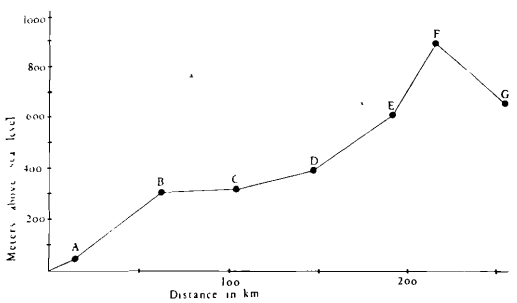

Fig. 2. The altitude of collecting sites plotted against distances from Kristiansand. A — Kristiansand, B — Evje, C — Bygland, D — Valle, E — Bykle, F — Hovden, G — Haukeligrend.

Trapping periods, number of traps, etc. are given in Table 3.

At each locality three basic sampling methods were used: (1) Pitfalls (with 4% formalin), (2) sweep nets and (3) sieving with subsequent extraction of foerna in Tullgren funnels.

Pitfalls were set at Zone I, II, III, IV and V in April. At Hovden (Zone VI) in June (because of a snow covered sampling area). In each habitat ten traps with an upper diameter of 12 cm were arranged in one row with intervals of 1.5 meter. Each trap was provided with a roof made of zink as shelter against rain.

Sweep nets were used in summer and autumn at all localities in the tree-, shrub- and field-layers.

Table 1. Data from some meteorological stations in Setesdalen.

	Mean annual temp. (°C)	Mean temperature(°C) Warmest month	Coldest month	Annual amplitude (°C) Continentality	Numbers of days with snow cover	Mean annual precipitation (in mm)
Kristiansand	7.0	16.4	-0.8	17.2	5	1412
Hægeland	5.0	15.2	-3.3	18.5		
Byglandsfjord	5.3	15.2	-3.0	18.2	84	1349
Austad	5.5	15.3	-3.6	18.9		
Brokke					150	735
Bykle	1.0	12.9	-3.9	16.8	197	687

Table 2. Sampling sites in Setesdalen.

Main Areas	Loc. nr.	Grid Ref.	Vegetation association	Slope	Description of locality
Kristiansand 50 m a.s.l.	1	32VMK379487	Populus-Quercetum	20 W	Oak dominated hardwood with sparce Shrub layer. Stony.
	2	32VMK378489	Grassland	-----	Open moisty grass-land.
	3	32VMK378489	Populus-Quercetum	20 W	Hardwood with Oak Aspen,Sloe,Sycamore. Sparce shrub layer. Rotten logs.
	4	32VMK368529	Populus-Quercetum	-----	Open calcareous Pine wood.
Evje 300 m a.s.l.	5	32VMK293947	Vaccinio-Pinetum	20 E	Mixed wood of Aspen, Pine,Birch and Sloe.
	6	32VMK283966	Vaccinio-Pinetum	30 E	Relatively dense Pine-Wood.
	7	32VMK342973	Vaccinio-Pinetum	5 SE	Mixed-Wood of Pine and Birch.
	8	32VMK308987	Vaccinio-Pinetum	-----	Open Pine-Wood with same Birches. Rotten logs.
Bygland 320 m a.s.l.	9	32VML302195	Eu-Piceetum	-----	Dense Spruce-Wood.
	10	32VML304198	Eu-Piceetum	20 W	Open Mixed-Wood of Birch,Sloe and Spruce. Stony.
	11	32VML294226	Eu-Piceetum	5 W	Open Pine-Wood,with-out shrub layer.
	12	32VML284247	Eu-Piceetum	-----	Pine and Spruce-Wood Very Stony.
Valle 400 m a.s.l.	13	32VML153521	Eu-Piceetum	20 E	Pine-Wood with spar-se shrub layer.
	14	32VML156529	Melico-Piceetum	30 E	Hardwood of Sloe, Birch and Mauntain Ash,same Pines and Spruce. Very rich field layer with 22 herbs.
	15	32VML151534	Eu-Piceetum	----	Coniferous Wood.
	16	32VML149553	Cladonia-Pinetum	----	Heterogenous site. Dry Pine-Wood and more open moisty-areas with Sphagnum.
Bykle 600 m a.s.l.	17	32VML058775	Eu-Piceetum	5 N	Dense Pine-Wood
	18	32VML055783	Eu-Piceetum	20 SE	Mixed-Wood of Birch and Pines with many stones and sparse ground and filed layer.
Hovden 900 m a.s.l.	19	32VMM094058	Eu-Piceetum -Myrtilosum	----	Shrub layer of Betula spp.Ground layer Cladonia dominated.
	20	32VMM106086	Eu-Piceetum -Myrtilosum	----	Like loc.19

Table 3. Survey of some important parameters from the investigated areas.

Zone	Nemoral	Boreo-nemoral	Boreal	Boreal	Boreal	Alpin
Station no.	I	II	III	IV	V	VI
Trapping periods	28/4-25/9	29/4-26/9	29/4-26/9	30/4-26/9	30/4-27/9	27/6-27/9
Numbers of localities	4	4	4	4	2	2
Numb. of trapping days (5 traps)	3020	3020	3020	3020	1510	920
Numb. of families registered	13	10	11	13	8	8
Numb. of species registered	86	80	64	81	46	25
Species in only one area	29	8	9	11	3	8
Numb. of specimens in pitfalls	978	1092	814	1001	621	283
Mean no. of specimens pr. day	0.32	0.36	0.27	0.33	0.41	0.31

Except for loc. 19 and 20, sieving was carried out three times at all localities, at Hovden (Zone VI) only in June and September because of the snow cover.

A majority of spider species belong to the most active soil living invertebrate fauna. For sampling these animals pitfalls are well fit. On the other hand, some species live permanently above the ground layer (Duffey 1962) or have a very low mobility and thus avoid being trapped in pitfalls. Pitfall material thus only to some extent is useful as a base of quantitative calculations. All results from the investigation are discussed with this in mind.

RESULTS AND DISCUSSION

A. The nemoral zone — Kristiansand

The four localities of the Kristiansand region are situated in an area with luxuriant vegetation implying a highly varied spider fauna. The high species diversity together with the occurrence of a number of peculiar spider species result in low similarity values when compared with the zones further north (Fig. 3). Altogether 86 species were registered of which 28 species were found exclusively in this part of the valley. These last-mentioned species were: *Centromerus expertus* (O.P.-Cambridge), *Centromerita concinna* (Thorell), *C. bicolor* (Blackwall), *Dismodium bifrons* (Blackwall), *Meioneta saxatilis* (Blackwall), *Walckenaera acuminata* (Blackwall), *W. mitrata* (Menge), *W. obtusa* (Blackwall), *Dicymbium nigrum* (Blackwall), *Tiso vagans* (Blackwall), *Savignya frontata* (Blackwall), *Bathyphantes parvulus* (Westring), *B. nigrinus* (Westring), *Erigone dentipalpis* (Wider), *Erigonella hiemalis* (Blackwall), *Porrhomma convexum* (Westring), *Haplodrassus silvestris* (Blackwall), *Zelotes latreillei* (Simon), *Z. petrensis* (C.L. Koch), *Clubiona pallidula* (Clerck), *Micaria fulgens* (Walckenaer), *Scotina celans* (Blackwall), *Anyphaena accentuata* (Walckenaer), *Pardosa palustris* (L.), *Pachygnatha degeeri* (Sundevall) and *Segestria senoculata* (L.).

As shown in Fig. 4 there is a marked variation in the fauna of the different localities within

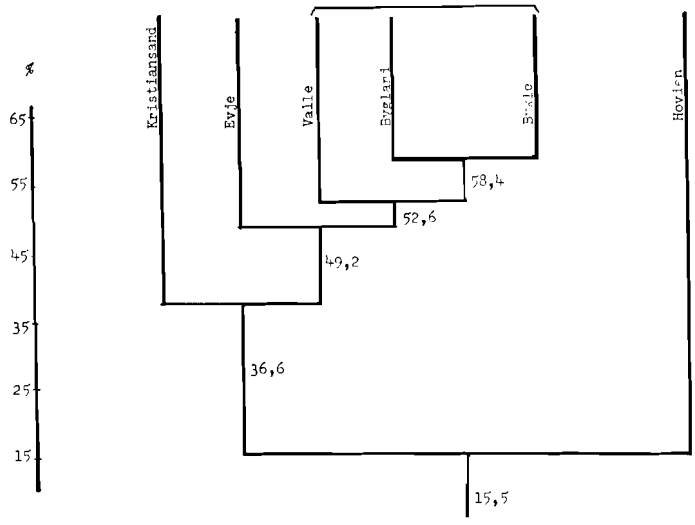

Fig. 3. Dendrogram (based on species in common) showing the similarities of the spider faunas (in %) between the 6 main areas.

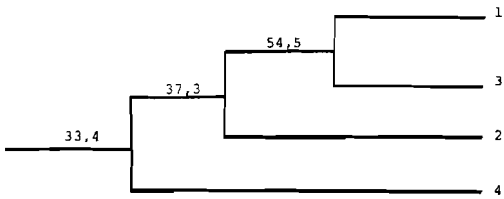

Fig. 4. Similarity in species composition (in %) between the 4 localities in the nemoral zone (Kristiansand).

the zone. Even though the localities are situated in the same area and are classified as belonging to the same type of plant sosiological association, the species composition, diversity and individual frequences strongly depend on the development of the tree layer. Particularly the evaporation rate and the input of light and heat to the ground layer are important (Wallwork 1976).

The most diverse families were Linyphidae, represented by 50 species (58.1% of all registered species), Clubionidae 9 species (10.5%), Gnaphosidae 8 species (9.3%) and Lycosidae 6 species (7.0%).

The most abundant species were *Pardosa lugubris* (Walckenaer) (20.9%), *Trochosa terricola* (Thorell) (11.3%) and *Pardosa pullata* (Clerck) (10.5%). Only 6 species were found in all four localities: *Pardosa lugubris, Trochosa terricola, Lepthyphantes mengei* Kulczynski, *Tapinocyba pallens* (O.P.-Cambridge), *Diplostyla concolor* (Wider) and *Lepthyphantes flavipes* (Blackwall). The four latter species are among the most abundant ones in Setesdalen, while *D. concolor* was not found north of Bygland, and *L. flavipes* was taken only in the southernmost vegetation zones.

A1. Oak forest (Populus-Quercetum association) — Loc. 1 and 3

The area is dominated by oaks and scrubs. Both localities represent the same habitat type characterised by a very high species diversity of linyphiids making up about 50% of all species found. The lycosids dominated the pitfall material (Table 5). Altogether 47 species were recorded at loc. 1 and 3, nine of them were exclusively found at these two localities. No saltisids were

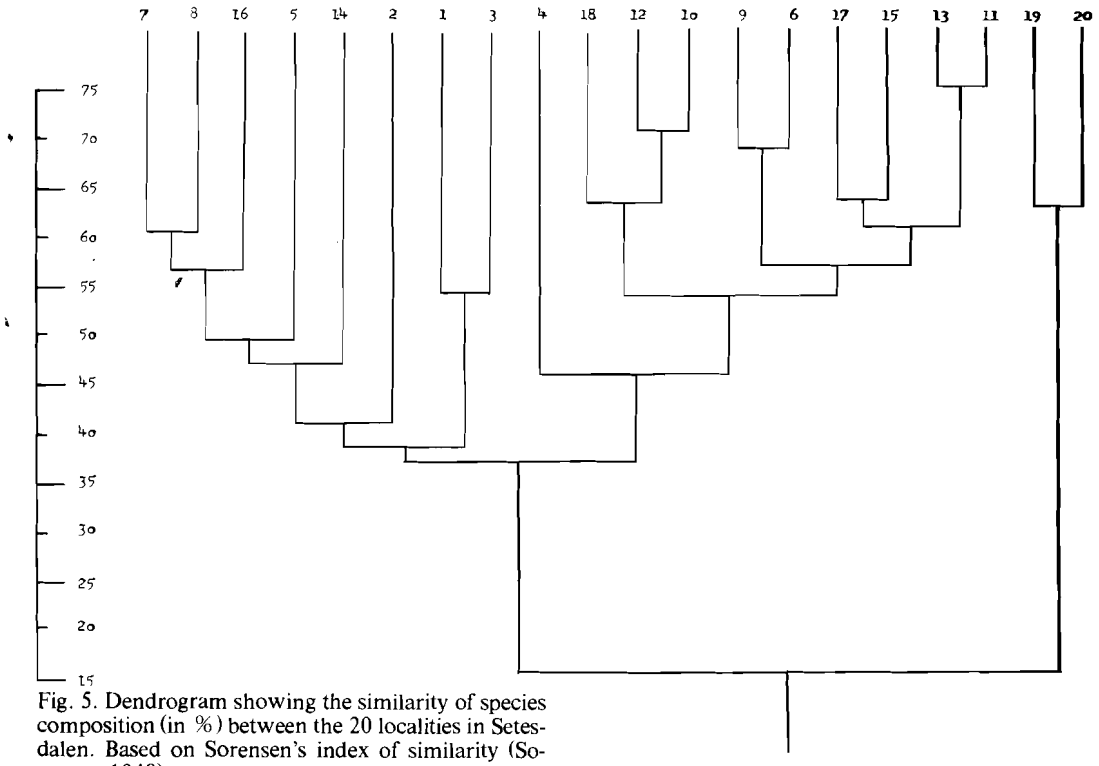

Fig. 5. Dendrogram showing the similarity of species composition (in %) between the 20 localities in Setesdalen. Based on Sorensen's index of similarity (Sorensen 1948).

found, while Araneidae, Thomisidae and Zoridae were represented by one species each.

Except for *Tapinocyba pallens* and *Lepthyphantes flavipes,* none of the linyphides were taken in high numbers. The two last mentioned species, together with *Pardosa lugubris, Trochosa terricola* and *Zelotes subterraneus* were most abundant at these localities.

The two oak habitats constitute a faunistic group which is well distinguished from the other desiduous and mixed forests elsewhere in the valley (Fig. 5).

The high structural diversity of the deciduous forest dominated areas might be the cause of low similarity values between grouped localities shown in Fig. 5. A comparison of the faunas at loc. 1 and 3 for instance both classified as oak dominated *Populus-Quercetum* associations, shows that the species lists are markedly different despite of a high floristic similarity. At loc. 1 a total of 9 families and 37 species registered, while 7 families and 27 species were recorded at loc. 3. Several species were recorded at only one of the two localities.

Four Gnaphosidae species (*Gnaphosa bicolor* (Hahn), *Haplodrassus signifer* (C.L. Koch), *H. silvestris* and *Zelotes subterraneus* (C.L. Koch)) were trapped at both localities, and were also found in different habitat types elsewhere in the valley. On the other hand none Clubionidae species were shared between loc. 1 and 3. The Clubionidae species at loc. 1 were *Phrurolitus festions* (C.L. Koch), *Scotina celans* and *Clubiona pallidula,* all probably stenotopic species and quite uncommon in the rest of the investigated localities of the valley.

A2. Meadow (Populus-Quercetum association) — Loc. 2

Floristically this locality is much different from the other ones in the valley. There is no tree or scrub layer developed.

Faunistically, however, the locality is intermediate between the oak forests of the nemoral zone and the deciduous and mixed forests further north (Fig. 5).

A total of 39 species were registered. Thirteen species are very common in this habitat type, more or less regarded as open field species, and were not recorded elsewhere in the valley (Tables 5, 6, 7).

The dominating families were the Linyphiidae (20 species) and Gnaphosidae (7 species). The pitfall samples were dominated by Lycosidae (48.7 % of all adult spiders). The Linyphiidae (22.5 %) and the Gnaphosidae (16.1 %) were also numerous. For the Gnaphosidae the num-

Table 4. Trelli's diagram showing the relations between the 20 localities in Setesdalen, based on percentage of spider species in common.

7	8	16	5	14	2	1	3	4	18	12	10	9	6	17	15	13	11	19	20	
																				7
60.6																				8
56.7	56.3																			16
55.9	47.2	45.8																		5
46.4	40.0	55.7	42.3																	14
45.1	46.4	40.0	36.6	37.3																2
44.1	32.5	41.2	55.1	38.6	39.4															1
33.3	34.5	23.7	46.7	37.5	35.1	54.5														3
41.3	38.8	35.3	55.1	28.1	27.1	43.8	29.1													4
52.5	49.3	56.6	45.1	47.5	32.4	36.4	28.1	39.4												18
54.5	48.6	50.7	47.2	56.7	29.0	47.8	37.9	44.8	63.8											12
45.7	48.6	53.3	44.7	53.1	30.1	45.1	36.1	33.8	63.0	70.3										10
45.2	49.1	34.5	44.1	42.6	21.4	33.3	26.7	51.9	46.4	52.6	49.2									9
48.0	44.4	56.4	46.4	56.4	25.5	39.2	28.6	51.6	56.6	59.3	51.7	68.3								6
52.6	49.2	54.8	47.6	51.0	30.0	41.4	24.5	48.3	60.0	62.3	52.3	54.2	57.8							17
50.1	54.2	53.3	52.5	36.7	24.1	35.7	25.5	46.4	48.3	57.6	50.8	60.9	60.5	64.0						15
36.4	44.1	36.6	42.6	40.8	17.2	28.6	25.5	46.5	51.7	54.2	44.4	52.2	60.5	64.0	66.7					13
45.6	45.9	51.6	38.1	39.2	33.3	37.9	24.5	50.7	60.0	68.9	52.3	54.2	55.3	65.4	60.0	75.0				11
17.0	12.0	19.6	23.2	10.0	12.2	16.7	10.5	21.3	16.3	12.0	14.8	10.8	17.6	14.6	23.1	30.1	24.3			19
17.7	16.3	24.0	11.8	15.4	8.3	8.7	5.7	13.0	16.7	12.2	11.3	11.1	12.1	15.0	20.5	15.8	20.0	62.1		20

% similarity:

100-75 50-25

75-50 25-0

ber of species (7) as well as the number of individuals were the highest registered throughout the valley. Agelenidae, Araneidae, Zoridae and Salticidae were not found at loc. 2.

The most abundant species were *Pardosa pullata* (29.7%) and *Trochosa terricola* (15.0%). *Pachygnatha degeeri*, the only Tetragnathidae species in Setesdalen, was quite common at loc. 2. Except for *Lepthyphantes mengei* (5.8%) none of the linyphids were frequent in the pitfalls (< 3.0%).

A3. Pine forest (Populus-Quercetum association) — Loc. 4

The area is a pine dominated *Populus-Quercetum* association, with species composition similar to that of the mixed forests further north in Setesdalen, see Table 4 and Figure 5. Here its low similarity indices and peripheral position within the pine forest group is indicated. The locality has most in common with loc. 5 (Table 4), a conifer dominated *Vaccinio-Pinetum* association. This is mostly due to the presence of some species, only found at loc. 5 outside the nemoral zone: *Lepthyphantes flavipes, Gongylidiellum vivum* (O.P.-Cambridge) and *Tapinopa longidens* (Wider). Several species found at loc. 4 were lacking in most localities forther north in the valley. These were: *Centromerus sylvaticus* (Blackwall), *Diplocephalus latifrons* (O.P.-Cambridge), *Diplostyla concolor* (Wider), *Neon reticulatus* (Blackwall). In spite of this loc. 4 has more in common with the conifer dominated forests (Tables 5, 6, 7). The higer similarity to loc. 5 may be due to high humidity at both localities. Further shared species, lacking elsewhere in the valley, *Erigonella hiemalis, Walckenaera obtusa, Centromerita bicolor* and *Segestria senoculata*, all are regarded as hygrophilous species.

A total of 35 species and 8 families were registered at loc. 4. Linyphiidae was the dominating family (25 species). Gnaphosidae and Thomisidae were not recorded.

The pitfall catches were dominated by Linyphiidae (80.6% of the adult specimens), as they were in all conifer dominated localities in the valley.

The most abundant species were *Micrargus herbigradus* (Blackwall) (16.7% of the pitfall material), *Trochosa terricola* (13.3%), and *Erigonella hiemalis* (12.8%). *Tapinocyba pallens* and *Gongylidiellum vivum* had a low frequency in the pitfall samples, but made up 67.0% of the specimens caught by this sampling method. The high number of *G. vivum* was astonishing as the species is rarely found in Norway, with exception of the coastal *Calluna* heaths in Western Norway where it may be quite frequent and regarded as a typical open field species (Hauge et al. 1975).

Despite of a highly developed tree and scrub layer only eight species were caught by sweep netting. Except for *Meta mengei* (Blackwall) and *Maso sundevalli*, none of the species registered were lacking in the pitfall samples.

B. The boreonemoral zone — Evje

This area is dominated by coniferous and mixed forests, classified as *Vaccinio-Pinetum* association. Rocks and sandy soil, typical for the region, appear to have a considerable influence on the composition of the spider fauna. The four localities at Evje are situated in the boreo-nemoral zone. The fauna has more in common to the boreal zone than to the nemoral zone (Fig. 3).

A comparison of the spider faunas of the four localities at Evje shows high similarities between loc. 5, 7 and 8 (mixed forests), making a faunistic group, while loc. 6 (pine forest) has a more peripheral position (Fig. 6). The difference between loc. 7/8 and 5 may be partly explained by differences in humidity.

Altogether 80 species were registered in the boreonemoral zone, eight of which were not recorded in other parts of the valley. These eight species are: *Centromerus prudens* (O.P.-Cambridge), *Oreonetides abnormis* (Blackwall), *Micaria subopaca* (Westring), *Thanatus striatus* (C.L. Koch), *Alopecosa pinetorum* (L.), *Philodromus aureolus caespiticolis* (Walckenaer), *Cercidia prominens* (Westring and *Araneus cucurbitinus* (Clerck).

Most species belonged to the Linyphiidae (45), while the Lycosidae was most numerous (50.6% of a totally 1092 adult spiders).

The most abundant species were *Pardosa lugubris* (30.5%), *Trochosa terricola* (13.5%) and *Lepthyphantes mengei* (5.8%), which together with *Centromerus arcanus* (O.P.-Cambridge), *Tapinocyba pallens, Walckenaera antica* (Wider), *Macrargus rufus* (Wider), *Lepthyphantes cristatus* (Menge), *Evarcha falcata* (Clerck), *Hahnia pusilla* (C.L. Koch) and *Robertus lividus* (Blackwall), were found in all localities in the boreonemoral zone. The four last mentioned species were also registered in the nemoral zone and the boreal zone, but at lower frequencies. Also *B. lugubris* and *T. terricola*, the most common species in the valley, were most frequent in this zone compared to the neighbouring zone.

Table 5. Numbers of adult specimens (♀ ♀ / ♂ ♂) caught in pitfall traps at the 20 localities in Setesdalen, April—September 1980.

	1	2	3	4	5	6	7	8	9	1o
Segestria senóculata(Linnaeus)	-	-	-	o/1	-	-	-	-	-	-
Drassodes lapidosus (Walck.)	-	o/1	-	-	-	-	1/o	-	-	-
D.pubescens (Thor.)	-	o/2	-	-	-	-	4/1	1/4	-	1/o
Gnaphosa bicolor (Hahn)	o/1	o/1	1/1	-	-	-	o/4	3/13	-	-
G.lapponum (L.Koch)	-	-	-	-	-	-	-	-	-	-
G.leporina (L.Koch)	-	-	-	-	-	-	-	-	-	-
Haplodrassus signifer (C.L.Koch)	1/2	4/9	2/5	-	1/o	-	o/3	3/2	-	1/2
H.silvestris (Blw.)	o/2	-	o/4	-	-	-	-	-	-	-
H.soerensni (Strand)	-	-	-	-	-	-	-	-	-	o/2
Zelotes clivicolus (L.Koch)	-	-	-	-	-	-	1/5	5/1o	-	7/15
Z.latreillei(Sim.)	-	1o/19	-	-	-	-	-	-	-	-
Z.petrensis (C.L.Koch)	-	1/2	-	-	-	-	-	-	-	-
Z.subterraneus (C.L.Koch)	8/11	5/2	2/1	-	25/16	o/1	-	-	-	2/1o
Agroeca brunnea (Blw.)	-	-	o/1	-	-	-	-	1/1	-	o/1
A.proxima (Cbr.)	-	-	-	-	-	-	-	o/1	-	2/7
Clubiona coerulescens (L.Koch)	-	-	1/o	-	-	-	-	-	-	-
C.comota (C.L.Koch)	-	-	2/o	1/o	1/o	-	-	-	-	-
C.pallidula (Clerck)	o/1	-	-	-	-	-	-	-	-	-
C.reclusa (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
C.stagnalis (Kulczynski)	-	-	-	-	-	-	-	-	-	-
C.subsultans (Thor.)	-	-	-	-	-	-	-	-	-	-
C.trivialis (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Micaria aenea (Thor.)	-	-	-	-	-	-	-	-	-	7/o
M.fulgens (Walck.)	-	-	o/1	-	-	-	-	-	-	-
M.pulicaria (Sundevall)	o/1	-	-	-	1/o	-	-	-	-	1/2
M.subopaca (Westring)	-	-	-	-	-	-	o/1	-	-	-
Phrurolithus festivus (C.L.Koch)	o/2	1/o	-	-	o/1	-	-	-	-	-
Scotina celans (Blackw.)	o/1	-	-	-	-	-	-	-	-	-
Zora nemoralis (Blackw.)	-	-	-	-	-	-	-	-	-	2/o
Z.spinimana (Sundevall)	1/o	-	-	o/1	-	-	1/2	-	-	o/1
Anyphaena accentuata (Walck.)	-	-	o/1	-	-	-	-	-	-	-
Oxyptila atomaria (Pańtzer)	-	-	-	-	-	-	-	-	-	o/1
O.trux (Blackw.)	-	-	-	-	-	-	-	-	-	-
Tibellus maritimus (Menge)	-	-	-	-	-	-	-	-	-	o/1
Xysticus cristatus (Clerck)	-	-	-	-	-	-	-	-	-	-
X.luctuosus (Blackw.)	-	-	-	-	-	-	-	-	-	-
X.obscurus (Collett)	-	-	-	-	-	-	-	-	-	o/1
Evarcha falcata (Clerck)	-	-	-	-	-	-	-	o/1	-	1/o
Heon reticulatus (Blackw.)	-	-	-	o/1	o/1	-	-	-	-	-
Alopecosa aculeata (Clerck)	-	-	-	-	-	o/1	6/28	5/11	3/o	39/2
A.pinetorum (Linnaeus)	-	-	-	-	-	1/o	-	-	-	-
A.pulverulenta (Clerck)	-	1/9	-	-	-	-	1/o	2/9	-	-
Pardosa hyperborea (Thor.)	-	-	-	-	-	-	-	-	-	-
P.lugubris (Walck.)	16/77	3/o	17/94	o/2	43/184	2/o	12/5o	22/15	o/2	3/2
P.palustris (Linnaeus)	-	o/1	-	-	-	-	-	-	-	-
P.pullata (Clerck)	-	26/77	-	-	-	-	-	1/o	-	-
P.riparia (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Pirata hygrophilus (Thor.)	-	-	-	-	-	-	-	-	-	-
Trochosa terricola (Thor.)	9/17	19/33	1/8	2/22	4/31	12/14	21/54	5/26	-	2/2o
Xerolycosa nemoralis (Westr.)	o/2	-	-	-	-	-	-	2/o	-	-
Acantholycosa lignaria (Clerck)	-	-	-	-	-	-	-	-	-	-
Dolomedes fimbriatus (Clerck)	-	-	-	-	-	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	20
Segestria senoculata (Linnaeus)	-	-	-	-	-	-	-	-	-	-
Drassodes lapidosus (Walck.)	-	-	-	-	-	-	-	-	-	-
D.pubescens (Thor.)	-	2/o	-	o/1	-	-	-	o/1	-	-
Gnaphosa bicolor(Hahn)	-	-	-	-	-	-	-	-	-	-
G.lapponum (L.Koch)	-	-	-	-	-	-	-	-	1/9	-
G.leporina (L.Koch)	-	-	-	-	-	-	-	-	-	1/1o
Haplodrassus signifer (C.L.Koch)	-	5/6	-	-	2/1	7/3	2/o	o/2	-	-
H.silvestris (Blackw.)	-	-	-	-	-	-	-	-	-	-
H.soerenseni (Strand)	-	-	-	-	-	o/1	-	-	-	-
Zelotes clivicolus (L.Koch)	-	2/o	-	-	-	41/56	-	7/17	-	-
Z.latreillei (Sim.)	-	-	-	-	-	-	-	-	-	-
Z.petrensis (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Z.subterraneus (C.L.Koch)	-	o/1	-	2/7	-	-	o/1	6/13	-	-
Agroeca brunnea (Blackw.)	o/1	8/4	2/1	1/o	6/1	2/o	-	-	-	-
A.proxima (O.P.-Cambr.)	4/2	2/1o	1/o	1/o	-	1/o	-	o/3	-	-
Clubiona coerulescens (L.Koch)	-	-	-	o/2	-	-	-	-	-	-
C.compta (C.L.Koch)	1/o	1/o	-	-	-	-	-	-	-	-
C.pallidula (Clerck)	-	-	-	-	-	-	-	-	-	-
C.reclusa (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	1/o
C.stagnalis (Kulcz.)	-	-	o/1	-	-	-	-	-	-	-
C.subsultans (Thor.)	o/1	-	-	-	-	o/1	-	-	-	-
C.trivialis (C.L.Koch)	-	-	-	o/2	-	-	-	-	-	-
Micaria aenea (Thor.)	2/2	2/2	-	-	-	-	-	4/4	-	-
M.fulgens (Walck.)	-	-	-	-	-	-	-	-	-	-
M.pulicaria (Sundev.)	-	-	-	-	-	1/o	-	2/o	-	-
M.subopaca (Westr.)	-	-	-	-	-	-	-	-	-	-
Phrurolithus festivus (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Scotina celans (Blackw.)	-	-	-	-	-	-	-	-	-	-
Zora nemoralis (Blackw.)	1/o	o/3	-	-	-	o/1	-	6/6	-	-
Z.spinimana (Sundev.)	0/1	1/2	-	-	-	1/o	o/1	o/1	-	-
Anyphaena accentuata (Walck.)	-	-	-	-	-	-	-	-	-	-
Oxyptila atomaria (Pantzer)	-	-	-	o/2	-	o/1	-	-	3/2	o/1
O.trux (Blackw.)	-	-	1/o	-	-	-	-	-	-	-
Tibellus maritimus (Menge)	-	-	-	-	-	-	-	-	-	-
Xysticus cristatus (Clerck)	-	-	-	-	-	1/o	-	-	-	-
X.luctuosus (Blackw.)	-	o/1	-	o/2	-	o/2	o/1	o/2	-	-
X.obscurus (Collet)	-	-	-	-	-	-	-	-	-	-
Evarcha falcata (Clerck)	-	-	-	-	-	-	-	-	-	-
Neon reticulatus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Alopecosa aculeata (Clerck)	2/3	21/16	3/1	12/56	7/2	3/6	1o/43	22/2	2/o	-
A.pinetorum (Linnaeus)	-	-	-	-	-	-	-	-	-	-
A.pulverulenta (Clerck)	-	-	-	-	-	-	-	-	-	-
Pardosa hyperborea (Thor.)	-	-	-	-	-	-	-	-	44/15	1/1
P.lugubris (Walck.)	1/3	2/16	o/1	26/43	14/33	2o/1o	32/88	24/1o1	-	-
P.palustris (Linnaeus)	-	-	-	-	-	-	-	-	-	-
P.pullata (Clerck)	-	-	-	-	-	-	-	-	-	-
P.riparia (C.L.Koch)	-	-	-	o/1	-	5/1	-	-	-	-
Pirata hygrophilus (Thor.)	-	-	-	-	-	11/49	-	-	-	-
Trochosa terricola (Thor.)	7/17	1/16	o/3	9/44	o/9	3/19	o/9	6/4	-	-
Xerolycosa nemoralis (Westr.)	-	-	-	-	-	-	-	-	-	-
Acantholycosa lignaria (Clerck)	-	-	-	-	-	-	-	o/2	-	-
Dolomedes fimbriatus (Clerck)	-	-	-	-	-	1/2	-	-	-	-

	1	2	3	4	5	6	7	8	9	10
Amaurobius fenestralis (Ström)	-	-	-	-	-	-	-	-	-	o/1
Antistea elegans (Blackw.)	-	-	-	-	-	-	-	-	-	-
Cryphoeca silvicola (C.L.Koch)	o/6	-	-	-	-	2/o	-	-	2/5	o/1
Hahnia ononidum (Simon)	-	-	-	-	-	-	-	-	-	-
H.pusilla (C.L.Koch)	o/4	-	-	1/o	o/3	1/o	o/2	-	-	-
Ero furcata (Villers)	-	-	-	-	-	-	-	-	-	-
Euryopis flavomaculata (C.L.Koch)	o/1	1/o	o/1	-	o/2	1/o	o/2	-	-	3/9
Robertus lividus (Blackw.)	-	o/1	-	o/4	o/1	-	o/9	o/6	o/1	-
R.scoticus (Jackson)	-	-	-	-	-	-	-	o/1	-	-
Nesticus cellulanus (Clerck)	-	-	-	-	-	-	-	-	-	o/1
Pachygnatha degeeri (Sundev.)	-	1/39	-	-	-	-	-	-	-	-
Cercida prominens (Westr.)	-	-	-	-	-	-	-	1/o	-	-
Ceratinella brevis (Wider)	-	-	1/1	-	1/1	-	o/1	-	-	-
Walckenaera acuminata (Blackw.)	-	1/o	-	-	-	-	-	-	-	-
W.antica (Wider)	3/7	1/8	-	1/o	1/7	o/2	1/3	o/2	o/2	o/1
W.cucullata (C.L.Koch)	o/1	-	-	o/9	1/o	1/o	-	1/1	3/o	o/1
W.cuspidata (Blackw.)	-	-	-	-	o/3	-	-	-	-	-
W.dysderoides (Wider)	-	-	-	o/3	-	1/o	-	o/3	-	-
W.mitrata (Menge)	o/1	-	-	-	-	-	-	-	-	-
W.nudipalpis (Westr.)	-	-	-	-	1/o	-	1/o	2/o	-	-
W.obtusa (Blackw.)	-	-	-	1/4	-	-	-	-	-	1
W.unicornis (O.P.-Cambr.)	-	-	1/o	-	o/1	-	-	1/1	o/1	-
Abacoproesces saltuum (L.Koch)	-	-	-	-	o/1	-	-	-	-	-
Dicymbium nigrum (Blackw.)	-	1/7	-	-	-	-	-	-	-	-
D.tibiale (Blackw.)	-	-	-	-	1/4	-	2/1	1/1	-	-
Gonatium rubellum (Blackw.)	-	-	-	-	-	-	1/o	1/o	-	-
G.rubens (Blackw.)	-	3/7	-	-	-	-	-	-	-	-
Maso sundevalli (Westr.)	-	-	-	-	-	-	-	-	-	-
Pocadicnemis pumila (Blackw.)	-	-	-	-	-	-	o/1	6/3	-	-
Pelecopsis elongata (Wider)	-	-	-	-	-	-	-	-	-	-
Cnephalocotes obscurus (Blackw.)	-	-	-	-	-	-	-	-	-	1/o
Evansia merens (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Tiso vagans (Blackw.)	-	o/1	-	-	-	-	-	-	-	-
Minyriolus pusillus (Wider)	1/o	-	-	o/2	o/1	-	-	-	-	-
Tapinocyba pallens (O.P.-Cambr.)	24/2	1/o	3/1o	2/8	o/4	o/2	2/1o	o/6	2/4	o/3
Gongylidiellum vivum (O.P.-Cambr.)	-	o/2	-	o/1	-	-	-	-	-	-
Micrargus apertus (O.P.-Cambr.)	-	-	-	-	-	1/o	-	o/1	1/1	1/1
M.herbigradus (Blackw.)	o/1	1/1	-	11/19	1/3	-	1/3	1/1	-	-
Notioscopus sarcinatus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Erigonella hiemalis (Blackw.)	-	-	-	4/19	-	-	-	-	-	-
Erigone dentipalpis (Wider)	-	o/1	-	-	-	-	-	-	-	-
Diplocephalus latifrons (O.P.-Cambr.)	1/o	-	o/1	5/5	-	-	-	-	-	-
Leptorhopterum robustum (Westr.)	-	-	-	-	-	-	-	-	-	-
Porrhomma convexum (Westr.)	-	1/o	-	-	-	-	-	-	-	-
P.pallidum (Jackson)	-	-	-	o/1	o/1	o/2	1/o	-	4/4	2/2
Agyneta conigera (O.P.-Cambr.)	o/1	-	o/1	-	-	-	-	-	-	-
A.ramosa (Jackson)	-	-	-	-	-	-	-	-	-	-
Meioneta beata (O.P.-Cambr.)	-	o/3	-	-	-	-	-	-	-	-
M.saxatilis (Blackw.)	-	2/5	1/o	-	-	-	-	-	-	-
Microneta viaria (Blackw.)	1/3	-	5/7	-	5/29	-	-	-	-	o/1
Centromerita dicolor (Blackw.)	-	-	-	4/o	-	-	-	-	-	-
C.concinna (Thor.)	1/o	-	-	-	-	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	2o
Amaurobius fenestralis (Ström)	-	o/5	-	-	-	-	-	-	-	-
Antistea elegans (Blackw.)	-	-	-	-	-	-	-	-	o/42	o/43
Cryphoeca silvicola (C.L.Koch)	5/1o	o/4	o/4	-	o/1	-	1/1	o/2	-	-
Hahnia ononidum (Simon)	-	-	-	-	-	-	-	-	6/22	o/1
H.pusilla (C.L.Koch)	-	o/1	-	-	-	-	-	-	-	-
Ero furcata (Villers)	-	-	-	-	-	-	-	-	-	-
Euryopis flavomaculata (C.L.Koch)	-	o/1	-	o/2	-	2/13	-	o/1	-	-
Robertus lividus (Blackw.)	-	-	-	-	o/3	o/3	-	-	-	-
R.scoticus (Jackson)	-	-	-	-	-	-	-	o/2	-	-
Nesticus cellulanus (Clerck)	-	-	-	-	-	-	-	-	-	-
Pachygnatha degeeri (Sundev.)	-	1/39	-	-	-	-	-	-	-	-
Cercidia prominens (Westr.)	-	-	-	-	-	-	-	-	-	-
Ceratinella brevis (Wider)	-	-	-	-	-	-	-	-	-	-
Walckenaera acuminata (Blackw.)	-	-	-	-	-	-	-	-	-	-
W.antica (Wider)	-	o/3	-	o/1	-	2/5	o/3	-	-	-
W.cucullata (C.L.Koch)	4/1	4/6	5/7	2/o	o/1	2/o	1/o	12/7	-	-
W.cuspidata (Blackw.)	-	-	1/o	-	4/1	-	-	1/2	4/1	-
W.dysderoides (Wider)	-	-	-	-	-	1/2	-	-	-	-
W.mitrata (Menge)	-	-	-	-	-	-	-	-	-	-
W.nudipalpis (Westr.)	1/1	-	3/3	-	o/1	1/o	3/o	-	o/1	o/1
W.obtusa (Blackw.)	-	-	-	-	-	-	-	-	-	-
W.unicornis (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Abacoproesces saltuum (L.Koch)	-	-	-	-	-	-	-	1/o	-	-
Dicymbium nigrum (Blackw.)	-	-	-	-	-	-	-	-	-	-
D.tibiale (Blackw.)	-	o/1	-	-	1/19	1/3	1/1	-	-	o/1
Gonatium rubellum (Blackw.)	-	-	-	-	-	-	-	1/2	-	-
G.rubens (Blackw.)	-	-	-	-	-	1/o	-	-	-	-
Maso sundevalli (Westr.)	-	-	-	-	-	-	-	1/o	-	-
Pocadicnemis pumila (Blackw.)	-	-	-	2/o	-	2/5	o/1	3/1	-	1/-
Pelecopsis elongata (Wider)	-	o/1	-	-	-	-	-	-	-	-
Cnephalocotes obscurus (Blackw.)	-	-	o/1	-	-	-	1/o	-	6/1	-
Evansia merens (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Tiso vagans (Blackw.)	-	-	-	-	-	-	-	-	-	-
Minyriolus pusillus (Wider)	o/3	1/1	1/2	-	o/1	-	o/4	-	o/1	-
Tapinocyba pallens (O.P.-Cambr.)	o/1o	o/13	o/2	o/1	o/1	2/8	o/4	2/3	o/1	-
Gongylidiellum vivum (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Micrargus apertus (O.P.-Cambr.)	-	o/1	-	-	o/2	-	-	-	-	-
M.herbigradus (Blackw.)	1/2	-	-	-	o/1	o/1	-	-	-	-
Notioscopus sarcinatus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Erigonella hiemalis (Blackw.)	-	-	-	-	-	-	-	-	-	-
Erigone dentipalpis (Wider)	-	-	-	-	-	-	-	-	-	-
Diplocephalus latifrons (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Leptorhoptrum robustum (Westr.)	-	-	-	-	-	-	o/1	-	-	-
Porrhomma convexum (Westr.)	-	-	-	-	-	-	-	-	-	-
P.pallidum (Jackson)	2/12	o/4	o/2	o/1	3/1	-	o/2	o/2	-	o/4
Agyneta conigera (O.P.-Cambr.)	o/1	o/1	1/1	-	-	-	-	-	-	-
A.ramosa (Jackson)	-	-	-	-	1/1	o/1	-	-	-	-
Meioneta beata (O.P.-Cambr.)	-	-	-	2/1	-	1/3	1/o	-	-	-
M.saxatilis (Blackw.)	-	-	-	-	-	-	-	-	-	-
Microneta viaria (Blackw.)	-	-	-	-	-	-	-	o/1	-	-
Centromerita bicolor (Blackw.)	-	-	-	-	-	-	-	-	-	-
C.concinna (Thor.)	-	-	-	-	-	-	-	-	-	-

	1	2	3	4	5	6	7	8	9	1o
Centromerus arcanus (O.P.-Cambr.)	-	-	-	1/2	1/5	5/8	1/2	o/2	o/1	5/o
C.expertus (O.P.-Cambr.)	-	o/3	-	-	-	-	-	-	-	-
C. incilius (L.Koch)	13/4	o/1	-	-	8/3	-	8/5	-	-	-
C.prudens (O.P.-Cambr.)	-	-	-	-	1/o	-	-	-	-	-
C.sylvaticus (Blackw.)	2/o	-	-	1/o	-	-	-	-	-	-
Oreonetides abnormis (Blackw.)	-	-	-	-	1/9	-	-	o/3	-	-
Macrargus carpenteri (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
M.rufus (Wider)	-	-	-	3/o	2/1	16/2	-	-	-	-
Bathyphantes parvulus (Westr.)	-	o/1	-	-	-	-	-	-	-	-
Diplostyla concolor (Wider)	1/o	1/6	o/2	o/1	9/28	-	-	1/o	1/1	o/2
Drapetisca sosialis (Sundev.)	-	-	-	-	-	-	-	-	o/1	-
Tapinopa longidens (Wider)	-	-	-	o/1	o/1	-	-	-	-	-
Stemonyphantes lineatus (Linnaeus)	-	-	-	-	1/o	-	1/o	-	-	-
Bolyphantes alticeps (Sundev.)	-	-	-	o/1	-	-	-	-	-	-
Lepthyphantes alacris (Blackw.)	-	-	-	2/o	-	1/o	-	-	13/7	-
L.angulipalpis (Westr.)	4/3	-	o/1	-	3/5	-	1/o	-	2/o	1/o
L.cristatus (Menge)	-	-	-	9/1	4/3	1/o	8/2	15/7	o/1	3/1
L.flavipes (Blackw.)	1o/6	-	5/6	3/o	1/o	-	-	-	-	-
L.mengei (Kulcz.)	2/5	1o/1o	o/1	13/3	4/1	16/1o	2o/2	7/3	4/2	8/4
L.obscurus (Blackw.)	-	-	-	-	-	-	-	-	o/1	-
L.pallidus (O.P.-Cambr.)	o/2	-	-	-	-	-	1/o	-	3/7	1/8
L.tenebricola (Wider)	-	-	-	2/1	-	1/o	1/o	2/o	33/21	-
Helophora insignis (Blackw.)	-	-	-	o/2	-	-	-	-	1/o	-
Linyphia triangularis (Clerck)	-	-	-	-	-	-	-	-	-	1/o
Neriene clathrata (Sundev.)	-	-	-	-	-	-	-	-	-	o/1
Allomenga scopigera (Grube)	-	-	-	-	o/3	-	-	-	-	-

Lokalitet	11	12	13	14	15	16	17	18	19	2o
Centromerus arcanus (O.P.-Cambr.)	o/7	-	1/6	-	9/18	o/15	2/4	1/1	-	-
C.expertus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
C.incilius (L.Koch)	-	-	-	9/o	-	1/o	-	-	-	-
C.prudens (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
C.sylvaticus (Blackw.)	-	-	-	-	-	-	-	-	1/4	5/22
Oreonetides abnormis (Blackw.)	-	-	-	-	-	-	-	-	-	-
Macrargus carpenteri (O.P.-Cambr.)	-	-	-	-	-	-	-	-	o/1	-
M.rufus (Wider)	27/4	14/6	13/9	-	8/11	-	6/1	1/o	-	-
Bathyphantes parvulus (Westr.)	-	-	-	-	-	-	-	-	-	-
Diplostyla concolor (Wider)	-	-	-	-	-	-	-	-	-	-
Drapetisca socialis (Sundev.)	-	-	-	-	-	-	-	-	-	-
Tapinopa longidens (Wider)	-	-	-	-	-	-	-	-	-	-
Stemonyphantes lineatus (Linnaeus)	-	-	-	-	-	-	-	-	-	-
Bolyphantes alticeps (Sundev.)	1/o	-	-	-	-	-	o/1	o/1	o/2	1/o
Lepthyphantes alacris (Blackw.)	-	-	16/7	-	11/2	-	-	o/1	-	-
L.angulipalpis (Westr.)	-	4/1	-	5/2	-	-	-	-	-	-
L.cristatus (Menge)	11/2	5/o	4/1	-	16/9	2/1	6/2	1/3	-	-
L.flavipes (Blackw.)	-	-	-	-	-	-	-	-	-	-
L.mengei (Kulcz.)	9/1	1o/26	3/3	4/6	1/o	7/7	24/3o	4/1	o/2	2/5
L.obscurus (Blackw.)	-	-	-	-	-	-	-	-	-	-
L.pallidus (O.P.-Cambr.)	2/5	o/3	-	o/2	o/1	8/13	2/12	o/17	-	-
L.tenebricola (Wider)	34/12	2/4	23/7	-	-	-	-	2/o	-	-
Helophora insignis (Blackw.)	o/1	o/2	2/o	1/o	-	-	6/1	-	-	-
Linyphia triangularis (Clerck)	-	-	-	2/o	-	-	-	-	-	-
Neriene clathrata (Sundev.)	-	o/1	-	-	o/1	-	-	-	-	-
Allomengea scopigera (Grube)	-	-	34/4	-	-	-	-	-	-	-

Table 6. Numbers of adult specimens (♀ ♀ / ♂ ♂) collected by siewing at the 20 localities in Setesdalen, April—September 1980.

	1	2	3	4	5	6	7	8	9	1o
Zelotes clivicolus (L.Koch)	-	-	-	-	-	-	-	-	-	o/1
Z.subterraneus (C.L.Koch)	1/o	-	-	-	o/1	-	-	-	-	-
Clubiona stagnalis (Kulcz.)	-	-	-	-	-	-	-	-	-	-
Oxyptila atomaria (Pantzer)	-	-	-	-	-	-	1/o	-	-	-
O.trux (Blackw.)	-	-	-	-	-	-	-	-	-	-
Thanatus striatus (C.L.Koch)	-	-	-	-	-	-	-	1/o	-	-
Xysticus luctuosus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Neon reticulatus (Blackw.)	-	-	-	-	-	2/o	-	-	-	-
Trochosa terricola (Thor.)	-	-	-	-	2/1	-	-	-	-	-
Cryphoeca silvicola (C.L.Koch)	-	-	-	1/o	-	-	-	-	-	-
Hahnia pusilla (C.L.Koch)	-	-	-	-	3/1	1o/o	-	4/1	-	-
Robertus lividus (Blackw.)	-	-	-	3/1	-	1/o	o/2	1/o	-	-
R.scoticus (Jackson)	-	-	-	-	-	3/1	-	o/1	-	-
Pachygnatha degeeri (Sundev.)	-	o/2	-	-	-	-	-	-	-	-
Ceratinella brevis (Westr.)	-	-	-	-	-	-	1/1	-	-	-
Walckenaera antica (Wider)	-	-	-	-	-	-	o/1	-	-	-
W.cucullata (C.L.Koch)	-	-	-	-	3/o	-	-	-	-	-
W.cuspidata (Blackw.)	-	-	-	-	o/1	-	-	-	-	-
W.dysderoides (Wider)	-	-	-	-	-	-	-	-	-	-
W.nudipalpis (Westr.)	-	-	-	-	-	-	-	-	-	2/o
Dicymbium tibiale (Blackw.)	-	-	-	-	-	o/1	-	-	-	-
Maso sundevalli (Westr.)	-	-	-	-	-	-	-	-	-	-
Cnephalocotes obscurus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Minyriolus pusillus (Wider)	-	-	-	4/o	-	15/4	-	-	-	o/1
Gongylidiellum vivum (O.P.-Cambr.)	-	-	-	1o/2	-	-	-	-	-	-
Micrargus herbigradus (Blackw.)	-	-	-	4/5	-	-	-	-	-	-
Tapinosyba pallens (O.P.-Cambr.)	12/2	-	1/1	23/12	4/1	11/3	16/6	1/3	1/2	4/2
Erigonella hiemalis (Blackw.)	-	-	-	5/5	-	-	-	-	-	-
Savignya frontata (Blackw.)	-	1/o	-	-	-	-	-	-	-	-
Porrhomma pallidum (Jackson)	-	-	-	-	-	-	-	-	-	-
Microneta viaria (Blackw.)	-	-	-	-	1/1	-	-	-	-	-
Sisicus apertus (Holm)	-	-	-	-	-	1/o	-	-	-	-
Centromerus arcanus (O.P.-Cambr.)	-	-	-	-	-	4/3	-	o/1	-	1/o
C.incilius (L.Koch)	-	-	-	-	-	-	-	o/1	-	-
C.sylvaticus (Blackw.)	1/o	-	-	-	-	-	-	-	-	-
Macrargus rufus (Wider)	-	-	-	-	-	3/o	1/o	-	-	-
Bolyphantes alticeps (Sundev.)	-	-	-	-	1/o	-	1/o	-	-	-
Lepthyphantes cristatus (Menge)	-	-	-	-	1/o	-	-	-	-	-
L.tenebricola (Wider)	-	-	-	-	-	-	-	-	-	-
L.pallidus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Diplocephalus latifrons (O.P.-Cambr.)	-	-	1/o	-	-	-	-	-	-	-
Helophora insignis (Blackw.)	-	-	-	-	-	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	20
Zelotes clivicolus (L.Koch)	-	-	-	-	-	2/1	-	1/o	-	-
Z.subterraneus (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Clubiona stagnalis (Kulcz.)	-	-	o/1	-	-	-	-	-	-	-
Oxyptila atomaria (Pantzer)	-	-	-	-	-	-	-	-	-	-
O.trux (Blackw.)	-	1/o	-	-	-	-	-	1/1	-	-
Thanatus striatus (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
Xysticus luctuosus (Blackw.)	-	-	-	o/1	-	-	-	-	-	-
Neon reticulatus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Trochosa terricola (Thor.)	-	-	-	o/1	-	1/o	-	-	-	-
Cryphoeca silvicola (C.L.Koch)	-	1/o	1/o	-	-	-	-	1/o	-	-
Hahnia pusilla (C.L.Koch)	-	2/o	-	-	1/1	-	-	-	-	-
Robertus lividus (Blackw.)	-	-	-	-	3/o	-	o/1	-	-	-
R.scoticus (Jackson)	2/2	1/1	6/o	-	-	-	3/o	-	-	-
Pachygnatha degeeri (Sundev.)	-	-	-	-	-	-	-	-	-	-
Ceratinella brevis (Westr.)	-	-	-	-	-	-	-	-	-	-
Walckenaera antica (Wider)	-	-	-	-	-	-	-	-	-	-
W.cucullata (C.L.Koch)	-	1/o	-	-	-	-	-	-	-	-
W.cuspidata (Blackw.)	-	-	-	-	1/o	-	-	-	-	-
W.dysderoides (Wider)	-	-	-	-	-	1/o	-	-	-	-
W.nudipalpis (Westr.)	-	-	-	-	1/o	-	-	-	-	-
Dicymbium tibiale (Blackw.)	-	-	-	-	-	-	-	-	-	1/o
Maso sundevalli (Westr.)	-	-	-	-	-	-	-	1/o	-	1/o
Cnephalocotes obscurus (Blackw.)	-	-	-	1/o	-	-	-	-	-	-
Minyriolus pusillus (Wider)	3/2	-	5/4	-	4/6	1/o	2/1	-	2/o	-
Gongylidiellum vivum (Cbr.)	-	-	-	-	-	-	-	-	-	-
Micrargus herbigradus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Tapinocyba pallens (Cbr.)	2/2	1/o	6/2	1/1	2/1	8/o	1/1	4/4	2/o	7/o
Erigonella hiemalis (Blackw.)	-	-	-	-	-	-	-	-	-	-
Savignya frontata (Blackw.)	-	-	-	-	-	-	-	-	-	-
Porrhomma pallidum (Jackson)	o/1	1/1	-	-	-	-	-	-	-	-
Microneta viaria (Blackw.)	-	-	-	-	-	-	-	-	-	-
Sisicus apertus (Holm)	-	-	1/1	-	-	-	-	-	-	-
Centromerus arcanus (Cbr.)	1/o	-	o/2	-	2/o	-	o/1	-	-	1/o
C.incilius (L.Koch)	-	-	-	-	-	-	-	-	-	-
C.sylvaticus (Blackw.)	-	-	-	1/o	-	-	-	-	-	-
Macrargus rufus (Wider)	o/1	-	3/o	-	-	-	-	-	-	-
Bolyphantes alticeps (Sundev.)	-	-	-	-	-	-	-	-	-	-
Lepthyphantes cristatus (Menge)	-	-	-	-	-	-	-	-	-	-
L.tenebricola (Wider)	-	-	1/o	-	-	-	-	-	-	-
L.pallidus (Cbr.)	-	-	-	-	-	-	-	-	-	-
Diplocephalus latifrons (Cbr.)	-	-	-	-	-	-	-	-	-	-
Helophora insignis (Blackw.)	-	-	-	1/o	-	-	-	-	-	-

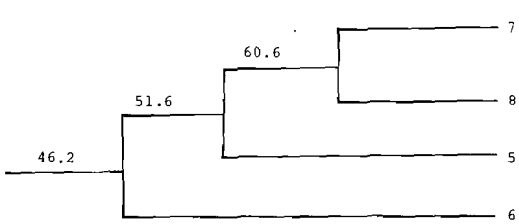

Fig. 6. Similarity in species composition (in %) between the 4 localities in the boreo nemoral zone (Evje).

B1. Humid mixed forest (Vaccinio-Pinetum association) — Loc. 5

This locality constitutes a faunistic group with loc. 7, 8 and 16, classified as *Vaccinio-Pinetum* association (loc. 7, 8) and *Cladonia-Pinetum* association (loc. 16).

A total of 45 species were registered, of which the majority were linyphiids (31 species).

An amount of 474 adult spiders were caught in pitfalls. Most numerous were Lycosidae (55.3%), Linyphiidae (33.8%) and Gnaphosidae (8.8%). The other families each made up less

Table 7. Numbers of adult specimens (♀ ♀ / ♂ ♂) collected by sweep nets at the 20 localities in Setesdalen, April—September 1980.

	1	2	3	4	5	6	7	8	9	1o
Dictyna arundinacea (Linnaeus)	-	-	-	-	-	-	-	-	-	-
Clubiona coerulescens (L.Koch)	-	-	1/o	-	1/o	-	-	-	-	-
C.compta (C.L.Koch)	-	-	-	3/o	-	2/o	-	-	-	-
C.trivialis (C.L.Koch)	-	-	-	-	-	1/o	-	-	-	-
Zora spinimana (Sundev.)	-	-	-	-	-	1/o	-	-	-	-
Xysticus cristatus (Clerck)	1/o	1/o	-	-	-	-	-	-	-	-
Philodromus aureolus (Clerck)	-	-	-	-	-	-	-	-	1/o	-
P.aureolus caespiticolis (Walck.)	-	-	-	-	-	-	-	1/o	-	-
Evarcha falcata (Clerck)	-	-	-	-	3/o	1/2	3/o	o/1	-	1/o
Neon reticulatus (Blackw.)	-	-	-	1/o	-	1/o	-	-	-	-
Ero furcata (Villers)	-	-	-	-	-	-	-	-	-	-
Theridion bimaculatum (Linnaeus)	-	1/o	-	-	-	-	-	-	-	-
T.sisyphium (Clerck)	-	-	-	-	-	-	-	-	-	-
T.varians (Hahn)	1/o	-	-	-	-	-	-	-	-	-
Pachygnatha degeeri (Sundev.)	o/1	-	-	-	-	-	-	-	-	-
Araneus cucurbitinus (Clerck)	-	-	-	-	1/o	-	1/o	o/1	-	-
A.sturmi (Hahn)	-	-	-	-	-	-	-	-	-	-
Cyclosa conica(Pallas)	-	-	-	-	-	-	1/o	-	-	-
Meta mengei (Blackw.)	-	-	o/1	1/o	-	-	o/1	-	-	-
Walckenaera nudipalpis (Westr.)	-	-	-	-	-	-	-	-	-	-
Dismodium bifrons (Blackw.)	-	1/o	-	-	-	-	-	-	-	-
Dicymbium tibiale (Blackw.)	-	-	-	-	-	-	-	-	-	-
Entelecara acuminata (Wider)	-	-	-	-	-	-	-	-	-	-
Gonatium rubellum (Blackw.)	-	-	-	-	-	-	-	-	-	-
G.rubens (Blackw.)	-	-	-	-	-	-	1/o	1/o	-	-
Maso sundevalli (Westr.)	-	-	-	1/o	1/o	5/1	-	-	-	-
Minyriolus pusillus (Wider)	-	-	-	-	-	1/o	-	-	-	-
Gongylidiellum vivum (O.P.-Cambr.)	-	-	-	-	1/o	-	-	-	-	-
Notioscopus sarcinatus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Erigone atra (Blackw.)	-	-	-	-	-	-	-	-	-	o/1
Bathyphantes nigrinus (Westr.)	o/1	-	-	-	-	-	-	-	-	-
Drapetisca socialis (Wider)	-	-	-	-	-	-	-	-	1/2	-
Stemonyphantes lineatus (Linnaeus)	-	-	-	-	1/2	1/o	2/o	-	-	-
Bolyphantes alticeps (Sundev.)	2/2	-	-	1/o	3/1	1/2	o/1	-	-	-
B.crusifer (Menge)	-	-	-	-	-	-	-	1/o	-	-
B.index (Thor.)	-	-	-	-	-	-	-	-	-	-
Pityohyphantes phrygianus (C.L.Koch)	-	-	-	-	-	-	-	-	2/o	-
Lepthyphantes alacris (Blackw.)	-	-	-	1/o	-	1/1	-	-	o/1	-
L.cristatus (Menge)	-	-	-	-	1/o	1/o	o/1	2/1	-	-
L.expunctus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
L.flavipes (Blackw.)	-	4/o	-	-	1/o	-	-	-	-	-
L.mengei (Kulcz.)	-	2/1	6/3	3/3	8/2	1/o	1/o	-	o/1	1/o
L.obscurus (Blackw.)	-	-	-	-	-	-	-	-	1/1	-
Helophora insignis (Blackw.)	-	-	-	1/4	-	3/1	-	-	-	-
Linyphia montana (Clerck)	-	-	-	-	-	4/o	-	-	-	-
L.peltata (Wider)	-	-	1/o	-	1/o	-	-	-	-	-
L.triangularis (Clerck)	-	-	1/o	-	4/o	-	-	-	-	-
Neriene clathrata (Sundev.)	-	-	o/1	-	o/2	-	-	-	-	-
Microlinyphia pusilla (Sundev.)	-	-	-	-	-	-	-	-	-	-

than 1 %. *Pardosa lugubris* was the most abundant species (47.9 % in the pitfalls), most numerous in the first trapping period. *Diplostyla concolor* (7.8 %) was the dominant species in the autumn as also indicated from other studies by Miller & Obrtel (1975). *D. concolor* was less frequent in other localities (Table 5). Also common at loc. 5 were *Zelotes subterraneus, Trochosa*

	11	12	13	14	15	16	17	18	19	20
Dictyna arundinacea (Linnaeus)	-	-	1/o	-	-	-	-	-	1/o	-
Clubiona coerulescens (L.Koch)	-	-	-	-	-	-	-	-	-	-
C.compta (C.L.Koch)	-	-	-	-	-	-	-	-	-	-
C.trivialis (C.L.Koch)	-	-	-	-	-	o/1	-	-	-	-
Zora spinimana (Sundev.)	-	-	-	-	-	1/o	-	-	-	-
Xysticus cristatus (Clerck)	-	-	-	-	-	-	-	-	1/o	-
Philodromus aureolus (Clerck)	-	-	-	-	-	-	-	-	-	-
P.aureolus caespiticolis (Walck.)	-	-	-	-	-	-	-	-	-	-
Evarcha falcata (Clerck)	-	1/1	-	3/o	-	-	-	-	-	-
Neon reticulatus (Blackw.)	-	-	-	-	-	-	-	-	-	-
Ero furcata (Villers)	-	-	-	-	1/o	-	-	-	-	-
Theridion bimaculatum (Linnaeus)	-	-	-	-	-	-	-	-	-	-
T.sisyphium (Clerck)	-	-	-	1/o	-	-	-	-	-	-
T.varians (Hahn)	-	-	-	-	-	-	-	-	-	-
Pachygnatha degeeri (Sundev.)	-	-	-	-	-	-	-	-	-	-
Araneus cucurbitinus (Clerck)	-	-	-	-	-	-	-	-	-	-
A.sturmi (Hahn)	-	1/o	-	-	-	-	-	-	-	-
Cyclosa conica (Pallas)	-	-	1/o	-	-	-	-	-	-	-
Meta mengei (Blackw.)	-	-	-	3/2	2/o	1/o	-	-	-	-
Walckenaera nudipalpis (Westr.)	-	-	-	-	-	-	-	-	-	o/1
Dismodium bifrons (Blackw.)	-	-	-	-	-	-	-	-	-	-
Dicymbium tibiale (Blackw.)	-	-	-	-	-	-	-	-	-	1/o
Entelecara acuminata (Wider)	-	-	-	1/o	-	-	-	-	-	-
Gonatium rubellum (Blackw.)	-	-	1/o	-	1/o	2/1	-	2/1	-	-
G.rubens (Blackw.)	-	-	1/o	-	3/1	-	-	-	6/o	1/o
Maso sundevalli (Westr.)	o/1	2/o	-	2/o	4/o	1/o	1/1	1/o	-	1/o
Minyriolus pusillus (Wider)	-	1/o	-	-	-	-	-	-	-	-
Gongylidiellum vivum (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Notioscopus sarcinatus (O.P.-Cambr.)	-	-	-	-	-	-	-	-	-	-
Erigone atra (Blackw.)	-	-	-	-	-	-	-	-	-	-
Bathyphantes nigrinus (Westr.)	-	-	-	-	-	-	-	-	-	-
Drapetisca socialis (Wider)	-	-	-	-	1/o	-	-	-	-	-
Stemonyphantes lineatus (Linnaeus)	-	-	-	o/1	-	-	-	-	-	-
Bolyphantes alticeps (Sundev.)	3/2	1/o	4/4	3/o	o/2	4/4	3/3	1/1	-	-
B.crusifer (Menge)	-	-	-	-	-	o/1	-	-	-	-
B.index (Thor.)	-	-	-	-	-	-	-	-	9/4	4/2
Pityohyphantes phrygianus (C.L.Koch)	-	1/o	-	1/o	-	-	-	-	-	-
Lepthyphantes alacris (Blackw.)	-	1/o	5/7	-	4/6	-	o/1	o/1	-	-
L.cristatus (Menge)	2/1	6/o	1/2	-	5/2	2/1	6/2	1/3	-	-
L.expunctus (O.P.-Cambr.)	-	-	-	-	-	-	1/2	1/o	-	-
L.flavipes (Blackw.)	-	-	-	-	-	-	-	-	-	-
L.mengei (Kulcz.)	1/1	3/2	2/o	2/1	-	7/2	-	2/2	-	-
L.obscurus (Blackw.)	-	-	-	-	1/o	-	1/o	o/1	-	-
Helophora insignis (Blackw.)	1o/4	3/2	14/8	1/1	5/3	o/2	4/4	1/o	-	-
Linyphia montana (Clerck)	-	-	-	2/o	-	-	-	-	-	-
L.peltata (Wider)	-	-	-	-	3/o	-	-	-	-	-
L.triangularis (Clerck)	-	-	-	2/o	-	2/o	-	-	-	-
Neriene clathrata (Sundev.)	-	o/1	-	o/2	-	o/1	-	-	-	-
Microlinyphia pusilla (Sundev.)	-	-	-	o/2	-	-	-	-	-	-

terricola and *Microneta viaria* (Blackwall). The other 41 registered species each had a relative occurrence of less than 3.0 % in the pitfall material. The heterogeneity of humidity and vegetation within this locality may explain the remarkable composition of the spider fauna. Several of the less frequent species are known to prefer similar conditions. These are: *Gongylidiellum vivum, Walckenaera cuspidata, Maso sundevalli, Tapinopa longidens* and *Micaria pulicaria* (Sundevall). Several species such as *Abacoproeces saltuum* (C.L. Koch), *Neriene peltata* (Wider), and *Lepthyphantes triangularis* (Clerck) apparently avoid high humidity (see Palmgren 1972). In the

arid part of the locality was found one specimen of *Centromerus prudens* (O.P.-Cambridge). This species is very rare in Norway and is previously reported only from exposed, open areas with low humidity (*Calluna* heaths).

B2. Dry mixed forest (Vaccinio-Pinetum association) — Loc. 7, 8

Floristically these localities seem to be quite similar to loc. 5, but marked differences in humidity obviously result in a different spider fauna. Several species such as *Microneta viaria, Walckenaera cuspidata, Gongylidiellum vivum, Zelotes subterraneus* and *Micaria pulicaria*, all absent from loc. 7 and 8 and prefering high humidity were recorded at loc. 5. On the other hand, several species frequent at loc. 7 and 8 such as *Gnaphosa bicolor, Drassodes pubescens* (Thorell), *Alopecosa aculeata* and *A. pulverulenta* (Clerck) (all absent from loc. 5, Tables 5, 6, 7), prefer low humidity and often are found in pine and mixed forests dominated by *Calluna* and moss.

Of particular interest is the registration of *Thanatus striatus* known to be strictly bound to sandy habitats (Locket & Millidge 1951, Lohmander 1955). The soil in the Evje region is dominated by sand and thus probably suitable to this species.

Loc. 7 and 8 have higher similarities to loc. 16 than to loc. 5. This is somewhat peculiar as loc. 5, 7 and 8 are believed to be of the same plant sociological association. Some spider species recorded at loc. 5 were not found at loc. 7, 8 and 16. These are: *Microneta viaria, Walckenaera cuspidata, Gongylidiellum vivum* and *Zelotes subterraneus.* Several other species which probably prefer relatively low himidity *(Gonatium rubellum* (Blackwall), *G. rubens* (Blackwall), *Pocadicnemis pumila* (Blackwall), *Alopecosa aculeata),* were common at loc. 7, 8 and 16.

C. The boreal zone (lower part) — Bygland

The whole area is dominated by conifers implying a less varied spider fauna than in the zones further south. Faunistically this area groups together with the most northern part of the boreal zone, Bykle, probably due to great similarity in plant communities. Except for the alpine zone, the lower and upper part of the boreal zone are the poorest concerning species diversity.

Of a total of 64 spider species registered in this lower boreal zone, only 9 were found exclusively in this area. These 9 are: ***Erigona atra*** (Blackwall), *Evansia maerens* (O.P.-Cambridge),

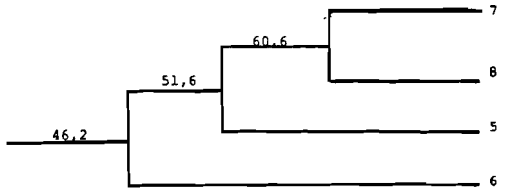

Fig. 7. Similarity in species composition (in %) between the 4 localities in the lower boreal zone (Bygland).

Pelecopsis elongata (Wider), *Philodromus aureolus* (Clerck), *Xysticus obscurus* (Collett), *Tibellus maritimus* (Menge), *Amaurobius fenestralis* (Stroem), *Araneus sturmi* (Hahn) and *Nesticus cellulanus* (Clerck).

The four localities within this zone have great faunal similarities. This especially applies to loc. 10 and 12 (Fig. 7) floristically somewhat different, but both characterized as *Eu-Piceetum* associations and both with similar ground conditions (large stones etc.). Loc. no. 9 and 11 primarily differ from each other because of the marked difference in humidity.

The most abundant species were *Lepthyphantes tenebricola* (Wider) (12.9%), *Alopecosa aculeata* (Clerck) (10.4%), *Macrargus rufus* (Wider (8.0%), *Lepthyphantes mengei* (Kulcz.) (7.8%) and *Trochosa terricola* (Thorell) (7.7%), all of which except for *L. tenebricola* and *T. terricola* (both species absent at loc. 9 and 10), were found in all 4 localities. Present at all localities were also *Tapinocyba pallens* (O.P.-Cambridge), *Lepthyphantes cristatus* (Menge), *L. pallidus* (O.P.-Cambridge), *Walckenaera cucullata* (C.L. Koch), *Porrhomma pallidum* (Jackson) and *Cryphoeca silvicola* (C.L. Koch).

C1. Loc. no. 9. Spruce forest (Eu-Piceetum-association)

Linyphiidae was the dominant family at loc. no. 9 (19 species). In the pitfall trap material they compose 91.2% of all adult specimen. Dominating were *Lepthyphantes tenebricola* (36.9%), *L. alacris* (13.6%) and *Macrargus rufus* (8.8%).

The spider species composition at this locality seems to be affected by the massive density of the forest causing darkness and high humidity on the forest floor. These conditions are shared with the pine forest dominated *Vaccinio-Pinetum* association of the boreonemoral zone (loc. 6), to which it also faunistically is associated, according to our diagram (Fig. 5). As also can be seen from Fig. 5, loc. 6 and 9 constitute a sub-

group parallel to the pine forest dominated *Eu-Piceetum* association of the boreonemoral zone (loc. 10, 12 and 18). Species absent from loc. 9, but present at loc. 10, 11 and 12 are: *Minyriolus pusillus* (Wider), *Agroeca brunnea* (Blackwall), *A. proxima* (O.P.-Cambridge), *Micaria aenea* (Thorell), *Zora spinimana* (Sundevall), *Z. nemoralis* (Blackwall) and *Trochosa terricola*. These species seem to have preferance for medium humidity and light, and open land (Locket & Millidge 1951, Palmgren 1972, Hauge et al. 1975), which obviously exclude them from loc. 9. On the other hand, some species absent from loc. 10, 11 and 12 were found at loc. 9. These were: *Lepthyphantes obscurus* (Blackwall), *Drapetisca socialis* (Sundevall), *Walckenaera unicornis* (O.P.-Cambridge), *Robertus lividus* (Blackwall) and *Philodromus aureolus*.

C2. Loc. no. 10 and 12. Spruce/pine forest (Eu-Piceetum-association)

The localities represent the same habitat type. However, loc. 12 is intact while at loc. 10 there have been some felling of trees. A common element is the stony ground, which may be the cause of the faunal similarity to loc. 18, also a stony *Eu-Piceetum* association.

Several species shared between loc. 10 and 12, or present at only one of the localities, all have in common that they are absent from loc. 9 and 11. Several of these species give a good characterization of loc. 10 and 12. Species such as *Drassodes pubescens* (Thorell), *Haplodrassus signifer* (C.L. Koch), *Neriene clathrata* (Sundewall) and *Walckenaera antica* (Wider) prefer low humidity, light and a field layer dominated by stones, ling and grass, according to Locket & Millidge (1951) and Palmgren (1972, 1976). The spiders are supposed to cling to the upper part of the ground vegetation. In addition species preferring less light and relatively high humidity, such as *Amaurobius fenestralis* (Stroem) and *Nesticus cellulanus* (Clerck), often are found in cellars, under large stones etc. In Setesdalen *N. cellulanus* was found only at loc. 10. Species such as *Euryopis flavomaculata* (C.L. Koch) prefers much light and high humidity. In conclusion all species mentioned here have in common a preference to stony ground, often large stones. This probably must be decisive since all species mentioned above were lacking at the nearby loc. 9 and 11, belonging to the same plant sosiological association type as loc. 10 and 12.

Loc. 10 and 12 have a high species diversity with dominance of Linyphiidae and Lycosidae (60—70% in pitfall trap material). Clubionidae with a relatively low frequency in the rest of the valley reached their highest density at loc. no. 10/12, especially the species *Agroeca proxima* (O.P.-Cambridge) and *A. brunnea* (Blackwall). On the other hand in the pine forest dominated *Eu-Piceetum* associations, loc. 10 and 12, had a marked element of Gnaphosidae (absent at loc. 9, 11 and 13).

C3. Loc. 11. Pine forest (Eu-Piceetum association)

Altogether 28 species of which 16 belong to the Linyphiidae were found in loc. 11. Gnaphosidae (except one), Thomisidae and Araneidae were lacking, while Clubionidae were represented by the following 4 species: *Clubiona compta* (C.L. Koch), *C. subsultans* (Thorell), *Agroeca proxima, A. brunnea,* and also *Micaria aenea* (Thorell).

In the pitfall traps the Linyphiidae were highest in number (71.0% of all adult specimens). Together with Lycosidae (15.2%), Agelenidae (6.9%) and Clubionidae (6.0%) they comprized as much as 99%.

The most common species were *Lepthyphantes tenebricola* (21.2%), *Macrargus rufus* (14.3%) and *Trochosa terricola* (11.1%), all among the dominant species in all coniferous localities in the boreal zone. Absent were *Lepthyphantes alacris* (Blackwall) and *Allomengea scopigera* (Grube), both numerous at loc. 13.

The fauna is nearly identical to faunas of the other pine forest dominated *Eu-Piceetum* associations in the boreal zone. This can be seen from Fig. 5 where loc. 11 faunistically groups together with loc. 13. Some species reached their maximum dominance in pitfall trap material at these two localities. These species are: *Lepthyphantes tenebricola, Porrhomma pallidum, Macrargus rufus* and *Cryphoeca silvicola,* all of which were found several places in Setesdalen, but most numerous in coniferous forests. The species are regarded as having a relatively wide ecological amplitude, but in Setesdalen they varied much in numbers indicating preference for certain conditions. In particular this is the case with *Cryphoeca silvicola,* common in moss and ling throughout the whole country, but avoiding areas with *Calluna* (Palmgren 1972). This probably explains why the species were absent from loc. 5, 7, 8, 14 and 16, where *Calluna vulgaris* was dominating.

As pointed out above several species present at loc. 10 and 12 were absent at loc. 11. However, of all species registered at loc. 11 only two

species, *Micrargus herbigradus* (Blackwall) and *Clubiona subsultans* (Thorell), were lacking in the spruce/pine forests (loc. 10/12) indicating great differences in complexity of substrate and vegetation at these three localities.

D. The boreal zone (middle part) — Valle

The area is situated in the most luxuriant part of the boreal zone with 4 localities of quite different vegetation types. This results in a more varied spider fauna with higher diversity. Altogether 81 species were registered. 11 species, *Lepthyphantes zimmermanni* (Bertkau), *Microlinyphia pusilla* (Sundevall), *Notioscopus sarcinatus* (O.P.-Cambridge), *Agyneta ramosa* (Jackson), *Entelecara acuminata* (Wider), *Clubiona stagnalis* (Kulczynski), *Pirata hygrophilus* (Thorell), *Pardosa riparia* (C.L. Koch), *Dolomedes fimbriatus* (Clerck), *Ero fucata* (Villers) and *Theridion sisyphium* (Clerck) were found exclusively in this part of the valley.

The four localities make two faunistic groups (Fig. 8). As might be expected the *Eu-Piceetum* associations (loc. 13 and 15) have great similarity (66.7%), and differ somewhat from the *Melico-Piceetum* (loc. 14) and *Cladonia-Pinetum* (loc. 16) associations, which have a richer vegetation and more varied spider fauna.

D1. Pine forest (Eu-Piceetum association) — Loc. 13 and 15

Relatively low diversity and dominance of Linyphiidae (60 species) characterize this very homogeneous pine forest area. Highest number of specimens had also Linyphiidae (90% of all adult specimens caught by pitfall trapping). Agelenidae, Thomisidae and Araneidae were represented by two species each, Gnaphosidae by one species and Clubionidae by four species.

The most common species were *Macrargus rufus, Lepthyphantes alacris* and *Centromerus arcanus.*

According to Fig. 5 loc. 13 and 15 are closely

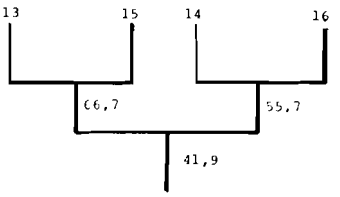

Fig. 8. Similarity in species composition (in %) between the 4 localities in the middle boreal zone (Valle).

associated with the pine forest dominated *Eu-Piceetum* association of the boreal zone and faunistically closest to loc. 11 and 17. These four localities have 14 species in common (Tables 5, 6, 7) and can be regarded as representatives for the medium dry, open coniferous forests in the boreal zone.

D2. Deciduous forest (Melico-Piceetum association) — Loc. 14

In this border zone of deciduous forest and cultivated land 8 families and 39 spider species were registered. The Linyphiidae were dominating (25 species), but in numbers the Lycosidae dominated (74.9% of all adult specimens in the pitfalls). Except for *Lepthyphantes angulipalpis* (Westring), *L. mengei* and *Centromerus incilius* (L. Koch) the Linyphiidae were not frequent (< 2%). However, they were quite numerous in the field layer where 15 species were registered. The highest relative abundance at loc. 14 had *Pardosa lugubris* (27.1%), *Alopecosa aculeata* (27.7%) and *Trochosa terricola* (20.8%).

Faunistically the area groups together with loc. 5, 7, 8 and 16, all some forms of *Pinetum* associations. However, this locality shares most species with loc. 12 (56.7%) and loc. 10 (53.1%) also situated in the boreal zone, but classified as *Eu-Piceetum* associations.

The reason why loc. 14 does not group together with loc. 10/12, which have high similarity values compared to the other coniferous localities in the valley, might be the fact that typical coniferous species are quite dominant elsewhere in the boreal zone, but are completely absent from loc. 14. Some of these species are *Lepthyphantes cristatus, Tapinocyba pallens, Macrargus rufus, Haplodrassus signifer* and *Cryphoeca silvicola.* Also *Lepthyphantes tenebricola* belongs to this group (Tables 5, 6, 7). This species in particular were numerous in the lower and middle part of the boreal zone. According to Palmgren (1972) the species is typical for coniferous forests. However, it also seems to be quite common in northern deciduous forests (Hauge et al. 1975, Hauge 1977).

D3. Pine forest/bog (Cladonia-Pinetum/bog association — Loc. 16

In this heterogeneous area 9 families and 46 species were registered, of which 24 (52.5%) were Linyphiidae. Clubionidae and Lycosidae were represented with 5 species each. In the pitfalls Lycosidae (35.1%), Gnaphosidae (29.8%) and Linyphiidae (26.5%) constituted the bulk of the

adult spiders. The most common species were *Zelotes clivicolus* (26.8%), *Pirata hygrophilus* (16.8%), *Pardosa lugubris* (8.5%), *Trochosa terricola* (6.2%) and *Lepthyphantes pallidum* (5.9%).

This was the most diverse of the localities in Setesdalen, and probably due to the special humid conditions a special fauna. In the Trelli's diagramme (Fig. 4), based on Sørensen's index of similarity, this locality groups with loc. 7, 8 and 14, all dominated by deciduous forest and characterized as *Vaccinio-Pinetum* and *Melico-Piceetum* associations. One explanation is probably the heterogenity of loc. 16. Partly it consists of pine forest, partly of bog with *Salix* spp. More or less hygrophilous species are *Agyneta ramosa* (Jackson), *Notioscopus sarcinatus, Walckenaera nudipalpis* (Westring), *Euryopis flavomaculata* (C.L. Koch), *Pardosa riparia, Pirata hygrophilus* and *Dolomedes fimbriatus* (Clerck) (according to Locket & Millidge 1951, 1953; Hauge 1972, Palmgren 1972, 1976). In the dry pine dominated areas species were found which demand drier conditions. The most common ones, *Linyphia triangularis, Neriene clathrata, Walckenaera dysderoides* (Wider), *Centromerus incilius* (L. Koch), *Agroeca brunnea* and *Meta mengei* (Blackwall), were not found north of loc. 14.

E. Boreal zone (upper part) — Bykle

The localities are situated near the northern limit of the boreal zone. The vegetation is monotonous, mostly pine and birch dominated *Eu-Piceetum* associations. Faunistically the area is most similar to the southern part of the boreal zone, and some species such as *Haplodrassus soerenseni* (Strand), *Micaria aenea* (Thorell) and *Clubiona subsultans* (Thorell) are restricted to these two areas. The three boreal zones differ markedly from the other zones (Fig. 3).

Species exclusively found in this zone were *Lepthyphantes expunctus* (O.P.-Cambridge), *Leptorhoptrum robustum* (Westring) and *Acantolycosa lignaria* (Clerck).

The two localities in the area belong to the same association type, but pines are dominating at loc. 17, and birches at loc. 18. There is a great similarity in species composition (Fig. 9). From Fig. 5, however, the two localities do not group together faunistically. The reason is that at loc. 18 were found about 30 more species than at loc. 17, and some of these such as *Drassodes pubescens* (Thorell), *Agroea proxima, Micaria aenea, Zore nemoralis* and *Euryopis flavomaculata* were shared with loc. 10 and 12. Most species shared between loc. 17 and 18 were also registered at loc. 10 and 12. Thus higher similatiry values were obtained between loc. 17 and 18.

E1. Pine forest (Eu-Piceetum) — Loc. 17

At this northernmost *Eu-Piceetum* association 7 families and 30 spider species were registered. The Linyphiidae was the dominating family (21 species), but except for *Lepthyphantes mengei* (17.5%) the other species in this family had a dominance of less than 5% in the pitfall material. Here *Pardosa lugubris* (38.8%) was the dominating species. Lycosidae (58.8%) and Linyphiidae (38.5%) made up the bulk of the adult pitfall material, and usual dominance in all *Eu-Piceetum* associations (loc. 11, 13 and 15). Faunistically loc. 17 groups closest to loc. 15.

E2. Birch forest (Eu-Piceetum association) — Loc. 18

A total of 39 species were registered, of which 20 were Linyphiidae. The pitfall trap material was dominated by Lycosidae (51.6% of all adults). This is in contrast to loc. 12 (45.8% Linyphiidae).

Common species which were absent or had low frequency in the other deciduous forests and mixed forests in the valley were *Lepthyphantes obscurus, L. alacris, L. tenebricola, Walckenaera cuspidata, Micaria aenea* and *Cryphoeca silvicola*, all common in the coniferous forests.

Pardosa lugubris (40.1%) was the most common species. In loc. 5 (with a marked element of *Betula*) this species had a similar high frequency (Table 5), while it was less common at loc. 10 (2.5%) and loc. 12 (7.2%).

Alopecosa aculeata (7.7%), *Walckenaera cucullata* (6.1%) and *Lepthyphantes pallidum* (5.4%) were relatively common.

F. Alpine Zone — Hovden

F1. Birch forest (Eu-Piceetum myrtillosum association) — Loc. 19/20

The area is dominated by bog with dryer «islands» covered by shrubs. Faunistically it is

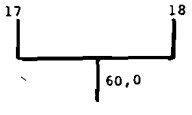

Fig. 9. Similarity in species composition (in %) between the 2 localities in the upper boreal zone (Bykle).

Fig. 10. Similarity in the species composition (in %) between the two localities in the alpin zone (Hovden).

clearly different from the rest of Setesdalen (Fig. 3) with lower species diversity than in the areas further south and in the northern/alpine areas.

Loc. 19 and 20 are almost identical, and the spider species composition also are relatively similar (Fig. 10). It is therefore reasonable to assume that differences in the species domminances are caused by differences in the microclimates.

A total of 25 species were registered, 8 exclusively in this zone: *Macrargus carpenteri* (O.P.-Cambridge), *Bolyphantes index* (Thorell), *Gnaphosa lapponum* (L. Koch), *G. leporina* (L. Koch), *Pardosa hyperborea* (Thorell), *Antistea elegans* (Blackwall), *Hahnia ononidium* (Simon), *Clubiona reclusa* (O.P.-Cambridge).

Most species (16) were Linyphiidae. Absent were Zoridae, Salticidae, Theridiidae and Araneidae.

In the pitfalls Agelenidae dominated (40.3%), relatively abundant were also Linyphiidae (27.6%) and Lycosidae (22.3%). At Finse (Hauge et al. 1978) and in Jotunheimen (Hauge & Refset 1979) the Agelenidae had a low frequency or were lacking. At Finse the linyphiids were the most numerous, while the lycocids made up 80% of all specimens in Jotunheimen. In these three areas several conditions such as altitude, climate, vegetation and period of sampling were almost the same. At Hovden 7 families were represented, at Finse and in Jotunheimen only 4 and 5, respectively.

The most common species at Hovden were *Antistea elegans* (30.0%), *Pardosa hyperborea* (21.6%), *Centromerus sylvaticus* (11.3%) and *Hahnia ononidium* (10.0%). *Antistea elegans* was equally common at both localities, while *P. hyperborea* and *H. ononidium* were most numerous at loc. 19, and *C. sylvaticus* at loc. 20.

A brief summary of the total spider material from the research area

A total of 8862 specimens (3048 juveniles) and 155 species were found. The dominating families were Linyphiidae and Lycosidae. Except for in the alpine zone these two families together made up about 80% of all specimens trapped, a relative constant percentage, but mutually they showed great variations. The Linyphiidae was most numerous in the northernmost part of the boreal zone (55.8% at Bykle), but decreased in dominance northwards until it reached its lowest numbers at Bykle (30.9%), the norhtern limit of the boreal zone. The opposite trend was the case with the Lycosidae (55.2% at Bykle and 21.9% at Bygland). Similar investigations in coniferous areas at high altitudes in Jotunheimen also showed clear cominance for Lycosidae (Hauge & Refseth 1979), while the Linyphiidae often are more numerous in boreal area at lower altitudes (Hauge & Wider 1980). In the nemoral zone and the boreo-nemoral zone the Lycosidae was the most numerous family. Pitfall catches in the West Norwegian coastal areas showed a marked dominance of Linyphiidae (Klausen 1978, unpublished).

The dominance of Agelenidae (especially *Antistea elegans* and *Hahnia ononidium*) in the alpine zone was in great contrast to other pitfall catches elsewhere in alpine areas such as Stigstuv (Hauge & Kauri 1972), Finse (Hauge et al. 1978) and Jotunheimen (Hauge & Refseth 1979). This is probably due to the well known preferance for high humidity of *A. elegans*, and the differences in humid conditions at the areas just mentioned and in Setesdalsheiene.

There obviously is no coherence between altitude and population densities of spiders within the investigated area, according to calculations based on pitfall material (Tab. 3). However, there is a clear decrease in numbers of both families and species at Bykle and Hovden compared to localities further south. A similar tendency was mentioned by Collings (1980).

Within the boreal zone there were relatively small variations in species composition (Fig. 3), but comparatively great variations in numbers of specimens of some species from one locality to another.

Pardosa lugubris was found at all localities below the alpine zone and showed the highest reletive abundance.

P. lugubris, Trochosa terricola, Alopecosa aculeata and *Lepthyphantes mengei* each constituted more than 5% of the total pitfall trap material. Among the 128 species registered by this method 103 reached dominance values less than 1.0%. Most species showed a more or less clear preference to one of the vegetation zones and had higher densities in their neighbouring zones than in the more peripheral zones. Except for

the alpine zone with its special climate this tendency is expressed by the faunistic grouping of the different main areas in Fig. 3. The impression of zone preferency is also strengthened by the fact that 43.9% of the species were found only in one of the main areas, while 4.5% were common to all areas *(Lepthyphantes mengei, Tapinocyba pallens, Minyriolus pusillus, Maso sundevalli, Gonatium rubens, Bolyphantes alticeps* and *Porrhomma pallidum).* According to Palmgren (1972, 1975, 1976), all these species belong to the most common species in most habitat types near the coast, in high mountains and in the north (Lappland). On the base of the vegetation analysis which shows that each vegetational zone has developed its special plant sosiological association type, the zone preference of the spiders were not quite unexpected. The nemoral zone is classified as *Populus-Quercetum* association, the boreonemoral zone as *Pinetum* association and the boreal zone as *Piceetum* association. One exception is loc. 16, situated in the boreal zone, but classified as *Cladonia-Pinetum* association.

A more shaded picture of common trends between the localities is given in Fig. 5. In spite of geographical location the deciduous forest dominated localities and the coniferous dominated localities divide into two separate groups, while the alpine zone falls outside both groups. In the dendrogram there is a clear tendency for localities with great floristic similarities within each main group (coniferous, deciduous, alpine) also to group faunistically. However, it is obvious that the highest indices occur between localities which belong to the same vegetation zone or the nearest neighbour zone. Some localities of the deciduous forest group deviate from this tendency. This is probably due to a higher structural diversity in the richer deciduous forest localities as compared to the coniferous forest localities, giving a more varied spider fauna. Several species showed a clear preference to deciduous dominated localities, and consequently lead to a grouping of these localities. On the other hand, there were registered a number of deciduous forest spider species with a limited distribution in the valley. As can be seen from Fig. 5 and Table 4 this causes lower similarity indices between localities within the deciduous forest group than within the more homogenous coniferous forest group.

One should always bear in mind that superficial similarities between two localities, such as being classified within the same type of plant socialogical association, do not nessesarily imply high similarities in their spider faunas. There are too many other unobserved parametres such as microclimate, habitat structure and not to mention unsufficient sampling techniques, which may have an influence on the composition of the spider catches.

NOTES ON SOME SPECIES FOUND IN SETESDALEN

Altogether 155 species were found during the investigation, and all are listed in Tables 5—7. Brief comments to some of the species are as follows:

Haplodrassus sylvestris (Blackwall). In pitfalls, loc. 1 (2 ♂) and loc. 3 (4 ♂), 24.4.—25.6.1980 (oak forests). Prefers foerna in rich deciduous forests (Braun & Rabeler 1969).

Zelotes clivicolus (L. Koch). Found at 6 localities (Tables 5 and 6), spring and autumn, more frequent in the first sampling period. Previously known only from Vestlandet and Vassfaret, but probably to some extent misidentified to the more often reported *Z. subterraneus* in Norway.

Micaria fulgens Walckenaer. One ♂ trapped 28.4.—25.6.1980 at loc. 3. The species is new to Norway and is probably close to its northern limit of distribution compared to the records in Sweden given by Tullgren (1946).

M. subopaca Westring. One single ♂ in dry mixed forest (loc. 7), 29.4.—26.6.1980. The habitat was open and dry (sandy), suitable for a species which prefers warm, sunny places (Lohmander 1954). The species is new to Norway.

Scotina celans (Blackwall). Found in the nemoral zone (loc. 1), 1 ♂ 25.6.—25.9.1980. In Norway previously recorded only at Os near Bergen and on the island Bjørnen, Sunnhordland (Klausen, unpublished).

Thanatus striatus C.L. Koch. One ♀ sieved from the foerna of dry mixed forest (loc. 8) 26.9.1980. In Britain adults have been found from May to July (Locket & Millidge 1951, Merret 1967), while our record (and Tullgren 1944, Palmgren 1972) shows that the species' mature period at least in the nordic countries extends far into the autumn.

Hahnia ononidium (Simon). Only found in the two uppermost localities of the valley (loc. 19 and 20), which confirms the alpin/northern distribution pattern of the species: Previously found in Nordland (Hauge 1977), in Jotunheimen (Hauge & Refseth 1979) and in Vassfaret (Hauge & Wiger 1980). Our specimens were trapped in pitfalls in the autumn period. Palmgren (1977) reports adults throughout the whole year, and Hauge (1977) registered in N. Norway both sexes from May to September (a material based on sieving only!). In the alpine areas the catches of adults have been concentrated in June/july (pitfall trapping).

Walckenaera obtusa (Blackwall). The species has previously not been recorded from Norway. It was found in a pine dominated forest, all males trapped 28.4.—25.6.1980, while the single female was trapped 25.6.—25.9.1980.

W. unicornis (O.P.-Cambridge). Two males and two females were trapped 29.4.—26.6.1980 and 1 ♀ in the autumn period. The species is rare in Norway and previously recorded only once in W. Norway (Hauge 1971).

Sisicus apertus (Holm). Previously known from Vassfaret (Hauge & Wiger 1980) and from Elverum and Heddal (Hauge & Kvamme 1983). In Setesdal found at loc. 6 and 13, whose ecological conditions are in accordance with the high humidity (*Sphagnum* in spruce forest or bogs) requirement proposed by Palmgren (1975).

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Ticks (Acari, Ixodides) on migratory birds in Norway

REIDAR MEHL, JAN MICHAELSEN AND GUNNAR LID

Mehl, R., Michaelsen, J. & Lid, G. 1984. Ticks (Acari, Ixodides) on migratory birds in Norway. *Fauna norv. Ser. B. 31*, 46–58.

More than 4000 birds were examined for ticks during spring migration in the period 1964 to 1976 on the islands of Akerøya, Store Færder and Svenner in Outer Oslofjord, Southern Norway. Five species of ticks were collected: *Ixodes ricinus* (L., 1758), *I. arboricola* Schulze & Schlottke, 1929, *I. frontalis* (Panzer, 1798), *I. caledonicus* Nuttall, 1910 and *Hyalomma marginatum* C.L. Koch, 1844. *I. ricinus* made up 93% of the specimens, 602 ticks.

65 bird species were investigated and of these 21 species of passerine birds were found infested with ticks. The tick infestations of different bird species are compared and the seasonal changes in infestation rates are described for the most common bird species. The relationship between the number of larvae and nymphs of *I. ricinus* varied with both season and size of bird.

H. marginatum was found on *Phoenicurus phoenicurus, Acrocephalus scirpaceus, Lanius collurio* and *Phylloscopus trochilus*. The records of this tick demonstrate long distance transport by birds from Southern Europe and Africa into Norway.

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INTRODUCTION

Parasitic arthropods of birds, such as mites, ticks, featherlice, louseflies and fleas, live permanently or for a shorter period on their hosts. Consequently, they accompany their hosts on their daily and seasonal movements. During these movements some parasites, such as ticks, will leave their hosts and thus have a chance to find new hosts at a new location.

Ticks are important vectors and reservoirs for viruses and microorganisms which cause disease in man and domestic animals. Owing to intracontinental and intercontinental migration, and to a frequently high rate of tick infestation, birds have an important role in distributing ticks and infectious agents. Much attention has been paid to this field of research during the past 20 years (Hoogstraal & Kaiser 1961, Hoogstraal et al. 1961, 1963, Lord & Calisher 1970, Hoogstraal 1972, Watson, Shope & Kaiser 1972, Kaiser, Hoogstraal & Watson 1974, Nosek & Folk 1977).

The role of migratory birds as transporters of ticks to a particular region depends on the species of birds which are involved, migratory routes and the species of ticks present at the resting places along the migration routes. In order to clarify the role of birds as transporters of ticks, it is a prerequisite that investigations are conducted at several locations in a large geographical region. In Northern Europe investigations have been conducted in Finland by Nuorteva & Hoogstraal (1963), and Saikku, Ulmanen & Brummer-Korvenkontio (1971); in Sweden by Ash (Arthur 1952), Brinck, Svedmyr & Zeipel (1965), and Nosek & Balat (1982). In Norway, however, the results of such investigations, have not been published.

The present study was initiated in 1964 and its aims were to ascertain which tick species infest migratory birds in Norway, and to compare the tick infestation of different bird species. We also attempted to isolate arboviruses from ticks collected from migratory birds arriving in Norway during spring in 1973 and 1974 (Traavik, Mehl & Petterson 1974).

MATERIAL AND METHODS

The study was initiated on the Akerøya island south of Fredrikstad. Collections were made by the senior author during the spring migration in 1964, 1965, 1968 and 1970, and during the autumn migration in 1966 and 1967. Jan Michaelsen examined a large number of birds in connection with bird ringing at the ornithological stations on the islands of Akerøya and Store Færder (map Mehl 1983) in 1967 and 1968 respecti-

vely. He also collected ticks for virus isolation attempts on Store Færder in 1973. Birds were examined for ticks on Akerøya by the late Gunnar Lid in 1965, 1967, 1969—71 and 1973—76. The late Einar Brun also participated with collections on Akerøya in 1967.

During these investigations we examined 3943 birds belonging to 65 species presented in Tabs. 2, 3 and 4. Beside this sample of birds, ticks were occasionally collected from birds without having registered the numbers of investigated birds, or else the number of birds examined on each occasion was too small to be included in the main material (Tab. 5).

Morten Brant collected 162 ticks from migratory birds on the small island Svenner 25 km to the southwest of Færder, from 21 April to 5 May 1974. The investigated birds were not counted.

During bird ringing in 1967 and 1968, only the heads of the birds were examined for ticks. During 1965, 1968 and 1970 the entire bodies of the birds were examined (by RM), as described by Mehl (1970). The birds captured in 11—13 May 1970 were sacrificed in connection with collecting blood samples, and the dead birds were frozen and subsequently examined. The majority of ticks were found on the head, around the base of the beak, and near the eyes and ears.

The ticks were preserved in alcohol and identified in the laboratory. Some nymphs of *Hyalomma* were maintained alive for subsequent development (Kaiser & Hoogstraal 1968). The samples collected by the late E. Brun were not available and are therefore unidentified. However, his information concerning total number investigated and number of infested birds are included in the Tabs. 3, 6 and 7.

A total number of 602 ticks were collected. Some of the material was used for arbovirus isolation attempts and the remainder is found in the collection of the Zoological Museum in Oslo.

RESULTS

The ticks collected in the present study are shown in Tab. 1. Five species were found. *Ixodes ricinus* (L., 1758) was the most dominant species accounting for 93% of the individuals. It was found on 21 of the 65 bird species which were examined (Tabs. 2, 3, 4 and 5). All of the *Ixodes arboricola* Schulze & Schlottke, 1929 (1 ♀, 12 nymphs and 7 larvae) are from a single *Sturnus vulgaris* examined on 28 May 1967 (Tab. 3). *Ixodes caledonicus* Nuttall, 1910 (1 ♀) was also collected from a *S. vulgaris* examined 2 June 1965 (Tab. 5). *Ixodes frontalis* (Panzer, 1798) was found on two species: 1 nymph from *Phylloscopus trochilus* on 17 May 1971 (Tab. 5), and 1 ♀ from *Prunella modularis* examined on 14 April 1965 (Tab. 2).

Hyalomma marginatum C.L. Koch, 1844 was collected from 4 host species: 14 nymphs from *Phoenicurus phoenicurus* (1N in Tab. 3, 13N in Tab. 5), 1 nymph from *Acrocephalus scirpaceus* (Tab. 3), 2 nymphs from *Lanius collurio* on 18 May 1971 and 1 nymph from *Phylloscopus trochilus* on 15 May 1975 (Tab. 5). All *H. marginatum* were collected during the period 15 May through 3 June. *H. marginatum* is overrepresented in Tab. 1 column B, and in Tab. 5 since special efforts were made to collect this species for virus isolations during the latter half of May 1973.

Since *I. ricinus* greatly dominated in the present study it is assumed that the unidentified ticks in 1967 (Tab. 3) were also *I. ricinus*, with the exception of the ticks collected from *Sturnus vulgaris*. On this host we have collected two other tick species, but never *I. ricinus*.

The samples of the unidentified ticks in 1967 are derived from the following bird species: *Anthus trivialis* 18 May, *Prunella modularis* 6 May, *Phylloscopus throchilus* 12 May, *Saxicola rubetra* 21 May, *Phoenicurus phoenicurus* 21 May, *Erithacus rubecula* 14 April, 5 May (2 birds), 22 May (2 birds), *Turdus pilaris* 6 May, *Turdus*

Table 1. Ticks collected from migratory birds on the islands of Akerøya, Svenner and Store Færder in the Outer Oslofjord. Column A: Ticks from birds in tables 2, 3 and 4. Column B: Ticks from birds in table 5 and from Store Færder in 1973.

Tick species	A	B	Total	%
Ixodes ricinus	324	237	561	93
Ixodes arboricola	20	0	20	3
Ixodes caledonicus	0	1	1	0,2
Ixodes frontalis	1	1	2	0,3
Hyallomma marginatum	2	16	18	3
Total	374	255	602	

Table 2: Ticks on migratory birds examined at Akerøya in 1965, 1968 and 1970. The columns indicate the number infested birds/number investigated birds. *Ixodes ricinus* was found on all the infested birds. One *Prunella modularis* in the period 14—17 April 1965 had both *I. ricinus* and *Ixodes frontalis*.

Bird species	6-15 April 1968	14-17 April 1965	30 April -5 May 1965	11-13 May 1970	Total
Falco columbarius		1			1
Falco tinnunculus	1				1
Lymnocryptes minimus		1			1
Columba palumbus			1		1
Jynx torquilla				6	6
Alauda arvensis				1	1
Anthus pratensis	4	1	3	2	10
Motacilla alba	3		3	2	8
Lanius excubitor	1				1
Sturnus vulgaris	5			3	8
Troglodytes troglodytes	3	2	1/2		1/7
Prunella modularis	12	2/5	1	1/1	3/19
Sylvia communis				4	4
Sylvia curruca				8	8
Phylloscopus trochilus				1/23	1/23
Phylloscopus collybita	1	2	1/3	11	1/17
Regulus regulus	9	2		15	26
Ficedula hypoleuca				2	2
Muscicapa striata				2	2
Saxicola rubetra				12	12
Oenanthe oenanthe	1	1	1	2	5
Phoenicurus ochruros		1			1
Phoenicurus phoenicurus			1	12/61	12/62
Erithacus rebecula	1/122	1/7	2/32	17/75	21/236
Luscinia svecica				1/3	1/3
Turdus pilaris		3	2	2	7
Turdus torquatus		1			1
Turdus merula	1/26	10	2/5	5	3/46
Turdus iliacus	5		1	1/1	1/7
Turdus philomelos	5	2	1/5	3/8	4/20
Parus caeruleus	1				1
Parus major	1				1
Fringilla coelebs	2	1			3
Fringilla montifringilla		2	1/2		1/4
Carduelis chloris		1	1		2
Emberiza citrinella	1				1
Emberiza schoeniclus			2		2
Calcarius lapponicus	1				1
Total	2/204	3/43	8/65	36/249	49/561
Prevalence (Passerines)	1,0%	7,3%	12,5%	14,8%	8,9%

Table 3. Ticks on migratory birds examined at Akerøya in 1967. The columns indicate the number infested birds/number investigated birds. Samples of ticks from 15 birds were not identified. They were probably *Ixodes ricinus* except for one sample from *Sturnus vulgaris*. The ticks on the remainder of the birds were *I. ricinus* with three exeptions: *Ixodes arboricola* on *Sturnus vulgaris* May 28, *Hyalomma marginatum* on *Acrocephalus scirpaceus* June 3. and on one *Phoenicurus phoenicurus* May 20.

Bird species	4-24 April	25 April -8 May	9-22 May	23 May- 5 June	Total
Haematopus ostralegus		1	2		3
Charadrius hiaticula	3	3	2		8
Vanellus vanellus			1		1
Arenaria interpres			1		1
Tringa hypoleucos			3		3
Scolopax rusticola		1			1
Streptopelia decaocto		1			1
Asio otus	1	1			2
Caprimulgus europaeus				2	2
Jynx torquilla		9	8		17
Hirundo rustica			5	5	10
Anthus trivialis		1/2	1/17	1	2/20
Anthus pratensis	9	2	4	3	18
Motacilla alba	5	4	7	1	17
Lanius collurio			6	8	14
Lanius excubitor		1			1
Sturnus vulgaris	19	1/17	21	1/8	2/65
Troglodytes troglodytes	12	2/19	2/3		4/34
Prunella modularis	2/31	2/8	1/2		5/41
Acrocephalus schoenobaenus			2	1	3
Acrocephalus scirpaceus			2	1/9	1/11
Hippolais icterina			8	22	30
Sylvia borin			48	75	123
Sylvia atricapilla			2/12	18	2/30
Sylvia communis			2/50	23	2/73
Sylvia curruca			21	25	46
Phylloscopus trochilus		14	3/529	2/216	5/759
Phylloscopus collybita	3	32	15	1	51
Phylloscopus sibilatrix			4		4
Regulus regulus	23	8	1		32
Ficedula hypoleuca		1	38	4	43
Muscicapa striata			1/29	24	1/53
Saxicola rubetra			1/14	2	1/16
Oenanthe oenanthe	3	5	63	15	86
Phoenicurus phoenicurus		12	11/159	4/27	15/198
Phoenicurus ochruros	1			1	2
Erithacus rubecula	1/45	16/185	4/19		21/249

Table 3 (Continued)

Bird species	4-24 April	25 April - 8 May	9-22 May	23 May-5 June	Total
Luscinia svecica			2		2
Turdus pilaris	6	1/16	2	1	1/25
Turdus torquatus		1/3	6	1	1/10
Turdus merula	6/119	1/16	4	1	7/140
Turdus iliacus	18	4			22
Turdus philomelos	24	3/26	1/16	1	4/67
Parus ater	1				1
Fringilla coelebs	5				5
Fringilla montifringilla		2/5	1/1	1	3/7
Carduelis chloris	1				1
Carduelis spinus		1/3	1		1/4
Acanthis cannabina				1	1
Pyrrhula pyrrhula	3		1		4
Emberiza citrinella		2			2
Emberiza schoeniclus	1	2	20	1	24
Calcarius lapponicus		1			1
Total	9/333	31/404	30/1149	8/498	78/2384
Prevalence (Passerines)	2.7%	8.0%	2.7%	1.6%	3.3%

philomelos 11 May, *Fringilla montifringilla* 6 May (2 birds) and *Sturnus vulgaris*, 6 May.

The investigations were carried out over a number of years during various periods in the spring. The results are listed in chronological order. The total sample of birds examined for ticks, including infestation rates, are shown in Tabs. 2, 3 and 4.

Ticks were found on 164 of 3,943 birds yielding a mean prevalence of 4.2%. Ticks from 15 of the birds in Tab. 3 were neither counted nor identified. There were 347 ticks on the remaining 149 birds yielding an infestation rate of 2.3 ticks per infested bird.

I. ricinus was found on 146 (98%) of the 149 birds from which tick samples were identified (Tab. 2, 3 and 4). One of these birds also had *I. frontalis* (Tab. 2). Two other tick species were found on the three remaining birds (Tab. 3): *I. arboricola* from *Sturnus vulgaris*, and *H. marginatum* from *Acrocephalus scirpaceus* and *Phoenicurus phoenicurus*.

Information on 212 ticks from an unknown number of host species are included in Tab. 5. In addition to these are ticks collected on Store Færder during the period 30 April–16 May 1973 (included in Tab. 1). This last sample consists of 27 nymphs and 3 larvae of *I. ricinus* from *Turdus merula*, *T. torquatus*, *T. philomelos* and *T. iliacus*, and 8 nymphs and 5 larvae of *I. ricinus* from *Troglodytes troglodytes*, *Phylloscopus collybita* and *Erithacus rubecula*.

Only passerine birds were found to be infested with ticks. 52 specimens from the following orders were also examined: Charadriiformes, Falconiformes, Columbiformes, Caprimulgiformes, Piciformes and Strigiformes.

The prevalence of ticks on passerines for each collection period varied between 1.0% and 14.8% (Tab. 2, 3 and 4). On Akerøya in 1967 the prevalence was highest (8%) during the period 25 April through 8 May, and lowest (1.6%) from 23 May to 5 June. On Færder in 1968 the prevalence was highest (5.1%) from 16–25 May and lowest (1.8%) during the period 6–16 April. During 6–15 April 1968, the prevalence of ticks on birds from Akerøya was very low (1%), whereas during the corresponding period in 1965 it was relatively high (7.3%). The highest prevalences in the present study were observed during the first week of May in 1965 (12.5%) and the second week of May in 1970 (14.8%).

The ornithological stations Akerøya and Store

Table 4. Ticks, *Ixodes ricinus*, on migratory birds on the island Store Færder in 1968. The columns indicate the number infested birds/number investigated birds.

Bird species	6-16 April	16-25 May	3-8 June	Total
Accipiter nisus	1			1
Asio otus	2			2
Hirundo rustica		3	4	7
Anthus trivialis			1/1	1/1
Anthus pratensis	3		1	4
Anthus spinoletta	2	3	3	8
Motacilla alba		6	1	7
Troglodytes troglodytes	3			3
Prunella modularis	3/29			3/29
Acrocephalus scirpaceus			1	1
Hippolais icterina		3	1	4
Sylvia borin		3	27	30
Sylvia atricapilla		9	10	19
Sylvia communis		14	6	20
Sylvia curruca		11	2	13
Phylloscopus collybita	13	2		15
Phylloscopus trochilus		15/404	27	15/431
Regulus regulus	37			37
Ficedula hypoleuca		8	2	10
Ficedula parva		3	1	4
Muscicapa striata		17	9	26
Saxicola rubetra		4	2	6
Oenanthe oenanthe		6	3	9
Phoenicurus phoenicurus		5/27	1	5/28
Erithacus rubecula	2/141	1		2/142
Luscinia svecica		1/2		1/2
Turdus pilaris	3	5/8	2/2	7/13
Turdus merula	1/74	1/2		2/76
Turdus iliacus	12			12
Turdus philomelos	10			10
Turdus viscivorus	1			1
Fringilla coelebs	7			7
Fringilla montifringilla	2			2
Carduelis chloris		1/2		1/2
Carduelis spinus	2			2
Acanthis cannabina		2	4	6
Emberiza citrinella	2	1		3
Emberiza schoeniclus		4	1	5
Total	6/344	28/545	3/109	37/998
Prevalence (Passerines)	1,8%	5,1%	2,8%	3,7%

Table 5. Collections of ticks from migratory birds on the islands of Akerøya, Store Færder and Svenner from 1965 to 1976, made from small samples of birds or from birds not counted.

LOCATION Bird species	Month	Ticks spp.	No. ticks/ No. birds
AKERØYA			
Motacilla alba	June	*I. ricinus*	1N/1
Lanius collurio	May	*H. marginatum*	2N/1
Sturnus vulgaris	June	*I. caledonicus*	1♀/1
Troglodytes troglodytes	Oct.	*I. ricinus*	3L/1
Sylvia communis	May	"	1N/1
Sylvia curruca	May	"	1N/1
Phylloscopus trochilus	May	*I. frontalis*	1N/1
Phoenicurus phoenicurus	May	*I. ricinus*	1N/1
" "	May	*H. marginatum*	2N/1
Erithacus rubecula	Sept.	*I. ricinus*	3N/1
Turdus pilaris	June	"	1N 2L/1
Turdus merula	Oct.	"	4N/2
" "	April -May	"	2N/2
STORE FÆRDER			
Sylvia communis	May	*I. ricinus*	1N/1
Phylloscopus trochilus	May	*H. marginatum*	1N/1
Phoenicurus phoenicurus	April	*I. ricinus*	2N 4L/1
" "	May	*H. marginatum*	11N/?
Turdus merula	April	*I. ricinus*	4N/2
Turdus iliacus	April	"	2N/1
SVENNER			
Anthus trivialis	April	*I. ricinus*	3N/?
Prunella modularis	-May	"	3N/?
Erithacus rubecula	"	"	17N 4L/?
Turdus merula	"	"	125N 7L/?
Turdus philomelos	"	"	3N/?

Færder are located 20 km from each other in the outer Oslo fjord. It was therefore assumed that this short distance would not influence the tick infestation rate on migratory birds. The data in Tabs. 2, 3 and 4 were therefore combined in Tab. 6 and 7.

The prevalence and mean numbers of *I. ricinus* per infested bird for the most common species are shown in Tab. 6. In this table the birds are grouped according to the habitats where they feed and carry out other activities. The species having the highest infestation rates are those which feed on the forest floor and the ground at the edge of forests. Species which are rarely on the ground, and birds which remain on open fields with short grasses have few if any ticks.

There were sufficiently large samples for six species of birds to allow a comparison of infestation rates for different periods during spring (Tab. 7). The prevalences showed large variations between collections and were greater in May than in April.

Table 6. Prevalence and mean numbers of the tick *Ixodes ricinus* on the most common birds from tables 2, 3 and 4. The birds are arranged in groups according to where they carry out the majority of their food searching and general activity. The largest species, the thrushes, are placed in a group by themselves.

HABITATS Bird species	No. birds	Prevalence of ticks %	No. of ticks per infested bird
THRUSHES. SEARCH FOR FOOD ON THE GROUND			
Turdus pilaris	45	17,8	8,6
Turdus philomelos	97	8,2	2,1
Turdus merula	262	4,6	1,4
Turdus iliacus	41	2,4	2,0
SEARCH FOR FOOD ON THE GROUND IN THE WOODS			
Anthus trivialis	21	14,3	4,5
Prunella modularis	89	12,4	1,5
Troglodytes troglodytes	44	11,4	3,2
Phoenicurus phoenicurus	288	11,1	1,8
Erithacus rubeculae	627	7,0	1,9
SEARCH FOR FOOD IN BUSHES AND TREES			
Sylvia atricapilla	49	4,1	3,0
Sylvia communis	97	2,1	1,0
Phylloscopus trochilus	1213	1,7	1,8
Phylloscopus collybita	83	1,2	1,0
Muscicapa striata	81	1,2	1,0
Sylvia borin	153	0	0
Sylvia curruca	67	0	0
Regulus regulus	95	0	0
Ficedula hypoleuca	55	0	0
SEARCH FOR FOOD ON THE GROUND IN OPEN FIELDS			
Motacilla alba	32	0	0
Anthus pratensis	32	0	0
Oenanthe oenanthe	100	0	0

The prevalence in *Erithacus rubecula* varied greatly, increasing continuously from 0.8% in mid-April to 22.7% in mid-May. Concerning *Turdus philomelos* (n = 39) ticks were never found during the first collection period, whereas this species (n = 55) hosted relatively many ticks during the following four periods. The prevalence of ticks on the same host species for the same period can also show large variations from year to year as exemplified by *Phoenicurus phoenicurus* and *Phylloscopus trochilus* during the period 9—25 May during 1967, 1968 and 1970. The prevalence for both hosts were low in 1967 and high in 1968 and 1970.

The number of ticks, larvae and nymphs, per bird are shown in Fig. 1. Most of the birds hosted a single individual, and more rarely 2 or 3 ticks, and a few had more than 5. This tendency is similar for thrushes (*Turdus* spp) and for the smaller birds with the exception of thrushes during the last period when the number of ticks per host varied from 1 to 14. However, it appeared as though most of the thrushes were not migrating, but seemed to be more or less stationary during the last collection period.

Small birds having 4 or more ticks had only larvae or else more larvae than nymphs.

The relationship between the number of larvae and nymphs varied with both season and size of bird. The thrushes hosted few larvae, with larvae accounting for 5% of all ticks during the first two periods together, and 14% during the last period.

The relative number of larvae for the smaller birds during the first period was similar to that for the thrushes, but the proportion of larvae increased during the three following periods to 57%, 64% and 71%. There were only small differences between the different species when one does not take into account species which are represented by only a few individuals. *Troglodytes troglodytes* and *Phylloscopus trochilus,* the smallest birds, had a greater proportion of larvae than the average with *P. trochilus* having 81% larvae during the last period.

A similar pattern for the proportions of larvae and nymphs were also observed for birds collected on Færder from 30 April to 16 May 1973. The larvae accounted for 10% of the ticks found on thrushes and 38% on the smaller birds. For birds captured from 21 April to 5 May 1974 on the island of Svenner, the larvae accounted for 5% of the ticks on thrushes and 15% on the smallest birds.

The attachment site for 60 ticks revealed that the preferred site was the corner of the mouth where 76% of all ticks were found. Half of these ticks were attached inside the rim of the gape and the other half on the outside. Eight percent were attached between the beak and the eyes, 6% on the proximal border of the lower beak, 3% on the eyelids, 3% on the top of the head, 3% behind the ears and 1% in the ear opening.

DISCUSSION

The results of the present investigation are similar to the findings of studies of ticks on migra-

Table 7. The prevalence (in per cent) of *Ixodes ricinus* on six species of birds from nine sampling periods in the spring from 1965 to 1970 on the islands of Akerøya and Store Færder. (Data from Tables 2, 3 and 4). Symbols O = no ticks found on the investigated birds. x = ticks found, but only a few birds investigated. - = no birds examined.

Bird species	6-15 April 1968 Akerøya	6-16 April 1968 Færder	4-24 April 1967 Akerøya	30 April - 5 May 1965 Akerøya	25 April - 8 May 1967 Akerøya	11-13 May 1970 Akerøya	9-22 May 1967 Akerøya	16-25 May 1968 Færder	23 May- 5 June 1967 Akerøya	No birds
Turdus merula	3,8	1,4	5,0	x	6,3	0	0	x	0	262
Prunella modularis	0	10,3	6,5	0	x	x	x	-	-	89
Erithacus rubecula	0,8	1,4	2,2	6,3	8,6	22,7	21,0	0	-	627
Turdus philomelos	0	0	0	x	11,5	x	6,3	-	0	97
Phoenicurus phoenicurus	-	-	-	0	-	19,7	6,3	18,5	14,8	288
Phylloscopus trochilus	-	-	-	-	0	4,3	0,6	3,7	0,9	1213

tory birds in Southern Sweden and Southern Finland, with regard to the tick species which were found, their relative numbers and the relative importance of individual host species (Arthur 1952, Nuorteva & Hoogstraal 1963, Brinck et al. 1965, Saikku et al. 1971, Nosek & Balat 1982). In these studies *I. ricinus* (254 samples, n = 482) was the most common species on birds during the spring, followed by *I. arboricola* (4 samples, n = 145), and *H. marginatum* (8 samples, n = 18). During autumn, on the other hand, they found *I. ricinus* (156 samples, n = 342), two samples of *Haemaphysalis punctata* Canestrini & Fanzango, 1877 (n = 2), and *I. arboricola* (n = 1). The proportion of *I. arboricola* was larger than in our investigation due to the large numbers of ticks which were collected from 2—3 *Sturnus vulgaris*. Furthermore, we found two additional tick species, *I. frontalis* and *I. caledonicus*, neither of which have previously been observed on migratory birds in Fennoscandia.

In the five other Nordic investigations ticks were found on passerine birds only, with the two exceptions of *Accipiter nisus* and *Aegolius funereus*. In these other investigations a total of 7229 passerines and 556 birds from the following orders were examined: Anseriformes (n = 46), Falconiformes (n = 38), Charadriiformes (n = 423, of these 411 were Charadrii), Columbiformes (n = 4), Cuculiformes (n = 4), Strigiformes (n = 17), Caprimulgiformes (n = 3), Apodiformes (n = 9), and Piciformes (n = 12). In addition to these samples, Brinck et al. (1965) and Saikku et al. (1971) examined a large number of birds where only birds (n = 162) hosting ticks were denoted.

During spring in Finland, Nuorteva & Hoogstraal (1963) found ticks on 2.4% of the passerines they examined (n = 2455), and Saikku et al. (1971) found ticks on 3.7% of the passerines (n = 2980). These values are slightly lower than the mean infestation rate of 4.2% in our investigation, but are well within the range for the different sampling periods in Norway. The mean number of ticks per infested bird were 1.9 and 1.8 in these two Finnish studies, and in Sweden Brinck et al. (1963) found an average of 1.8 ticks

per infested bird during spring. These values are also lower than our mean value of 2.3 ticks per infested bird. These differences in observed infestation rates are probably due to a number of variables such as phenology, the weather during collection periods, the relative numbers of host species, differences in their migration routes, and personal examination techniques, etc.

Nuorteva & Hoogstraal (1963) made a rough calculation whereby each year approximately 2.3 million ticks enter Finland with migratory birds, and that a similar number of ticks are transported out again during the autumn migration.

The most important and most heavily infested hosts for *I. ricinus* in the present study were the same species as in the other nordic studies: Thrushes *Turdus* spp., *Erithacus rubecula, Phoenicurus phoenicurus, Prunella modularis, Anthus trivialis* and *Luscinia svecica*. To these species we add *Troglodytes troglodytes*. These birds feed mainly on the ground both in and along the borders of woods, which are the best habitats for *I. ricinus*. The most heavily infested bird in Finland was *Turdus iliacus* (Saikku et al. 1971). However, in our material it was the least infested *Turdus* species.

We found the highest prevalence values for *I. ricinus* on robins *Erithacus rubecula*, 21% and 22.7%, and on redstarts *Phoenicurus phoenicurus*, 18.5% and 19.7%, during the middle of May (Tab. 7). However, the mean values for these two species are much lower (7% and 11.1%, respectively (Tab. 6)) because most of the robins migrate early in the season (April) when tick activity and infestation rates are low, and for the redstart about half of the entire sample was collected in 1967 when the number of ticks during the middle of May was generally low. The peak migration for redstarts is in mid May, a period when tick activity is much greater than in April.

It is impossible to determine the place of origin for the ticks that are transported to Norway with migratory birds. They probably originate from a very large area, because the species of birds (and even different populations of the same species) have different overwintering areas, different migratory routes, and migrate during different periods during spring and autumn. The migratory routes are also influenced by prevailing weather conditions and thus can vary from year to year. The dominant direction of migration during spring in Northern Europe is from southwest towards northeast, and the opposite direction during autumn. However, a number of species *Lanius collurio, Motacilla alba, Sylvia curruca, Luscinia svecica* and *Luscinia luscinia* migrate towards the southeast during the autumn migration and return from the same direction during the following spring. (Salomonsen 1967, Nosek & Folk 1977, Alerstam 1982).

The length of time used during migration will influence the ability of birds to spread ticks. *I. ricinus* larvae remain attached to its bird host for 2—5 days whereas nymphs remain attached for 2—7 days (Balashov 1972). This relatively short period limits the ability to spread *I. ricinus* when compared with *H. marginatum* which can remain on birds for 12—27 days (Balashov 1972). In general, the spring migration goes faster than the autumn migration. However, it is difficult to predict the rate of migration over long distances. Bird ringing has revealed that birds have flown from Iceland to Southern France in four days, and from Denmark to Akerøya in one day.

Weather conditions have the greatest influence on the birds which migrate earliest during the spring. The prevailing weather conditions influence the initiation of migration, the speed and routes for the earliest migrators to a much greater extent than those birds which migrate at the end of May and beginning of June (Salomonsen, 1967, Nosek & Folk 1977, Alerstam 1982).

Weather is very variable during early spring with temperatures varying above and below the temperature limits of tick activity. Consequently, it is possible to observe large variations in infestations on the earliest migrating birds. This especially applies to species such as *Prunella modularis, Erithacus rubecula, Turdus merula* and other species of *Turdus*. This phenomenon has been demonstrated in Finland by Saikku et al. (1971) and in our material.

It appears likely that very few of the ticks are picked up by the birds on Akerøya and Store Færder, since the populations of *I. ricinus* on these islands are very small, and because the birds spend a very short time here before continuing their migration. Mehlum (1983) found that robins remained on the islands for about half of a day and only a few birds remained for several days.

During the first collection period (4—24 April) we found nymphs of *I. ricinus* almost exclusively (Fig. 1). During the period from 25 April to 8 June there was a large increase in the proportion of larvae on small passerines, yet the thrushes still had few larvae. A possible explanation for these observed differences is that nymphs become active earlier in the spring than

larvae, and that small birds are more able to pick up larvae than the larger thrushes. In central Europe and England, nymphs are active in April whereas larvae first become active in May (Barnett 1969, Nosek & Folk 1977).

We assume that birds mainly become infested with *I. ricinus* when they attempt to eat them, and that larvae, because of their small size, are less attractive for thrushes than for small passerines. If this hypothesis is correct, it also helps to explain why the majority of *I. ricinus* are attached near the beak or even inside the gape. The ticks may hang onto the beak, either on the inside or outside, and thus avoid being swallowed. They may also escape from the grasp of the beak, as we have seen them twist from the grip of forceps, and continue to climb up the beak.

I. frontalis were collected from two birds, *Prunella modularis* and *Phylloscopus trochilus*. Both ticks were nearly fully engorged indicating that they probably became attached outside Norway. *I. frontalis* has not been reported previously from Fennoscandia, but has been observed twice in Denmark (Schulze 1929, Arthur 1955).

Both *I. caledonicus* and *I. arboricola* were found on *Sturnus vulgaris* during the end of May and the beginning of June. This period corresponds to the end of nesting period for starlings and it is therefore likely that the ticks were collected from resident birds or roaming nonbreeding birds. Both of these tick species occur in Denmark, Sweden and the British Isles (Schulze 1930, Arthur 1955, 1963). *I. arboricola* has previously been collected on migrating birds in Sweden (Brinck et al. 1963, Nosek & Balat 1982). *I. frontalis, I. caledonicus* and *I. arboricola* are exclusively bird ticks (Nosek & Folk 1977).

Records of *H. marginatum* in Norway, Finland, Sweden and Denmark demonstrate long distance dispersal of ticks by birds from the Mediterranean Countries, Southwest USSR and Africa.

Birds migrating from Africa and the Mediterranean countries into Northern Europe may carry two sub-species of the tick *H. marginatum: H. m. rufipes* Koch, 1844 which occur in most of Africa (Ethiopian Fauna Region) and *H. m. marginatum* which inhabits the southwestern Plaearctic Fauna Region, from southwestern USSR and Northern Iran through much of the Mediterranean Basin to the Atlantic. However, it is usually impossible to separate the nymphs found on migratory birds into subspecies. In Finland one nymph was positively identified as *H. m. rufipes* (Saikku et al. 1971), whereas we identified one female, reared from a nymph, as *H. m. marginatum* (Mehl 1983).

H. marginatum is a two-host tick. Larvae moult to nymphs without detaching from the host, and therefore remain attached for a longer period (12—27 days) than the three-host tick *I. ricinus*. Consequently, they can be transported with migrating birds over longer distances.

Immature stages of *H. marginatum* chiefly infest birds and small mammals. Adults mainly feed on large wild and domestic artiodactyl mammals. Thus, nymphs have been collected on migrating birds in Central- and Northern Europe, from Finland in the east to the British Isles in the west (Brinck et al. 1965). Adult ticks rarely occur in this region. Cerny (1972) reported an adult *H. marginatum* on cattle in Czechoslovakia. Johnsen (1943) caught an adult male in the vegetation on the island of Bornholm in Denmark. The date of capture, 5 June, indicates that the tick most likely overwintered there.

H. marginatum was the prevalent ticks on migrating birds in Cyprus (Kaiser, Hoogstraal & Watson 1974) and accounted for 81% and 95% of all ticks during autumn and spring, respectively. Forty seven out of 92 investegated species of birds were infested with this tick. Many of these birds breed in Northern Europe.

In Finland, Denmark, Sweden and Norway *H. magrinatum* has been found on 11 species of birds: *Anthus trivialis, Motacilla alba, Motacilla flava, Lanius collurio, Acrocephalus scirpaceus, Phylloscopus trochilus, Oenanthe oenanthe, Phoenicurus phoenicurus, Luscinia luscinia* (From Denmark, Mehl unpublished), *Luscinia svecica* and *Emberiza hortulana*. In Finland and Sweden 2/3 of the ticks were collected from three specimens of *Anthus trivialis*. Each of the other bird species have been reported as being host species only once. *Anthus trivialis* was one of the most common hosts for *H. marginatum* on Cyprus. In Norway, most of the specimens were collected from *Phoenicurus phoenicurus*, a less frequent host on Cyprus.

In Switzerland (Aeschlimann & Büttiker 1975), the recorded hosts for *H. marginatum* were: *Turdus viscivorus, Luscinia svecica, Motacilla alba, Acrocephalus scirpaceus* and *Phoenicurus phoenicurus*, and in Czechoslovakia (Cerny 1972); *Anthus trivialis, Luscinia svecica* and *Erithacus rubecula*. This is much the same species as in the Nordic countries and we might conclude that among these 13 bird hosts for *H. marginatum* we have the most important transporters of *H. marginatum* into Northern Eu-

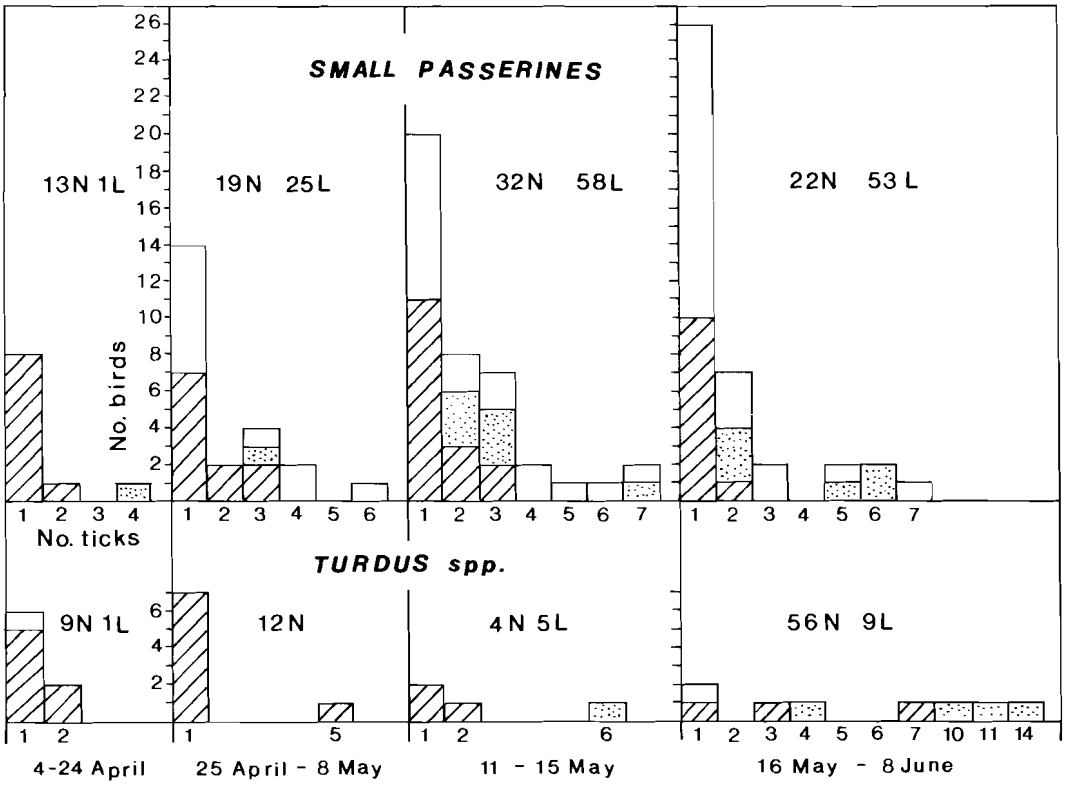

Fig. 1. Number of ticks, *Ixodes ricinus*, on the birds from four collection periods during spring. Data from several years. Hatched = the birds had only nymphs (N), unhatched = the birds had only larvae (L), dotted = the birds had both nymphs and larvae.

rope. These birds return to Scandinavia in spring from both south and south-east.

Arboviruses can be spread over large distances by the birds themselves or in the ticks which they carry (Hoogstraal 1972, Watson, Shope & Kaiser 1972). The first arbovirus isolated in Norway, Uukuniemi virus, came from *I. ricinus* collected from migrating birds on Store Færder in early May 1973 (Traavik, Mehl & Petterson 1974).

Ticks are also vectors for bacteria, Rickettsia and Protozoa causing diseases in man and domestic animals.

We have observed a number of *I. ricinus* adults on farm animals and dogs in districts outside of this ticks' distribution area in Norway (Mehl 1983). These ticks were probably transported up the valleys in central Norway by migrating birds from the coast of Norway or from other countries. These records demonstrate the possibilities of spreading diseases to domestic animals by ticks which have been transported with birds over great distances, and to regions where ticks do not normally reside.

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Short communications

NYE FUNN AV BILLER I NORGE

JOHAN ANDERSEN, TORE R. NIELSEN & KARL ERIK ZACHARIASSEN

The article presents a list of 61 species of Coleoptera which either are new to certain districts in Norway or are of special interest for other reasons, e.g. due to their rarity. The new records are the northernmost in Norway for five species.

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I denne artikkelen publiseres 61 funn av biller som representerer ny utbredelse for vedkommende art i henhold til Lindroth (1960) med senere kompletteringer av Strand (1977), Zachariassen (1972 og 1977) Nilssen og Andersen (1977), Engdal og Zachariassen (1979) og Refseth (1979).

Dessuten er det tatt med enkelte funn som ikke representerer ny utbredelse, men som fortjener omtale på grunn av artens sjeldenhet eller funnomstendighet. Funn som representerer ny nordgrense for vedkommende art i Norge er merket ^{N}. I tilfelle der funnene er gjort av andre enn forfatterne er dette angitt i parentes. Nomenklaturen følger Silfverberg (1979) med de tidligere navnene i parentes.

Blethisa multipunctata (L.): STI. Selbu. Ved bredden av Selbusjøen.

Bembidion grapii Gyllenhal: TRY: Senja, Straumsbotn, 25.7.1973. Ett eksemplar. Tromsø, Tønsvika og Tromsø: Flere eksemplarer i sandtak og i veiskjæringer.

Bembidion litorale (Olivier) AK: Gjerdrum 28.8.1971. I antall på leirskrent ved bredden av Leira.

Tachys (Tachyta) nanus (Gyllenhal) AAY: Åmli, Dølemo, 25.7.1981. To eksemplarer under bark på tørr granstamme.

Badister bullatus (Schrank) *(bipustulatus* Fabricius) ON: Lalm, 30.5.1981. Ett eksemplar i tørr, sørvendt skiferskråning med xerofil vegetasjon. Sammen med bl.a. *Harpalus puncticollis* Paykull.

Harpalus solitaris Dejean *(fuliginosus* Duftschmid) FI: Karasjok, Assebakte 10.7.1977. Ett eksemplar under planke på nesten tørr, vegetasjonsløs sand i et sandtak.

Amara familiaris (Duftschmid) TRY: Tromsø^{N}. Gjentatte funn på kultivert mark i mai—juni.

Amara tibialis (Paykull) STI: Heimdal, Øysand, nær utløpet av Gaula, august 1979. Ett eksemplar springende fremme på tørr sand. Ellers bare tatt ved Røros i STi.

Agonum dolens (Sahlberg) NTI: Snåsa^{N}, Snåsavatn, juni 1972. Ett eksemplar på meget fuktig mudderbunn med vegetasjon av bl.a. *Scirpus* sp.

Agonum piceum (L.) NTI: Snåsa^{N}, Snåsavatn, Juni 1972. Flere eksemplarer tatt sammen med den foregående art.

Dromius agilis (Fabricius) TEI: Treungen, Høgefoss, 7.7.1982. Under bark på granstokk i skyggefull granskog.

Haliplus fulvus (Fabricius) NNV: Andøya, Prestvatn, (Leg. A. Klemetsen).

Pteroloma forsstroemi (Gyllenhal) NNØ: Narvik, Forselv i Skjomen, juni 1979. Under stein og mose ved liten elv.

Anisotoma axillaris Gyllenhal AAY: Tvedestrand, Laget, 13.7.1979. I antall på sopp på gammel granstubbe.

Ocypus (Staphylinus) opthalmicus (Scopoli) TEY: Kragerø, Kammerfoss, 23.7.1980. (Leg. Mauritz Tangen).

Lomechusoides (Lomechusa) strumosus (Fabricius) AK: Oslo, Gaustad, juni 1963—65. Arten var tallrik under en stein med tue av *Formica sanguinea*. Området ble oppsøkt i august 1979, men det var da sterkt forandret og hverken maur eller kortvinger ble funnet. Ingen andre norske funn av arten synes å foreligge siden 1930-årene.

Hypocaccus (Saprinus) rugifrons (Paykull) AAY: Tromsøy, Hove, 14.8.1977. Svermende ved sandstrand om dagen.

Dendrophilus pygmaeus (L.) NNØ: Narvik, Forsheim i Skjomen, juni 1977. Flere eksemplarer i maurtuer av *Formica* sp.

Lygisopterus sanguineus L. AAI: Bygland, 14.7.1976.

Actenicerus (Corymbites) sjaelandicus (Müller) FØ: Sør-Varanger, v. Sortbrysttjern, 30.6.1977.

Trixagus (Throscus) carinifrons (Bonvouloir) TEI: Treungen, Høgefoss, 7.7.1982. Krypende på granstokk, aften.

Melanophila cyanea (Fabricius) TEI: Treungen, Høgefoss, Eikhom, 6.7.1982. Svermende på furutømmer.

Chrysobothris affinis (Fabricius) TEI: Treungen, Høgefoss, Eikhom, 7.7.1982. Krypende på nyfelt furutre i solskinn.

Agrilus angustulus (Illiger) VAY: Søgne, 11.7.1978. Svermende i antall rundt eikebusker nær vedstabel med eikeved.

Agrilus sulcicollis Lacordaire VAY: Søgne, 11.7.1980. Ett eksemplar tatt på eiketømmer.

Dascillus cervinus (L.) ON: Fron, Hammeren ved Hundorp 8.7.1981.

Glishcrochilus quadripunctatus (L.) NNØ: Narvik, Gamnes i Skjomen, juni 1980. Noen eksemplarer under furubark.

Ipidia quadriplagiata Biström (*quadrimaculata* Qu-

ensel) TEI: Treungen, Eikhom ved Høgefoss, 7.7.1982. Under bark på furustokk.

Rhizophagus cribratus Gyllenhal AAY: Gjerstad 21.7.1981. I vedstabel.

Rhizophagus ferrugineus (Paykull) NNØ: Narvik, Gamnes i Skjomen, juni 1980. Under furubark.

Rhizophagus nitidulus (Fabricius) AAY: Tvedestrand, Laget, 22.7.1981. Under bark på eikestokk.

Silvanoprus fagi (Guérin-Méneville) AAY: Gjerstad, 21.7.1981. Tre eksemplarer på løvtreved.

Dendrophagus crenatus (Paykull) TEI: Treungen, Høgefoss, 6.7.1982. Under bark på granstamme i skyggefull skog.

Pediacus fuscus Erichson FN: Vadsø, Vestre Jacobselv^{N}, 17.7.1967. Tallrike eksemplarer tatt svermende om ettermiddagen i åpen bjerkeskog.

Cerylon fagi Brisout de Barneville AAY: Tvedestrand, Laget, 21.7.1980. Tatt under bark på ospestamme.

Anisosticta strigata (Thunberg) TRY: Tromsø, september. Flere år på rad tatt i antall ved sikting av strø og vegetasjon i en kalkmyr. I ytre Troms tidligere tatt i Finnkroken.

Calvia (Propylaea) quattuordecimpunctata (L.) RY: Finnøy, Eidssund, 29.5.1977.

Arpidiphorus (Aspidiphorus) orbiculatus (Gyllenhal) NNØ: Narvik, Skjomen, juni 1979. Ett eksemplar på slimsopp på furustubbe.

Stephanopachys linearis (Kugelann) FØ: Sør Varanger, Lyngmo i Øvre Pasvik, juli 1967. Flere eksemplarer tatt svermende om kvelden (ca. kl. 22.00) i varmt, stille og overskyet vær.

Ptilinus fuscus (Fourcroy) TEI: Treungen, Eikhom ved Høgefoss, 7.7.1982. Under bark på liggende ospestammer. I antall.

Mordella holomelaena Apfelbeck TEY: Kragerø, Kammerfoss, 25.7.1967.

Zilora ferruginea (Paykull) TEI: Treungen, Eikhom ved Høgefoss, 7.7.1982. Ett dødt eksemplar under bark på furustubbe.

Hallomenus axillaris (Illiger) VAY: Vennesla 25.7.1981. Under soppbevokst bark på granstubbe.

Bius thoracicus (Fabricius) TEI: Treungen, Høgefoss, 7.7.1982. Puppe av arten funnet under bark på granstokk i tømmerlunne i skyggefull granskog.

Potosia (Cetonia) cuprea (Fabricius) NNØ: Narvik, Sandvika og Klubbvika i Skjomen, juni 1976 og 1979. Flere eksemplarer ved utsivende saft av nylig felt bjørk. Også tatt flyvende.

Tragosoma depsarium (L.) AAY: Åmli, Dølemo, 25.7.1981. Ett eksemplar (♀) tatt under løs bark på liggende granstamme.

Asemum striatum (L.) VE: Tønsberg, 24.7.1980. Dødt eksemplar funnet i barkbillefelle. NNØ: Narvik, Gamnes i Skjomen, juni 1980. Ett eksemplar på furutømmer.

Callidium aeneum (Degeer) OS: Gausdal, Svatsum, 17.7.1981.

Callidium coriaceum Paykull TEI: Treungen, Høgefoss, 6.—7.7.1982. Tre eksemplarer tatt om aftenen (ca. kl. 23.00) på grantømmer i skyggefull granskog. Mange utgangshull i tømmeret.

Callidium violaceum (L.) FN: Tana, Levajok, 5.7.1977.

Clytus arietis (L.) BØ: Lier, Sylling, 8.8.1982. Ett eksemplar funnet dødt i barkbillefelle.

Saperda carcharias (L.) NNØ: Narvik, Straumsnes^{N}, 16.7.1980. (Leg. E. Pedersen). Også observert flyvende ved Forså i Skjomen. 29.7.1972 (Obs. K. Felsted). Tidligere nordligste funn i Rana-distriktet.

Donacia obscura Gyllenhal NNØ: Narvik, Klubbviksetra i Skjomen, juni 1979. I dam.

Plateumaris discolor (Panzer) NNØ: Narvik, Klubbviksetra i Skjomen, juni 1979. Tatt sammen med den foregående.

Gonioctena Chevrolat (*Phytodecta* Kirby) *quinquepunctata* (Fabricius) HOY: Fana, Paradis, 23.5.1970.

Cimberis (Rhinomacer) attelaboides (Fabricius) NNØ: Narvik, Sandvika i Skjomen, juni 1980. Ett eksemplar tatt på furu.

Otiorrhynchus raucus (Fabricius) BØ: Nedre Eiker, Solbergelva, 24.5.1979. To eksemplarer på husvegg, ettermiddag.

Hylobius piceus (Degeer) TEI: Treungen, 25.7.1981. I antall i barkbillefeller.

Hypera (Phytonomus) diversipunctata (Schrank) (*elongata* Paykull) AAY: Tvedestrand, Laget, 21.7.1980. På gressmark.

Dendroctonus micans (Kugelann) VE: Tønsberg, 24.7.1980. I barkbillefelle.

Hylastes attenuatus Erichson BØ: Nedre Eiker, Solbergelva, 24.5.1979. På husvegg, ettermiddag.

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LØPEBILLEFUNN FRA FORSKJELLIGE DELER AV NORGE; DE FLESTE FRA INDRE TELEMARK (TEi) (COLEOPTERA)

SINDRE LIGAARD

During the last three years 36 carabidae species new to different Norwegian regions, mainly within Telemark (TEi), have been registered.

Sindre Ligaard, Kvitsund gymnas, N-3850 Kviteseid, Norway.

I løpet av de tre siste årene har jeg gjort en del carabide-funn som ikke er registrert i **Catalogus Coleopterorum Fennoscandiae et Daniae** eller i tillegg til denne katalogen. De fleste funnene er fra Telemark hvor jeg nå er bosatt. Katalogen synes å være mangelfull når det gjelder indre Telemark (TEi). Dette gjelder derimot ikke bare familien *Carabidae* men også andre billefamilier, noe jeg håper å komme tilbake til senere.

Carabus coriaceus L. TEi. Kviteseid. 1 eks. funnet på en åker nær Kviteseid sentrum 6.9.83.

Cychrus caraboides (L.) HEs. Hamar. En relativt vanlig art spesielt om våren i Hamar-området.

Blethisa multipunctata (L.) AAy: Grimstad 7.6.83. 8 eks. funnet ved et lite vann nær Drotningborg. Billene kom fram under nedtramping av mose.

Dyschirius aeneus (Dejean). Ø. Eidsberg, 28.7.82. 1 eks. på vestsiden av Glomma.

D. aeneus TEi. Kviteseid 4.6.83. 4 eks. innerst i Sundkilen, sammen med *Dyschirius politus*.

Bembidion grapii Gyllenhal. HEs. Elverum 7.7.82. 1 eks. funnet langs Glomma sammen med bl.a. *Bembidion prasinum*. Meg bekjent det sørligste funnet i landet.

Bembidion deletum Audinet—Serville. HEs. Vang 12.8.81. Arten var meget tallrik i Vangsåsa utenfor Hamar (500—600 m over havet).

B. deletum VAy. Lyngdal 28.5.81. 1 eks ble funnet nær Nebdalsvannet.

Bembidion quinquestriatum Gyllenhal. V. Tønsberg 31.12.80. Av denne sjeldne arten tok jeg 2 eks. på Slottsfjellet. Jeg kjenner kun til ett tidligere funn fra Norge. (Oslo 1922). Arten synes å leve synantropt. 31.12.80 var en mild vinterdag og marka var snøfri. Et eks. ble funnet helt nede ved bakken på muren som omkranser Slottsfjell-festningen. Den andre billa satt bak en løstsittende barkbit ved basis av et kraftig bjørketre. Året etter besøkte jeg lokaliteten i mars måned, men leting etter *B. quinquestriatum* ga ikke resultater. Snøforholdene gjorde derimot effektiv leting vanskelig.

Bembidion schueppeli Dejean. HEs. Elverum 7.7.82. Denne arten er nok mere utbredt i sør-Norge enn det katalogen gir inntrykk av. Ved Glomma på eiendommen til Norsk skogbruksmuseum var arten nevnte dato meget tallrik. Billene holdt til i råtnende planterester som elva hadde skylt opp. Jeg har også funnet *B. schueppeli* i Oppland fylke (Gausdal, Segalstad bru); flere eks.

Bembidion stephensi Crotch. er rapportert fra Akershus tidligere men arten er ikke vanlig. 3 eks. tatt flygende i Maridalen 15.5.82. (AK. Oslo). Denne dagen svermet også *Bembidion deletum* tallrikt på samme lokalitet.

Bembidion tetracolum Say. NTi. Stjørdal 12.7.82. 3 eks. funnet ved Stjørdalshalsen under småstein på stranda.

Bembidion mannerheimi Sahlberg. TEi. Kviteseid 1982—83. Arten er vanlig i området på østsiden av Sundkilen. Spesielt mange eks. ble sollet ut av tykke lag med tørt løv mars—april 1983.

Tachys bisulcatus (Nicolai). TEi. Kviteseid 7.7.83. Kun ett eks. ble fanget i flukt en varm og stille sommerkveld ved en lagerplass for gran- og furutømmer. Litteraturen sier at arten lever i råtne trestammer, men treffes gjerne ved sagverk og barkhauger.

Agonum ericeti (Panzer). HEs. Trysil 3.5.81. 2 eks. tatt av Roar Solheim på ei myr.
Jeg har også 2 eks. fra HEs. Vang, nærmere bestemt Vangsåsa funnet en gang mellom 1970 og 1975.

Agonum muelleri (Herbst). MRy. Ålesund 1.3.81. 1 eks. funnet i strø under et grantre på Godøy.

Agonum dolens (Sahlberg). Ø. Eidsberg 22.7.83. Arten er tallrik langs vestsiden av Glomma på leirbunn med sparsom vegetasjon. Den er også observert ved senere besøk.

Agonum dorsale (Pontoppidan). AK. Oslo 27.4.82. Arten fortsetter sin framrykning her i landet. 1 eks plukket under stein på Ekebergsletta.

A. dorsale TEi. Kviteseid august -82. Arten var temmelig tallrik flere steder rundt Sundkilen. De holdt til under steiner og plankebiter i utkanten av åker og eng. 10 eks. observert under en og samme stein.

Amara ovata (Fabricius). TEi. Kviteseid sommer -82 og -83. Arten er relativt vanlig på solåpne plasser på østsiden av Sundkilen. Dette er nok en art som har blitt vanligere i de senere år. I Oslo-området har jeg funnet tallrike eks. på sensommeren. Også i Hamar-området synes denne Amara-arten å være vanlig nå.

Amara nitida Sturm. HEs. Hamar 10.5.81. Jeg fant 1 eks. inntil en stein i Furuberget.

Amara curta Dejean. TEi. Kviteseid 1982—83. Arten er relativt vanlig på begge sider av Sundkilen. 8 eks. 20.6.83.

Amara ingenua (Duftschmid). TEi. Kviteseid 2.10.82. 4 eks. funnet i kålåker ved Kviteseid gml. kirke.

Amara municipalis (Duftschmid). TEi. Kviteseid 25.10.83. 1 eks. funnet under dørmatta på østsiden av Sundkilen.

Amara fulva (Degeer). TEi. Kviteseid 1982—83. Flere funn på tørr vegetasjonsfattig mark. 2 eks. 3.9.82. Arten holder gjerne til sammen med *Amara consularis, Amara apricaria* og *Amara praetermissa*.

Amara interstitialis Dejean. TEi. Kviteseid 4.6.83: 1

eks. under stein innerst i Sundkilen. Jeg tror dette er det sørligste funnet av arten i Norge.

Harpalus rufibarbis Schauberger. TEi. Kviteseid aug. -83. 5 eks. i barberfelle øst for Sundkilen.

Anisodactylus binotatus (Fabricius). TEi. Kviteseid 4.9.82. Flere enn 10 eks. ble funnet under stein på en åker som lå brakk.

Acupalpus parvulus (Sturm). TEi. Kviteseid 4.6.83. Over 10 eks. innerst i Sundkilen sammen med *Acupalpus flavicollis*. De fleste eks. ble funnet under løstsittende bark på liggende trestammer nær vannet.

Badister bullatus (Schrank). TEi. Kviteseid 13.5.83. 1 eks. under tørt løv.

Oodes helopioides (Fabricius). V. Tønsberg 18.6.81. Sammen med kortvingen *Paederus riparius* fant jeg 1 eks. av arten under en planke. Funnet ble gjort på bløt myrbunn i takrør-skog ved Akersvatnet nær Tønsberg. I Cat. Col. står arten påført under øvre Buskerud. Lokaliteten er Fiskum (Hegstadmyra).

Lebia chlorocephala (L.). TEi. Kviteseid 13.5.83. 1 eks. under planke nær Kviteseid sentrum.

Dromius agilis (Fabricius). TEi. Kviteseid høst -82 og høst -83. Tallrik flere steder, under bark av flere treslag, både løv- og bartrær.

Dromius schneideri Crotch. TEi. Kviteseid 8.11.82. 2 eks. funnet ved Heivatn under bark av furu.

Dromius fenestratus (Fabricius). TEi. Kviteseid høst -82 og -83. Som for D. agilis. Billene plukkes under bark helt nede ved bakken.

D. fenestratus MRy. Ålesund 28.2.81. 2 eks. tatt under bark av lerk på øya Godøy.

Dromius spilotus (lliger). TEi. Kviteseid høst -82 og -83. En rekke eks. er funnet under bark av helst små furutrær. Arten lever sammen med *Salpingus castaneus* (Salpingidae).

Dromius sigma (Rossi). V. Tønsberg 16.6.81. Arten var relativt tallrik ved Presterødkilen under råtne plantedeler i takrørskog.

Dromius notatus Stephens. TEi. Kviteseid 23.1.83. 1 eks. kom fram under solling av en løvhaug.

Trechus quadristriatus (Schrank). HEs. Hamar aug. -81. 1 eks. funnet under en planke på ei fylling i byen.

Trechus obtusus Erichson. MRy. Ålesund 1.3.81. 2 eks. i gresstue i bjørkeli på øya Godøy.

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BEMBIDION VARIUM (OLIVIER, 1795) (COL., CARABIDAE) NY FOR NORGE

SINDRE LIGAARD

Bembidion varium (Olivier, 1795) (Carabidae) is reported new to Norway from Eidsberg, Østfold province (Ø). Eight specimens were found along the river Glomma on clay with sparse vegetation.

Sindre Ligaard, Kvitsund gymnas, N-3850 Kviteseid, Norway

Langs Glomma i Eidsberg kommune, (Ø) (EIS 29) fant jeg sist sommer flere eks. av carabiden *Bembidion varium* (Olivier). Arten er tidligere rapportert fra Norge, men det dreide seg om forveksling med *Bembidion semipunctatum* (Donovan) (Lindroth 1945). *Bembidion varium* er relativt vanlig i sør-Sverige og Danmark. Jeg har funnet arten i Skåne, men for å være helt sikker ble to eks. sendt til Mikael Sørensson i Lund i Skåne. Han kunne bekrefte bestemmelsen.

22.7.83 ble to eks. funnet få meter fra vannet på Glommas vest-side. Senere samme sommer, 13.8. besøkte jeg øst-siden og fant da ytterligere 6 eks., noe som tyder på at dette kan være en sikker lokalitet. Elva renner her veldig rolig og bred med flate, leirete bredder på begge sider. Av andre carabide-arter var følgende tallrike i området: *Nebria rufescens* (Strøm), *Pelophila borealis* (Paykull), *Elaphrus riparius* (L.), *Bembidion dentellum* (Thunberg), *Bembidion obliquum* (Sturm), *Agonum viduum* (Panzer), *Agonum dolens* (Sahlberg). Dessuten kunne jeg plukke 10 eks. av den fine arten *Chlaenius nigricornis* (Fabricius) på stedet. Floraen på lokaliteten er meget sparsom da flommen oversvømmer elvebreddene hver vår. Ved siden av diverse Carex og kortvokste gress, er artene krypsoleie *(Ranunculus repens)* og evjesoleie *(Ranunculus reptan)* dominerende. Ellers kan nevnes at jeg ble oppmerksom på arten på grunn av adferden. Den skilte seg fra andre Bembidion-arter på stedet ved å være kvikkere, og de prøvde å unnslippe ved å ta til vingene. Flygende eks. av denne arten er da også observert av andre samlere.

LITTERATUR

Lindroth, C.H. 1945. Die fennoscandischen Carabidae. I. *Göteborgs K. Vetensk. — o. Vitterh. Samh. Handl. Ser. B 4*, 1—709.

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OPLOCEPHALA HAEMORRHOIDALIS (FABRICIUS, 1787) (COL., TENEBRIONIDAE) NY FOR NORGE

SINDRE LIGAARD

Oplocephala haemorrhoidalis (Fabricius, 1787) is reported new to Norway. Two specimens were found in Kviteseid, Telemark province (TEi). The beetles, a male and a female were picked from a dead and dry fungus *(Fomes fomentarius)* on the stem of a rotten but standing birch-tree.

Sindre Ligaard, Kvitsund gymnas, N-3850 Kviteseid, Norway.

Under leting etter biller i kjuker fant jeg 20.6. i fjor (1983) to eks. av arten *Oplocephala haemorrhoidalis* (Fabricius). Tenebrioniden er funnet i våre naboland. Den var i det 18. århundre ganske vanlig på enkelte lokaliteter i Danmark men er senere ikke gjenfunnet (Hansen, 1973).

Billene ble funnet i en tørr og råtten knuskkjuke *(Fomes fomentarius)* på et dødt men stående bjørketre ca. 1,5 m opp fra bakken. Stammen var angrepet av flere knuskkjuker, men intens leting ga ikke større utbytte enn disse to. Lokaliteten, som ligger i Kviteseid kommune (TEi) på sørsiden av Sundkilen, er relativt fuktig og mørk med rikt planteliv. Løvtrær dominerer, og flere bjørketrær har falt overende og ligger og råtner i skogbunnen.

Jeg fant både en hann og en hunn, og sistnevnte hadde de karakteristiske, oppstående horn på pannen med en dyp grube mellom dem.

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PHRYGANOPHILUS RUFICOLLIS FABRICIUS. NÅGOT OM BIOLOGIN I NORRA SKANDINAVIEN (COL., MELANDRYIDAE)

STIG LUNDBERG

The biology of *Phryganophilus ruficollis* in Birch in Norway near the border of Sweden at Gäddede, Jämtland is described. The species develop in birches laying on the ground in very wet and soft wood. The development take at least 3 years and the beetle is overwintering as pup.

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Phryganophilus ruficollis, Fabricius. Den ca. 1,5 cm långa svarta heteromeren med röd halssköld och röda två sista buksegmenten, hör till våra allra sällsyntaste vedarter.

I Sverige har Thure Palm beskrivit utvecklingen i en eklåga intill Båtfors vid Dalälven (Palm 1940, 1945 och 1959). Från detta område föreligger ytterligare ett fynd av en imago den 2.6.1972 vid håvning på aktuell ö (Henrik Walling in litt.) samt en död puppa i en ekgren vid Båtfors den 21.6.76 (Rickard Baranowski in litt.).

Därtill har 1 exemplar tagits 24.6.1914 vid Ragunda i Jämtland flygande (Frisendahl 1916) och 1 exemplar 3.7.1927 vid Kyrktåsjö i Ångermanland sittande på en husvägg (Cedergren 1931). I Finland föreligger enstaka fynd från södra delarna men också fynd av 1 exemplar dött under nävret på en björklåga hösten 1981 så långt norrut som vid Olanka nationalpark, N Kuusamo (Jyrki Muona in litt.). På dessa lokaler saknas ek varför det har varit uppenbart att utvecklingen också måste kunna ske i annat trädslag.

1979 togs så arten i 2 exemplar i Norge mitt för Gäddede det ena 24.6. krypande i skolsken mitt på dagen på en nyavverkad granstubbe, det andra 22.6. sittande på undersidan av en björkticka *(Polyporus betulinus)* på en björkstubbe vid solnedgången. Där togs ytterligare 3 exemplar på liknande sätt under tickor 1980, medan arten förgäves eftersöktes 1981—83 på lokalen ifråga (Zachariassen 1980 och in litt.).

I samband med ett besök i Gäddede i slutet av juni 1983 passade jag på kvällen 27 och 28 juni att leta efter arten i aktuellt område. Jag koncentrerade mig på björkstubbar och björklågor, som förekom talrikt såväl inne i bestånd som på hyggen. Då det regnade i stort sett hela tiden var möjligheten få tag på imago i det fria liten och först då jag undersökte lågor på ett hyggesbränt område den 28 juni hade jag framgång.

Först påträffade jag larver i en liggande mindre starkt förmultnad stam. Larverna, som fanns i 3 storlekar, höll till i veden under näver strax intill ett näverfritt parti av björken, som var ca 1,5 dm i diameter vid angreppsstället. Veden var nästan helt uppluckrad och några flyghål kunde jag inte upptäcka.

I en annen grövre björk som kapats vid av-

verkningen före hyggesbränningen för ca 10 år sedan och nu låg på marken påträffades starka angrepp i nedre delen, där den var ca 3 dm grov och starkt bevuxen med små sidentickor *(Trametes versicolor).* Larvangreppen förekom på ca 2 m längd från rotändan och starkast på nordsidan av lågan där veden var så mjuk att vatten kunde pressas ut i handen. Denna mjuka ved övergick inåt i hård fast ved. Även i denna låga fanns larver av 3 storlekar, men dessutom flera redan tomma puppkammare med helt runda utgångshål varav åtminstone 5—6 var årets. Puppkammarna låg 3—5 cm under ytan. En larv som ätit i ett smalt rötstråk på översidan hade lagt puppkammaren i hårdare ved, vilket medfört att imagon ännu inte hunnit äta sig ut utan låg kvar i puppkammaren den 28 juni. Flera av de fullväxta larverna hade redan förberett puppkammare och i vedbitar som togs hem skedde förpuppningen i slutet av augusti. Arten övervintrar således som puppa, vilket ju också var fallet vid Dalälven (Palm 1939).

I en tredje björk, som vindfällts och som vilade på rotbenen, påträffades ytterligare angrepp av *Phryganophilus,* dels i form av några färska flyghål, dels en halvvuxen larv. Detta angrepp hade skett i vitrötad lös ved under näver vid rotbenen där jord som följt med vid vindfällningen täckte nävret.

Då arten uppenbarligen ägglägger lämpliga björklågor flera år i rad så länge konsistensen passar är det lätt konstatera om arten finns i ett område. Å andra sidan förekommer varken skogsbrand eller hyggesbränning särskilt ofta idag vilket torde missgynna arten även om den säkerligen inte är helt beroende av brandskadad björk. Jag har nämligen hittat motsvarande konsistens på björkved utanför brända områden. En annan faktor som kan reducera stammen är att övervintring som puppa sannolikt kan medföra problem.

Det blir intressant att se om den ökade kännedomen om biologin medför att nya fynd kan göras även i norra Sverige, där *Phryganophilus* uppenbarligen också bör efterletas i fjälltrakterna där det ju är gott om björk.

Jag vill passa på att tacka Karl Erik Zachariassen, Jyrki Muona, Henrik Wallin och Rickard Baranowski för fynduppgifter om arten.

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MYRMECINA GRAMINICOLA (LATREILLE, 1802) (HYM., FORMICIDAE) NEW TO THE NORWEGIAN FAUNA

TORSTEIN KVAMME & FRED MIDTGAARD

Myrmecina graminicola (Latreille, 1802) is reported new to the Norwegian fauna, with a short description of the locality.

Torstein Kvamme and Fred Midtgaard, Norwegian Forest Research Institute, P.O.Box 61, N-1432 Ås-NLH, Norway.

In connection with a study of the insect fauna of Ostøya in the Oslofjord, specimens of several orders were collected. Light-traps were mainly used, and in addition window-traps were placed out.

On AK: Bærum, Ostøya (EIS:28) two males of *Myrmecina graminicola* (Latreille, 1802) were caught in a window-trap, 11—18th July 1983 (Leg. F.M.). The trap was located on a very dry and sunexposed stony slope. *Seseli libanotis* (L.) Koch, *Prunus spinosa* L., *Origanum vulgare* L., *Geránium sanguineum* L., *Artemisia campestris* L. and *Rosa spp.* dominated the vegetation. The soil is eroded slate with a high content of lime. *M. graminicola* is not earlier found in Norway (Kvamme 1982). However, the species is found locally and scattered in South-Sweden. The nearest locality is in Västergötland (Douwes 1976, Collingwood 1979). In Denmark *M. graminicola* is recorded only in East-Jutland (Skøtt 1973, Collingwood 1979). The occurrence in Norway is therefore not surpricing.

M. graminicola is the only species of the genus in North Europe (Kutter 1977, Collingwood 1979), and the male is easily separated from other species in our fauna by the very dark

wings, reduced mandibles, quadrangular petiole and postpetiole, the very short scape and 13 antennal segments.

Colonies of *M. graminicola* can be found under stones in pasture land and open woodland (Collingwood 1979). The species is living very hidden and is easily overlooked, also because the workers are simulating dead when disturbed. Skøtt (1973) mentions sifting as a method to sample the species.

ACKNOWLEDGEMENTS

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NOLA AERUGULA (HÜBNER, 1793) (LEP., NOLIDAE) NEW TO NORWAY

LEIF AARVIK & SIGURD A. BAKKE

Nola aerugula (Hübner) (*N. centonalis* (Hübner)) is recorded for the first time in Norway. The biology and the distribution of the species are briefly outlined.

Leif Aarvik, Tårnveien 6, N-1430 Ås, Norway.
Sigurd A. Bakke, Rådyrveien 3, N-1430 Ås, Norway.

The single Norwegian specimen, a male, was captured in a bog at Helgesjøen, Eidskog HEs (EIS:38) 12 July 1974, S.A. Bakke leg.

The larva of *N. aerugula* feeds on *Trifolium, Lotus, Medicago, Fragaria, Potentilla* and possibly other plants. The larva is full grown in June, and imago emerges in July/August. It flies at night and is attracted to light. In Fennoscandia the habitat is bogs, whereas in central Europe the species prefers dry habitats (Forster & Wohlfahrt 1960, Nordström et al. 1961).

In Sweden the species is distributed from Skåne north to Gästrikland and Dalarne, but it is not common. In south Finland north to the provinces Tavastia borealis and Karelia borealis, it is more common (Nordström et al. 1961). In Denmark *aerugula* occurs in two separate areas, the nominate subspecies is distributed in the southeast and ssp. *holsatica* (Sauber) is found in western Jutland (Hoffmeyer 1960, Karsholt & Nielsen 1976). Ssp. *holsatica* has been considered a distinct species by many authors, but is now treated as a subspecies of *aerugula* (Karsholt & Nielsen 1976, Leraut 1980). This subspecies occurs on heaths and has otherwise been found in northwestern Germany, Holland and Belgium (Forster & Wohlfahrt 1960, Leraut 1980). The nominate race occurs locally throughout central Europe extending into Asia. In Britain the species is a migrant which sometimes has been established in the southeast (Revell 1979).

ACKNOWLEDGEMENTS

We wish to thank Mr. Håkan Elmquist who verified the identification of the specimen and Mr. Tor Gulliksen for taking the photograph.

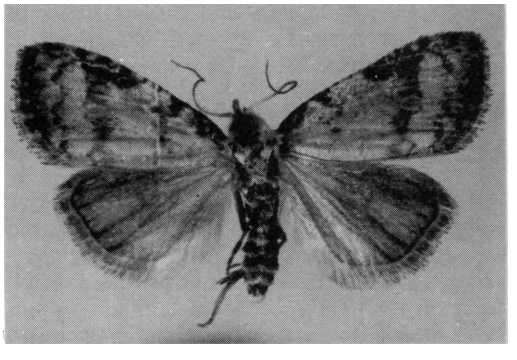

Fig. 1. The Norwegian specimen of *Nola aerugula* (Hb).

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DICTYNA ARUNDINACEA (L.) (ARANEAE, DICTYNIDAE) FOUND IN ICELAND

ÁRNI EINARSSON

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The spider *Dictyna arundinacea* (L.) is reported from Iceland for the first time. It is common in *Betula nana* scrubland in the vicinity of Lake Mývatn northern Iceland.

INTRODUCTION

The Icelandic spider fauna has been studied for about a century, and 87 species have been recorded (Brændegaard 1958, Lindroth 1965, Lindroth *et al.* 1973, Bengtson *et al.* 1976, see also Ashmole 1979). Recently a considerable sampling effort has been spent by various investigators in different habitats and climatic zones in Iceland. This has only revealed one species of spider not reported before from Iceland, *Dictyna arundinacea* (L.).

RESULTS

Dictyna arundinacea was found by sweep netting and collecting by hand in dwarf birch *(Betula nana* L.) in the vicinity of Mount Vindbelgjarfjall in the Mývatn district and in Laxárdalur, North Iceland. The species was common in moist scrubland dominated by *B. nana, B. pubescens,* Ehrhenberg, *Salix phylicifolia* L. and *Vaccinium uliginosum* L. but its characteristic webs were only spotted in the *B. nana* bushes.

Table 1. The records of *Dictyna arundinacea* in Iceland.

Date	
24 Apr. 1981	1 juv. ♀, 4 juv. ♂
1 May 1981	1 juv. ♂
18 July 1976	1 juv. ♂ (*leg.* Erling Ólafsson)
18 July 1983	5 ad. ♀
28 July 1980	6 juv. ♀, 1 juv. ♂
28 July 1983	4 ad. ♀, 2 ad. ♂ (with eggs)
3 Aug. 1982	3 ad. ♀ (with hatching eggs)
5 Aug. 1982	many ad. ♀ ♀ observed (with small young)

The individuals found in early spring (Table I) were all juveniles. Some of those collected on 24 April 1981 and kept alive at room temperature matured on 5—6 May the same year. In late July some females in the field had eggs and in the first week of August newly hatched young were found with some adult females. In July almost full grown but immature individuals were found along with mature animals.

The animals collected conform well to the description given by Locket and Millidge (1951). The total length of mature individuals was about 3.5 mm. The carapace was deep brown with rows of light hairs running lengthwise on the elevation on the front half of the carapace. Similar hairs were found along the edge of the carapace. The pearly white eyes were evenly and widely spaced; the clypeus wide. An undivided cribellum and a calamistrium were present. The male chelicerae were excavated along their inner margins. The light grey abdomen had dark markings along the dorsal midline and on the

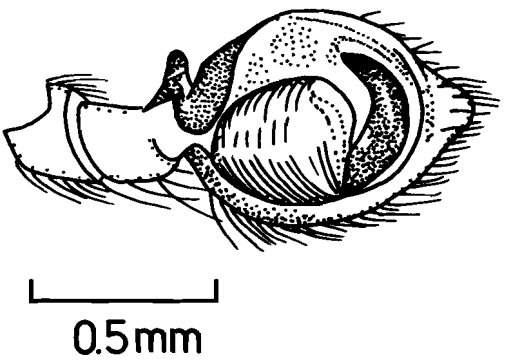

Fig. 1. *D. arundinacea,* a male right palp viewed from below.

sides. The tibial apophysis on the palp was relatively short and broad. The twisted process at the base of the palpal tarsus pointed upwards towards the tibia (Fig. 1).

The specimens collected are kept in the Museum of Natural History in Reykjavik, Iceland.

DISCUSSION

Dictyna arundinacea is common in a type of habitat which is characteristic of the Mývatn district but of limited occurrence elsewhere in Iceland. *D. arundinacea* has not been systematically searched for in other parts of the country but the lack of habitat there may explain why this species has not been collected before.

D. arundinacea is widespread in NW-Europe: the British Isles (Locket *et.al.* 1974), Fennoscandia (Palmgren 1977a), Denmark (Nielsen 1928) and Germany (Wiehle 1953). It is recorded from Orkney but neither from Shetland nor from the Faroes (Ashmole 1979). It is found sparingly in boreal North America (Chamberlin and Gertsch 1958), but has not been reported from Greenland.

Locket and Millidge (1951) state that *D. arundinacea* builds its web in the heads of plants (living or dead) and in bushes, gorse *(Ulex europaeus* L.) etc. In Finland, according to Palmgren (1977a), *D. arundinacea* is mainly a species of the heather *(Calluna)* in open, dry forests but also common in *B. nana* bogs and in low scrub. Palmgren (1977b) mentions *Vaccinium vitis-idea* L. as the most typical habitat for *D. arundinacea* in Mäntyharju in Finland.

Palmgren (1977b) states that in Finland *D. arundinacea* has a two year life cycle: Egg-laying in June—early July, hatching in July—early August, growth to semiadult stage the following summer and maturation in May of the third summer. The Icelandic material is consistent with a two year life cycle. Only immature individuals were found in the spring, but during the summer both mature animals and immatures.

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Bokanmeldelser

DURANTON J.-F., LAUNOIS, M. LAUNOIS-LUONG, M.-H. OG LECOQ M. 1982. — *MANUEL DE PROSPECTION ACRIDIENNE EN ZONE TROPICALE SÈCHE (Håndbok om akridologiske undersøkelser i tørre tropiske områder).* G.E.R.D.A.T., Paris. Bind I: 1—695 + 7 sider uten nummer; Bind II: 707—1496, + 5 sider uten nummer. Pris: 320 FF: (Hos: G.E.R.D.A.T./P.R.I.F.A.S., BP 5035, 34032 Montpellier Cedex, Frankrike)

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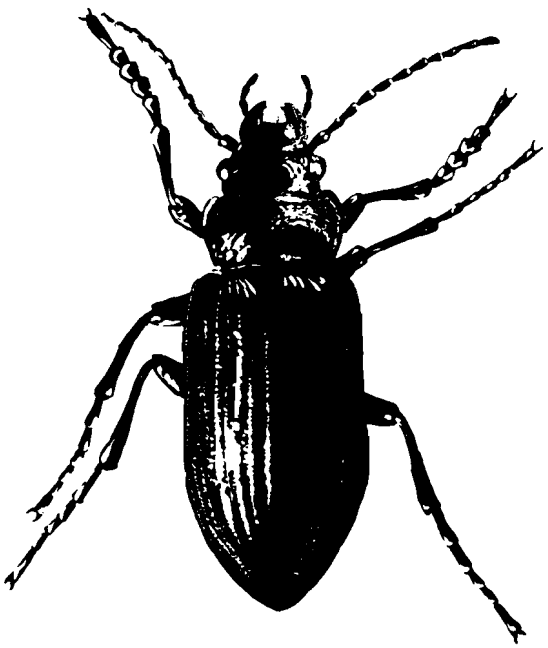

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