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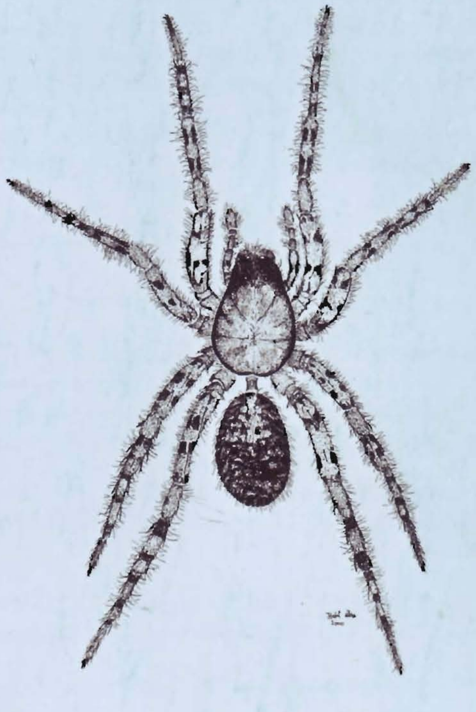

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Factors affecting diversity of poultry house insects, with emphasis on beetles (Coleoptera)

Anders Aak & Preben S. Ottesen

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Twenty-three poultry houses from five areas in the southern part of Norway were sampled for insects associated with manure. The farms belong to five different poultry production categories. Species from the orders Coleoptera, Diptera, Lepidoptera and Hymenoptera were trapped using Tullgren funnels. Among the Diptera, Sphaeroceridae and Psychodidae were dominating, while *Carcinops pumilio* was the most abundant Coleoptera species. Measurements of manure depth, temperature, and moisture content were performed. The production categories showed significant differences in the abiotic measurements. Cage-layer houses had small amounts of moist manure. Broiler houses type 1 and type 2 had small amounts of dry manure, while deep-pit and breeder houses had large amounts of manure with high and medium moisture contents respectively. The manure amounts were related to length of time in production. Distribution and abundance of the various taxa were analysed using reciprocal averaging (RA). Differences in the fauna between the production categories were observed. Houses with long accumulation periods contained Coleoptera and Lepidoptera species, while houses with shorter accumulation periods, mainly contained Diptera species. The most important factor affecting the insect fauna was found to be the length of time of manure accumulation, but indications of influence from the manure moisture content and the temperature on the faunal composition in poultry houses were also detected.

Key words: Poultry manure, diversity, Coleoptera, Diptera, Hymenoptera, Lepidoptera.

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INTRODUCTION

The insect fauna in poultry houses consists of a wide variety of species. Axtell & Arends (1990) present the most common ones, the problems associated with them and the different methods to help regulate their abundance. The major problems with poultry house species are annoyance because of their large numbers (Mian 1994), structural damage by adults and larvae (Vaughan et al. 1984), their potential as reservoirs for diseases (Reyna et al. 1982, Davies & Wray 1995) and their ability to spread diseases between poultry houses (Ottesen 1997). Blood mites and insects may also affect the productivity of the birds (Axtell 1986, Höglund et al. 1995). On the other hand there are neutral or beneficial species present in the manure. These species do not cause any problems even if they appear in large numbers. Predatory species such as Carcinops pumilio (Erichson, 1837) (Coleoptera: Histeridae) can help to reduce the pest populations (Axtell 1986).

The insect fauna of Norwegian poultry houses has only been investigated through limited surveys, and there are few published records about insects in poultry manure (Mehl 1981, Ottesen 1997). This study is an attempt to gather information about Norwegian poultry houses as a habitat for a large number of species, and it tries to establish the relationship between the different families and species in the poultry production systems. This kind of information is useful in the handling of present and future problems associated with insects in poultry manure, and may be a starting point for an increased understanding of biological control and IPM in Norwegian poultry houses.

Previous studies in this field have concentrated on one or a few pest species and their potential control agents (Hulley 1983, Mullens et al. 1996, Rueda et al. 1997). The interactions between *Musca domestica* (L., 1758) (Diptera: Muscidae) and predatory Coleoptera have been studied by Hulley and Pfleiderer (1988), and models of *C. pumilio* population growth and their effects on House fly populations have been generated (Wilhoit et al. 1991). Other investigations have taken the form of general surveys presenting the different species present in poultry houses (Green 1980, Pfeiffer & Axtell 1980, Rueda & Axtell 1996) and some investigations have studied the effects of manure characteristics on the species (Hulley 1986, Stafford & Collison 1987, Fatchurochim et al. 1988, Bernard & Harms 1992).

Our survey took a wider approach by treating the various production systems as different habitats. The faunal components are considered separately by relating the individual taxa to the abiotic measurements, and as a whole by using multivariate analysis on the entire data set. To successfully manage the manure and control the insect fauna it is important to understand the interactions between species combined with the effects of the abiotic factors. The purpose of the present study is to compare the different «habitats» for similarities or differences in species composition according to the measured abiotic factors.

MATERIALS AND METHODS

Sampling sites

Norwegian poultry houses are structurally similar in many aspects, but they may be grouped in five major production systems: broiler house 1, broiler house 2, caged-layer, deep-pit and breeder houses. These production types all differ in the way or the period of time that the manure accumulates. In broiler house 1 and 2 the manure accumulates directly on the floor for 15 and four weeks respectively. In cage-layer houses it drops on transporting bands directly below the cages and is removed once a week. Deep-pit houses accumulate the manure in the basement for approximately 45 weeks. In breeder houses it accumulates below slanted platforms for the same length of time. Samples were taken from a total of 23 poultry farms. The farms are located in five areas in the southern part of Norway (Figure 1). The five areas are the North (area 1), the South-West (area 2), the South-East (area 3), the East (area 4) and the North East (area 5). The West Coast of Norway and the mountain areas have little or no poultry production. The initial idea was to sample one poultry house from each production category in each area for a total of 25 farms, but because of differences in the number of poultry houses in the areas, combined with permission to sample, and one failure in the sampling process, we ended up with a skewed distribution of the farm numbers. The farms were picked out from a data base at the National Institute of Public Health, and they were chosen to ensure that each poultry house in the different production categories should be as similar as possible. A list of the farms is given in Table 1. Farms with the lesser Mealworm *Alphitobius diaperinus* (Panzer, 1797) (Coleoptera: Tenebrionidae) were deliberately avoided since this is a new, and not naturally occurring, species in Norway (Ottesen 1997). It is, furthermore, only found in one of the areas sampled.

Sampling method

The sampling was done in the summer of 1998 (20 July – 19 August). Four basic investigations were performed on each farm: manure sampling for extraction of insects with Tullgren funnels, and measurements of manure depth, moisture content and temperature. In addition, observations and interviews with the farmers provided the necessary information about house design and peculiarities of the poultry production.

Manure sampling. From each farm six samples of 0.4 l each were taken at random from the top 15 cm of the manure layer because this layer was known to contain the largest numbers of individuals and the greatest diversity (Stafford et al. 1988). The extraction was done on the farms and manure was immediately transferred to Tullgren funnels.

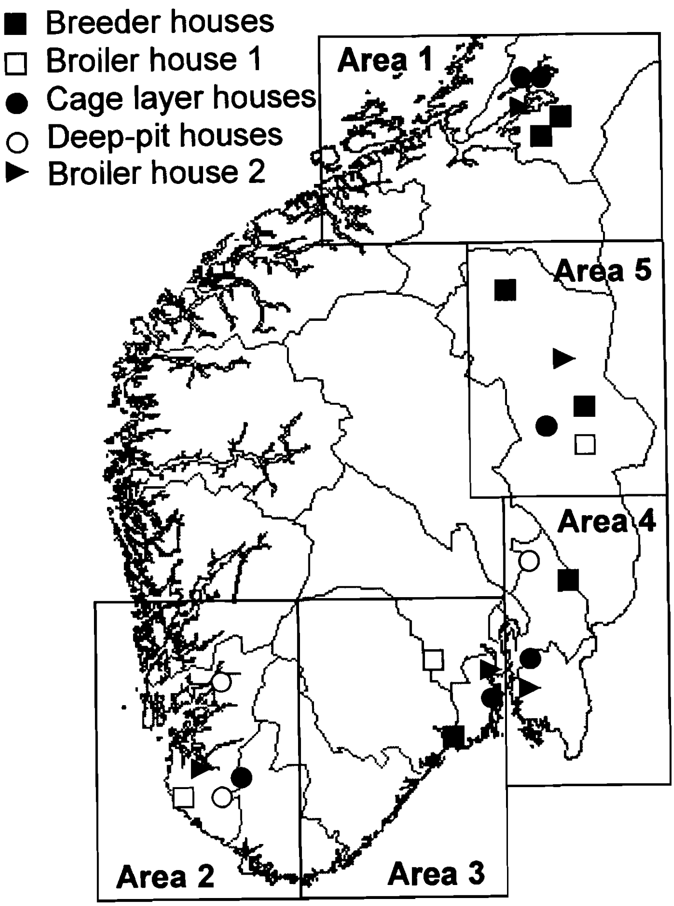

Figure 1. Map of the sampling areas and the different poultry houses in Southern Norway

The top openings of the funnels were covered with mesh lids (1 mm openings), and plastic bags covered the open area between the spout and the plastic cup. This prevented insects from entering or escaping the system during the six days of extraction and made it possible to collect adult Diptera trapped inside the manure sample. Without the closing of the funnel system these species would have escaped upwards by flying. The insects were collected in plastic cups containing 1.25 dl of ethylene glycol mixed with 1.25 dl of water. In the laboratory the samples were put into a white tray and examined with the help of a magnifying screen. Loose material was removed and the insects picked up, roughly sorted, and stored in 70 % alcohol for closer examination and identification with a stereo dissecting microscope. All Coleoptera and Lepidoptera were identified to species, Diptera to families, while the Hymenoptera were just registered as Hymenoptera. The larvae were registered as Coleoptera, Lepidoptera or Diptera.

Abiotic factors. Measurements of the manure depth were made with a metal stick that was forced vertically through the manure. The measurement of the depth was carried out as close to the manure sample spot as possible and it was taken next to each of the six samples. Manure samples of 0.15 l were taken next to the sample for the Tullgren funnel and put into paper bags that were closed and immediately weighed with an electronic balance. The samples were pre-dried at room temperature for six days, then opened and dried at 40°C for a week, followed by drying at 75°C until constant weight. The difference between the measurements before and after drying was used to calculate the moisture content in percent. Temperatures were measured six times in each poultry house. Two measurements were taken 1.5 m above the floor, two 0.5 cm above the manure and two 7.0 cm below the manure surface. If the manure layer was less than 15 cm, measurements in the manure were taken in the centre of the layer. In each house the measurements were taken at the location of manure sample 1 and 3.

Visual inspection and interviews with the farmers were used to register variations in the structural design of the buildings. Factors registered were age of the building, types of food, feeding and watering mechanisms, types of insulation, number of birds, preferred optimum temperature, litter used on the floor, cleaning and disinfection of the building before production, point of time in the production cycle and any insect pest management performed prior to the sampling. The results of the visual inspection and interviews are given in Table 1.

Species identification, nomenclature

Coleoptera were identified using Hansen (1951, 1957, 1968), Landin (1970), Freude et al. (1964) and Palm (1948, 1968). Genital dissection was used to identify most of the *Atheta* species. The Diptera were identified using Unwin (1981) and the Lepidoptera using Weidner (1971). Full Latin names of species or families including authorities are given in Table 2.

Calculation and statistics

ANOVA, correlations, regressions and statistical calculations were performed using the statistical package MiniTab 12 for Windows. Graphs and plots were created with SigmaPlot 4.0. For the multivariate analysis, reciprocal averaging (RA)

Table 1. Distribution of the farms and individual differences registered by visual inspection and interviews with the farmers. - = none, Ws = wood shavings, s = sand, H = hay, C-D = cleaned and disinfected, C-F = Cleaned and flushed with water.

Production categories:	Poultry house	Area	Preferred normal temperature (°C)	Measured average temperature (°C)	Measured average moisture (% water)	Measured average manure depth (cm)	Time in production (weeks)	Number of birds (x1000)	Litter	Age of building (years)	Cleaning of building
Deep-pit houses	1a	2	18	19.7	48.5	27.0	41	8.6	-	26	C-D
	1b	2	18	18.0	52.1	8.3	11	2.0	-	16	C-F
	1c	4	19	21.2	55.0	15.2	30	6.0	-	20	C-D
Cage-layer houses	2a	1	19	17.5	59.7	2.5	30	15.5	-	26	C-D
	2b	1	19	20.2	62.4	5.3	15	15.0	-	30	C-D
	2c	2	20	18.5	45.2	1.8	9	12.0	-	35	C-D
	2d	3	21	23.3	44.2	7.3	45	2.0	-	22	C-D
	2e	4	21	21.7	59.5	3.6	7	30.0	-	3	C-D
	2f	5	21	19.8	64.2	1.0	8	7.0	-	10	C-D
Broiler houses (type one)	3a	2	22	19.7	11.3	6.7	13	5.0	s/Ws	22	C-D
	3b	3	20	22.2	22.5	2.8	9	9.0	Ws	16	C-D
	3c	5	22	28.0	24.9	2.6	15	3.9	Ws	12	C-D
Breeder houses	4a	1	20	23.5	35.5	53.1	39	5.5	Ws	2	C-D
	4b	1	20	23.8	40.7	44.2	17	15.0	Ws	2	C-D
	4c	3	22	27.2	58.3	36.7	28	2.5	Ws	11	C-D
	4d	4	19	25.2	44.6	40.7	28	5.5	s/Ws/H	2	C-D
	4e	5	18	18.7	27.9	42.9	32	5.0	Ws	12	C-D
	4f	5	19	19.8	23.4	38.2	34	3.0	s/Ws/H	1	C-D
Broiler houses (type two)	5a	1	20	22.2	20.3	5.3	4	17.0	Ws	3	C-D
	5b	2	20	31.0	20.5	1.4	1	8.0	Ws	8	C-D
	5c	3	21	25.0	19.8	3.2	4	12.5	Ws	3	C-D
	5d	4	22	25.8	31.5	2.6	3	18.3	Ws	74	C-D
	5e	5	22	26.5	20.5	3.7	4	8.1	Ws	3	C-D

Table 2. Total number of individuals (N) of each species/family/order sampled in the 23 poultry houses. Data are sorted according to family.

ORDER / Family / Species	**Abbrev.**	**N**
COLEOPTERA		
Carabidae		
Calathus melanocephalus (L., 1758)	Cal-mel	1
Ptiliidae		
Ptenidium pusillum (Gyllenhal, 1808)	Pte-pus	6
Ptiliolum spencei (Allibert, 1844)	Pti-spe	1
Baerocrara variolosa (Mulsant & Rey, 1873)	Bae-var	2
Acrotrichis ssp. (indet.)	Acr-spp.	3
Acrotrichis montandonii (Allibert, 1844)	Acr-mon	1
Scydmaenidae		
Schydmaenus tarsatus (Muller & Kunze, 1822)	Sch-tar	1
Staphylinidae		
Phyllodrepa nigra (Gravenhorst, 1806)	Phy-nig	1
Megarthrus denticollis (Beck, 1817)	Meg-den	1
Oxytelus sculptus (Gravenhorst, 1806)	Oxy-den	30
Medon apicalis (Kraatz, 1857)	Med-api	2
Astenus pulchellus (Mannerheim, 1843)	Ast-pul	1
Philonthus nigriventris (Thomson, 1867)	Phi-nig	18
Philonthus sordidus (Gravenhorst, 1802)	Phi-sor	1
Leptacinus pusillus (Stephens, 1833)	Lep-pus	1
Tachyphorus nitidulus (Fabricius, 1781)	Tac-nit	1
Dexiogya forticornis (Strand, 1939)	Dex-for	41
Philhygra palustris (Kiesenwetter, 1844)	Phi-pal	3
Acrotona pygmaea (Gravenhorst, 1802)	Acr-pyg	1
Acrotona parvula (Mannerheim, 1830)	Acr-par	1
Atheta harwoodi (Williams, 1930)	Ath-har	83
Atheta nigricornis (Thomson, 1852)	Ath-nigric	337
Atheta nigricornis/harwoodi (indet.)	-	1
Atheta longicornis (Gravenhorst, 1802)	Ath-lon	1
Atheta euryptera (Stephens, 1832)	Ath-eur	1
Atheta coriaria (Kraatz, 1856)	Ath-cor	5
Atheta crassicornis (Fabricius, 1792)	Ath-cra	1
Atheta nigra (Kraatz, 1856)	Ath-nigra	72
Atheta fungi (Gravenhorst, 1806)	Ath-fun	1
Atheta fungi gr. (indet.)	Ath-fgr	1
Atheta nidicola (Johansen, 1914)	Ath-nid	1
Atheta spatuloides (Benick, 1939)	Ath-spa	4
Atheta castanoptera (Mannerheim, 1830)	Ath-cas	1
Atheta amicula (Stephens, 1832)	Ath-ami	2
Atheta trinotata (Kraatz, 1856)	Ath-tri	2
Amischa bifoveolata (Mannerheim, 1830)	Ath-bif	1
Amischa analis (Gravenhorst, 1802)	Ami-ana	1
Falagria caesa (Erichson, 1837)	Fal-cae	1
Oligota parva (Kraatz, 1862)	Oli-par	3
Oligota inflata (Mannerheim, 1830)	Oli-inf	1
Hydrophilidae		
Cercyon melanocephalus (L., 1758)	Cer-mel	1
Histeridae		
Carcinops pumilio (Erichson, 1834)	Car-pum	773
Gnathoncus nannetensis (Marseul, 1862)	Gna-nan	26
Clambidae		
Clambus pubescens (Redtenbacher, 1849)	Cla-pub	7
Dermestidae		
Dermestes lardarius (L., 1758)	Der-lar	4
Anthrenus museorum (L., 1761)	Ant-mus	1
Anobiidae		
Anobium punctatum (Degeer, 1774)	Ano-punc	1
Ptinidae		
Ptinus tectus (Boieldieu, 1856)	Pti-tec	1
Aspidiphoridae		
Aspidiphorus orbiculatus (Gyllenhal, 1808)	Asp-orb	2
Monotomidae		
Monotoma spinicollis (Aube, 1837)	Mon-spi	8
Monotoma bicolor (Villa, 1835)	Mon-bic	23
Monotoma picipes (Herbst, 1739)	Mon-pic	1
Monotoma brevicollis (Aube, 1837)	Mon-bre	1
Cryptophagidae		
Cryptophagus pseudodentatus (Bruce, 1934)	Cry-pse	23
Cryptophagus acutangulus (Gyllenhal, 1827)	Cry-acu	0
Atomaria apicalis (Erichson, 1839)	Ato-api	21
Atomaria lewisi (Reitter, 1877)	Ato-lew	3
Atomaria nigrirostris (Stephens, 1830)	Ato-nig	2
Lathridiidae		
Latridius minutus (L., 1767)	Lat-min	9
Corticaria elongata (Curtis, 1830)	Cor-elo	7
Cortinicara gibbosa (Herbst, 1793)	Cor-gib	3
Tenebrionidae		
Tribolium castaneum (Herbst, 1797)	Tri-cas	42
Alphitophagus bifasciatus (Say, 1823)	Alp-bif	75
Chrysomelidae		
Phyllotheta sp. (indet.)	Phy-sp.	1
Curculionidae		
Apion ssp. (indet.)	Api-ssp.	2
Coleoptera larvae (indet.)	Cole(l)	670
DERMAPTERA		
Forficulidae		
Forficula auricularia (L., 1758)	For-aur	1
DIPTERA		
Psychodidae	Psycho	7944
Chironomidae	Chiron	539
Ceratopogonidae	Cerato	1554
Scatopsidae	Scatop	61
Mycetophilidae	Myceto	37
Sciaridae	Sciari	303
Cecidomyiidae	Cecido	1328
Empididae	Empidi	18
Dolchipodidae	Dolchi	4
Phoridae	Phorid	53
Sphaeroceridae	Sphaer	6598
Ephydridae	Ephydr	16
Drosophilidae	Drosop	19
Chloropidae	Chloro	2
Calliphoridae	Callip	8
Muscidae	Muscid	6
Fanniidae	Fannid	2
Periscelididae	Perisc	3
Diptera larvae (indet.)	Dipt(l)	749
HYMENOPTERA	Hymeno	176
LEPIDOPTERA		
Tineidae		
Niditinea fuscella (L., 1758)	Nid-fus	322
Oecophoridae		
Endrosis sarcitrella (L., 1758)	End-sar	64
Lepidoptera larvae (indet.)	Lepi(l)	104
Total:		**22255**

was used, and the shareware program MVSP (Multivariate Statistical Package, ver. 2 by Warren L. Kovach, University College, Wales) performed the ordination of the site x species matrix. Reciprocal averaging use species abundance to create scores for each poultry house. This score places houses with similar faunal composition close to each other. This procedure is repeated until all the variation in the data explained. The two first sets of scores account for most of the variation in the data and are further used to plot the farms according to species abundance. Correlating these two sets of scores with abiotic measurements gives explanations for the factors determining the species abundance. The method also creates scores for the species and this makes it possible to plot and investigate the distribution of species according to their biology. Prior to the analysis the data was, as recommended by Gauch (1982), octave transformed (1–8=1, 9–16=2, 17–32=3, 33–64=4, 64–128=5, ... etc.). Rare species with less than 10 specimens in the total material, and species with only one specimen present on a farm, were removed from the analysis.

RESULTS

Poultry houses

Manure depth. Manure depth was positively correlated with the length of time of manure accumulation ($r = 0.844$, $p < 0.0001$). The measurements of the average manure depths in the five production categories are displayed in Figure 2. Breeder houses had the deepest manure layers followed by the deep-pit houses. Cage-layer houses, broiler house 1 and broiler house 2 had accumulated equal, and small, amounts of manure.

Moisture content. The means of the moisture contents in the five production categories are given in Figure 2. Cage-layer and deep-pit houses had the highest moisture content, broiler house 2 and broiler house 1 were dry, and breeder houses had moisture contents half way between these two extremes. Comparing the averages of the different farms proved significant differences between the means (ANOVA: $F_{4,18} = 15.13$, $p < 0.0001$). To distinguish the means that were significantly different from each other a Tukey-test was used. All the combinations were significantly different from

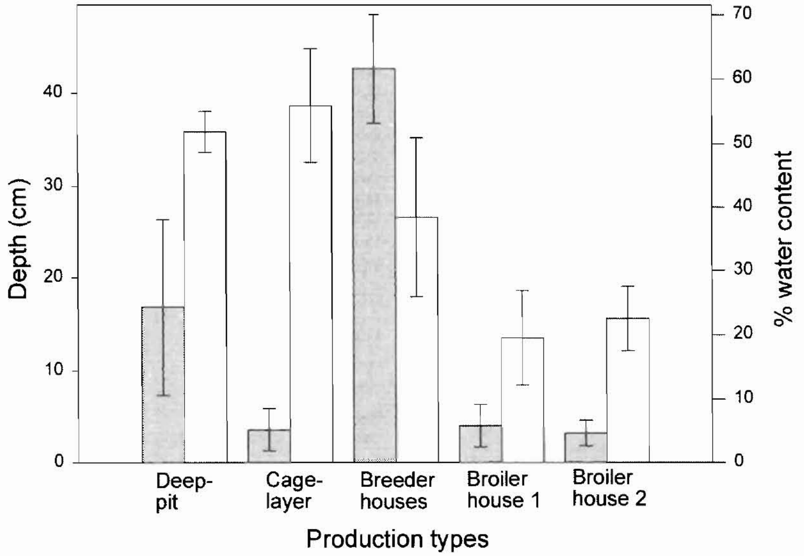

Figure 2. Averages (with SD) of the manure depths (grey) and the moisture content (white) in the five different production types.

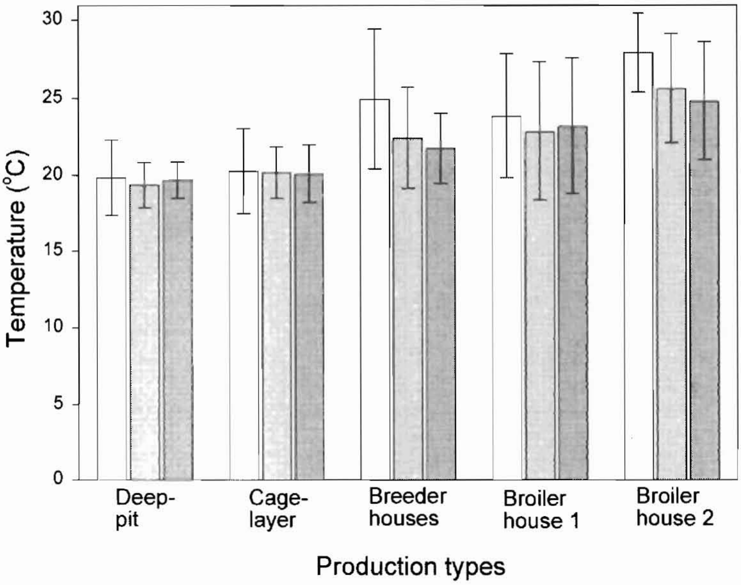

Figure 3. Averages (with SD) of temperature measurements 7 cm inside the manure (white), 0.5 cm above the manure (grey) and 1.5 m above the floor (dark grey).

each other except cage-layer/deep pit, cage layer/breeder house, broiler house1/broiler house 2 and broiler house 2/breeder house.

Temperature. The means of the various measurements for the different production systems are given in Figure 3. Comparing the means of all six measurements at all three levels gave significant differences between the different production systems (ANOVA: $F_{4, 18} = 3.62$, $p = 0.025$). Tukey-test of the means showed that only broiler house 2 had temperatures significantly higher than cage layer houses. Temperatures in the manure of the various production types were found to be significantly different from each other (ANOVA: $F_{4, 18} = 4.58$, $p = 0.010$). This was also the case for temperatures 0.5 cm above the manure (ANOVA: $F_{4, 18} = 2.95$, $p = 0.049$). Tukey-tests showed that in the manure, broiler house 2 had temperatures significantly higher than both deep-pit and cage-layer houses, while above the manure significant differences were found only between broiler house 2 and cage layer houses. The measurements 1.5 m above the floor showed no significant temperature difference between the farms (ANOVA: $F_{4, 18} = 2.61$, $p = 0.070$).

Building variations and observations. An overview of the different farms and their registered differences and similarities is, together with the measured abiotic factors, given in Table 1. Three of the houses showed differences important for the insect fauna in the manure. One poultry house (deep-pit house – 1a) had been treated with chemicals against insects. Another building was composed of four sections. This house (broiler house – 5a) had production at different stages inside one building at all times. The third divergent farm (broiler house – 3b) had no birds, but the manure was still on the floor. There had not been any addition of fresh manure for 3 days before the sampling started.

The fauna

The insects found during this survey belonged to four orders: Diptera, Coleoptera, Lepidoptera and Hymenoptera. Among the orders a total of 38 families were observed. In addition, one specimen of Dermaptera *(Forficula auricularia* (L., 1758) (Forficulidae)) was found. A total of 20732 adult insects and 1523 larvae were collected. Of the sampled insects, both adult and larvae, 85.5% belonged to Diptera, 10.5% to Coleoptera, 2.2% to Lepidoptera and 0.8% to Hymenoptera. A complete list, with the total numbers of the orders, families and species, is given in Table 2.

Diptera. Eighteen different families were found among the adult Diptera. Two families dominated

Table 3. Total numbers and percentages of the most abundant Diptera families on the 23 farms and in the 138 separate samples.

	Family					
	Psychodidae	Sphaeroceridae	Ceratopogonidae	Cecidomyiidae	Chironomidae	Sciaridae
Total number found	**7944**	**6598**	**1554**	**1328**	**539**	**303**
Farms with family present	23	22	18	22	18	21
% of farms	**100.0 %**	**95.7 %**	**78,3 %**	**95.7 %**	**78.3 %**	**91.3 %**
Samples with family present	124	120	113	110	105	75
% of samples	**89.9 %**	**87.0 %**	**81.9 %**	**79.7 %**	**76.1 %**	**54.3 %**

both in total numbers and in the number of samples in which they were present. The Psychodidae contributed with 43.0% of the total number and Sphaeroceridae with 35.7% and these two families were present in 89.9% and 87.0% of the samples, respectively. Other Diptera families found were Ceratopogonidae (8.4%), Cecidomyiidae (7.2%), Chironomidae (2.9%) and Sciaridae (1.6%). These families were present on most of the farms, in all production types and in at least 50 % of the samples (Table 3). The remaining 12 families made up 1.2% of the total number.

Coleoptera. The two families Histeridae and Staphylinidae dominated in the samples. They represented 47.7% and 37.2%, respectively, of the total numbers of adult Coleoptera. Histeridae species were found in deep pit and breeder houses only, and were present in 8 out of 9 houses. Only two species were found, the abundant *C. pumilio* and *Gnathonchus nannetensis* (Marseul, 1862). Staphylinids were found in all kinds of production systems, but most of the specimens came from breeder houses. 32 different species belonging to 15 genera were found. *Atheta* spp. contributed with the largest part of the Staphylinids, and the dominating species were *Atheta nigricornis* (Thomson, 1852), *Atheta harwoodi* (Williams, 1930) and *Atheta nigra* (Kraatz, 1856). For the other 12 species, no more than one to five specimens were found. The genera *Dexiogia*, *Oxytelus* and *Philonthus* were also found in fairly large numbers. *Dexiogia* and *Oxytelus* were only present on one farm each and *Philonthus* on three farms. The four families Tenebrionidae, Cryptophagidae, Monotomidae and Lathridiidae (13.0%) comprised the rest of the Coleoptera normally occurring in poultry houses.

Lepidoptera. Only two species were found among the adult Lepidoptera: *Niditinea fuscella* (L., 1758) (Tineidae) and *Endrosis sarcitrella* (L., 1758) (Oecophoridae). *Niditinea fuscella* clearly dominated, with 322 out of 386 specimens. The Lepidoptera species were only found in houses where the manure had accumulated for longer periods and in large amounts, i.e. in deep pit and breeder houses. Five specimens occurred on farms not fitting this description.

Larvae. Adult insects of all orders except Lepidoptera were found in all the different production types, while larvae were only detected in deep-pit, cage-layer and breeder houses. Coleoptera and Lepidoptera larvae appeared only in deep-pit and breeder houses, while Diptera larvae were present in all the three production types containing larvae.

Multivariate analysis

The sampling sites and areas were chosen to make it possible to compare the fauna of the different production categories according to geographical area. Most species and families were present in all areas and no trends of geographic distribution were found. One species *Alphitophagus bifasciatus* (Say, 1823) (Coleoptera: Tenebrionidae) that are known to be abundant in the Southern part of Norway was only found in area 2 (South-West). The distribution of the insects was investigated according to the production types and manure conditions by multivariate analysis. The octave transformed data was organised according to the first axis scores for the sites and the species/families (Table 4).

Sites plot. By plotting axis 1 and axis 2 of the RA analysis, farms with similar species/family composition were placed close to each other and farms with greater differences further apart. The plot divided the farms into four major groups as indicated by the dotted lines in Figure 4. A strong correlation between the scores of the first axis and time of manure accumulation was found ($r^2 = 0.84$, $p < 0.0001$), indicating that Axis 1 in the plot reflects a gradient through time. The regression plot and equation is given in Figure 5. The outlayer marked with a circle was excluded since the farm (1a) had been treated with insecticides. Axis 2 in Figure 4 correlates with the average moisture level measured on each farm ($r = 0.55$, $p = 0.006$). In addition to moisture the temperature appears to have an effect on the species composition on the farms as the multivariate analysis also groups the farms according to temperature, but no significant correlation was found. The first group of poultry houses are houses with moist manure and low

Table 4. Octave transformed abundance data ordinated according to sites and species using reciprocal averaging (RA). + = 1 individual, not included in the calculations. - = no record. Species with less than 10 individuals in the total material were not included in the analysis, but are listed in Table 2. Habitat: Dd = Decaying matters (dung), Dv = Decaying matters (vegetable), F = Associated with fungus and fermenting products, B = Birds nest, - = Other. Feeding habit: D = Detritivore, P = Predatory, F = Fungivore, O = Omnivore, p = Parasitic, - = other.

			Accumulation time:																					
		Feeding	Short < 15 weeks																Long > 15 weeks						
Taxa	Habitat:	habit:	2b	1a	5a	2e	2d	5c	5e	3b	2a	2c	3a	2f	1b	5b	3c	5d	4b	4f	1c	4c	4e	4d	4a
Dipt(l)	Dd/Dv	D	7	3	-	4	7	-	-	-	-	-	-	-	5	-	-	-	+	-	-	+	-	+	-
Ephydr	Dv	D	1	-	-	-	-	2	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ath-nigra	B	P	-	-	5	+	-	-	-	1	1	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Drosop	Dv	F	-	-	-	-	1	1	1	-	1	+	+	-	+	-	-	+	-	-	+	-	-	-	-
Ath-har	B	P	1	-	4	-	1	-	-	-	+	+	+	-	-	-	-	1	3	-	-	-	-	-	-
Cry-pse	F	F	-	-	+	-	-	-	-	-	1	-	-	-	3	-	-	+	-	-	-	-	-	-	-
Chiron	Dv	D	-	6	2	+	1	4	1	3	5	3	2	2	2	+	-	1	2	1	1	2	-	-	-
Empidi	Dv	P	-	+	-	-	1	1	-	+	1	-	-	-	+	-	-	-	1	-	+	+	-	-	-
Alp-bif	F	F	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	+	-	-	-	-
Cerato	-	-	1	6	4	1	3	5	-	7	8	1	1	-	2	1	-	3	1	3	4	3	-	2	-
Scatop	Dd	D	1	+	3	-	-	1	-	+	1	1	-	-	+	+	+	-	1	-	1	-	-	1	-
Hymeno	-	p	-	1	+	1	2	1	1	1	4	1	1	1	3	1	-	1	1	-	3	2	+	+	+
Ato-api	F	F	-	-	+	-	1	-	-	+	1	1	-	1	1	-	-	-	+	-	1	1	-	-	-
Psycho	Dv	D	1	6	10	2	7	7	3	5	8	4	5	2	8	4	1	6	5	4	6	8	2	7	2
Sphaer	Dd	D	6	-	4	2	11	6	2	3	6	3	5	2	3	3	+	1	4	7	7	2	4	4	3
Scian	F/Dd/Dv/B	F	-	1	1	+	3	3	1	2	5	+	1	2	4	+	+	1	2	1	4	3	+	2	-
Cecido	Dv	D	1	3	1	3	3	4	-	2	8	4	2	4	4	2	-	3	2	1	4	6	2	3	2
Phorid	Dv/Dd/-	D	-	-	-	+	-	-	-	1	2	-	-	-	3	+	-	+	1	-	1	1	1	+	-
Ath-nigric	B	P	1	-	-	-	-	1	-	1	1	-	+	-	+	-	-	-	7	1	-	-	1	-	-
Myceto	F	F	-	-	-	1	+	+	-	-	-	-	-	-	1	-	-	-	+	-	3	1	1	-	-
Mon-bic	F	F	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	-	-	-	-
Lepi(l)	Dv/Dd/B	O	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4	2	-	3	-	-
Oxy-scu	Dd	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Tri-cas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	+
Dex-for	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Gna-nan	Dd	P	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	+	1	2
Cole(l)	Dd/Dv/B	P	-	+	-	-	-	-	-	-	-	-	-	+	2	-	-	-	5	1	6	5	4	6	5
Phi-nig	Dd/B	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	2	-
Nid-fus	B	O	-	+	-	+	-	-	-	-	+	-	-	-	+	-	-	1	-	3	1	1	1	7	-
Car-pum	Dd/Dv/B	P	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	2	-	4	8	2	5	5
End-sar	Dd/Dv/B	O	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	4	-

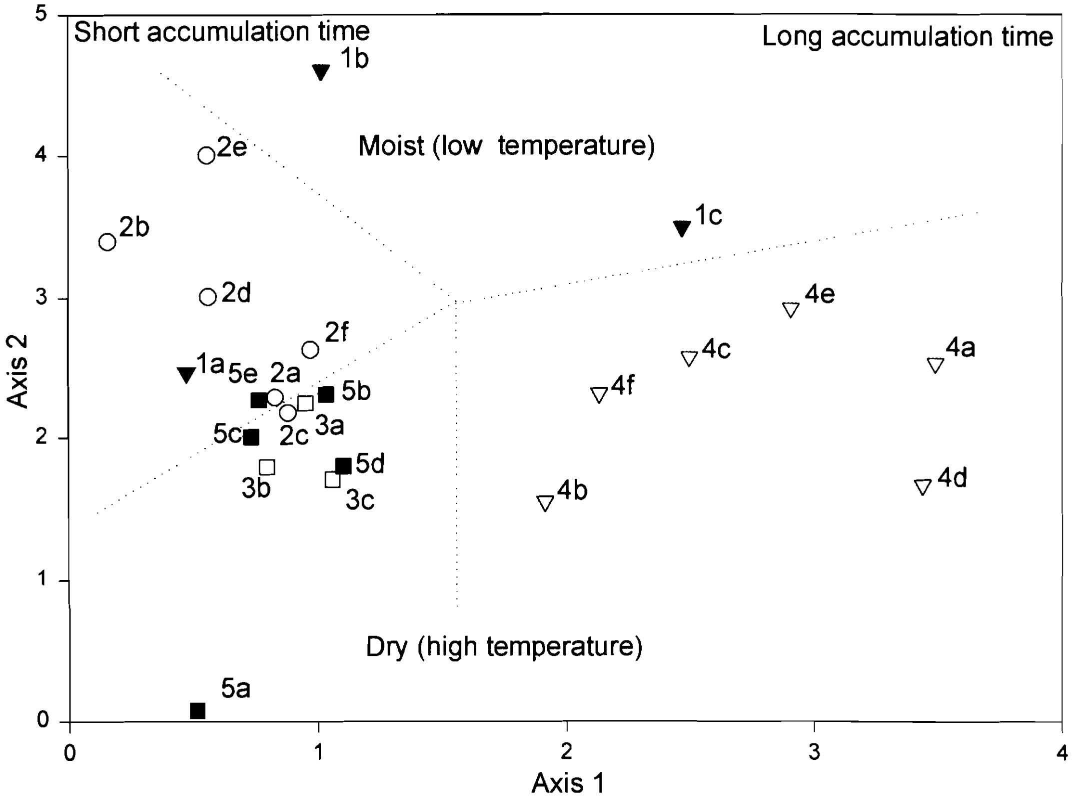

Figure 4. The sampling sites, plotted on axis 1 and 2 scores from a reciprocal averaging (RA) on the species x sites matrix. Axis 1 reflects a gradient through time and axis 2 a moist-dry gradient. The symbols shows the production types: ▽ = breeder houses, O = cage layer houses, ❑ = broiler house (type 1), ■ = Broiler house (type 2), ▼ = deep-pit houses. The numbers and letters correspond to the poultry houses in Table 4 and Table 1.

temperatures, accumulated for a short time. These conditions are mainly found on the cage-layer farms. The second group has drier manure with higher temperatures, accumulated for a short time. This is typically found in broiler house 1 and 2. The third group consists of farms with medium to dry manure, accumulated for longer periods, as found in breeder houses. The fourth group, although not as obvious as the first three ones, is moist manure with lower temperatures, accumulated for longer periods as found in deep-pit houses. Only one farm deflected adversely from the group it was expected to belong to. This was the insecticide treated deep-pit house 1a, where manure had accumulated for 40 weeks. In spite of the long accumulation time, it ended up together with farms with much shorter manure accumulation periods.

Fauna plot. By plotting axis 1 and axis 2 from the RA analysis, the different families and species could be grouped by their trophic preferences. The species/families could be categorised into four groups: 1) predators, 2) omnivores, 3) fungivores, and 4) saprophags, which include families feeding on filth, decaying matters, manure and dung. The different symbols indicate the groups and they are also marked with solid ellipses in Figure 6. Abbreviations of the species/family names are included in the plot. The *Atheta* species, which depart from the other predators, are marked with a dotted ellipse. Also included in the plot are the Hymenoptera, the typical grain pests *Tribolium castaneum* (Herbst, 1797) (Coleoptera: Tenebrionidae) and the blood feeding Ceratopogonidae. The plot gathers widespread and abun-

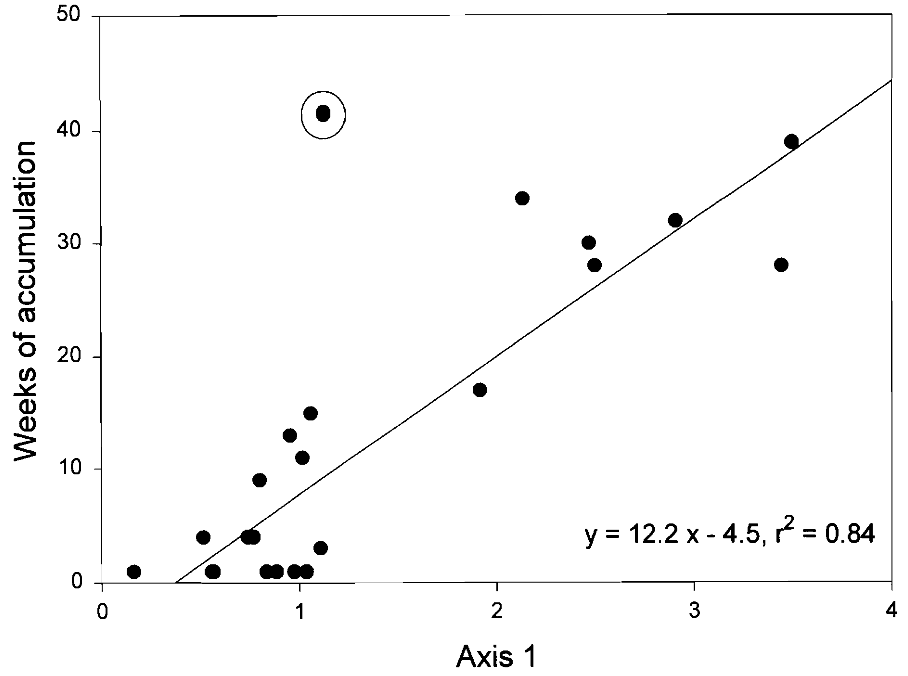

Figure 5. Regression plot and regression equation of axis 1 and weeks of manure accumulation. The value marked with a circle is excluded from the analyses.

dant species close to the centre and places other species according to their abundance and distribution.

Manure moisture and temperature vs. species

By treating the 138 manure samples independently, a detailed analysis of taxa according to moisture and temperature could be performed. This was done for species, families and orders that appeared in large numbers and were present in many separate samples.

Most of the Diptera families were evenly distributed between the various poultry houses (Table 4), and no particular trend or relation according to moisture could be found. The individual moisture content of manure connected to the various insect samples, ranged from 8.8 to 75.0%. Grouping the samples into eight 10% intervals from 0 – 80% and calculating the mean numbers of individuals of different insects, identified the interval containing most specimens of the particular species, families or orders. *Carcinops pumilio* and the Coleoptera larvae were found in largest numbers in the two intervals 50-60% and 40-50%, respectively. All the Staphylinidae species were grouped together, and most of the specimens were found in the two moisture intervals 30-40% and 40-50%. The number of Diptera larvae was positively related to the moisture level and the largest number of Hymenoptera was found in the 60-70% interval.

A similar detailed analysis was made for distribution according to temperature. Mean temperatures for the six measurements were assigned to the individual samples of insects. The samples were grouped in temperature intervals. The intervals were chosen to assure that each interval contained approximately the same number of samples. *Carcinops pumilio* were found in largest numbers in the interval 23-25°C, while most of the Staphylinidae were found in the interval 19-21°C. Hymenopterans appeared to decrease with increasing temperature. Most of the Coleoptera larvae were found in the 23-25°C interval, while the Diptera larvae were found in the two intervals 19-21°C and 23-25°C.

DISCUSSION

Species

The insects found in the course of this survey may be categorised in two groups. The first and most important one includes species or families having poultry houses as a natural habitat. These species are exclusively living in manure and dung. The second one includes species normally found in similar habitats such as decaying vegetable matters. They are attracted to the manure as a potential breeding site resembling the habitat they originally prefer, but are not as well adapted to this environment. Most of the species found in large numbers belong to the first group and have earlier been described as typical poultry manure species. *Carcinops pumilio* is mentioned as the dominating species in several publications (Axtell & Rutz 1986, Pfeiffer & Axtell 1980) and various Staphylinidae are common (Pfeiffer 1980, Green 1980). The Sphaeroceridae is almost always present in large numbers (Green 1980, Hulley 1983) and Ceratopogonidae and Drosophilidae are also often found (Hulley 1983, Farkas & Papp 1989, Harrington & Axtell 1994). Parasitic Hymenoptera are mentioned as control agents for Diptera pest species (Rutz & Axtell 1980, Rueda & Axtell 1985) and the Lepidoptera are well-known pest species associated with various human made habitats.

The number of individuals from the Muscidae family, and in particular *Musca domestica*, is probably underestimated in this investigation. *M. domestica* is considered one of the more serious pests in poultry facilities and is often found in large

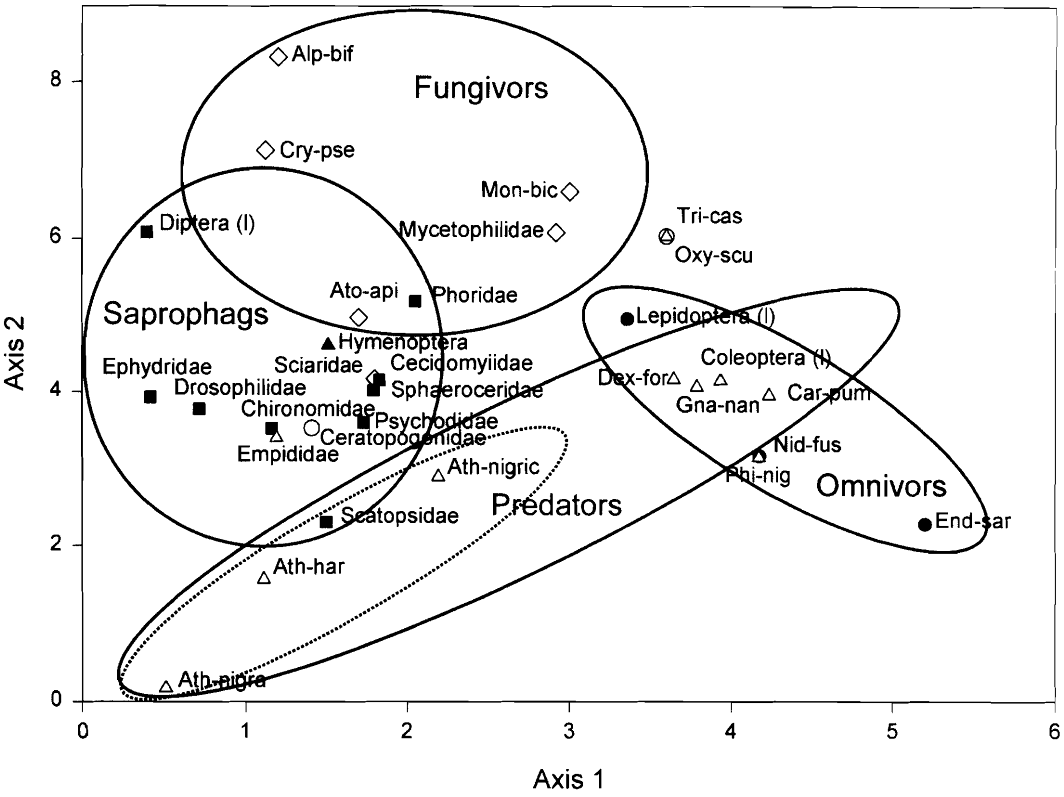

Figure 6. Species plotted by axis 1 and 2 scores from a reciprocal averaging (RA) of the sites x species matrix. The symbols indicate the species way of life. Δ = predatory species, ◊ = Fungivore, ■ = (Saprophagous) filth-, decaying matters-, manure- and dung eating, ● = Omnivore, ▲ = parasitic species, ○ = other. The abbreviations of the species names consists of the first three letters of the genus and the first three to six letters in the species name.

numbers (Mian 1994, Barnard 1995, Horton 1987). The sampling method used is clearly not adequate for sampling adult Muscidae, because the adults escape the manure as the sample is taken. Muscidae are not considered a serious pest in Norwegian poultry houses, and during the sampling process very few individuals were observed. Sphaeroceridae were trapped in large numbers and are, in contrast to the Muscids, probably over-represented compared to the other families. Many of the Sphaeroceridae are considered poor flyers and they prefer to walk or jump instead of flying, and may therefore have a lower frequency of escape during the sampling. Between these two extremes, the remaining Diptera families probably make out a continuum according to their flying abilities.

Species and habitat

The Diptera species found in poultry houses are mainly detritus feeders. Their natural habitat is decaying vegetable matter or dung, and almost all of the Diptera families are considered pests in various habitats resembling manure (Smith & Withman 1998). The Sphaeroceridae is the only family, detected in large numbers, that in nature is directly associated with animal droppings (Pitkin 1988). Phoridae, Scatopsidae, Muscidae, Fannidae and Calliphoridae are other Diptera families naturally associated with dung, while Psychodidae and a few species from the Cecidomyiidae family have their natural habitat in decaying vegetable matter. A few families deflect from the habit of being detritus feeders. The Mycetophilidae and Sciaridae are closely related and are in nature associated with fungi (Freeman 1983), while the Ceratopogonidae of the genus *Culicoides* are known to be blood feeding on birds and mammals (Chinery 1993). The Dolichopodidae and Empididae are the only predatory adult Diptera that was found (Chinery 1993).

Many of the Coleoptera species found in poultry houses have their natural habitat in birds' nests, or are associated with dung, decaying matter or fungi. Many are typical predators on Diptera eggs and larvae, such as the Staphylinidae and *C. pumilio*. In nature *C. pumilio* is found in decaying vegetable matter and animal droppings, and it has been reported from birds' nests. The Staphylinids *Atheta harwoodi*, *A. nigra*, *A. nigricornis*, *A. nidicola*, *A. trinotata*, *Philonthus nigriventris* and *Ph. sordidus* are all found in birds' nests (Palm 1948, 1968), while almost all the other *Atheta* species, as well as some of the other genera are associated with dung. The species found in birds' nests and in dung have in poultry houses found an artificial habitat resembling their natural habitat and might be expected to be able to appear in large numbers. The other Staphylinid species are mostly associated with decaying vegetable matter and probably utilize the poultry houses and the manure because of the large amount of prey. In the course of this investigation some Coleoptera species normally found in association with fungi and mould were detected. The Monotomidae, Latridiidae and Cryptophagidae are typical families representing these kinds of species. They utilize the products of the decaying processes in the manure, and given the right conditions they may sustain populations inside the building. Some detritus-feeding Coleoptera were also detected, but only in small numbers.

The Lepidoptera were only represented with two species. Taking account of both adults and larvae, they may be considered omnivorous in the poultry house. Both live naturally in birds' nests and were probably found because the poultry houses resemble this habitat.

The Hymenoptera were not identified to species, but previous reports from poultry manure shows that most of the Hymenoptera are parasitic species laying their eggs in Diptera larvae (Rutz & Axtell 1980, Rueda & Axtell 1985). The species appear naturally in poultry houses and are able to sustain large populations (Axtell & Arends 1990).

Multivariate analysis

The multivariate analysis uses the species composition as starting point and analyses the data set in its entirety. The resulting plots (Figure 4 and Figure 6) and the ordination of Table 4, are only based on the abundance data, but the effect of the abiotic factors creating the differences and equalities in species composition are displayed as they correlates with the axis of the plot. The method eliminated many species in the data set due to small numbers of several Stapylinids. However, only 0.6% of the total number of individuals was excluded from the analysis.

Sites plot: Running the reciprocal averaging on the data set and plotting the first two axes (Figure 4) gave a good differentiation of most of the poultry houses (sites). The farms showed similarities and differences in species composition according to some of the measured abiotic factors. Basically the farms may be divided in two groups: those with short accumulation times (cage-layer and broiler houses) and those with long accumulation times (deep-pit and breeder houses). In houses where manure is removed frequently, most species requiring longer time to establish themselves are absent. These houses are dominated by species with short generation times and good abilities to invade the manure and re-establish themselves. In addition the manure in broiler houses (types 1 and 2) is available to the birds. The birds' habit of picking at everything that moves and resembles food, will probably remove many of the larger species and the larvae from the manure. The shuffling of the manure by the birds also makes the substrate unstable and dry, and hence less suitable for insects. This is a possible explanation for the failure of the multivariate analysis to distinguish between broiler house 1 (15 weeks of accumulation) and broiler house 2 (4 weeks of accumulation). These two houses had very similar manure characteristics and species composition in spite of the differences in manure accumulation time. In deep-pit and breeder houses the manure accumulates without interference from the birds for a long time, and the connection with time is apparent for the Coleoptera and Lepidoptera, which need a prolonged period of time to establish themselves and increase in numbers. Generally there is a succession in the fauna from short accumulation time, with mostly Diptera species, to long accumulation time where the Coleoptera and Lepidoptera increase in numbers. This trend has previously been found in other investigations (Geden & Stoffolano 1987, Tobin et al. 1999). The two extremes (short and long accumulation time) can be divided into categories according to moisture content, which is further connected to temperature, because higher temperatures will increase the evaporation from the manure and hence make it drier. One would expect that there would be a difference in the faunal composition between moist/cold and dry/warm. This was found, but two of the moist cage-layer houses overlapped in species composition with the dryer broiler houses. It should be taken into account that the removal of the manure from cage-layer houses not always is complete, and the manure spilled out and accidentally left in the building will dry up and resemble the manure in broiler houses.

Two of the three farms mentioned in the results as deflecting from the normal farms, in manners of potential effect on insect fauna composition, showed up as outlayers in the multivariate analysis. The fauna composition of the deep-pit house treated with insecticides (1a) was similar to the fauna of houses with short accumulation time. The insects requiring more time to establish themselves have probably been excluded by the treatment. The broiler house type 2 (5a) which was constructed as four houses built together as one, and having production at different stages running at all times, also differed in species composition. A large amount of Staphylinidae (*A. harwoodi* and *A. nigra*) was found on this farm. This might be an effect of manure availability for the insects. The house has manure in three of the four parts of the building at any time. Leaving manure in a building during clean out will allow faster recolonisation of the new manure and help the Coleoptera to re-establish (Axtell & Arends 1990). It will also give the insects cover during the clean out and disinfection of the building. The third divergent farm (3b), where the birds had been removed from the building before the sampling, showed no difference in species composition compared with other broiler houses.

Fauna plot: The four categories (Figure 6) are composed of general habits and the feeding preferences of the various species and families, and are not complete descriptions of the particular species' or family's way of life. Psychodidae, Sphaeroceridae, Sciaridae and Cecidomyidae, which are the most widespread Diptera families, may be considered as a starting point for the examination of the plot. The species above these points are species often associated with fungi and moist habitats, and they were to a large extent found in deep-pit houses. The conditions in these houses are dark, moist and cool and should promote growth of various fungi. Phoridae have also been found in large numbers in moist and dark breeding sites (Smith & Withman 1998). The placement of the Diptera larvae in the upper left part is an effect of large number of larvae found in one of the cage-layer houses (2d). The species on the right side of the plot are mostly found in the breeder houses and some deep-pit houses. The Coleoptera in these parts of the plot are usually abundant and predatory species in poultry manure (Axtell 1986, Axtell and Rutz 1986). The large amount of predatory species probably reduces the amount of prey, which typically is larvae and small adult Diptera. The *Atheta* species below the centre were present in all the different production types, but most of them were found in breeder houses. These species were found in a wide range of moisture levels, and they were the only Coleoptera (with more than 10 specimens in the total material) present in broiler houses. Species directly to the left of the centre have a wide distribution on the various farms, but most of them were found in houses with short accumulation periods. The three species not included in the four major groups are Hymenoptera, *T. castaneum* and Ceratopogonidae. The Ceratopogonidae and Hymenoptera had a wide distribution and were therefore placed near the middle of the plot. The Ceratopogonidae should appear independently of the manure conditions because of its blood feeding habit, and since there are birds to feed on everywhere it is positioned near the centre of the plot. The parasitic Hymenoptera are expected to follow the distribution of the Diptera larvae. This was not found and may be an effect of the method used for the sampling. Hymenoptera are probably randomly captured in small amounts and hence placed near the middle of the plot. The grain pest *T. castaneum* is plotted between the species typical of the deep-pit and breeder houses.

CONCLUSIONS

The differences in the total numbers and composition of the insects are connected to the manure characteristics, and conditions on the different farms. The five production types have different and specific manure conditions except the two broiler houses (type 1 and type 2), which are very similar. The factor having the largest effect on the composition of the fauna is time of manure accumulation followed by the moisture levels combined with temperature. These three conditions play an important role in determining the insect fauna of different production systems. They can be used to understand the large scale pattern, but many other factors, like competition, predation and amount of poultry food spilling may have an influence. The method of using multivariate analysis and treating poultry houses as different habitats, proved useful as a tool to understand the differences in the insect fauna. The various species and families appear to have different demands and preferences for the manure, and they are connected to each other as predators and prey. The understanding of poultry manure as a habitat, with abiotic factors and changes through time, is important for the management of poultry manure. Knowledge of all the factors, individually and as a whole is important in IPM, which considers all the factors from manipulation of moisture levels and temperature, to parasitic predation.

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Additions to the Norwegian Hoverfly fauna (Diptera, Syrphidae)

Tore R. Nielsen

Nielsen, T. R. 2002. Additions to the Norwegian Hoverfly fauna (Diptera, Syrphidae). Norw. J. Entomol. 49, 18.

Four hoverfly species, *Eumerus sabulonum* (Fallén, 1817), *Platycheirus splendidus* Rotheray, 1998, *Pocota personata* (Harris, 1780) and *Xylota xanthocnema* Collin, 1939 are reported new to the Norwegian fauna, and a second find of *Eristalis similis* (Fallén, 1817).

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The following species are reported from South Norway [* = new to Norway].

Eristalis similis (Fallén, 1817)

A female was caught on *Angelica silvestris,* at **VAI** Audnedal: Hellestøl (EIS 5) 3 Aug. 2000, leg. and coll. TRN. This is the second record of *E. similis* in Norway.

* *Eumerus sabulonum* (Fallén, 1817)

A female collected in Malaisetrap at **VAY** Kristiansand: Kjevik (EIS) 18 July 2000, on a dry, sandy slope with scattered scrub and remnants of old gardens with *Muscari* and *Lilium*. Leg. Kai Berggren, coll. TRN.

* *Platycheirus splendidus* Rotheray, 1998

HOY Bergen: Isdalen (EIS 40) 9 May 1971 1♂, leg. TRN; Bergen, Paradis (EIS 30) 19 May 1966, 1♂, leg. TRN; Alversund, Alversund bru (EIS 39) 19 May 1966 1♂, leg A. Løken. **HOI** Kvinnherad: Rosendal (EIS 31) 22 May 1969 1♂, leg. «fieldcourse»; all in coll. Zoological Museum, University of Bergen. **HOY** Bergen: Biskopshavn (EIS 39) 27 May 1982 1♂, leg. Eva Songe Paulsen, in coll. TRN.

The species was recently described from Britain and is very much like *P. scutatus* (Meigen, 1822). According to Rotheray (1998) it differs in a shiny face with the medial stripe broader than central knob, and in darker legs. The male has a more produced upper mouth-edge and the genitalia parameres with the basal projection longer than broad. Speight (pers. comm.) also found differences in the male front tarsi. In the fore leg of male *scutatus*, tarsomere 3 is hardly 2x as wide (max) as long, whereas in *splendidus* it is distinctly more than 2x as wide as long.

* *Pocota personata* (Harris, 1780)

A female was found by Bengt Ehnstrøm at **VE** Hedrum: Middagskollen v/Farris (EIS 19) 25 May 1998. The specimen was newly hatched and was sitting in the sun on an aspen stump, some 1.5 m from the ground. The collecting site was a wooden slope with old aspens, spruce, pine, birch, sallow, alder and juniper. The specimen is kept in the collections of Zoological Museum, University of Bergen.

* *Xylota xanthocnema* Collin, 1939

A female was caught at **AAI** Bygland: Heddevika (EIS 9) 27 Aug. – 5 Oct. 1998, in Malaisetrap, leg. Kai Berggren, in coll. Zoological Museum, University of Oslo. A female at **VAI** Audnedal: Viblemo (EIS 5) TRN, 29 July – 5 Aug. 2000 in a light trap, leg. Kai Berggren, in coll. TRN.

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Norw. J. Entomol. 49, 19–22. 2002

Distinguishing the second-stage larvae of two *Oxythrips* species (Thysanoptera)

Sverre Kobro

Kobro, S. 2002. Distinguishing the second-stage larvae of two *Oxythrips* species (Thysanoptera). Norw. J. Entomol. 49, 19-22.

Diagnostic characters of the second-stage larvae of *Oxythrips bicolor* and *Oxythrips ajugae* are shown. The larva of the former has not been described previously.

Key words: Thrips, *Oxythrips bicolor, Oxythrips ajugae,* larvae, diagnostic characters.

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INTRODUCTION

Identification of larvae of thrips traditionally has not been given high priority, as they are small and difficult to study. Publications on thrips larvae deal mainly with species of economical interest (Kobro 2001). The eggs of thrips are relatively large and the oviposition lasts for a long time. Thus the larvae often occur together with the imagines (Lewis 1973), which can help the identification (Priesner 1964, Kobro 2001). However, when imagines and larvae of several species occur together the identification of the larvae may be more complicated.

In a study of forest biodiversity by the Norwegian Forest Research Institute, almost 30 000 arthropod specimens were recorded by canopy fogging of 24 Scots pines, *Pinus silvestris*, in the years 1998 and 1999. The study sites were Geitaknottane, Kvam (HOI) and Gudbrandsseterfjellet, Sigdal, (BV) (Gjerde et al. 1997). Of the specimens collected close to 5000 were of the order Thysanoptera. Two species, *Oxythrips bicolor* (Reuter) and *Oxythrips ajugae* Uzel, were by far the most common of the adult thrips. Second stage larvae from the three pines with the highest number of thrips in 1999 were classified to two types, according to Nakahara (pers. com.), termed type A and type B (Figures 1 and 2):

Type A: Two dark spines at apex of 10th abdominal segment close together (Fig. 1). Posterior margin on 9th abdominal segment sclerotised.

Type B: Two dark spines at apex of 10th abdominal segment well separated (Fig. 2). Posterior margin on 9th abdominal segment not sclerotised.

Larvae of *O. ajugae* have previously been described by Priesner (1964), and it belongs to type B. The classification could be done without preparation of the specimens and with a binocular microscope with 40 X magnification.

RESULTS

The composition of larvae was compared to the composition of imagines and the results are presented here.

Larvae of type B were the most common in the three pines. *O. ajugae* was the most common species of the imagines in two of the three pines and also in total (Table 1).

DISCUSSION

In addition to *O. bicolor* and *O. ajugae*, which reproduce on male cones of pine, three other species of the genus have been reported from Britain:

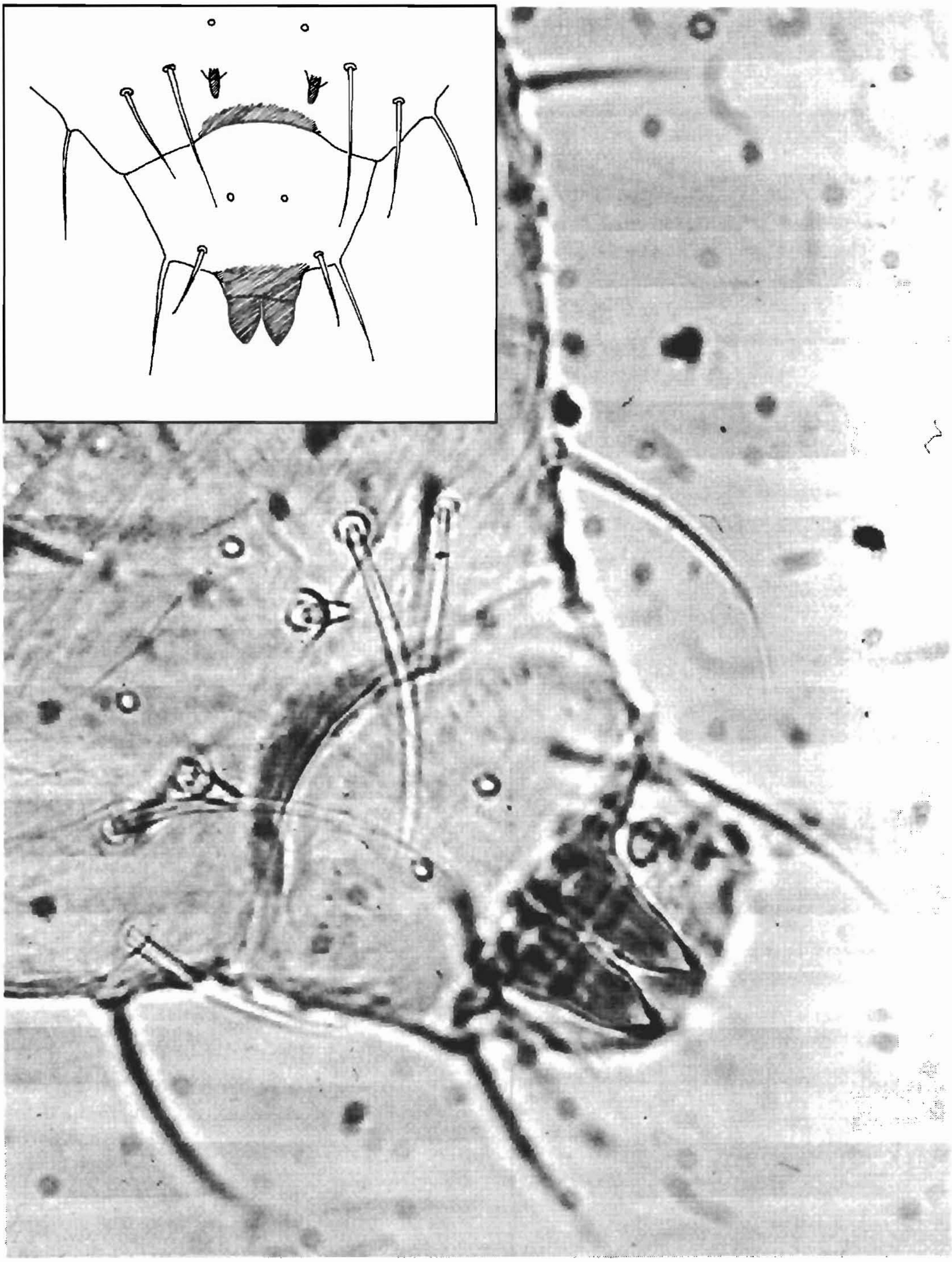

Figure 1. Diagnostic characters on abdomen of larvae of *Oxythrips bicolor.*

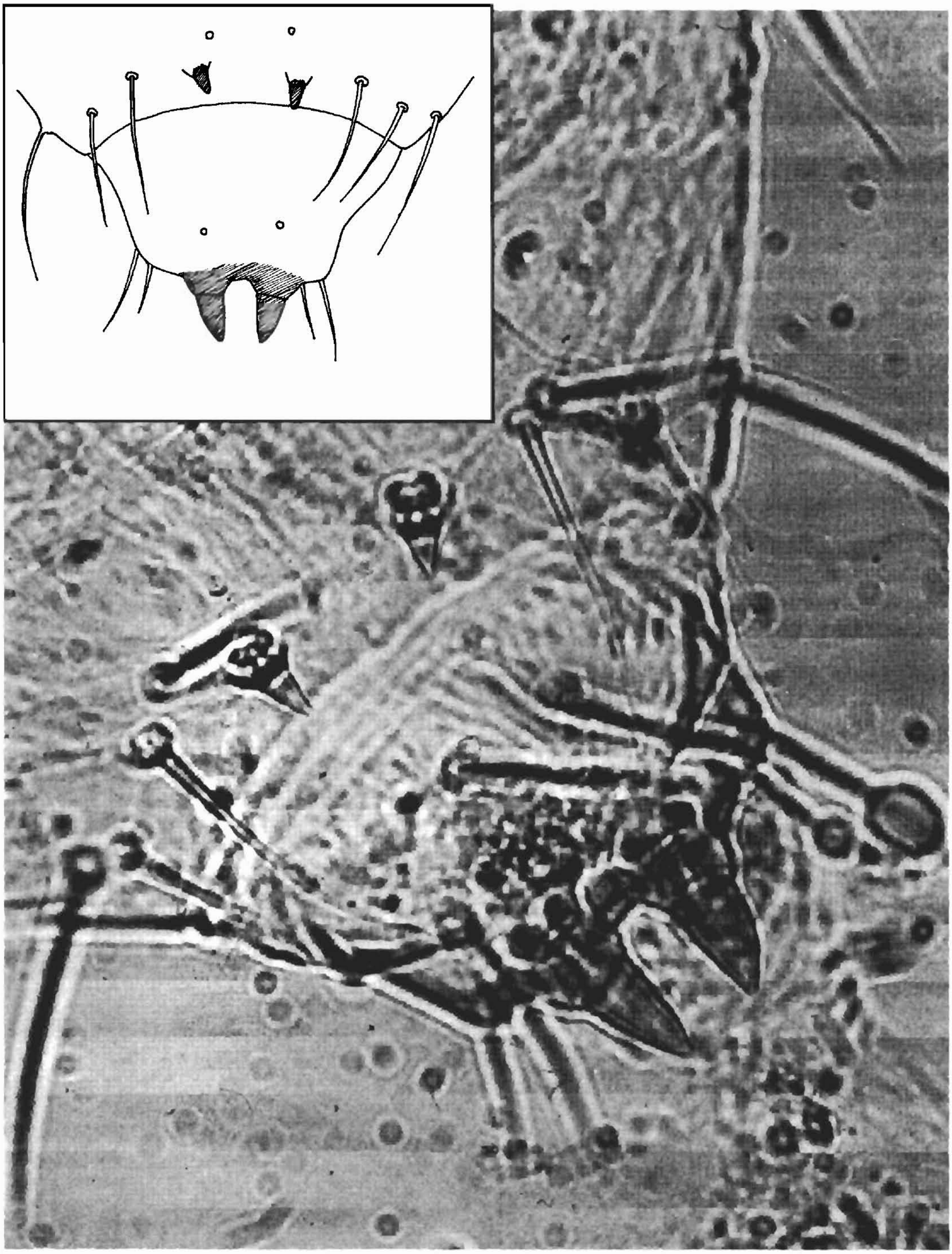

Figure 2. Diagnostic characters on abdomen of larvae of *Oxythrips ajugae*.

Table 1. Number of imagines and larvae of *Oxythrips* from three pine trees.

Pine	*Oxythrips*			
	Imagines		Larvae	
	bicolor	*ajugae*	A	B
46g	5	24	74	170
71g	3	11	21	91
102g	24	20	22	533
Sum	**32**	**55**	**117**	**794**

O. haliday Bagnall, *O. ulmifoliorum* Haliday and *O. quercicola* Bagnall, living on *Fraxinus, Ulmus* and *Quercus* respectively (Mound et al. 1976). Among the latter, only *O. ulmifoliorum* was recorded from Norway, and twice only (zur Strassen, pers. com.). I therefore assume that all the *Oxythrips* larvae found in pine in this study were *O. bicolor* or *O. ajugae.*

Assuming that the most common larvae belong to the most common of adults, the results presented in Table 1 may indicate that the larvae of type A are *O. bicolor* and larvae of type B are *O. ajugae.*

During a survey in pine in the northern Netherlands only one *Oxythrips* species was found (Vierbergen, pers. com.). Examination of preserved material from Vierbergen's survey, containing adults of *O. ajugae* (n=23) and larvae (n=8), showed that the larvae were of type B.

The results presented here, together with the material from the Netherlands, confirm the description of the larva of *O. ajugae* given by Priesner (1964). I therefore conclude that the *Oxythrips* larvae of type A belong to *O. bicolor.*

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Checklist of naturally occurring pathogens of insects and mites in Norway

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Klingen, I., Salinas, S.H. & Meadow, R. 2002. Checklist of naturally occurring pathogens of insects and mites in Norway. Norw. J. Entomol. 49, 23-28.

A checklist of naturally occurring microbes and nematodes that are pathogenic to insects and mites in Norway is presented. All records are listed by pathogen group (fungi, bacteria, viruses, and nematodes). Each record is listed with reference to the original author, and subsequent references have been included. The checklist should be updated periodically to assist researchers and policy makers within the field of entomology and crop protection.

Keywords: arthropod pathogens, Norway, insects, mites.

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INTRODUCTION

Arthropod pathogens are key factors in population dynamics and regulation of several insect and mite species, and are capable of causing high levels of mortality in insect and mite populations (Dustan 1927, Bovien 1937, Smitley et al. 1986, Bellotti 1990, Peters 1996, Cross et al. 1999, Moscardi 1999, Puterka 1999, Richards et al. 1999, Stark et al. 1999, Klingen et al. 2000). The relation between pathogens and their insect and mite hosts is important, not only in population dynamics, but also in relation to conservation and biodiversity. Many insect and mite pathogens are host-specific and therefore dependent on the presence of their host. Should the host insect become extinct, it is likely that the pathogen will also become extinct. New species of arthropod pathogens and new interactions between arthropods and microorganisms are being discovered and described continuously. Some of the more «exotic» areas in Norway may provide habitats for rare species and isolates that might be of interest to the science of insect pathology and also to the pharmaceutical and pesticide industries.

Pathogens are often neglected in insect and mite ecology (Onstad 1990), and mortality factors are, therefore, often classified as 1) Biotic (predators and parasitoids) and 2) Abiotic. By classifying mortality factors in this way, studies are often conducted in a manner that makes it difficult to observe the effect of arthropod pathogens on insect and mite populations. One of the reasons for this «negligence» of pathogens as a mortality factor may be that, unless specifically looked for, some pathogens are difficult to observe on insect and mite hosts, in addition they may be missed due to rapid degradation of the host. Most ecological studies of insects and mites in Norway have also concentrated on aspects other than epizootiology (the study of diseases in non-human animal populations), and only scattered studies on the natural occurrence of arthropod pathogens have been conducted. Previous studies have revealed the occurrence of several insect pathogenic species in Norway. We have attempted to collect all records of naturally occurring arthropod pathogens in the country, and present them in this checklist (Table 1). We have limited the list to known or suspected pathogens, and excluded microbes commonly associated with insects that we do not expect to be important for population dynamics and regulation. Even though there is some controversy about the effect of Laboulbeniales on their host, it has been suggested that they might be important for population dynamics and regulation (Andersen & Skorping 1991, Tanada & Kaya 1993), and consequently we have included this order in the list. Updated nomenclature of generic and specific names has been avoided, and we have instead referred to the original names reported. In the checklist we have listed both the natural host from which the pathogen has been isolated, and insect hosts that have been used to bait the pathogen. For organization of genera under families or large groupings we followed the work of Glare et al. (1993), with modifications.

It is our intention to update this checklist periodically, and more insect and mite pathogens will be described in the near future. Furthermore, we may have missed some records, and would therefore welcome all records of interactions between arthropods and pathogenic organisms in Norway. Submissions of diseased insects and mites to the authors are also welcomed.

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Table 1. Checklist of pathogens recorded on insects and mites in Norway.

Pathogen	**Host (insect or mite)**		**References**
	Species (stage)	**Order/ Family**	
FUNGI			
Ascomycota			
Euascomycotina			
Pyrenomycetes			
Hypocreales			
Cordyceps sp.	*Noctua pronuba* (larva)	Lepidoptera: Noctuidae	Kobro, S. unpublished
Cordyceps bifusispora	Lepidoptera Unidentified (pupa)	Lepidoptera	Stensrud 2000
Cordyceps entomorrhiza	*Carabus* sp. (larva)	Coleoptera: Carabidae	Eckblad 1967
Cordyceps entomorrhiza	*Carabus nemoralis* (adult)	Coleoptera: Carabidae	Eckblad 1967
Cordyceps gracilis	*Hepialus* sp. (larva)	Lepidoptera: Hepialidae	Lauritzen 1971
Cordyceps militaris	*Dendrolimus pini* (larva)	Lepidoptera: Lasioicampidae	Olsen 1903, Olsen Sopp 1911, Eckblad 1967
Cordyceps myrmecophila	*Formica* sp. (adult)	Hymenoptera: Formicidae	Granmo & Simons 2002
Laboulbeniomycetes			
Laboulbeniales			
Laboulbenia pedicellata	*Bembidion* spp.	Coleoptera: Carabidae	Andersen & Skorping 1991
Laboulbenia vulgaris	*Bembidion* spp.	Coleoptera: Carabidae	Andersen & Skorping 1991
Deuteromycotina			
Hyphomycetes			
Beauveria bassiana	*Delia radicum* (adult)	Diptera: Anthomyiidae	Klingen, I. unpublished
Beauveria bassiana	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Klingen et al. 2002a
Beauveria bassiana	*Ips typographus* (adult)	Coleoptera: Scolytidae	Klingen, I. & Midtgaard, F. unpublished
Fusarium merismoides	*Delia floralis* (larva, baited)	Diptera: Anthomyiidae	Klingen et al. 1998
Fusarium merismoides	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Klingen et al. 1998
Metarhizium anisopliae	*Delia floralis* (larva, baited)	Diptera: Anthomyiidae	Klingen et al. 2002a
Metarhizium anisopliae	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Klingen et al. 2002a
Metarhizium anisopliae	*Phyllopertha horticola (larva)*	Coleoptera, Scarabaeidae	Klingen, I. & Salinas, S.H. unpublished
Paecilomyces farinosus	*Cydia pomonella* (larva)	Lepidoptera: Torticidae	Sæthre 2001
Tolypocladium cylindrosporum	*Delia floralis* (larva/pupa, baited)	Diptera: Anthomyiidae	Klingen et al. 2002a
Verticillium lecanii	*Myzus cerasi* (adult)	Hemiptera: Aphididae	Klingen et al. 2002b
Zygomycota			
Zygomycetes			
Enthomophthorales			
Conidiobolus obscurus	*Myzus cerasi*	Hemiptera: Aphididae	Klingen et al. 2002b
Entomophthorales Unident.	*Thrips vulgatissimus* (adult)	Thysanoptera: Thripidae	Klingen, I. & Kobro, S. unpublished
Entomophthora muscae, group B	*Botanophila fugax* (adult)	Diptera: Anthomyiidae	Thomsen, L. unpublished
Entomophthora muscae	*Delia floralis* (adult)	Diptera: Anthomyiidae	Eilenberg et al. 1994, Klingen et al. 2000b
Entomophthora muscae	*Delia radicum* (adult)	Diptera: Anthomyiidae	Eilenberg et al. 1994, Klingen et al. 2000b
Entomophthora planchoniana	*Myzus cerasi*	Hemiptera: Aphididae	Klingen et al 2002
Entomophthora trinucleata	Cyclorrhapha Unidentified (adult)	Diptera	Eilenberg, J. unpublished
Erynia spp.	*Delia floralis* (adult)	Diptera: Anthomyiidae	Eilenberg et al. 1994
Erynia neoaphidis	*Myzus cerasi*	Hemiptera: Aphididae	Klingen, I. unpublished

Table 1. Continued.

Pathogen	Host (insect or mite)		References
	Species (stage)	**Order/ Family**	
Erynia virescens	*Mamestra brassicae* (larva)	Lepidoptera: Noctuidae	Johansen 1996
Neozygites floridana	*Tetranychus urticae* (adult/nymph)	Arachnida: Tetranychidae	Klingen, I. & Trandem, N. unpublished
Neozygites fresnii	*Elatobium abietinum* (adult/nymph)	Hemiptera: Aphidoidea	Austarå et al. 2000
Strongwellsea castrans	*Delia floralis* (adult)	Diptera: Anthomyiidae	Eilenberg et al. 1994, Klingen et al. 2000
Strongwellsea castrans	*Delia radicum* (adult)	Diptera: Anthomyiidae	Eilenberg et al. 1994, Klingen et al. 2000
BACTERIA			
Bacillus thuringiensis	*Delia floralis* (pupa)	Diptera: Anthomyiidae	Eilenberg et al. 1994
ANIMALIA			
NEMATODA			
Secernentea			
Tylenchida			
Allantonematidae			
Heterotylenchus autumnalis	*Bembidion bruxellense* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion difficile* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion hyperboraeorum* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion lunatum* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion prasinum* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion schuppelii* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion semipunctatum* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Heterotylenchus autumnalis	*Bembidion virens* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1990, 1991
Rhabditida			
Heterorhabditidae			
Heterorhabditis sp.	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Salinas 1996
Heterorhabditis megidis	*Phyllopertha horticola* (larva)	Coleoptera: Scarabaeidae	Salinas & Reid 2001
Steinernematidae			
Steinernema spp.	*Delia floralis* (larva, baited)	Diptera: Anthomyiidae	Salinas, S.H. unpublished
Steinernema spp.	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Salinas 1996
Steinernema affinis	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Haukeland 1993
Steinernema feltiae	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Haukeland 1993
Steinernema intermedia	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Haukeland 1993
Steinernema krauseii	*Galleria mellonella* (larva, baited)	Lepidoptera: Pyralidae	Eidet 2000
Adenophorea			
Mermithida			
Mermithidae			
Genus not identified	*Ablabesmyia monilis* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.

Table 1. Continued.

Pathogen	**Host (insect or mite)**		**References**
	Species (stage)	**Order/ Family**	
Genus not identified	*Bembidion difficile* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1991
Genus not identified	*Bembidion prasinum* (adult)	Carabidae: Coleoptera	Andersen & Skorping 1991
Genus not identified	*Conchapelopia melanops* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.
Genus not identified	*Conchapelopia pallidula* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.
Genus not identified	*Procladius barbatus* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.
Genus not identified	*Procladius signatus* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.
Genus not identified	*Thienemannimyia fusciceps* (adult)	Diptera: Chironomidae	Aagaard 1974, Aagaard pers.comm.
Gastromermis sp.	*Aedes hexodontus* (larva)	Diptera: Culicidae	Nielsen et al. 1981
VIRUSES			
Baculoviridae			
Subgroup A:			
Nuclear Polyhedrosis Virus	*Neodiprion sertifer* (larva)	Hymenoptera: Tenthredinidae	Tvermyr 1968
Subgroup B:			
Granulosis Virus	*Eupsilia transversa* (larva)	Lepidoptera: Noctuidae	Edland 1965, 1968

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Canopy cover favours sporocarp-visiting beetles in spruce forest

Bjørn Økland

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Several studies conclude that sun-exposed habitats with sufficient supply of dead wood are essential for many saproxylic and mycetophagous beetle species in forests. This has induced Scandinavian foresters to leave artificial tall stumps on clear-cuts in spruce forests. In the present study of Norway spruce forest, habitat preferences during flight were studied for saproxylic and mycetophagous beetles recorded as sporocarp-visitors of *Fomitopsis pinicola* and *Fomes fomentarius*, using 690 randomly placed window traps in 69 sites covering three forest types: clear-cuts, young and oldgrowth stands. Many of the sporocarp-visitors showed a strong preference for oldgrowth forest, avoiding clear-cuts and young replantations. By stepwise linear multiple regression, presence of canopy cover appeared as a major factor while variables associated with sporocarps and dead wood were most often secondary in importance. The results indicate that sufficient canopy cover is important for many sporocarp-visiting beetles in Norway spruce forests.

Key words: Biodiversity, Coleoptera, dead wood, flight activity, microclimate, polypore fungi.

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INTRODUCTION

In the last few years Scandinavian forestry has introduced several measures specifically aimed at conserving biodiversity. These practices imply large expenses for the forest companies. Since the measures are most often based on only scanty scientific evidence, it is necessary to scientifically evaluate their accuracy (Larsson & Danell 2001).

Insects associated with dead wood (saproxylic insects) and wood-inhabiting fungi (mycetophagous insects) are of special interest for maintenance of biodiversity in boreal forests (Dajoz 2000). In Sweden, more than a thousand of beetle species are dependant on dead trees (Ehnström 2001). Many species of these diverse insect groups are on red-lists (Gärdenfors 2000, Esseen et al. 1997, Direktoratet for Naturforvaltning 1999, Rassi et al. 1992). Due to their habitat preferences, they are in principle competitors with timber harvesting. To create artificial tall stumps and leave single dead trees on clear-cuts have become the most common measures to meet the requirements of saproxylic and mycetophagous fauna in boreal forests of Fennoscandia. This measure, which easily can be combined with forestry practice, is particularly suited for species preferring sun-exposed dead wood (Kaila et al. 1997), in areas with a rich saproxylic fauna in the surrounding forest (Ehnström pers. comm.). However, it may be questioned to what extent all saproxylic and mycetophagous insects benefit from this practice, and whether microclimate or other factors are limiting dead-wood habitats of open environments.

Several authors conclude that density and quality of dead-wood substrates are of major importance for the saproxylic fauna (Ehnström & Waldén 1986, Økland et al. 1996, Esseen et al. 1997, Martikainen 2000, Martikainen et al. 2000, Siitonen & Saaristo 2000, Siitonen et al. 2000, Ehnström 2001). Particularly important for red-listed invertebrates are certain dead-wood elements, such as snags and logs (Berg et al. 1994) and dying and dead aspen (Siitonen & Martikainen 1994, Siitonen et al. 1996). The abundance as well as species richness of saproxylic beetles may increase with the age of the stumps and logs (Irmler et al. 1996). Habitat density seems to act at several spatial scales. Schiegg (2000a, b) found that fragmentation occurs at a local scale through isolation of single dead wood pieces, while other authors revealed a strong influence of dead wood at large scales (Siitonen 1994, Siitonen & Martikainen 1994, Økland et al. 1996). For insect diversity in sporocarps, the amount of dead wood at and near the sampling site also appears to be a major factor (Thunes et al. 2000). The concentration of fruiting bodies has been found to be important for beetle species (Rukke & Midtgaard et al. 1998, Rukke 2000). Substrate properties of the sporocarps are important for the inhabiting faunal composition, including tissue hardness and persistence (Paviour-Smith 1960, Lawrence 1973, Klopfenstein & Graves 1989, Økland 1995), size and water content (Willassen & Thunes 1996, Midtgaard 1998), and successional stage from start to full degradation (Ackerman & Shenefelt 1973, Thunes 1994, Økland & Hågvar 1994). Properties of the host tree influence the insect fauna of sporocarps, e.g. tree diameter and number of dead sporocarps on the tree (Nilsson 1997a, Sverdrup-Thygeson & Midtgaard 1998), whether the tree is standing or lying, and degree of contact between the tree and the ground (Nilsson 1997b).

Only few studies mention species with a preference for shaded sites and canopy cover; this may, however, determine whether artificial tall stumps on clear-cuts are utilised or not. Some saproxylic invertebrates, especially those living in the last successional stages (Jonsell et al. 1998), and some insects breeding in sporocarps of *Fomitopsis pinicola* and *Fomes fomentarius* (paper 1 in Jonsell 1999) are dependent on shaded sites. For species associated with oak in pasture woodlands, Ranius & Jansson (2000) found that only species using fruiting bodies of saproxylic fungi benefited from forest regrowth due to lacking management.

Sensitivity of canopy may possibly be found in more insect groups if the flying stage is studied. It is assumed that adaptations to prefer or avoid characteristics of the surrounding forest environment are reflected in the flight behaviour during the search for suitable habitats. During flight, many insects show negative phototactic response or respond directly to other stimuli in the surrounding environment, such as moisture, temperature, wind and odour (Romoser 1981, Faldt et al. 1999).

The present study focuses on the additional effect caused by absence of canopy cover for saproxylic and mycetophagous insects visiting living sporocarps of *F. pinicola* and *F. fomentarius* in boreal spruce forest. A recent study gives a list of beetle species that have been recorded as visitors of living sporocarps of *F. pinicola* and *F. fomentarius* in the present study area (Hågvar 1999). Sporocarps and dead wood substrates used by these beetle species are found in all successional stages of spruce forest in the experimental area, making it possible to test the additional effect of canopy cover. Randomly placed flight interception traps were used to acquire information about preference and avoidance in this assemblage of beetles. Three forest types were compared: clear-cut, young spruce forest and oldgrowth spruce forest.

METHODS

All study sites were situated within an area of about 160 km^2 of continuous spruce-dominated forest in Østmarka (59°51'N 10°57'E, about 15 km south-east of Oslo city centre) with only slight variations in elevation (200 to 300 m above sea level). Flying beetles were trapped in 69 sites, each site placed in the centre of different spruce forest stands within *Eu-Piceetum myrtilletosum* vegetation type (Kielland-Lund 1973). Ten sites were located in *clear-cut stands* (clear-cut 2-3 years before, without artificial tall stumps), ten in *young stands* (plantations after clear-cutting 14-16 years ago, without artificial tall stumps), and 49 in *oldgrowth stands* (minimum 80 years old) with various densities of dead wood. There was a minimum distance of 200 m between the sites, and sites of the three forest categories were mixed within the study area. In each site, ten window traps were placed in a randomly centred circle (diameter 20 m) near the middle of the stand to secure random distances to sporocarps and dead logs. The traps were operated from 22 April to 13 September 1991 and emptied four times. Window traps, catching flying individuals who hit a transparent window, are effective for capture of flying saproxylic and mycetophagous beetles (Siitonen 1994, Økland et al. 1996). The traps consisted of two vertical cobex plates (21 x 39 cm) mounted cross-wise above a 22 cm wide plastic funnel, hanging with the trapping surface 0.7-1.0 m above the ground. A cup with preservative (ethylene-glycol) was mounted below the funnel (photo of the trap is given as Fig. A in Økland 1996). Ecological variables associated with sporocarps and dead wood were recorded in a square of 40 by 40 meters around the site centres (Table 1).

Species recorded as sporocarp-visitors of *F. pinicola* and *F. fomentarius* in the same area (Hågvar 1999) were sorted out of the trapping material. These 42 species are referred in Table 2 using the nomenclature of Hansen (1996) supplemented by Silfverberg (1992) for a few species which are not included in Hansen's catalogue (1996). The second column in Table 2 shows the polypore species under which the beetle species in question has been recorded as a sporocarp-visitor by Hågvar (1999); however, the beetle species may visit various sporocarp species (Benick 1952, Nuss 1975). Based on information given in Hågvar (1999, Table 1), the species are described as: obligate saproxylic (species that are dependent, during some part of their life cycle, upon the dead or dying wood of moribund or dead trees, or upon wood-inhabiting fungi, or upon the presence of other saproxylics); facultative saproxylic (species that use the same kind of habitats as obligate saproxylics but may use alternative habitats); and mycetophil/mycetobiont (species requiring or associated with fungi).

Mean densities of sporocarps and dead wood in each of the forest categories are presented in Table 3. To avoid low-numbered species in the statistical treatment, only species with a minimum mean of five specimens per site in at least one forest category were tested. For these 27 species (Table 2), the mean numbers of individuals per site were compared between the three forest types (*clear-cuts*, *young forest* and *oldgrowths*) by means of Kruskal-Wallis One-Way Analysis of Variance (Freund 1992). Using the ranks, this method is not sensitive of deviations from normal distribution or the imbalanced numbers of sites between forest category. The *p*-level was adjusted to 0.005 to compensate for the multiple tests, giving a low chance of species turning out as significant by

Table 1. Ecological variables recorded in the study sites.

Variable	Explanation	Range
Number of sporocarp:		
SPOROCARP	*No. of living sporocarps*	0 - 232
PINICOL	*No. of living Fomitopsis pinicola sporocarps*	0 - 153
FOMENT	*No. of living Fomes fomentarius sporocarps*	0 - 50
Amount and quality of dead wood:		
WOOD	*Dead wood (m^3)*	0.09 - 21.76
DECID	*Dead decidiuous wood (m^3)*	0.00 - 4.53
STUMPS	*Dead wood of stumps (m^3)*	0.02 - 4.73
BETULA	*Dead birch wood (m^3)*	0.00 - 3.27
Stand characteristics:		
CANOPY	1: presence of canopy cover 0: absence of canopy cover	0 - 1
CLEARCUT	1: clear-cut 0: covered with trees	0 - 1

chance (27 species x 0.005 = 0.135 species). Either Kruskal-Wallis One-Way Analysis of Variance or Mann-Whitney U test were applied for testing differences between forest categories for sporocarps and dead wood variables (Freund 1992). The relationships between ecological variables (Table 1) and the abundance per site in single species (n=69) were tested by forward stepwise multiple linear regression up to two steps (Weisberg 1985) (Table 4). Due to deviations from normal distribution, abundance in single species was transformed by natural logarithm before entering as dependant variable in regression analyses. Pearson correlation between all possible predictors showed no strongly intercorrelated variables. All tests were performed by means of the statistical software Systat (SYSTAT 8.0).

Results

Altogether 14 species out of 27 tested showed significant differences in the variance analyses (Table 2). The majority (10) of these species were found in great numbers in oldgrowth, while they were completely absent or appeared to be rare in clear-cuts and young replantations. Most of the significant species (Table 2) are facultative saproxylic (*Cerylon ferrugineum*, *Leptusa pulchella*, *Oxypoda alternans*, *Quedius xanthopus*, *Quedius plagiatus*, *Rhizophagus dispar*, *R. nitidulus*, *R. parvulus*, *Sepedophilus littoreus*) or obligate saproxylic (*Epuraea pygmaea*), and nearly all of them may be found in cortical or sub-cortical microhabitats (*C. ferrugineum*, *Agathidium nigripenne*, *Anisotoma humeralis*, *E. pygmaea*, *Salpingus ruficollis*, *L. pulchella*, *Anisotoma castanea*, *R. dispar*, *R. nitidulus*, *R. parvulus*). Four species have previously been reared from sporocarps (*L. pulchella*, *O. alternans*, *Q. plagiatus* and *R. dispar*) (Økland & Hågvar 1994, Thunes 1994), all of these being more abundant in oldgrowth (Table 2). Two species of the total material presented here are on red-lists in the Nordic countries. Even though their numbers appeared to be higher in oldgrowth, one species was too infrequent for testing (*Cis dentatus*) and the other was only close to the chosen significance level (*Dendrophagus crenatus*; p=0.008).

It could be suspected that a lower density of sporocarps is the reason for the small catches of many sporocarp-visiting beetles in clear-cuts and young plantations. However, the frequency of sporocarps was not significantly lower in clear-cuts than in oldgrowth (Mann-Whitney U=188.5, p=0.252), despite considerable variation between sites in both forest categories (Table 3). Accordingly, frequencies of sporocarps did not differ significantly between clear-cuts and oldgrowth stands for *F. pinicola* (Mann-Whitney U=194.0, p=0.299) and *F. fomentarius* (Mann-Whitney U=216.0, p=0.510) (Table 3).

Table 2. Mean number of individuals (per site, i.e. ten traps) of sporocarp-visiting species in three forest types (CLC = clear-cut, YNG = young stands, OLD = oldgrowth) and H and p values of Kruskal-Wallis One-Way Analysis of Variance between forest types; sign means p< = 0.005 (see methods); visit = visitor records by Hågvar (1999); Ff = Fomes fomentarius; Fp = Fometopsis pinicola; b = both Fomes Fomentarius and Fometopsis pinicola; hab = habitat; f = facultative saproxylic; o=obligate saproxylic; m=mycetophil or mycetobiont. For author names see methods.

Family	**literal information**			CLC	YNG	OLD	H	p
Species	visit	hab	(n=10)	(n=10)	(n=49)			
Aspidiphoridae								
Aspidiphorus orbiculatus	*Ff*	f; m	2.0	5.0	6.3	2.05	0.359	
Cerylonidae								
Cerylon ferrugineum	*Ff*	f	2.0	13.0	129.6	29.47	< 0.001	sign
Ciidae								
Cis boleti	*Fp*	m	25.0	45.0	51.6	3.52	0.172	
Cis dentatus	*Fp*	m	0.0	0.0	2.9			
Cis glabratus	b	m	2.0	0.0	6.3	7.24	0.027	
Cis jacquemarti	b	m	0.0	1.0	6.9	1.13	0.567	

Table 2. Continued.

Family	**literal information**			CLC	YNG	OLD	H	p
Species	visit	hab	(n=10)	(n=10)	(n=49)			
Corticariidae								
Cartodere nodifer	*Ff*	m	0.0	1.0	0.4			
Enicmus rugosus	*Fp*	m	1.0	1.0	0.8			
Enicmus testaceus	b	m	0.0	0.0	0.4			
Cryptophagidae								
Cryptophagus abietis	*Ff*	f	0.0	0.0	0.8			
Cucujidae								
Dendrophagus crenatus	*Fp*	o	0.0	0.0	8.2	9.56	0.008	
Erotylidae								
Triplax russica	*Ff*		0.0	2.0	2.7			
Leiodidae								
Agathidium nigripenne	*Ff*	m	1.0	4.0	20.0	10.43	0.005	sign
Anisotoma castanea	*Ff*		12.0	75.0	29.0	21.90	< 0.001	sign
Anisotoma glabra	*Ff*		29.0	14.0	12.9	6.25	0.044	
Anisotoma humeralis	b		21.0	47.0	224.5	35.99	< 0.001	sign
Monotomidae								
Rhizophagus dispar	b	f	4.0	4.0	72.9	35.51	< 0.001	sign
Rhizophagus nitidulus	*Ff*	f	0.0	13.0	79.6	27.82	< 0.001	sign
Rhizophagus parvulus	*Ff*	f	3.0	91.0	82.7	20.40	< 0.001	sign
Nitidulidae								
Epuraea muehli	*Ff*	o	1.0	1.0	4.9			
Epuraea pygmaea	*Ff*	o	10.0	2.0	56.3	25.39	< 0.001	sign
Epuraea silacea	*Ff*	m	0.0	0.0	0.4			
Epuraea variegata	b	f; m	3.0	5.0	7.3	2.54	0.281	
Glischrochilus hortensis	*Ff*	f	4.0	9.0	18.4	0.64	0.727	
Glischrochilus quadripunctatus	*Ff*	f	1.0	3.0	10.6	8.40	0.015	
Pocadius ferrugineus	*Ff*	f; m	1.0	0.0	1.0			
Salpingidae								
Salpingus ruficollis	*Ff*		11.0	46.0	201.0	34.56	< 0.001	sign
Scaphidiidae								
Scaphisoma agaricinum	*Fp*	f; m	0.0	13.0	0.2	2.27	0.322	
Staphylinidae								
Gyrophaena boleti	b		12.0	115.0	36.5	8.70	0.013	
Leptusa pulchella	b	f	24.0	13.0	87.8	29.84	< 0.001	sign
Lordithon lunulatus	*Ff*	f; m	3.0	9.0	22.0	8.56	0.014	
Lordithon trinotatus	*Ff*	m	2.0	4.0	8.6	2.86	0.240	
Oxypoda alternans	*Ff*	f; m	2.0	4.0	18.8	16.34	< 0.001	sign
Phloeonomus lapponicus	*Ff*	f	0.0	0.0	1.2			
Phloeonomus monilicornis	*Ff*	f	0.0	0.0	2.0			
Quedius plagiatus	*Ff*	f	9.0	1.0	41.2	18.65	< 0.001	sign
Quedius xanthopus	*Fp*	f	2.0	10.0	52.0	32.95	< 0.001	sign
Sepedophilus littoreus	b	f; m	44.0	11.0	41.8	12.45	0.002	sign
Stenus impressus	*Ff*		2.0	1.0	1.0			
Tenebrionidae								
Bolitophagus reticulatus	*Ff*	m	0.0	0.0	0.8			
Trogositidae								
Ostoma ferruginea	*Fp*	f	2.0	3.0	3.3			
Thymalus limbatus	b	f; m	0.0	0.0	0.2			

Table 3. Mean of sporocarps and dead wood per sampling site compared for three forest categories: clear-cut (n=10), young stands (12 – 14 years old; n=10) and oldgrowth stands (n=49). SE = standard error.

	No. of sporocarps		*Sporocarps of F. pinicola*		*Sporocarps of F. fomentarius*	
	Mean	SE	Mean	SE	Mean	SE
clear-cut	23.40	10.52	13.30	7.65	2.50	1.63
young stands	2.20	0.92	2.20	0.92	0.00	0.00
oldgrowth	27.24	5.62	13.36	2.88	2.76	0.77

	Dead wood (m^3)		Dead wood of stumps (m^3)		Dead wood of birch (m^3)	
	Mean	SE	Mean	SE	Mean	SE
clear-cut	4.88	0.70	2.97	0.33	0.02	0.01
young stands	4.95	0.08	1.76	0.08	0.04	0.02
oldgrowth	5.84	0.89	0.72	0.05	0.71	0.27

The amount of dead-wood substrates did not differ significantly between the forest types (Kruskal-Wallis H = 0.271, df=2, p=0.873). The amount of dead wood was nearly as abundant in clear-cuts as in oldgrowth, probably due to the larger abundance of stumps in clear-cuts (Table 3). *Dead birch wood* showed lower scores in clear-cuts than in oldgrowth (Table 3, H = 12.876, df=2, p=0.002). Even though dead birch is the main substrate for *F. fomentarius* in this area, the density of sporocarps of *F. fomentarius* was not significantly lower in clear-cuts than in oldgrowth (Table 3, Mann-Whitney U=216.0, p>0.05). Young forest showed a lower number of sporocarps compared to the other forest categories, both for sporocarps in general (H = 10.973, df=2, p=0.004) and for *F. pinicola* (H = 7.676, df=2, p=0.022) and *F. fomentarius* (H = 6.281, df=2, p= 0.043) (Table 3). The general amount of dead wood in young forest was not significantly lower (Kruskal-Wallis H = 0.271, df=2, p=0.873); however, a considerable fraction was older stumps, which are less suitable for *F. pinicola* and *F. fomentarius* (Table 3).

The combined influences of stand characteristics and the amount and quality of dead wood and sporocarps (all variables in Table 1) were tested for all species with high catches in oldgrowth by forward stepwise linear multiple regression. For all species tested (13) except for two, presence of a canopy cover was selected in first step and explained the major part of the variation in catches per site, and was the only selected variable for five of the species (Table 4). For the remaining two species *CANOPY* was selected in the second step. For two species, *CLEAR-CUT* was selected as a second negative variable after the selection of canopy cover (Table 4). Dead wood was selected in step one for the obligate saproxylic species *D. crenatus*, and in the second step for *C. ferrugineum* and *R. nitidulus*. *DECID* (amount of deciduous wood) was selected in step one for *A. nigripenne* and in the second step for *Q. plagiatus*, both species previously recorded from the deciduous-tree-living *F. fomentarius* (Ryvarden & Gilbertson 1993) (Table 4). *FOMENT* (no. of *F. fomentarius* per site) was a second variable for *E. pygmaea*, which is another beetle species previously recorded as visitor of this fungal species (Table 2).

Table 4. The influence of ecological variables on abundance in single species (ln) tested by stepwise forwards multiple regression up to two steps. F is given for each variable at entry into the model as well for the total model. p1 = significance value of F; T = T-value of slope; p2 = significance value of T; R2 = coeffisient of determination (given as adjusted R2 for multiple models).

Species	F	p_1	T	p_2	R^2	R^2adj
Cerylon ferrugineum						
Step 1: CANOPY	48.118	0.000	6.937	<0.001	0.418	
Step 2: WOOD	9.007	0.004	3.001	0.004	0.488	
Model: 1.704CANOPY + 0.040WOOD + 0.126	31.438	0.000				0.472
Dendrophagus crenatus						
Step 1: WOOD	30.513	0.000	5.524	<0.001	0.313	
Step 2: CANOPY	7.083	0.010	2.661	0.010	0.380	
Model: 0.032WOOD + 0.295CANOPY - 0.155	20.183	0.000				0.361
Agathidium nigripenne						
Step 1: DECID	37.148	0.000	6.095	<0.001	0.357	
Step 2: CANOPY	3.644	0.061	1.909	0.061	0.390	
Model: 0.157DECID + 0.276CANOPY + 0.131	21.128	0.000				0.372
Anisotoma humeralis						
step 1: CANOPY	104.627	0.000	10.229	<0.001	0.610	
step 2: CLEARCUT	3.187	0.079	-1.785	0.079	0.628	
Model: 1.604CANOPY - 0.543CLEARCUT + 0.1380	55.615	0.000				0.616
Rhizophagus dispar						
Step 1: CANOPY	83.935	0.000	9.162	<0.001	0.556	
Step 2: None						
Model: 1.627CANOPY + 0.208	83.935	0.000			0.556	
Rhizophagus nitidulus						
Step 1: CANOPY	42.593	0.000	6.526	<0.001	0.389	
Step 2: WOOD	3.448	0.068	1.857	0.068	0.419	
Model: 1.446CANOPY + 0.023WOOD + 0.142	23.799	0.000				0.401
Rhizophagus parvulus						
Step 1: CANOPY	21.878	0.000	4.677	<0.001	0.246	
step 2: CLEARCUT	3.321	0.073	-1.822	0.073	0.282	
Model: 0.848CANOPY - 0.808CLEARCUT + 0.988	12.979	0.000				0.261
Epuraea pygmaea						
Step 1: CANOPY	35.713	0.000	5.976	<0.001	0.348	
Step 2: FOMENT	7.641	0.007	2.764	0.007	0.415	
Model: 1.144CANOPY + 0.027FOMENT + 0.237	23.447	0.000				0.398
Salpingus ruficollis						
Step 1: CANOPY	136.324	0.000	11.676	<0.001	0.670	
Step 2: None						
Model: 2.063CANOPY+ 0.809	136.324	0.000			0.670	
Leptusa pulchella						
Step 1: CANOPY	57.368	0.000	7.574	<0.001	0.461	
Step 2: None						
Model: 1.279CANOPY + 0.830	57.368	0.000				
Oxypoda alternans						
Step 1: CANOPY	20.039	0.000	4.476	<0.001	0.230	
Step 2: None						
Model: 0.675CANOPY + 0.194	20.039	0.000				

Table 4. Continued.

Species	*F*	p_1	*T*	p_2	R^2	R^2adj
Quedius plagiatus						
Step 1: CANOPY	19.991	0.000	4.471	<0.001	0.230	
Step 2: DECID	4.676	0.034	2.163	0.034	0.281	
0.825CANOPY + 0.089DECID + 0.314	12.882	0.000				0.259
Quedius xanthopus						
Step 1: CANOPY	75.430	0.000	8.685	<0.001	0.530	
Step 2: None						
Model: 1.348CANOPY + 0.309	75.430	0.000			0.530	

DISCUSSION

In the present study of sporocarp-visiting beetles, the density of dead wood and sporocarps was less important for beetle abundance than was canopy cover. However, it cannot be deduced from this that these substrates are unimportant for this fauna element. Window traps respond to faunal abundance on large scale since they capture the flying stage. Even though other factors than substrate densities may dominate locally, the latter are assumed to have a strong influence in the forest landscape. Compared to the present study, other studies based on window traps have shown a strong influence of dead-wood and wood-fungi variables at larger scales of 3 ha or more (Siitonen 1994, Økland et al. 1996, Martikainen et al. 2000, Siitonen et al. 2000).

It could be questioned if quality of dead wood substrates was an underlying factor for the differences in beetle captures between forest types in the present study, especially the lower amount of dead birch in clear-cuts and young forest. However, linear regressional analyses and a closer examination of habitat preferences of the species did not support this. In multiple linear regression, amount of dead birch (BETULA) was not selected as an important factor for the ten species with significantly lower numbers in clear-cuts and young forest. The majority of these species are not known to have a special preference of dead birch. Three of them prefer or are more common on coniferous trees (*E. pygmaea*, *L. pulchella* and *Q. plagiatus*); five occur on both coniferous and deciduous trees or seem to be independent of tree species (*C. ferrugineum*, *A. humeralis*, *R. dispar*, *O. alternans* and *Q. xanthopus*); one is most frequent on aspen (*A. nigripenne*); while one may be more common on birch (*R. nitidulus*) Palm 1951, Palm 1959, Ehnström pers.comm.).

It is not likely that differences in catchability should be the reason for the significantly lower numbers recorded in clear-cuts and young forest. The flight height of beetles during trivial flight (see definition in Kennedy 1985) is supposed to be nearly the same in clear-cut and oldgrowth forest. However, few studies deal with flight heights of insects in forests. Using suction traps on a TV-tower, Forsse (1989, see paper I and V) captured common bark beetle species (*Ips typographus*, *Hylastes* spp and *Pityogenes chalcographus*) at various heights on a clear-cut situated 100 m from spruce forest. Even in this open environment the majority were found to fly fairly close to the ground (2 m). Also, vertical flight patterns of dipterans inside forests showed a decrease from forest floor to canopy (Service 1973, Raabe et al. 1996). Flight heights in clear-cuts and closed forest were not investigated in the present study. However, if the species in question fly higher under canopy cover, the catches in clear-cuts should be higher and not the opposite as found here. Forsse and Solbreck found that catch efficiency of forest insects by window traps decreased at lower wind speeds (see paper IV in Forsse 1989). Similarly, higher temperatures due to more radiation in clear-cuts are expected to have a positive effect on flight activity and catchability. Lower catches in the clear-cuts did, however, not indicate an influence of wind or temperature on catchability of the present study.

The results indicate a positive influence of canopy cover on habitat preferences of several sporocarp-visiting beetle species in boreal spruce forest. Increasing canopy cover was also found to be a positive factor for beetle species associated with saproxylic fungi on oak in pasture woodlands (Ranius & Jansson 2000). According to Jonsell et al. (1998), several red-listed saproxylic invertebrates, especially those living in the last successional stages of dead wood, prefer shady forest habitats. In colonisation experiments with insect species breeding in *F. pinicola* and *F. fomentarius*, Cis sp. were less successful colonisers of the sporocarps when they were forced to fly over open land (paper 5 in Jonsell 1999). In the present study, most Cis species were more numerous in old-growth than in the other forest categories; however, none of the species were significant when the level was adjusted for multiple tests ($p<0.005$). The density of canopy cover is associated with microclimate and light conditions. Clear-cuts and other open forest habitats may present decisive stimuli for species with a negative phototactic response or to those who are sensitive to moisture, temperature and wind (Romoser 1981). Response to such cues appears to be adaptive, since the insect will save energy by being directed into an optimal forest habitat before the search for microhabitat. This hypothesis needs to be verified by more specific testing.

It is aimed to increase the amount of dead wood in order to improve the condition for saproxylic species in Fennoscandian forestry (Ehnström 2001). The quantity of dead wood in managed forests can be enhanced in many ways (Ehnström 2001). The most common method so far is to leave dead wood, especially tall stumps, on clear-cuts during the logging operation. This method has proved valuable for many saproxylic species preferring sun-exposed dead wood (Ahnlund 1992, Lindelöw et al. 1999, Schroeder et al. 1999), especially those adapted to natural disturbances in boreal forests (Kaila et. al. 1997). Most of the artificial stumps are made from spruce attacked by root rot fungi. This method supports only a minor part of the deadwood communities, since many insects and lichens depend on other substrate types, such as the upper part of the stem and dead stems lying on the ground (Ehnström 2001). Leaving dead wood on clear-cuts seems, however, to be of little help for several saproxylic and mycetophagous insects, who seem to avoid open forest habitats even when dead wood and sporocarps are present. Ehnström (2001) describes several additional methods to increase the amount of dead wood. Among these methods, species preferring shade could be favoured by increasing the rotation time between planting and cutting, and by cutting and leaving single trees every year. For many sporocarp-visitors, favourable management should provide an abundance of dead wood and wood-inhabiting fungi under a closed canopy, and prevent clear-cuts and young stands from becoming a too dominant proportion of the forest landscape.

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Chorosoma schillingi (Schummel) (Heteroptera, Rhopalidae) new to Norway

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Olsen, T. J. & Hågvar, S. 2002. *Chorosoma schillingi* (Schummel) (Heteroptera, Rhopalidae) new to Norway. Norw. J. Entomol. 49, 40.

One specimen of the large, elongate Heteroptera species *Chorosoma schillingi* (Schummel) was sweep-netted from grasses on the island of Rauøy (Ø, Fredrikstad: EIS 19). The species is known from several sites in southern Sweden, but has never before been collected in Norway.

Key words: *Chorosoma schillingi*, Heteroptera, Rhopalidae, Norway.

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The 15 mm large Heteroptera species *Chorosoma schillingi* (Schummel, 1829) of the family Rhopalidae has recently been recorded for the first time in Norway. In Coulianos (1998) it can be added as no. 405 a. In habitus, the species resembles a large *Stenodema* of the family Miridae. An elongate body and straw-brown colour make both genera difficult to discover on grasses. One specimen was recorded at Ø Fredrikstad: Rauøy (EIS 19), 14-16 July 2000 (leg. Anne Lene Aase & Thor Jan Olsen). It was sweep-netted in low grasses on a SW-faced beach with dry, sparse vegetation. The ground is fairly lime-rich and has much gravel and stones, mainly of volcanic origin.

According to Moulet (1995) the species is polyphagous on grasses (Poaceae) and it lives typically on sandy ground. It occurs southwards in Europe to the Mediterranean and hibernates as egg.

Swedish records are limited to the southern parts of the country (Coulianos & Ossiannilsson 1976). It has been taken on grasses in dry, sunny and sandy places, mainly along the coast. Recently, the two northernmost sites were recorded in the archipelago outside Stockholm, on sandy or lime-rich localities (Coulianos, pers. comm.). Evidently, it is a stenotopic species: rather thermophilic and with predictable habitats and host plants. The species should be looked for elsewhere in the Oslofjord area.

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New species of dung flies (Diptera, Scathophagidae) from Norway with a checklist of the Norwegian Scathophagidae

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The following nineteen species of dung flies (Diptera, Scathophagidae) are published from Norway for the first time: *Acanthocnema glaucescens* (Loew, 1864), *A. nigrimana* (Zetterstedt, 1846), *Cleigastra apicalis* (Meigen, 1826), *Cochliarium cuneiventris* (Zetterstedt, 1846), *Cordilura picipes* (Meigen, 1826), *Cosmetopus longus* (Walker, 1849), *Gonarcticus abdominalis* (Zetterstedt, 1846), *G. antennata* (Zetterstedt, 1838), *Microprosopa lacteipennis* Ringdahl, 1920, *Nanna bispinosa* (Malloch, 1920), *N. fasciata* (Meigen, 1826), *N. leucostoma* (Zetterstedt, 1846), *N. minuta* (Becker, 1894), *N. multisetosa* (Hackman, 1956), *Scathophaga apicalis* (Curtis *in* Ross, 1835), *Scathophaga inquinata* (Meigen, 1826), *S. pictipennis* Oldenburg, 1923, *Staegeria kunzei* (Zetterstedt, 1821) and *Trichopalpus fraternus* Meigen, 1826. *Cordilura similis* Siebke, 1873 has recently been recaptured in Norway. The number of species of Scathophagidae now recorded from Norway is 78. A checklist of the Norwegian Scathophagidae is presented.

Key words: Scathophagidae, new species Norway, checklist Norwegian Scathophagidae.

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INTRODUCTION

Few papers on Norwegian Diptera in the later decades have been restricted to the family Scathophagidae. Ringdahl (1952) in his survey of the Swedish species of Scathophagidae also listed the species which up till that time had been recorded from Norway, a total of 42 species. However, Ringdahl listed *Spaziophora* (as *Spathiophora) hydromyzina* (Fallén, 1819) and *S. fascipes* (Becker, 1894) separately, today these species are considered to be the same species. This makes a total of 41 species listed by Ringdahl.

Ringdahl's survey is probably the basis for Gorodkov's (1986) catalogue of the Palaearctic species as far as Norway is concerned. Gorodkov, however, does not always specify the distribution of every species in each Nordic country.

Ottesen (1993) presents a systematic list of all the insect families represented in Norway, and for Scathophagidae he listed 42 published species, probably the same 42 listed by Ringdahl (1952). Ottesen (1993) also estimated that approximately 50 species are present in Norway.

Hedström (1991) listed as many as 94 species from Sweden. The similarity in the fauna in Sweden and Norway makes Ottesen's (1993) estimate of 50 species of Scathophagidae in Norway much too low.

Articles recording species of Scathophagidae in Norway are Ardö (1957) with records from marine shore dune ecosystems in southern Norway, Dahl (1968) with records of species from northern Norway including new species for the country, and Greve (1996) with records (determined by J. M. Nelson) from inner Hordaland county. Nelson & Greve (1997) presented a survey of the Hardangervidda mountain plateau where 29 species of Scathophagidae were recorded including *Gonatherus planiceps* (Fallén, 1826), *Pogonota (Lasio-*

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scelus) sahlbergi (Becker,1900), *Okeniella dasyprocta* (Loew, 1864), *Allomyella portenkoi* (Stackelberg, 1952), *Scathophaga incola* (Becker, 1900) and *S. obscurinervis* (Becker, 1900) which are new to Norway. *Nanna inermis* (Becker, 1894) was also listed and was probably new to Norway too, but not specified as such.

Johanson & Ervik (1997) recorded *Hydromya livens* (Fabricius, 1794) as new to Norway. Nelson & Greve (1999) recorded *Trichopalpus nigribasis* (Curran, 1927) from southern Norway, HEN Elverum at the river Glomma near Elverum and presented a drawing of the male genitalia. A synonym is *Chaetosa pilirostris* Ringdahl (1936) based on material from Tromsø in northern Norway.

LIST OF SPECIES

The nomenclature follows Gorodkov (1986), and Hackman (1980) for some subgenera. Some endings are after Chandler (1998). Biogeographic regions are given according to J. Økland (1976) and EIS - squares according to K.A. Økland (1981). The material is deposited in the collections of the Zoological Museum - University of Bergen unless otherwise stated. Malaise trap = MT.

Acanthocnema glaucescens (Loew, 1864) Synonym: *A. nigripes* Ringdahl, 1936

HEN Folldal: Atna, Vollen (EIS 72), MT, 1♂, 19 - 26 June 1988, leg. J. O. Solem.

Acanthocnema glaucescens is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records *A. glaucescens* from Sweden, and only from Jämtland, at same latitude as the city of Trondheim

Acanthocnema nigrimana (Zetterstedt, 1846) Synonym: *Hydromyza tiefii* (Mik, 1884).

STI Oppdal: Kongsvoll (EIS 79), MT, 1♂, 15 - 22 July 1992, leg. J. Skartveit.

Acanthocnema nigrimana is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records *A. nigrimana* from Skåne, Jämtland and Lule lappmark, viz. three areas widely separated, from southern, middle and northern Sweden.

Cleigastra apicalis (Meigen, 1826)

HOI Kvam: Berge Nature Reserve (EIS 31), 1♀, 6 June 2000, leg. G. Bakkerud and L. Greve.

Cleigastra apicalis is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records *C. apicalis* from five areas in Sweden from Skåne in the south to Lule Lappmark in the north.

Cochliarium cuneiventris (Zetterstedt, 1846)

STI Oppdal: Near Kongsvoll (EIS 79), approximately 900 m a s l, 1♂ 1♀ (J. M. Nelson Coll.), July - Aug. 1992, leg. J. Skartveit. **TRI** Målselv: Lappskaret (EIS 147), 870 m a s l, 1♀, 18 - 25 July 1992, leg. J. O. Solem.

Cochliarium cuneiventris is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from three provinces in middle and northern Sweden, but he lists no new records. *C. cuneiventris* is also known from northern Russia (Gorodkov 1986).

Cordilura picipes (Meigen, 1826).

VE Tjøme: Kjære (Eis 19), 1♂, 11 June 1965, leg. A. Fjellberg. **BV** Rollag: Rollag (EIS 35), 1♀, 12 July 1984, leg. B. A. Sagvolden.

Cordilura picipes is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). According to Gorodkov (1986) *C. picipes* is only recorded from southern Finland, and Hedström (1991) records it only from Skåne, viz southernmost Sweden. The records from VE and BV are both in south east Norway which fits well with the records from Sweden and Finland and indicates a southern distribution in Fennoscandia.

Cordilura similis (Siebke, 1873).

Cordilura similis was described from a single male taken by Siebke near Åmot in Østerdalen, Rena county. *C. similis* is not mentioned by Ringdahl (1952), and Gorodkov (1986) regards it as a nomen dubium. Hedström (1991) does not mention *C. similis* from Sweden.

Nelson (1998) discussed the status of *C. similis* which occurs in Britain in a restricted area in the Spey valley. *C. similis* is clearly closely related to

C. picticornis (Loew) recorded from Finland by Hackman (1956) and from Sweden by Hedström (1991). Siebke caught the holotype in 1870 at **HEN** Åmot: Åmot (EIS 55). Nelson (1998) also recorded a series of 24 specimens including both sexes taken by sweep-netting on an island near Kvernbekken; **HES** Elverum in the river Glomma (EIS 55), 14 June 1996, near midnight, leg. L. Greve. Two new records from the same area are **HES** Elverum: Innset (EIS 55), 1 ♂, 29 June 1998, Leg. L. Greve; **HEN** Åmot: Deset, (EIS 55), 1 ♂ 1 ♀, 29 June 1998, leg. L. Greve.

Cosmetopus longus (Walker, 1849)

TRI Målselv: Kjosvoll (EIS 147), MT, 70 m a s l, 3 ♂♂ 2 ♀♀ + 1 specimen (J. M. Nelson Coll.), 1 - 25 July 1992, 6 ♀♀, 25 July - 10 August 1992, leg. J. O. Solem.

Cosmetopus longus is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records this species from six areas in Sweden from Jämtland and northwards, viz. from middle and northern Sweden.

Gonarcticus abdominalis (Zetterstedt, 1846)

TRI Balsfjord: Reingjerdfjellet (EIS 154), 350 - 500 m a s l, alpine zone, 1 ♀, 11 July 1984, leg. Keith Bland.

Gonarticus abdominalis is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hackman records this species from Finland and Ringdahl found it in Sweden and considers it to be an arctic, high-boreal species. Hedström (1991) reports *G. abdominalis* from middle and northern Sweden, but has no new records. It is also recorded from northern Russia Gorodkov (1986).

Gonarcticus antennata (Zetterstedt, 1838).

HOI Eidfjord: Isdalen (EIS 42), 1200 m a s l, 1 specimen, 28 June 1969, leg. K. E. Jørstad et al. **STI** Oppdal: Kongsvoll (EIS 79), MT, 920 m a s l, 1 ♂ +1 specimen (J. M. Nelson Coll.), 15 - 22 July 1992, 2 ♀♀, 28 July - 12 August 1992, 5 ♀♀, 12 - 19 August 1992, Kongsvoll, Spræanbekken, 950 m a s l, yellow trays, 1 ♀, 10 August - 13 Sept. 1994, leg. J. Skartveit.

Gonarcticus antennata is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) presents three older records from three provinces in middle and northern Sweden. Hackman (1956) reports no Finnish material, but he has seen material from the Kola peninsula in Russia and considers it as an arctic, high-boreal species.

Microprosopa lacteipennis Ringdahl, 1920

HOI Ullensvang: Bersavikvann (EIS 32), 1140 m a s l , 1 ♂, 11 July 1968, 1240 m a s l, 2 ♀♀, 13 July 1968, leg. T. R. Nielsen et al., near Veivann, 1150 m a s l , 1 ♂, 16 July 1968, leg. A. Fjellberg.

Microprosopa lacteipennis is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) reports it from Torne Lappmark only, and has no new records. Hackman (1956) records a few specimens from northern Finland only. It is a rare alpine species which now is reported from southern Scandinavia. *M. lacteipennis* is an interesting addition to the fauna of Hardangervidda mountain plateau not included in Nelson & Greve (1997).

Nanna bispinosa (Malloch, 1920)

SFI Luster: Øyastrondi (EIS 60), MT, 560 m a s l, 1 ♂ 1 ♀ 1 specimen (J. M. Nelson Coll.), 24 June - 12 1988, leg. G. E. E. Søli.

Nanna bispinosa is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from Lule lappmark only, viz. the level of Lofoten islands. There are records from northern Finland (Hackman 1956).

Nanna fasciata (Meigen, 1826).

Ø Råde: Tasken (EIS 20), MT, 2 specimens, 6 - 24 June 1995, leg. O. Hanssen & J. I. I. Båtvik. **BØ** Drammen: Underlia (EIS 28), MT, 4 specimens, May 1994, leg. L. O. Hansen. **TEI** Tinn: Håkanes (EIS 26), MT, 1 specimen, June 1995, leg. B. A. Sagvolden. **SFI** Luster: Øyastrondi (EIS 60), MT, 1 ♀, 24 June - 12 July 1998, leg. G. E. E. Søli.

Nanna fasciata is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from Skåne and Småland in south east

Sweden. All the Norwegian records are from southern Norway collected during spring and summer.

Nanna leucostoma (Zetterstedt, 1846).

SFI Luster: Øyastrondi (EIS 60), 560 m a s l, MT, 1 ♂, 24 June - 12 July 1988, leg. G. E. E. Søli. **MRI** Norddal: Fjøra (EIS 77), MT, 1 ♂, 23 June - 18 July 1993, leg. O. Hanssen.

Nanna leucostoma is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from Dalarna, Norrbotten and Lule Lappmark, viz. from middle and northern Sweden. Both the Norwegian records are from the inner fjord areas in western Norway.

Nanna minuta (Becker, 1894).

SFI Luster: Fåbergstølgrandane (EIS 60), 560 m a s l, MT, 2 ♂♂, 23 - 24 June 1988, leg. G. E. E. Søli.

Nanna minuta is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hackman (1956) records *N. minuta* from southern Finland, and he notes it as not known from Sweden, but recorded from central and eastern Europe. Hedström (1991) does not record this species from Sweden.

Nanna multisetosa (Hackman, 1956).

HEN Storelvdal: End of Atnasjøen (EIS 72), MT, 1 ♂, 28 May - 5 June 1987, leg. J. O. Solem, Åmot: Deset (EIS 55), 1 ♂ 3 ♀♀ +1 specimen (J. M. Nelson Coll.), 29 June 1998, leg. L. Greve. **SFI** Luster: Øyastrondi (EIS 60), 560 m a s l, MT, 2 ♂♂, 24 June - 12 July 1988, leg. G. E. E. Søli. **STI** Støren: Haugen in Budal (EIS 87) 1 ♀, 21 June 1967, leg. A. Løken.

Nanna multisetosa is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from Uppland, Dalarna and Lule and Torne lappmark, viz. middle and northern Sweden. The Norwegian records are from southern and middle Norway, and all of them are from spring and early summer.

Scathophaga apicalis (Curtis in Ross, 1835)

TRI Målselv: Kirkedalen, Lappskaret (EIS 147), 870 m a s l, MT, 1 ♂, 12 - 25 July 1992, leg. J. O. Solem.

Scathophaga apicalis is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) does not record this species from Sweden. *S. apicalis* is a northern species with an holarctic distribution.

Scathophaga inquinata Meigen, 1826

BØ Nedre Eiker: Mjøndalen, Miletjern (EIS 28), 3 ♂♂, 8 June 1988, leg. Y. Berg. **HOY** Bergen (Åsane): Eidsvåg (EIS 39), 1 ♂, 18 June 1985, leg. L. Greve, (Fana): Stend (EIS 30), 1 ♀, 20 May 1968, leg. A. Løken; Os: Sælelid (EIS 30), MT, 1 ♀, 30 May - 6 June 1991, leg. G. A. Halvorsen; Kvam: Geitaknottheiane near Svevatn (EIS 31), MT, 34 specimens (♂♂/♀♀), 24 April - 29 Oct. 1997, 4 May - 8 July 1998, leg. J. Skartveit. **SFI** Vik: Fresvik, (EIS 50), MT, 2 ♀♀, 17 May - 31June 1997, leg. G. Bakkerud & H. Breilid.

Scathophaga inquinata is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from several areas in southern and middle Sweden at the same approximate latitude as the city of Trondheim.

Scathophaga pictipennis Oldenburg, 1923

AK Rælingen: Losby (EIS 29), collision trap, 1 ♂, early May - 3 June 1991, leg. B. Økland. **TEI** Tinn: Håkanes (EIS 26), MT, 1 specimen, May 1995, leg. B. A. Sagvolden (J. M. Nelson Coll.). **HOY** Os: Sælelid (EIS 30), MT, 1 ♂, 18 - 25 April 1991, leg. G. A. Halvorsen. **HOI** Kvam: Near Svevatn (EIS 31), 1 ♂ 1 ♀, MT, 28 April - 28 May 1997, leg. J. Skartveit and L.Greve. **TRI** Målselv: Kirkedalen, Kjosvoll (EIS 147), MT, 1 ♂ 1 ♀ 1 specimen, 1 - 27 Sept. 1992, leg. J. O. Solem. **TRY** Tromsø: Ramfjordnes (EIS 162), 1 specimen, May 1991, leg. H. Larsen.

Scathophaga pictipennis is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from middle and northern Sweden. The material presented here were caught in spring and early summer, three specimens, however, were caught in late autumn.

Staegeria kunzei (Zetterstedt, 1821)

ON Vang: Nystuen (EIS 52), 1 ♀, leg. J. H. Siebke, (Tromsø museum). **FØ** Sør-Varanger: Skogly (EIS 160), 1 ♂, 18 July 1969, leg. I. & T. R. Nielsen.

Staegeria kunzei is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records it from areas in middle and northern Sweden.

Trichopalpus fraternus (Meigen, 1826)

BØ Nedre Eiker: Mjøndalen, Miletjern (Eis 18), MT, 5 ♂♂ 2 ♀♀, July 1988, 2 ♂♂ 2 ♀♀, August 1988, leg. D. W. B. Johansen ♀ D. Ruud. **AAY** Evje & Hornes: Near Lislevann (EIS 9), 32 VMK 403902, 1 ♀, 3 August 1996, leg. L.Greve.

Trichopalpus fraternus is not listed from Norway by Ringdahl (1952) or Gorodkov (1986). Hedström (1991) records this species from five provinces in southern Sweden and Middle Sweden. Hackman (1956) records it as an southern species in Fennescandia. *T. fraternus* is also recorded from northern Russia and central Europe (Gorodkov 1986).

DISCUSSION

The number of 78 species of dung-fly recorded from Norway can be compared with 94 known from Sweden (Hedström 1991). It seems probable that further species will be found in Norway. Most of these will probably occur in northern marshy wooded habitats, but very little is known of their life histories. *Cordilura picticornis* (Loew, 1864) might be found with its larvae mining stems of *Carex* in riparian habitats. *Scathophaga lapponica* (Ringdahl, 1920) could occur in northern maritime marshes. Southern marshes might support *Scathophaga tinctinervis* (Becker, 1894) whose larva feed in dung. Other species feed in plants such as *Pedicularis sceptrum carolinum* in whose flowers are found *Gymnomera hirta* Hendel, 1930. *Paralellelomma media* Becker, 1894 and *P. paradis* Hering, 1923 should be easily found as they make conspicuous mines in the leaves of *Polygonatum* and *Paris* respectively.

A CHECK LIST OF NORWEGIAN SCATHOPHAGIDAE

The nomenclature follows Gorodkov (1986) with some exceptions: The genus *Norellia* is divided into *Norellia* Robineau-Desvoidy, 1830 and *Norelliosoma* Wahlgren, 1917; the genus *Cordilura* Fallén, 1810 is divided into *Cordilura* Fallén, 1810 and *Cordilurina* James, 1955 and the genus *Pogonota* Zetterstedt, 1860 is divided into *Pogonota* Zetterstedt, 1860 and *Lasioscelus* Becker, 1894 after Hackman (1980) and Chandler (1998). Some smaller corrections of endings have been done according to Chandler (1998). New species to Norway are marked with an asterisk.

Subfamily Scathophaginae

Norellisoma liturata (Wiedemann *in* Meigen, 1826)
  Syn. *Cordylura striolata* Meigen, 1826
  Syn. *spinigerum* Zetterstedt, 1838 (*Cordylura)*
N. spinimana (Fallén, 1819)
  Syn. *Cordylura spinimana* Fallén, 1819
Cordilura Fallén, 1810
Subgenus *Cordilura* Fallén, 1810
C. aberrans (Becker, 1894)
C. atrata (Zetterstedt, 1846)
C. ciliata (Meigen, 1826)
**C. picipes* (Meigen, 1826)
C. proboscidea (Zetterstedt, 1838)
C. pubera (L., 1758)
C. pudica (Meigen, 1826) (*Cordylura)*
  Syn. *geniculata* (Zetterstedt, 1846)
C. rufimana (Meigen, 1826)
  Syn. *tibialis* (Zetterstedt, 1838) (*Cordylura)*
C. similis (Siebke, 1873)
  Noted in list of «Doubtful genera and species» (Gorodkov, 1986). See text above.
Subgenus *Cordilurina* James, 1955
C. albipes (Fallén, 1819)
  Syn. *Parallellomma albipes* (Fallén, 1819) see Ringdahl, 1952
C. fuscipes (Zetterstedt, 1838)
  Syn. *Parallelomma fuscipes* (Zetterstedt, 1838) see Ringdahl, 1952
C. ustulata (Zetterstedt, 1838)
  Syn. *Scoliaphleps ustulata* (Zetterstedt, 1838) see Ringdahl, 1952
Gonatherus planiceps (Fallén, 1826)

Nanna armillata (Zetterstedt, 1846)
  Syn. *Amaurosoma armillatum* (Zetterstedt, 1846) see Ringdahl, 1952
  Syn. *armillata* Zetterstedt, 1846 *(Cordylura)*
**N. bispinosa* (Malloch, 1920)
N. brevifrons (Zetterstedt, 1838)
  Syn. *Amaurosoma brevifrons* (Zetterstedt, 1838) see Ringdahl, 1952
**N. fasciata* (Meigen, 1826)
N. flavipes (Fallén, 1819)
  Syn. *flavipes* Fallén, 1819 *(Cordylura)*
N. inermis (Becker, 1894)
**N. leucostoma* (Zetterstedt, 1846)
**N. minuta* (Becker, 1894)
**N. multisetosa* (Hackman, 1956)
N. tibiella (Zetterstedt, 1838)
  Syn. *Amaurosoma tibiellum* (Zetterstedt, 1838) see Ringdahl, 1952
  Syn. *tibiella* Zetterstedt, 1838 *(Cordylura)*
**Cleigastra apicalis* (Meigen, 1826)
Megaphthalma pallida (Fallén, 1819)
  Syn. *pallida* Fallén, 1819 *(Cordylura)*
Megaphthalmoides unilineatus (Zetterstedt, 1838)
  Syn. *unilineata* Zetterstedt, 1838 *(Cordylura)*
**Gonarcticus abdominalis* (Zetterstedt, 1846)
**Gonarcticus antennata* (Zetterstedt, 1838)
  Syn. *validicornis* (Zetterstedt, 1846) *(Cordylura)*
Pogonota Zetterstedt, 1860
Subgenus *Pogonota* Zetterstedt, 1860
P. barbata (Zetterstedt, 1838)
Subgenus *Lasioscelus* Becker, 1894
L. immunda (Zetterstedt, 1838)
  Syn. *immunda* Zetterstedt, 1838 *(Cordylura)*
L. sahlbergi (Becker, 1900)
Okeniella caudata (Zetterstedt, 1838)
  Syn. *caudata* Zetterstedt, 1838 *(Cordylura)*
O. dasyprocta (Loew, 1864)
**Cosmetopus longus* (Walker, 1849)
Allomyella albipennis (Zetterstedt, 1838)
  Syn. *niveipalpis* (Zetterstedt, 1846) *(Cordylura)*
  Syn. *Microprosopa albipennis* (Zetterstedt, 1838) see Ringdahl 1952
A. portenkoi (Stackelberg, 1952)
Microprosopa haemorrhoidalis (Meigen, 1826)
  Syn. *haemorrhoidalis* Meigen, 1826 *(Cordylura)*
**M. lacteipennis* Ringdahl, 1920
M. pallidicauda (Zetterstedt,1838)
  pallicauda (Zetterstedt) error see Ringdahl 1952

Bostrichopyga borealis Hendel, 1903
**Acanthocnema glaucescens* (Loew, 1864)
**A. nigrimana* (Zetterstedt, 1846)
Spaziphora hydromyzina (Fallén, 1819)
  Syn. *hydromyzina* Fallén, 1819 *(Cordylura)*
**Staegeria kunzei* (Zetterstedt, 1821)
**Trichopalpus fraternus* (Meigen, 1826)
Trichopalpus nigribasis Curran, 1927
  Syn. *pilirostris* Ringdahl, 1936 *(Chaetosa)*
Trichopalpus obscurella (Ztterstedt, 1846)
  Syn.*Paramicroprosopa subarctica* (Ringdahl, 1936) see Ringdahl, 1952
Chaetosa punctipes (Meigen, 1826)
  Syn. *punctipes* (Meigen, 1826) *(Cordylura)*
Ergoneura argus (Zetterstedt, 1838)
  Syn. *argus* Zetterstedt, 1838 *(Scatomyza)*
**Scathophaga apicalis* (Curtis *in* Ross, 1835)
S. calida (Haliday *in* Curtis, 1832)
  Syn. *villipes* (Zetterstedt, 1838) *(Scatomyza)*
S. furcata (Say, 1823)
  Syn.*fuscinervis* (Zetterstedt, 1838) (*Scatomyza)*
  Syn. *squalida* (Meigen, 1826) *(Scatomyza)*
S. incola (Becker, 1900)
**S. inquinata* Meigen, 1826
S. litorea (Fallén, 1819)
S. lutaria (Fabricius, 1794)
  Syn. *maculipes* (Zetterstedt, 1846) (*Scatomyza*)
S. obscura (Fallén, 1819)
  Syn. *Coniosternum obscurum* (Fallén, 1819) see Ringdahl, 1952
  Syn. *obscura* Fallén, 1819 *(Cordylura)*
S. obscurinervis (Becker, 1900)
**S. pictipennis* Oldenburg, 1923
S. scybalaria (L., 1758)
S. stercoraria (L., 1758)
  Syn. *merdaria* (Fabricius, 1794) *(Scatomyza)*
S. suilla (Fabricius, 1794)
  Syn. *scatomyzoides* Zetterstedt, 1838 *(Cordylura)*
  Syn. *spurca* Meigen, 1826 *(Scatomyza)*
Ceratinostoma ostiorum (Haliday *in* Curtis, 1832)
  Syn. *borealis* Zetterstedt, 1838 (*Scatomyza)*
Gimnomera dorsata (Zetterstedt, 1838)
  Note: *Gymnomera* Rondani error in Gorodkov
  Syn. *dorsata* Zetterstedt 1838 *(Cordylura)*
G. tarsea (Fallén, 1819)
  Syn. *tarsea* Fallén, 1819 *(Cordylura)*
Cochliarium albipilum (Zetterstedt, 1846)
  Syn. *albipila* Zetterstedt, 1846 *(Cordylura)*

**C. cuneiventris* (Zetterstedt, 1846)
Hydromyza livens (Fabricius, 1794)

Subfamily Delininae

Parallelomma vittata (Meigen, 1826)
  Syn. *Chylizosoma vittatum* (Meigen, 1826) see Ringdahl, 1952
  Syn. *vittata* Meigen, 1826 *(Cordylura)*
Micropselapha filiformis (Zetterstedt, 1846)
  Syn. *filiformis* Zetterstedt, 1846 *(Cordylura)*
Hexamitocera loxocerata (Fallén, 1826)
  Syn. *loxocerata* Fallén, 1826 *(Cordylura)*
Delina nigrita (Fallén, 1819)
  Syn. *nigrita* Fallén, 1819 *(Cordylura)*
Leptopa filiformis Zetterstedt, 1838

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Pholcus phalangioides (Fuesslin, 1775) (Araneae, Pholcidae) first record from the Faroe Islands

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Hauge, E., Berland, B. & Højgaard, D. P. 2002. *Pholcus phalangioides* (Fuesslin, 1775) (Araneae, Pholcidae) first record from the Faroe Islands. Norw. J. Entomol. 49, 48.

The species is recorded for the first time in the Faroe islands, with a note on its distribution in northern Europe.

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During the summers of 2000 and 2001 several hundred spiders descended from the ceiling in several rooms in a kindergarten in Saltangará, Skálafjørður, Eysturoy, the Faroes, and on reaching the floor each rapidly spun a nest around itself. A sample of these spiders – 1 ♂, 1 ♀ and 2 juveniles – were collected by one of us (D. P. H.) on 26 September 2001 and brought to Bergen for identification. This is the first record of *Pholcus phalangioides* (Fuesslin, 1775) from the Faroe islands. Although interesting, this record is not very surprising as the species seems well established (indoors only) in Iceland (Reykjavik) (Agnarsson 1996). In northern Europe it is known from southern Britain (Locket & Millidge 1953) and Sweden (Kronestedt pers. comm.), where it is known from the counties Scania, Västergötland and Uppland (Lars J. Jonsson pers. comm.); the species has been recorded from indoor locations only. This species is Red Listed in Sweden (Gärdenfors 2000, Kronestedt 2001). To our present knowledge (Palmgren 1977, Aakra & Hauge 2000) it is unknown in Finland and Norway.

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Pandivirilia eximia (Meigen, 1820) (Diptera, Therevidae) in Norway

Lita Greve

Greve, L. 2002. *Pandivirilia eximia* (Meigen, 1820) (Diptera, Therevidae) in Norway. Norw. J. Entomol. 49, 49-50.

The distribution of *Pandivirilia eximia* (Meigen, 1820) (Diptera, Therevidae) in Norway is recorded. The record from NSI Saltdal: Saltdal is the northernmost in Fennoscandia. A diapause persisting for two years for the pupa or the fifth instar is possible. *P. eximia* is a rare fly which should be considered listed in the Norwegian Red Data list.

Key words: *Pandivirilia eximia*, Diptera, Therevidae, Norway, Red Data list.

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INTRODUCTION

The Dipteran fly family Therevidae includes thirteen genera with around two hundred and thirty species in the Palaearctic (Majer, 1997). This family has not been surveyed in Norway since the time of Siebke (1877). Siebke (1877) listed two genera and thirteen species. Lyneborg (1965) listed three Danish genera including twelve species from Denmark, and Hedström (1986) listed three genera and seventeen species from Sweden.

Lyneborg (1986) revised the Palaeartic species of the genus *Pandivirilia* Irwin & Lyneborg, 1981. He listed one species, *Pandivirilia eximia* (Meigen, 1820), from Finland, Norway and Sweden with no records from Denmark and Great Britain. In Sweden *P. eximia* is distributed north to Dalarna, in Finland north to Tavastia australis and Savonia. Outside Fennoscandia the distribution covers Middle Europe and northern and central parts of the old U. S. S. R. (Lyneborg, 1986).

P. eximia males vary in body length from 1.30 - 1.46 cm, females from 1.29 - 1.71 cm. The females are mostly black coloured, with grey longitudinal tomentose stripes dorsally on the thorax, the males have in addition dorsally grey tomentose spots on abdomen. The haltera are yellowish, and the wings have a marked yellowish tinge. The femora are black while the tibia are light brown. Superficially there is a likeness to large Asilidae. See also Lyneborg (1986).

Another *Pandivirilia* species, *P. melaleuca* (Loew, 1847) is known from Southern England, West and Central Europe.

Lyneborg (1986) reported *P. eximia* as new to Norway; based on one female from AK Ås. However, Lyneborg (1986), overlooked that Siebke (1877) already had recorded *P. eximia* as *Psilocephala eximia* Meigen from Akershus: Oslo (=Christiania) and Siebke (1877) also reported an observation of *P. eximia* by W. M. Schøyen from Akershus: Odalen

Today there are three specimens determined as *Psilocephala eximia* in the collections of Zoological Museum, University of Oslo, one female lacks locality label. These have been examined and are included in the list of records below. The rest of the material listed here is in the collections Zoological Museum, University of Bergen.

THE RECORDS

Ø Rygge: Ekeby, Telemarkslunden (EIS 19), 19 May - 17 June 1992, 1♀, leg. G. Walberg & L. O. Hansen. **AK** Oslo: Oslo (=Kristiania) (EIS 28), 1

♀ (ZMO), Ås: Ås (EIS 28), 7 June 1984, 1 ♀, leg. L. Aarvik. **BV** Nore & Uvdal: Gvammen (EIS 35), 10 June 1983, 1 ♀, leg. J. Dammen, Rollag: Bråtåsen (EIS 35), July 1994, 1 ♀, Veggli (EIS 35), 29 June 1995, 1 ♀, leg. B.A.Sagvolden. **VE** Larvik: Røysås (EIS 19), 29 June 1990, 1 pupa; 1 ♂ hatched on 21 April 1992, leg. B. Borgersen. **MRI** Norddal: Fjøra, Ytre Fureneset (EIS 77), 100 m a s l, 5 May - 11 June 2000, 1♂, leg. K.J.Grimstad & D. Holtan. **NSI** Saltdal: Saltdal (EIS 127), 1 ♀, leg.W.M. Schøyen (ZMO).

DISCUSSION

Three of the ten specimens were collected in Malaise tents, one specimen from VE Larvik: Røysås was collected as a pupa from a hollow oak, and others were probably sweep-netted. The pupa from Larvik hatched on 21 April 1992, two years after collection. A diapause (for the pupa or the fifth larval instar) persisting for two years is known among the Therevidae (Majer 1997).

P. eximia must be a very rare species indeed, since only seven specimens have been caught since the time of Siebke who collected around 1840-50. *P. eximia* is a very large fly, the time of flight is in the summer and it should thus not easily be overlooked. I suggest that *P. eximia* could be added to the Norwegian Red Data list. *P. eximia* is also considered very rare in Sweden (Hedström 1986). The locality at Saltdalen is the northernmost in Fennoscandia, and also the locality in Fjøra is further north than earlier known from Fennoscandia.

P. eximia is associated with open mixed forests, and adults have been collected from leaves of *Populus, Alnus* and *Corylus* (Lyneborg, 1986). Finnish and Swedish specimens have been collected between 9 June - 20 July while the Central European specimens seen have been from June (Lyneborg, 1986).

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Spiders (Araneae) in organically managed ley and pasture, Tingvoll Farm, Norway

Reidun Pommeresche

Pommeresche, R. 2002. Spiders (Araneae) in organically managed ley and pasture, Tingvoll Farm, Norway. Norw. J. Entomol. 49, 51-58.

This study focusses on the spider fauna in two organically managed leys in different stages of a crop rotation and in one permanent pasture, all on the Tingvoll Farm in northwestern Norway. Spiders were collected by means of pitfall traps; the sampling period lasted from 28 April to 23 June 2000. Altogether 2415 specimens, representing 48 species, were found. A DCA-analysis shows differences in the spider populations found in the leys compared with the pasture, but less difference between the young and older ley. However, the number of species and the dominance pattern of the spider populations differ between the young and older ley. A total of 16 species were found in the young ley, 26 species in the older ley and 34 species in the pasture. *Bathyphantes gracilis*, *Erigone atra*, *Oedothorax fuscus* and *Savignia frontata* were the most abundant species in the leys, with *Pardosa amentata* and *Silometopus elegans* the most abundant in the pasture. *Collinsia inerrans* was represented by 83 specimens in the leys. This species is previously recorded only twice in Norway, and has been placed on the national Red List proposal.

Key words: Araneae, spider, ley, grass, organic farming, DCA

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INTRODUCTION

A recent review on spiders in agricultural areas focussed on spiders as natural control agents of crop pest insects and on diversification of habitats and land use effects on species and populations of spiders (Sunderland & Samu 2000). Organic agriculture produces food and other products in a sustainable system, without the use of artificial fertiliser or pesticides, and includes a focus on maintenance of biodiversity. Even though ploughing, harvesting and grazing reduce the total number of spiders (Thomas & Jepson 1997), several studies have shown that organic farming has positive effects on the diversity of species of spiders and other invertebrates compared with conventional farming (Azeez 2000, Glück & Ingrisch 1990, Feber et al. 1998, Stoltze et al. 2000).

In Norway most studies of the diversity of insects and spiders in agricultural landscapes are from conventionally managed field margins and seminatural biotopes, indicating the importance of these habitats for biodiversity (Dennis et al. 2000). No studies of spiders in organically managed leys or cereal fields have previously been conducted in Norway. *Erigone atra, E. dentipalpis* and *Oedothorax apicatus* were the most abundant species in a Norwegian study of spiders in conventionally grown barley fields (Andersen 1990). The same three species dominated in conventionally grown barley fields in Denmark (Toft 1989). The present study focusses on the spider fauna in two organically managed leys in different stages of a crop rotation, and in one permanent pasture. The aim is to see how management of the fields is reflected in the composition of the resident spider populations. The lack of comparable studies in Norway and the lack of arachnological investigations in the region contribute to the importance of this study. The northwestern location of the study area is especially important, as it contributes to completing the distribution ranges of spider species in Europe.

SITE DESCRIPTION

The three investigated fields are on the Tingvoll Farm at the Norwegian Centre for Ecological Agriculture (NORSØK), (EIS 85, MRY, Tingvoll) northwestern Norway (Figure 1). The fields have been organically managed at least since 1991. The spiders were collected in 2000. **Young ley (YL)**: The young ley was established after spring ploughing in 1999, by growing barley undersown with a mixture of timothy (*Phelum pratense* L.), fescue grass (*Festuca pratensis* Huds.), red clover (*Trifolium pratense* L.) and white clover (*Trifolium repens* L.). This grass and clover species continued to grow after the harvesting of the barley and made up the young ley of the sampling year. No manure was used in 2000. The first of two harvests for silage started shortly after the spider sampling period. **Older ley (OL)**: The older ley was established in 1997 in the same way as the young ley, but had had two additional years of grass and clover production. In the year of sampling, there was more red clover in the young ley than in the old ley and more fescue grass in the older ley. On the older ley, 1.5 tons of urine (incl. 30 % water) per da were used as a spring manure. The ley was harvested for silage twice a year; in the sampling year it was first harvested after the spider sampling period. **Pasture (PA)**: The permanent pasture has never been ploughed, but was manured and grazed by cattle. The sample site in the centre of the pasture was quite moist and was dominated by tufted hair grass (*Deschampsia cespitosa* [L.]) and creeping buttercup (*Ranunculus repens* L.). The sampling site nearer the field margin was dominated by meadow grass (*Poa* sp.). A few pines (*Pinus sylvestris* L.) were scattered throughout the pasture.

METHODS AND MATERIAL

Spiders were collected by means of pitfall traps. Glass jars 6.5 cm in diam., one-third filled with 50% propylene glycol and some detergent, were used as traps. Seven traps were placed 2 m apart in a row at each site. In each of the three fields, two rows of traps were used, one centrally located, the other 5 m from the edge of the field. The traps were in use continuously during the trapping period, which lasted from 28 April to 23 June 2000. Catches from each row were added together and treated as one sample. The spider catches from the sites in the middle of the young ley, older ley and pasture are referred to as YLm, OLm and PAm, respectively, and the catches from the sites nearer to the edge as YLe, OLe and PAe, respectively. Only adult spiders were identified to species

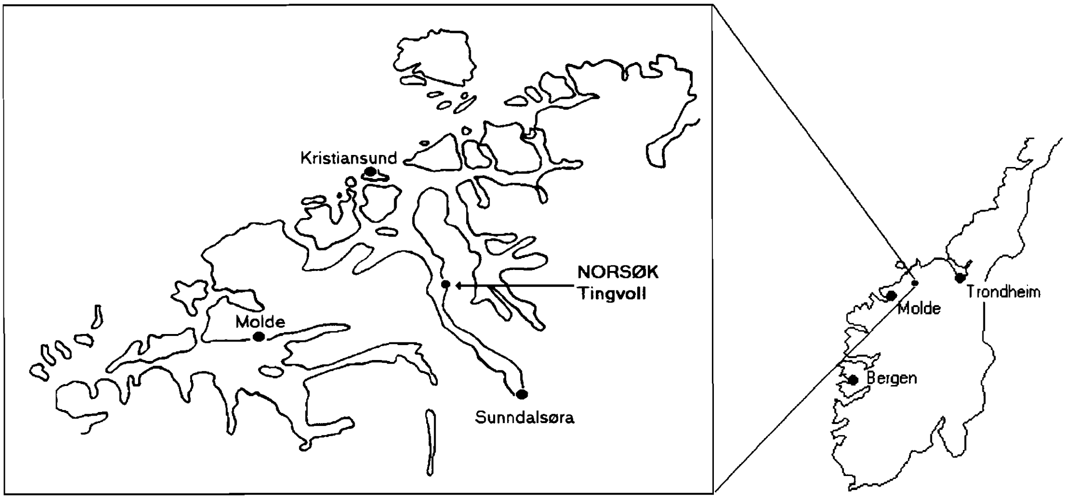

Figure 1. The location of the study area Tingvoll Farm at the Norwegian Centre for Ecological Agriculture (NORSØK), Norway.

level and used in this study. The identification keys of Roberts (1993a, b, 1995) and Nentwig et al. (2001) and nomenclature and taxonomy of Platnick (2001) were used.

To analyse the spider data, an ordination technique of multivariate analysis was used (ter Braak 1995). This detrended canonical analysis (DCA) (Hill & Gauch 1980) of the spider data was run in CANOCO 3.12 (ter Braak 1991). The aim of ordination is to arrange the spider data set so that points close together correspond to sites that are similar in species composition, while those that are far apart correspond to sites that are dissimilar in species composition. The analysis is based on the species and the number of specimens found on each of the six sites.

RESULTS

Altogether 2415 specimens, representing 48 species, were found (Table 1). 67 % of the species belonged to the Linyphiidae (75 % of individuals). A total of 16 different species were found in the young ley, 26 species in the older ley, and 34 species in the pasture.

The spider populations found on the different sites differ in species and dominance pattern. Nine species occurred in all three fields, and 18 of the 48 species were exclusively caught in the pasture. Spider populations of the two leys were represented by many species in common, but with different dominance patterns. The young ley (YLe + YLm) was dominated by *Bathyphantes gracilis* (41 % of the individuals), followed by *Erigone atra* (29 %), whereas *Oedothorax fuscus*, *Savignia frontata*, *E. dentipalpis* and *Collinsia inerrans* were less dominant (Figure 2, Table 1). The older ley (OLe + OLm) was dominated by *E. atra* (27 %), *S. frontata* (16 %), *B. gracilis* (15 %) and *O. fuscus* (15 %) (Figure 2, Table 1). Less dominant were *E. dentipalpis* and *C. inerrans*.

C. inerrans is an interesting species, found on all the four ley sites and represented by 83 specimens. This is a species proposed to be Red-listed in Norway (Aakra & Hauge 2000).

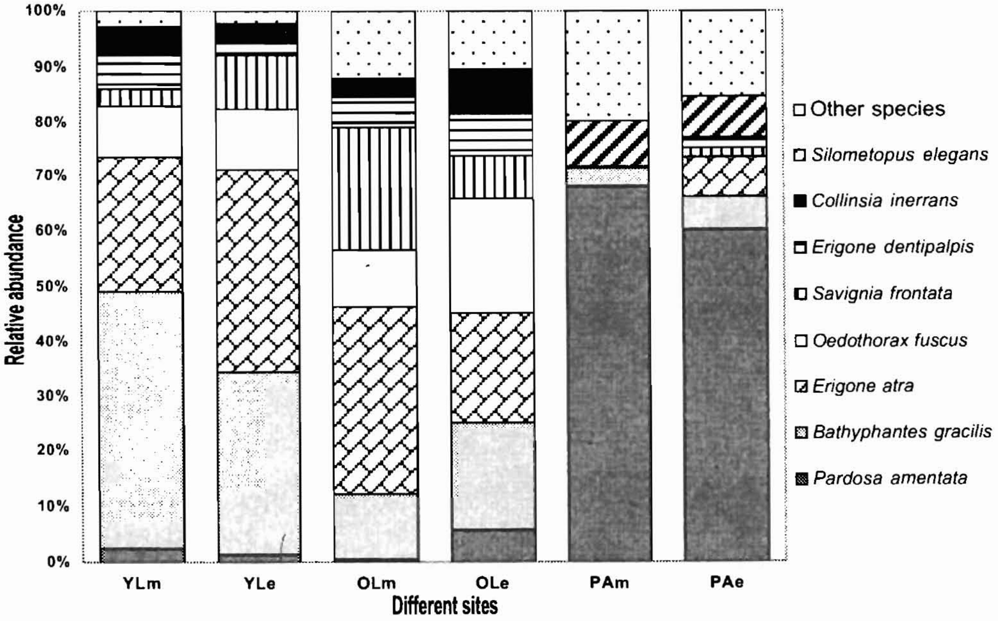

Figure 2. The dominance pattern of the spider populations found in organically managed young ley (YL), older ley (OL) and permanent pasture (PA). One site in the middle (m) and one nearer the edge (e) of each field. Spiders were collected by means of pitfall traps in 2000.

Table 1. Spider species and number of individuals from organically managed fields: young ley (YL), older ley (OL) and pasture (PA), one site in the middle (m) and one nearer the edge (e) of each field. Spiders collected by means of pitfall traps from April to June 2000.

Family / *Species*	YLm	YLe	OLm	OLe	PAm	PAe
Linyphiidae						
Bathyphantes gracilis (Blackwall)	235	113	51	77	15	18
Erigone atra (Blackwall)	122	127	149	80	1	22
Oedothorax fuscus (Blackwall)	48	38	45	82		
Savignia frontata Blackwall	16	34	98	32		5
Erigone dentipalpis (Wider)	31	8	24	31		6
Collinsia inerrans (O.P.-Cambridge)	25	11	15	32		
Silometopus elegans (O.P.-Cambridge)					35	23
Diplocephalus latifrons (O.P.-Cambridge)		2	11	17	5	
Dicymbium nigrum (Blackwall)	7	3	15	6	2	
Tenuiphantes cristatus (Menge)					17	1
Centromerita bicolor (Blackwall)			12	1		2
Erigonella hiemalis (Blackwall)					2	6
Tenuiphantes mengei (Kulczynski)			1		7	
Dicymbium tibiale (Blackwall)		1			5	
Diplostyla concolor (Wider)				1	2	1
Gongylidiellum vivum (O.P.-Cambridge)	2			2		
Meioneta affinis (Kulczynski)						4
Meioneta saxatilis (Blackwall)					4	
Porrhomma sp (egeria) Simon			4			
Tapinacyba pallens (O.P.-Cambridge)					3	1
Tiso vagans (Blackwall)				1		2
Agyneta cauta (O.P.-Cambridge)						1
Bathyphantes parvulus (Westring)					1	
Bolyphantes luteolus? (Blackwall)			1			
Ceratinella brevis (Wider)			1			
Meioneta rurestris (C.L.Koch)			1			
Micrargus apertus (O.P.-Cambridge)				1		
Neriene clathrata (Sundevall)			1			
Oedothorax gibbosus (Blackwall)	1					
Tallusia experta (O.P.-Cambridge)	1					
Tenuiphantes zimmermanni (Bertkau)					1	
Walckenaeria acuminata Blackwall				1		
Lycosidae						
Pardosa amentata (Clerck)	13	5	3	23	290	185
Pardosa pullata (Clerk)	2		2	1	22	2
Trochosa terricola Thorell		2	2	7	8	5
Pardosa nigriceps (Thorell)			1	1	5	2
Pardosa lugubris (Walckenaer)						4
Alopecosa taeniata (C.L.Koch)	1					1
Pardosa palustris (Linnaeus)						1
Haniidae						
Cryphoeca silvicola (C.L.Koch)						6
Hahnia pusilla C.L.Koch					1	
Tetragnathidae						
Pachygnatha degeeri (Sundevall)						3

Table 1. Continued.

Family / *Species*	YLm	YLe	OLm	OLe	PAm	PAe
Pachygnatha listeri (Sundevall)						2
Other families						
Haplodrassus signifer (C.L.Koch)						1
Ozyptila trux (Blackwall)						1
Robertus scoticus Jackson				1		
Segestria senoculata (Linneaus)				1		
Zora spinimana (Sundevall)						1
Number of specimens	504	344	437	398	426	306
Number of species	13	11	19	20	19	26
No. of diff. species in each field type	16		26		34	

Pardosa amentata was the most abundant species in the pasture (PAe + PAm) (65 %), but much less abundant in the leys (Figure 2, Table 1). The second most abundant species in the pasture was *Silometopus elegans*, which only occured there. *Bathyphantes gracilis* and *Erigone atra* were also present in the pasture, but with fewer specimens than in the leys.

When comparing the dominant species found in the centre and nearer the edge of the leys, few differences could be observed. More of the same species and more individuals common to the leys (e.g. *Erigone atra, Savignia frontata* and *E. dentipalpis*) were present in the site near the edge of the pasture (Pae) compared with the site in the centre of the pasture (PAm) (Figure 2, Table 1).

To compare and get an impression of the relationship among the spider populations present at the various sites, a DCA analysis was run on the spider data set. The results of the DCA-analysis are given in Figure 3. The first and second ordination axes respectively explain 70.2 % and 11.4 % of the total variability. The first DCA-axis indicates separation in the spider populations found on the sites in the leys compared with the ones found in the pasture, and shows less separation between the populations in young and older ley. In this analysis little separation was found between the spider populations from the middle of each field compared with those nearer the edge of the same field (Figure 3). The first DCA-axis probably shows a gradient, from left to right, of spider populations in more disturbed habitats to spider populations representing more permanent, less disturbed habitats. The distribution along the second axis cannot be attributed to any obvious gradient.

DISCUSSION

Arable ecosystems worldwide are characterised by instability caused by different disturbances compared with natural ecosystems. Major disruptions such as harvesting and ploughing have negative effects on spider assemblages (Topping & Sunderland 1994, Thomas & Jepson 1997). Compared with the pasture, the leys support more species and more individuals of species that are r-selected, such as *Bathyphantes gracilis, Erigone atra* and *E. dentipalpis*. This higher number amount of pioneer species in the leys is probably due to the more intensive management of the leys compared to the pasture: two harvests compared to differentiated grazing. Only minor differences were found between the young and older leys, such as a higher total number of species and fewer specimens of the pioneer species *Bathyphantes gracilis* in the older ley. This minor differences may indicate that the yearly disturbance of the ley by harvesting has greater effects on the local spider populations than the time period since ploughing. Several species that are restricted to the pasture in this study are known usually to prefer more undisturbed habitats like forest or shrubland, e.g. *Pardosa lugubris, Cryphoeca silvicola, Tapinocyba pallens* and *Thenuiphantes cristatus*. This

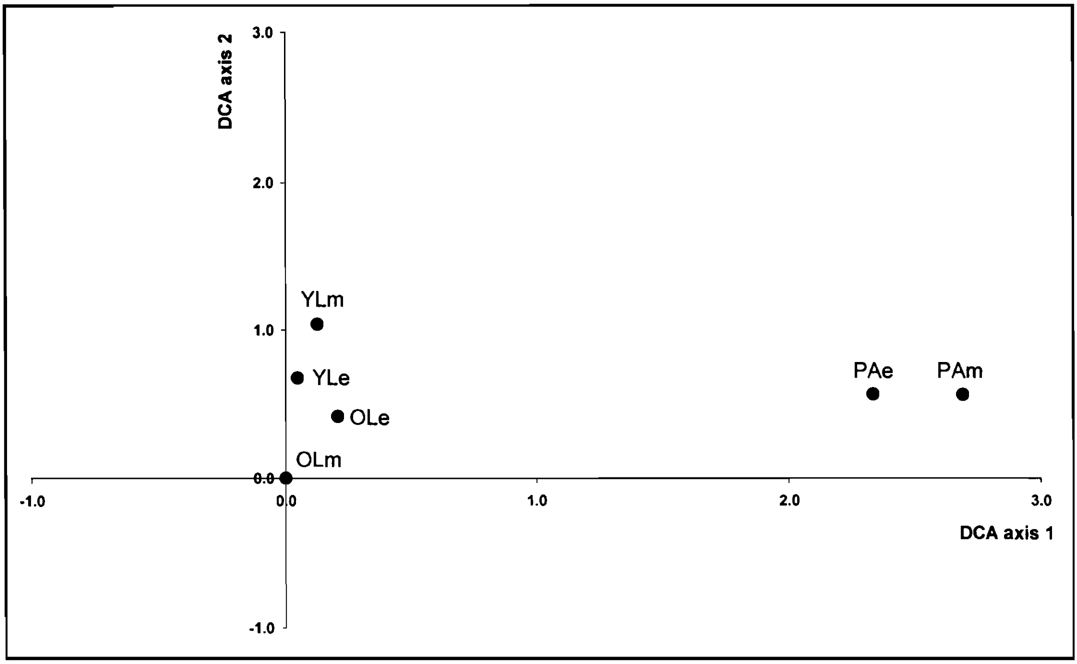

Figure 3. DCA ordination diagram of spider populations found in organically managed young ley (YL), older ley (OL) and permanent pasture (PA). One site is located in the middle (m) and one nearer the edge (e) of each field. Spider species and numbers of specimens are used as the basis of the analysis. Spiders were collected by means of pitfall traps in 2000.

indicates that the less intensive management of the pasture allow other species and more k-selected species to prevail than does the management of the leys.

The higher number of species and individuals of species typical of the leys that are present in PAe compared with PAm in the pasture (Table 1) may be explained by differences in the vegetation structure and grazing pressure on the two sites. PAe had been grazed more than PAm, something which reduced the complexity and height of the vegetation structure on PAe. PAm was dominated by creeping buttercup and tufted hair grass, which are not preferred by the cattle as food. This indicates that indirect or direct effects of grazing have selective effects on the vegetation structure and the resident spider population. A change in composition of spider populations, caused by increasing intensity of grazing management, to a fauna more like those found in cultivated areas, is not unknown (Gibson et al. 1992, Rushton & Eyre 1992).

Some of the most abundant species found in the ley, such as *Erigone atra, Bathyphantes gracilis, Oedothorax* spp. and *E. dentipalpis*, are also found in comparable grass and cereal fields in England and Denmark (Toft 1989, Thomas & Jepson 1997, Feber et al. 1998). *Meioneta rurestris* and *Lepthyphantes tenuis* were abundant in English grass and cereals fields (Thomas & Jepson 1997, Feber et al. 1998), as were *M. rurestris* and *O. apicatus* in Danish barley fields (Toft 1989), but these were all absent in our leys, except for one specimen of *M. rurestris*. In contrast, *Savignia frontata* and *Collinsia inerrans* were found in our leys in quite high numbers compared to the English and Danish studies. The reason for this difference is probably related to biogeography and climate.

The proposed Red-listed species *C. inerrans* (Aakra & Hauge 2000) found in this study has been recorded only twice in Norway (Hauge & Kvamme 1983, Andersen 1990). The species is considered critically endangered in Slovakia (Gajdos et al. 1999). Elsewhere in Europe it is a rarely found species reported from bogs (Heimer & Nentwig 1991), open land, and forests (Maurer & Hänggi 1990). According to Klapkarek & Riecken (1995), *C. inerrans* is a pioneer species, most often found in agroecosystems and reported from intensively managed grasslands (Rushton & Eyre 1992) and cereal fields (Duffey 1978). The high numbers of *C. inerrans* in the young and older ley in this study suggest that the habitat niche in Norway and the distribution range of *C. inerrans* may be broader.

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Three species of spiders (Araneae) new to Norway

Kjetil Aakra, Lars Ove Hansen & Helge Rinden*

Aakra, K., Hansen, L.O. & Rinden, H. 2002. Three species of spiders (Araneae) new to Norway. Norw. J. Entomol. 49, 59–61.

Three species of spiders are reported from Norway for the first time; *Arctobius agelenoides* (Amaurobiidae) from Finnmark, *Agroeca cuprea* (Liocranidae) from Buskerud and *Talavera thorelli* (Salticidae) from Østfold.. Ecological and distributional data are provided for each species.

Key words: Araneae, new species, Norway

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INTRODUCTION

Despite recent advances the spider fauna of Norway in still incompletely known and new species are found at regular intervals. The three species presented in the current paper originate from two different sources; the large insect inventory carried out in the Oslofjord region some years ago (Hanssen & Hansen 1998) and an investigation carried out by the second and third authors in Alta, Finnmark in 1996.

Abbreviations of faunal provinces follow Økland (1981). Nomenclature is according to Platnick (2001). The material is currently in the collection of Midt-Troms Museum.

RESULTS AND DISCUSSION

AMAUROBIIDAE

Arctobius agelenoides Emerton, 1919

Material: **FV** Alta: Detsika, Buolamalia (EIS 173), Malaisetrap in sandy slope, 6 Aug. - 25 Sept. 1996, 1 ♂ (leg. L. O. Hansen & H. Rinden).

This apparently rare and overlooked species has only been recorded once from Sweden (Koponen 1974) and a couple of times from Finland (Palmgren 1977). The species is otherwise known from Western parts of Canada, Alaska, the whole of Siberia south to Mongolia and westwards to the Kola Peninsula (Leech 1972, Marusik et al. 2000).

The paucity of records from Fennoscandia could lead to the conclusion that *A. agelenoides* is a rare species in the region. This is probably not true. The species is in all likelyhood overlooked and often missed by collectors because of its specialised habitat, described variously as «under rocks in talus slopes, under stones in dense coniferous woods and under stones at limestone outcrops on mountains otherwise covered with much glacial morraine» (Leech 1972) and «moss-covered lower slopes of cliffs in Lapland» (Lethinen, cited in Lindquist 1964). The Norwegian specimen was taken near a gentle slope covered with fine sand, located in a pine forest (Figure 1). The fact that the specimen was a male and was taken in a Malaisetrap suggests some vertical movement, possibly in connetion with mate search. The spider usually resides at the bottom end of a long silklined chamber enclosed by moss or detritus (Lethinen 1967).

Given previous habitat descriptions and the current record it would seem that *A. agelenoides* is to be associated with various types of habitats where any loose material (sand, gravel, stones) can be found. The most important factor is probably a suitable medium in which the characteristic silk tube can be constructed which also includes moss carpets. Having a largely sedentary mode of life and possibly a vertical rather than horisontal migration the species is not likely to be taken by pitfall traps and has consequently been overlooked in north Fennoscandian studies. *A. agelenoides* is probably widespread and locally common in the region.

LIOCRANIDAE

Agroeca cuprea Menge, 1873

Material: **BØ** Hole: Røysehalvøya, Søhol (EIS 36), pitfall-trap, 14 May - 14 June 1998, 1 ♀ (leg. L.O. Hansen).

This species is widespread in Sweden, having been found north to Västerbotten (Jonsson pers. comm.), it is not known from Finland (Palmgren 1977). *A. cuprea* is widespread throughout Europe and extends into central Asia (Grim 1986, Platnick 2001). It is likely the species is present in larger parts of southeastern Norway.

The species is commonly associated with dry sites, both in forests and various semi-open to open biotopes (Grimm 1986).

SALTICIDAE

Talavera thorelli (Kulczynski, 1893)

Material: **Ø** Råde: Tasken N (EIS 20), pitfall-trap, 2 - 24 June 1995, 1 ♀ (leg. J. I. I. Båtvik & O. Hanssen).

This small salticid is known north to Värmland in Sweden (Jonsson pers. comm.) and from the southern coast of Finland (Palmgren 1977). It is therefore likely that *T. thorelli* reaches its northwesternmost limit of distribution in Europe in the

Figure 1. The collection site of *Arctobius agelenoides* near Alta, Finnmark. The arrow indicates the malaise-trap. Photo: Lars Ove Hansen.

Oslofjord region, in common with many other evertebrates (Hanssen & Hansen 1998). *T. thorelli* is mainly a species of dry open areas.

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CZECH
ENTOMOLOGICAL
SOCIETY

SECOND INTERNATIONAL CONGRESS OF COLEOPTEROLOGY

PRAHA
CZECH REPUBLIC
SEPTEMBER 14 – 21, 2003

Announcement
October 2001

INVITATION

European Association of Coleopterology, Czech Entomological Society and Forestry and Game Management Research Institute Jiloviste – Strnady are pleased to organize and look forward to your participation at the Second International Congress of Coleopterology which is going to be held in Czechia between September 14 and September 21, 2003. The Congress will offer the possibilities in communication of specialists related to Coleopterology in any topic via oral, poster, slide, film, exhibition or what ever presentations.

CONGRESS VENUE

The Congress will be held in Praha, the capital of Czechia. Praha is easily reachable by plane, train or bus from many worldwide destinations or by car for nearer attendants. The main Congress activities will be centered in the hotel Pyramida, very near to down town (ten minutes walk from Praha Castle), where congress hall, lounges for parallel workshops, cinema as well as four stars accommodation and restaurants are available. Near student hostel, in walking distance, makes possibility for another accommodation.

SCIENTIFIC PROGRAM

The program will include 1 – 2 days of plenary lectures, 3 – 4 days of specialized symposia, and 1-day scientific-historical excursion, all together 5 days. The organizers welcome any suggestions for theme sessions and workshops.

The official Congress language will be English. Posters in other congress languages will be accepted providing that a sufficiently explanatory abstract in English is presented. We plan to publish extended, fully annotated abstracts only in Congress Proceedings. The possibility of publication of contributions at full length will be discussed at the Congress.

ACCOMPANYING PERSONS

There will be organized also the program for accompanying persons during the Congress, such as guided tours down town Praha and near areas of cultural and historical interest.

REGISTRATION

The registration fee will be stated later according to the interest of participants, there will be certain discount for students and accompanying persons. The fee will cover renting of session rooms and technical equipment, refreshments, ice-breaking and farewell party and printed materials.

The registration form and other more detailed information will be included in the first circular as well as in later constructed web page of the Congress.

Please, fill in and send to the contact address the enclosed form so as we learn the interest of people in such a Congress. There are many organization matters depending on such knowledge, also such main one as if the meeting will be held or not.

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Norw. J. Entomol. 49, 63–65. 2002

Further records of Norwegian Lauxaniidae (Diptera)

Lita Greve

Greve, L. 2002. Further records of Norwegian Lauxaniidae (Diptera). Norw. J. Entomol. 49, 63-65.

Four species of lauxanid flies (Diptera, Lauxaniidae) *Lyciella mihalyii* Papp, 1978, *Minettia fasciata* (Fallén, 1826), *M. filia* (Becker, 1895) and *Sapromyza opaca* Becker, 1895 are recorded for the first time from Norway. The total number of species of Lauxaniidae known from Norway is 37.

Keywords: Lauxaniidae, new species in Norway

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INTRODUCTION

A checklist numbering 33 species of the Lauxaniidae (Diptera) from Norway was presented by the author on the XXV Nordic-Baltic Congress of Entomology. This checklist was based on material in the collections of Zoological Museum, University of Bergen and on literature from Siebke (1877) to recent records by Rognes (1995), Greve (1997, 1999, 2000a, b), Greve & Skartveit (1998) and Greve, Pommeresche & Skartveit (1998). A more comprising checklist is planned in the future. The present article records four additional species.

The material is deposited in the Zoological Museum, University of Bergen. Collecting has been done with insect net, Malaise traps and Light traps. Regional abbreviations are given in accordance with Økland (1981). MT = Malaise trap, LT = Light trap. Unless otherwise stated the collections were done by the author.

THE RECORDS

Family Lauxaniidae

Subfamily Lauxaniinae

Lyciella mihalyii Papp, 1978

HEN Rena: Skjelmoen South, 1 ♂, 18 June 1997, Near mouth of river Åsta, 6 ♂♂, 22 June 1997. **BØ** Drammen: Underlia, MT, 1 ♂, June 1994, 1 ♂, Aug. 1995, leg. L. O. Hansen. **VE** Stokke: Melsomvik, 1 ♂, 1 July 2000. **AAY** Evje and Hornes: Road near Lislevann, 2 ♂♂, 2 Aug. 1996. **AAI** Bygland: Heddevika, MT, 1 ♂, 29 July - 27 Aug. 1998, leg. K. Berggren. **RY** Egersund: Near Gudalsåna, east of Terland, 5 ♂♂, 3 Aug. 1996. **HOY** Fusa: Bogøy, 25 Aug. 1993, 1 ♂, leg. G.W. Bakkerud & L. Greve. **HOI** Eidfjord: Hjølmodalen, 100 m. a. s. l., 1 ♂, 2 July 1967, 310 m. a. s. l., 1 ♂, 14 July 1967, 100 - 250 m. a. s. l., 1 ♂, 4 July 1968; Måbødalen, 580 m a s l, 1 ♂, 7 July 1968, leg. T. R. Nielsen et al; Voss: Myrkdalen near Mørkve, 1 ♂, 28 July 1997, Myrkdalen near Strandelva, 1 ♂, 24 July 1997. **SFY** Jølster: Vassenden, near Jølstratunet, MT, 1 ♂, 6 - 11 July 1998. **SFI** Flåm: Aurland, 2 ♂♂, 26 July 1981, leg. I. Greve Jensen, Vik: Fresvik, MT, 1 ♂, 1 - 17 July 1997, leg. G.W. Bakkerud & H. Breilid; Lærdal: Lærdalsøyra, 1 ♂, 24 July 1981, leg. I. Greve Jensen. **MRY** Volda: Near Store Rauelva, west, 1 ♂, 17 June 1995; Ørsta: Near Åreflot, 1 ♂, 20 July 1991.

EIS 3, 5, 9, 19, 28, 31, 32, 33, 41, 50, 51, 55, 58, 68.

Papp (1978) described *L. mihalyii* on characters of the male genitalia. Papp also remarked that *L. mihalyii* is very similar to *L. subfasciata* Zetterstedt, 1838, and that *L. mihalyii* can only be separated from *L. subfasciata* on characters in the male genitalia. Papp (1978) figures genitalia of both species. *L. subfasciata* does not have developed gonites as in *L. mihalyii* and the first flagellomere is not as pronounced dark as in *L. mihalyii.* Thus males of these two species are not difficult to separate.

Note, however, that males of *L. mihalyii* are very similar to males of *L. illota* (Loew, 1847) common in Norway. The difference is in the shape of the right gonite which is elongate and pointed in *L. illota* and truncated and bifid in *L. mihalyii.* The females of *L. illota* have a cleft eight sternite, and the females of *L. subfasciata* according to Elberg & Remm (1979) have not. The female of *L. mihalyii* has hitherto not been described with respect to this feature.

L. mihalyii is widely distributed in southern Norway and obviously fairly common. There are no records from alpine localities. The material was collected by net-sweeping in grass, ferns and once in a flowering meadow. On several localities specimens of *L. mihalyii* were collected together with specimens of *L. illota*.

Minettia fasciata (Fallén, 1826)

TEY Bamble: Langøya, MT at seashore, 1 ♀, 6 - 30 June 1995, leg. L. O. Hansen & R. Mehl.

EIS 11.

The genus *Minettia* can be identified on the intra-alar bristle being placed near or very near a line between the posterior dorsoventral bristle and the posterior supra-alar bristle. *M. fasciata* has a long-haired arista, the thorax is greyish and the abdomen brownish-yellow in colour. *M. fasciata* is very closely related to *M. rivosa* (Meigen, 1826), a species which also may occur in Norway. The best way to separate these species are using characters found in the male genitalia.

The female from Langøya has a clear grey color of the thorax and dark, brown stripes laterally on the segments of the abdomen. The genitalia of female *M. fasciata* and *M. rivosa* are very similar. The genitalia of the examined female agree well with the figures of *M. fasciata* shown by Remm & Elberg (1979). It should be mentioned that the figures of the female genitalia of *M. rivosa* are very similar which makes the determination somewhat uncertain.

M. fasciata is recorded from Sweden (H. Andersson, pers.comm.). Both *M. fasciata* and *M. rivosa* are mentioned in the Danish Diptera checklist; *M. fasciata* as fairly common, *M. rivosa* as rare (Merz et al. 2001).

Both species are widely distributed in Western Europe, and they are also known from Caucasus and the Near East. *M. rivosa* is also known from North America. Both are probably rare in Norway since the author has looked through much material of Lauxaniidae from areas in South Eastern Norway, but have not seen any further specimens.

Minettia filia (Becker, 1895)

Syn.: *Sapromyza pellucida* Becker, 1895

AK Enebakk: Nordre Bøler, MF, 1 ♀, July 1996, 1 ♂ 1 ♀, Aug. 1996 leg. H. Breilid & H. Solberg.

EIS 29.

M. filia is a yellow coloured species and therefore different from the other species of the genus *Minettia* hitherto known from Norway. Shatalkin (2000) presents a figure of the characteristic genitalia of the male. The males are easy to identify on characters in the genitalia. The female genitalia (as *S. pellucida)* are figured by Remm & Elberg (1979).

Shatalkin (1998) gives the distribution as the central and northern parts of East Europe and east towards Sakkalin.

Sapromyza opaca Becker, 1895

Syn.: *Sapromyza imitatrix* Czerny, 1932
S. nigrifacies Czerny, 1932
S. polonica Czerny, 1932

AK Vestby: Soner, 1 ♂, 7-13 Aug. 1988, leg. S. Ligaard; Asker: Bjørkås, 1 ♂, 2 July - 24 Aug. 1995, leg. L. O. Hansen; Ytre Enebakk: Vestbyveien, 1 ♂, 26 June 2000, leg. G. W. Bakkerud. **HES** Elverum:West of Enga, South of Sørbygrenda, 2 ♂♂, 19 June 1997. **BØ** Drammen: Underlia, MT, 2 ♂♂, June 1992, 1 ♂, Aug. 1995, leg. L. O. Hansen. **VE** Stokke: Åkersvannet, 1 ♂, 29 June 2000, Melsomvik, 9 ♂♂, 1 July 2000; Horten: Karljohansvern, 1 ♂, 30 June 2000. **RY** Hå: Ogna, MT, 1 ♂, 21 June - 17 July 1996, leg. I. Greve

Korsnes & L. Greve. **SFI** Lærdal: Lærdalsøra, 5 ♂♂, 24 July 1981, leg. I. Greve Jensen; Leikanger: Hermannsverk, Sanden, 1 ♀, 27 June 1990, 8 ♂♂, 18 July 1990, leg. S. Røkenes.

EIS 3, 7, 19, 28, 29, 50, 51, 55.

Sapromyza opaca belongs to a group of yellow to reddish-yellow *Sapromyza* species with pairs of black spots on some of the abdominal tergites. *S. opaca* and *S. sexpunctata* Meigen, 1826, which also are recorded from Norway, both have pairs of black spots on the tergites four, five and six. Other *Sapromyza* species in this group have spots only on tergites five and six, others again only on tergite six. The spots vary in size and specimens occur in which it is difficult to decide how many pairs of spots are present. Male genitalia present good characters while females are more difficult to identify. Females are therefore not included here.

S. opaca seems not to be a rare species in Norway. Specimens have been caught from late June untill August. Most specimens are from coastal areas or along fjords in Western Norway..

DISCUSSION

The total number of species of Lauxaniidae recorded from Norway including the four species listed here is now 37. More species of Lauxaniidae can be expected from the country in the future since the total number already recorded from Sweden are around 45 (Andersson, pers. comm., Hedström 1994). In Denmark the number is nearly the same according to the new checklist (Merz et al. 2001). The present Norwegian list also includes some species which are not recorded either from Sweden nor from Denmark; but may occur at least in Sweden as well.

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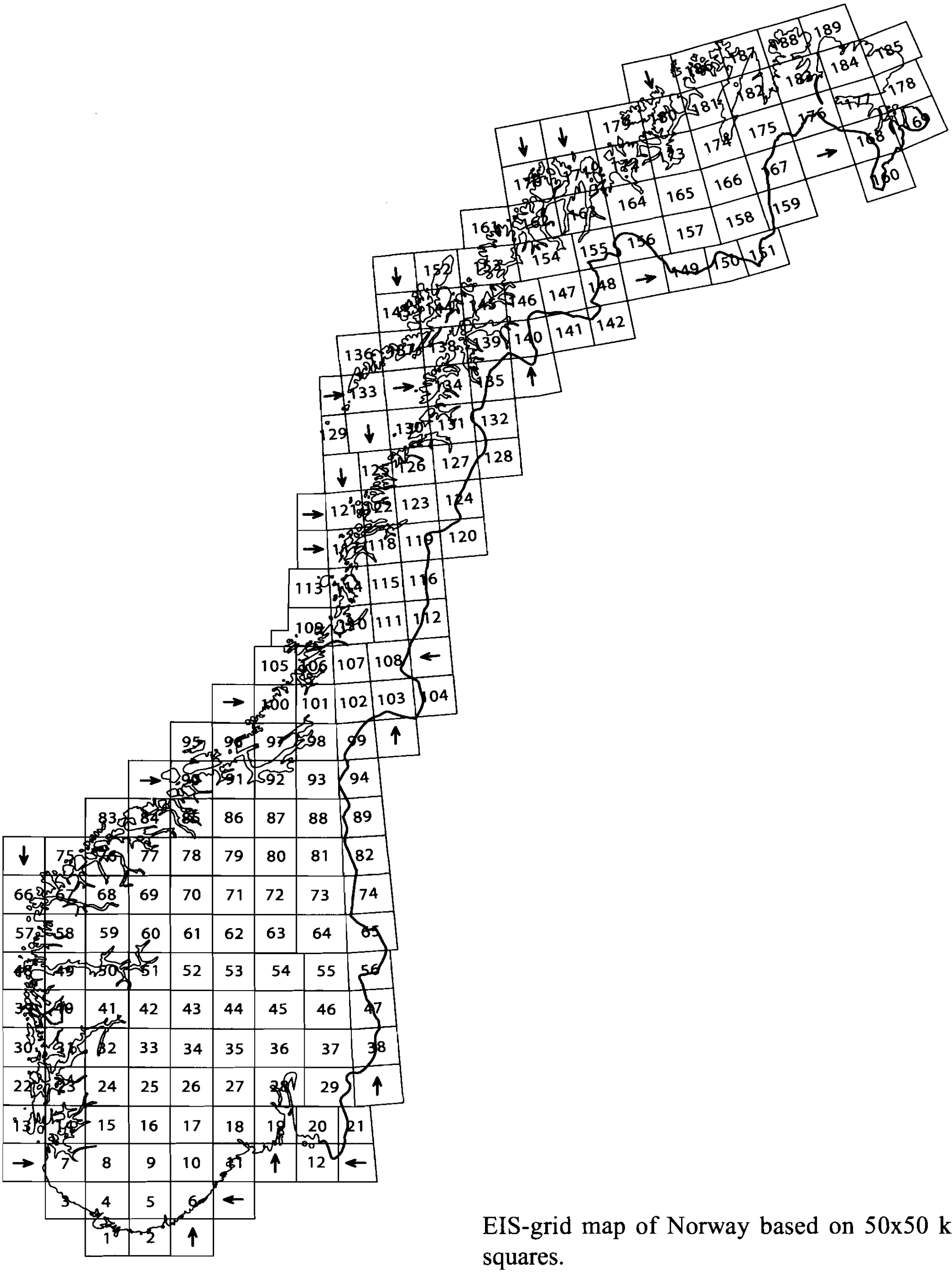
The EIS-grid system of Norway



EIS-grid map of Norway based on 50x50 km squares.

Norw. J. Entomol. 49, 67–70. 2002

Occurrence and damage by *Penthaleus major* (Dugés) (Acari: Penthaleidae) in Norwegian meadows

Tor J. Johansen & Roar Haug

Johansen. T.J. & Haug, R. 2002. Occurrence and damage by *Penthaleus major* (Dugés) (Acari: Penthaleidae) in Norwegian meadows. Norw. J. Entomol. 49, 67-70.

The mite *Penthaleus major* may infest meadows in northern Norway (65-71°N) and cause characteristic symptoms of damage. During the ground frost period (November-April) the mites survived in the egg stage. Development started along with beginning of grass growth in May or June. Occurrence predominated on timothy (*Phleum pratense*) in meadows older than three years. Most infested fields had loose sandy soils and were located in regions with low precipitation and early summer drought. Attack of mites did not cause any major yield reductions in our studies. Therefore, we conclude that most yield reductions associated with mites in our regions are confused with the effect of drought.

Keywords: *Penthales major*, Acari, meadows, northern Norway

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INTRODUCTION

The blue oat mite *Penthaleus major* (Acari: Penthaleidae) is regarded as a pest in pastures, meadows, cereal and other crops throughout temperate zones of the world (Narayan 1962, Chung et al. 1963, Wallace & Mahon 1971, Streu & Gingrich 1972, Kornilow & Kositsyna 1981, Kanda & Hirai 1990, Ridsdill-Smith 1991). During humid and cool winters several generations may develop, and, in the spring, drought-resistant aestivating eggs are produced. Distribution is restricted to loose mineral soils (Chada 1956, Narayan 1962, Streu & Gingrich 1972). Recently, it is shown that *P. falcatus* has been misidentified as *P. major* since 1926 (Weeks et al. 1995, Qin & Halliday 1996). This fact raises doubts about previous observations of *P. major*. According to Weeks & Hoffman (1999) both species are pests of pastures.

Although not scientifically published, it is observed that *Penthaleus* mites attach fodder grasses also in sub-arctic regions. Nielsen (1984) reported severe damage from *P. major* to timothy (*Phleum pratense* L.) and smooth meadow-grass (*Poa pratensis* L.) in southern Greenland. The mites occurred on well-drained soils from the start of the growing season in May. Further investigations showed a development of two generations throughout the cool summer period (Peter Nielsen, pers. comm.). In Iceland, damage was most severe in meadows dominated by timothy (Gudleifsson & Olafsson 1987, Gudleifsson 1988). In Norway, Johansen (1987), reported clear symptoms of damage with greyish, silvering leaves, mainly on timothy. Damage was restricted to light, sandy soils, in northern regions with regular summer drought. Previous observations from Norway in 1912 (Mehl 1979) and Greenland (Hammer 1937) show that *Penthaleus* mites have a natural distribution in this sub-arctic parts of the world.

Haug (1989) investigated the life history of the mite in northern Norway. He found that winter passed in the egg stage, and that mites were active from the beginning of growth season (end of May) until middle of July. A maximum of 14 800 *Penthaleus* mites per m^2 was calculated from smaller samples. Specimens from his study were identified as *P.*

major by E. Lindquist, Biosystematics Research Centre, Ottawa, Canada in 1989. Voucher specimens are deposited in the Canadian National Collection. Lindquist mentioned two forms of these mites in North America. The specimens from Norway, and previous studied specimens from arctic Canada, and also from Texas, had longer, more uniform, and fewer dorsal body setae than the other (Lindquist, pers. comm.).

Although *Penthaleus* mites are widely distributed around the world, few, if any, attempts have been made to quantify yield reduction from attack in meadow grasses. In the current studies, we aimed to assess such damage in a northern sub-arctic climate. We also wanted to learn more about the effect of drought on mite attack, and to gather more information on the biology of *Penthaleus* mites in Norway.

MATERIALS AND METHODS

Investigations were carried out in northern Norway (65-71ºN) from 1987 until 1993. Although temperatures occasionally rise to well above 20 °C, the normal mean temperature in the growing period (May-September) is about 10 °C. However, long days compensate to some degree for the short and cool growth season. The climate varies from humid along the coastal line (precipitation >1000 mm) to more continental conditions in inland areas (< 500 mm). Early summer drought occurs regularly in some regions. During the winter period the ground is normally frozen and covered by snow.

In 1987-1989, we distributed a questionnaire among all local extension groups, asking about mite observations, damage, host plants, soil types, pest management and agricultural practice at farm level. We also collected infested grass and soil samples in late autumn. These were kept at 18 °C to study the egg development.

In 1990-1991, we conducted five experiments with a randomised block design and four replicates for damage assessment in infested meadows. When mites became active (June), we suppressed mite populations on small plots of 12.5 m^2 by spraying pesticides. We were then able to study the potential as a pest species by comparing yields on plots with and without mites. Results are presented for treatments with fenpropathrin at a rate of 100 gram active ingredients (g a.i.) per ha.

In June 1992, we irrigated (20-30 mm) circular plots with a radius of 10 m in a heavily infested timothy meadow in Manndalen, Kåfjord. Effects on mites and yields were observed visually. In 1993, we conducted a split-plot trial in the same field with three replicates, irrigation (as above) 2 July on large plots and spraying (as above) 25 June on small plots (200 m^2). One week after spraying, we collected samples of sap-feeding mites by means of a 50 cm long and two cm wide moistened metal half pipe placed on the ground under the vegetation. When we shook the grass stand, the mites fell down and were trapped. Results were based on five mite samples and two harvest plots (each 7 m^2) per small plot.

RESULTS AND DISCUSSION

Questionnaire and field observations

Reports of damage from *Penthaleus* mites represented a total of 8 municipalities, 28 farms and 40 fields. Fields (numbers in brackets) were located in Alta (27), Kåfjord (6), Hamarøy (2), Kvalsund (1), Nordreisa (1), Balsfjord (1), Harstad (1) and Vestvågøy (1). Damage was most frequently (25 fields) reported from meadows dominated by timothy. Nevertheless, feeding mites and damage symptoms were also observed on meadow fescue (*Festuca pratensis*), smooth meadow-grass (*Poa pratensis*), couch grass (*Elytrigia repens*) and smooth brome-grass (*Bromus inermis*).

Most fields (38 out of 40) had well-drained, loose sandy soils, and were located in regions with low precipitation and early summer drought. On average, infested fields were six years old. Young meadows, one to three years after ploughing and sowing, had seldom any major symptoms of damage. Such positive effect of ploughing and re-establishment of grasses is previously stated by Kanda et al. (1992). Within most farms, clear borders were observed between fields or sites with and without mite attacks. This indicates a slow movement within the mite population, as recently shown by Weeks et al. (2000).

Penthaleus major eggs were found on the lower plant parts and in the soil near the plants. When samples were collected just before onset of frost and moved to 18 °C, nymphal stages developed within ten days, indicating non-diapausing eggs or a post-diapause stage. The presence of eggs at this time supports a previous statement of overwintering in the egg stage in our climate (Haug 1989). Whether these eggs originate from the spring generation or a second summer generation remains to be investigated. However, if not in diapause, we would expect that eggs deposited in June and beginning of July in northern Norway would produce a new generation of mites before the winter frost starts in October or November. Normally, two generations of these mites are active during moist winters between the latitudes 25 and 50-55 (Chada 1959, Wallace & Mahon 1971), in conditions similar to the summer climate in northern Norway.

Damage assessment

Although visual observations clearly indicated differences in mite occurrence and damage symptoms between sprayed and unsprayed plots, spraying affected dry matter grass yields significantly (p=0.05) in only one of the five trials in 1990-1991 (Table 1). In two out of five trials, fresh yields were significantly affected by spraying. Unsprayed plots had slightly higher dry matter content than sprayed plots indicating a certain desiccating effect from mite attack.

In 1992, the irrigated plots developed as green oases compared to a total withering outside the irrigated area. High numbers of mites occurred in both areas (not quantified). In 1993, irrigation increased grass yields significantly (Table 2). Dry matter percentage was highest when not irrigated as a result of desiccation. Moreover, increased yields were obtained in spite of higher mite numbers on irrigated plots. Besides demonstrating the vital importance of water supply for grass growth, these results also indicate a negative influence of drought on mite activity. Chada (1956) stated that these mites descend to the ground or burrow into the soil on hot and dry days.

In this trial, spraying did not affect yields, although mite numbers were reduced significantly (Table 2). In Norway, the highest reported density of *P. major* is 14 800 per m^2 in grassland (Haug 1989), while other authors have estimated average densities up to 80 000 per m^2 (Kanda & Hirai 1990). Such extreme densities may explain the pest status of the species in meadows and pastures. However, our results and observations only indicate a minor impact on grass yields in our regions.

In conclusion, our results show that although mites and damage symptoms are present, drought is the main reason for yield failure in some Norwegian regions. This is quite in contrast to the opinion of many farmers who believe in strong yield reductions from mite attacks. Our hypothesis is that they may be misled by the clearly visible symptoms, and the effect of drought.

Table 1. Effects on grass yields from suppressing populations of *Penthaleus major* with pesticide sprays (ANOVA, n=4)

	Experimental sites and years				
	Alta 1990	**Alta 1991**	**Kåfjord 1990**	**Kåfjord 1991**	**Harstad 1991**
Fresh yields (t/ha)					
Unsprayed	22.5	14.7	13.8	6.7	14.1
Sprayed	26.8	18.4	13.8	8.5	11.9
Stat. sign. (p)	0.000[1]	0.001	n.s.	n.s.	n.s.
Dry matter (t/ha)					
Unsprayed	5.2	3.3	3.5	1.9	2.5
Sprayed	5.7	3.8	3.3	2.4	2.3
Stat. sign. (p)	0.100	0.054	n.s.	0.043	n.s.
Dry matter (%)					
Unsprayed	23.2	22.3	25.4	29.4	18.2

[1] Statistical significance level (p) up to 0.100 presented. Else n.s. (not significant).

Table 2. Main effects of irrigation and pesticide treatment in a meadow infested with *Penthaleus major* (ANOVA, n=6)

	Fresh grass yield (t/ha)	**Dry matter yield** (t/ha)	**Dry matter** (%)	**No. of mites** per m^2
Not irrigated	10.5	4.0	38.1	670
Irrigated	16.4	5.2	31.7	1930
Stat. sign. (p)[1]	0.016	0.083	0.090	0.068
Unsprayed	13.6	4.6	33.8	2440
Sprayed	13.3	4.6	34.6	150
Stat. sign. (p)	n.s.	n.s.	n.s.	0.004

[1] Statistical significance level (p) up to 0.100 presented. Else n.s. (not significant).

For a better understanding of *Penthaleus* mite ecology and pest status in our regions, further studies should focus on biology and how soil and climatic conditions affect its activity and distribution.

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First report of the fungal entomopathogen *Paecilomyces* Bainier (Deuteromycota: Hyphomycetes) in Norway

Guy Mercadier, May-Guri Sæthre & Fernando E. Vega

Mercadier, G., Sæthre, M.-G. & Vega, F. E. 2002. First report of the fungal entomopathogen *Paecilomyces* Bainier (Deuteromycota: Hyphomycetes) in Norway. Norw. J. Entomol. 49, 71-73.

A search for natural enemies of the codling moth, *Cydia pomonella* L., was conducted in Norway in an attempt to find potential biological control agents. The fungal entomopathogen *Paecilomyces farinosus* was isolated from insects collected in nine locations. This is the first report for the genus *Paecilomyces* in Norway.

Key words: *Paecilomyces*, *Cydia*, biocontrol, entomopathogens, fungi.

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INTRODUCTION

One of the most important pests of apples and pears throughout the world is the codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae) (Barnes 1991). Females lay eggs singly or in small clusters on leaves or directly on the fruit; once hatched, larvae bore holes into the fruit reducing its quality or rendering it unusable (Alford 1984). In an attempt to identify microbial agents with potential for use in biological control programs against the codling moth, cardboard band traps used to capture overwintering codling moth prepupae were installed in 9 locations in Norway (Table 1) in late July of 1999. Insect pathogens from Norway might be of special interest as potential microbial agents if they have a lower temperature optimum than isolates obtained from southern locations in Europe. Eight of the locations sampled were in the eastern part of Norway, while one location, Sogndal, was in the west. Based on the annual distribution of temperature and precipitation, the climate in Norway may be roughly divided into two climatic subzones (Aune 1993). The western subzone is characterized by cool summers and mild winters, and most of the precipitation occurs during autumn. The eastern subzone is characterized by warm summers and relatively cold winters, and most of the precipitation occurs in the summer. The eastern and western populations of *C. pomonella* are separated by geographical barriers that make migration between the two very unlikely (Sæthre & Hofsvang, unpublished), and might have different microbial agents attacking them, or the agents might show different responses to temperature and/or humidity. It was therefore decided to search for microbial agents in both climatic subzones and only at locations where *C. pomonella* was already known to be present (Sæthre & Edland 2001).

MATERIALS AND METHODS

The traps consisted of corrugated cardboard double wrapped around the trunk or branches of apple trees, and covered with a plastic screen. Codling moth infested apples tend to ripen and drop prematurely, and the fully grown larvae leave the fruit in search for overwintering sites beneath the bark or at the base of the tree (Alford 1984). The corrugated cardboard provides such a site. Traps were retrieved in early May of 2000 and larvae that were alive within the corrugated cardboard were individually placed in 55 x 15 mm Petri dishes with a screened lid; the bottom section of the dish was lined with filter paper moistened with sterile water. Dishes were placed on a plastic platform inside a sealed plastic container containing water, thus creating a 100 % relative humidity environment suitable for the proliferation of fungi on the insects′ cuticle. The plastic container was kept in a growth chamber maintained at 28 °C. Larvae were examined daily for two weeks and when fungal growth was seen, an inoculating loop was used to subculture the fungus on to Sabouraud′s dextrose agar (Becton Dickinson France S.A., Le Pont de Claix, France) for subsequent identification. Larvae that were dead when removed from the cardboard were individually placed in sealed 35 x 10 mm Petri dishes containing Bacto agar (3 g/L; Becton Dickinson France S.A., Le Pont de Claix, France) with chloramphenicol (0.4 g/L; Fisher Scientific Labosi, Elancourt, France), kept at 28 °C, and examined daily for fungal growth.

RESULTS

The only insect pathogen isolated from all nine locations (Table 1) was the mitosporic fungal entomopathogen *Paecilomyces farinosus* (Holm ex S. F. Gray) Brown & Smith. This is the first report of the genus *Paecilomyces* in Norway (Klingen et al. 2002a). However, very few surveys have been conducted in Norway on the occurrence of insect pathogenic fungi, and the most intensive study of soil dwelling insect pathogenic hyphomycetous fungi was conducted on arable land and adjacent field margins in northern Norway (Klingen et al. 2002b). *P. farinosus* is frequently isolated from forest soils (Samson 1974) and has also been reported to be very sensitive to the disturbing effects of cultivation (Vänninen 1995). *P. farinosus* has a wide range of hosts, mainly lepidopteran larvae (Tanada & Kaya 1992).

The isolation of *P. farinosus* in Norway is of significant interest in the field of applied entomology, since Norwegian regulations requires that commercial products containing fungal spores can only be used if the fungal species has already been found in the country. Future research will determine the virulence and the temperature range of the *P. farinosus* strains against the codling moth. It will be of special interest to investigate if there are any differences between the strain from Sogndal in western Norway and the strains from eastern Norway regarding temperature optimum. All strains have been deposited in the European Bio-

Table 1. Locations in Norway where traps used to capture overwintering *Cydia pomonella* were installed.

County	Municipality	Location	Altitude m a.s.l.
Akershus	Ås	Skogvn. 39	90
Akershus	Ås	Kajavn. 23	90
Buskerud	Lier	Egge	100
Buskerud	Lier	Foss Gård	60
Telemark	Notodden	Nordre Sem	25
Telemark	Sauherad	Jønsi	80
Telemark	Sauherad	Rinde	80
Telemark	Sauherad	Flåtin	40
Sogn og Fjordane	Sogndal	Sogndalsfjøra	5

logical Control Laboratory (USDA, ARS) Fungal Entomopathogens Collection (Montpellier, France) and in the Plant Protection Centre Collection of Fungal Entomopathogens (Ås, Norway).

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Instructions to authors
with extended information on electronic submittance

Manuscripts

The language is English or occasionally Norwegian with an extended English summary.

Manuscripts, double spaced on one side of the paper must be submitted in duplicate. Separate sheets should be used for (1) title page with authors names, (2) abstract followed by the name(s) and postal address(es) of the author(s), (3) tables, (4) numbered figures and (5) legends to figures. *Acknowledgements* should be gathered under a single heading at the end of the text. All manuscripts will be considered by referees before acceptance.

Abstract should not exceed 300 words and should cover the main results and conclusions of the paper. A list of up to five *key words* may be added on a separate line below the abstract.

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Nomenclature. Scientific names of genera and species should be written in italics. The name of the author and year of description (if appropriate), separated by a comma, should be included the first time the name of an insect or another terrestrial arthropod is mentioned in the text, e.g. *Rhyacophila nubila* (Zetterstedt, 1840). Names of authors should be written in full.

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Correction to *Norw. J. Entomol.* 48 (2) 2001

Please add to contents for Volume 48 on p. 344 after Hippa et al.:

Greve, L. & Skartveit, J. The genus *Loxocera* (Diptera, Psilidae) in Norway 329

The same addition should be made to the back cover of 48 (2).

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The present journal is a continuation of **Fauna norvegica Series B** (Norwegian Journal of Entomology). With Volume 45 (1998) the publication of this journal by the Foundation for Nature Research and Cultural Heritage Research (NINA-NIKU) has been discontinued. Starting with Volume 46, the journal is published as **Norwegian Journal of Entomology** by the Norwegian Entomological Society. Editor is Professor Lauritz Sømme, University of Oslo.