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Cereals as host plants for thrips (Thysanoptera) in Norway

Sverre Kobro, Ann Elin Teksdal & Arild Andersen

Kobro, S., Teksdal, A. E. & Andersen, A. 2000. Cereals as host plants for thrips (Thysanoptera) in Norway. Norw. J. Entomol. 47, 1-6.

A survey of thrips (Thysanoptera) in cereals was carried out in southeastern Norway in 1996. No high densities of thrips were recorded. *Limothrips denticornis* and *Frankliniella tenuicornis* were the dominating species. *Stenothrips graminum,* which is new to the Norwegian fauna, was also found in abundance. *L. denticornis* reproduced in the cereals only to a small extent. *F. tenuicornis* completed two generations, one in winter cereals in June, and a second generation in spring cereals in July. Pollen as an oviposition stimulant is discussed.

Key words: Thysanoptera, *Limothrips denticornis, Frankliniella tenuicornis, Stenothrips graminum.*

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INTRODUCTION

Thrips (Thysanoptera) are often neglected as pests on outdoor cultivated plants in Norway, but damage has occasionally been ascribed to thrips. Crops may be attacked by different species of thrips in different parts of the world (Lewis 1973). This seems especially true for cereal thrips in Europe. *Haplothrips tritici* (Kurdjumov, 1912) is dominant on wheat in eastern and southern Europe. In western Europe the niche is filled by *Limothrips cereleum* Haliday, 1836. Further north, in Scandinavia, *Limothrips denticornis* Haliday, 1836, *Anaphothrips obscurus* (Müller, 1776), *Frankliniella tenuicornis* (Uzel, 1895) and *Haplothrips aculeatus* Fabricius, 1803 are dominant in wheat (Köppä 1967). *F. tenuicornis* and *L. denticornis* have oats as their host plant in Britain (Pitkin 1976), but are a minor problem in oats in Sweden (Larsson 1995).

Even within Scandinavia there are differences in the choice of cereals as host plants for thrips. Köppä (1970) focused on two species of thrips as pests in cereals in Finland, *L. denticornis* and *F. tenuicornis,* but *H. aculeatus* may also cause severe damage.

L. cerealium and *H. aculeatus* were previously reported as the most common pests in cereals in southern and central Sweden (Johansen 1946). Later Larsson (1995) stated that *L. denticornis* and *Stenothrips graminum* Uzel, 1895 were also pests in Sweden, while populations of *Thrips angusticeps* Uzel, 1895, *A. obscurus* and *F. tenuicornis* did not occur at injurious levels.

In Denmark *L. cerealium, L. denticornis* and *H. aculeatus* are the most important thrips pests in cereals (Anon.1998), while *F. tenuicornis* is commonly found, but rarely in damaging numbers (Maltbæk 1932). Thus, *L. denticornis* is the only species regarded as a pest in all the three countries, Denmark, Finland and Sweden, but *L. cereleum* is the most studied and described species (Johansen 1938).

The knowledge on occurrence of thrips living on cereals and grasses in Norway is limited. Herstad (1960) published some notes based mainly on information from the government entomologists W.M. Schøyen and T.H. Schøyen for the years 1862 to 1939. Some field trials have been performed in cereals for control of thrips in general (Andersen 2000), but there is little information on identified thrips species as pests in cereals and grasses. In an experiment on chemical control, *Chirothrips manicatus* Haliday, 1836, *F. tenuicornis, L. denticornis* and *A. obscurus* were found, but in small numbers (Selnes 1987). *L. cerealeum* is rare and *H. aculeatus* and *T. angusticeps* are not recorded in Norway (Olsen & Solem 1982).

As the information on occurence of thrips living on grasses and cereals in Norway is limited, further information must be obtained from our neighbouring countries, Denmark, Finland and Sweden, where this insect group has been better studied for many years.

The host plant choice of cereal thrips in Norway is also poorly known. Thrips have not evolved along phyletic lines of host plants in the same way as many other insect groups. The ancestor of thrips was probably a detritus feeder, which later radiated onto the leaves and flowers of higher plants (Mound & Teulon 1995). There they have a varied diet, including pollen, on which they are dependent for reproduction (Kirk 1995). A cereal leaf can trap pollen from any plant in the vicinity, even from trees in a nearby forest, and thus provide food and act as a potentional host plant for thrips. Such opportunistic behaviour is found for many thrips species (Mound & Teflon 1995), and may lead to different possibilities of host plant choice.

The impact of thrips as pests in cereals is difficult to evaluate because of their vagile and opportunistic habit, and reproductive demands. They may land on a plant that they do not eat, or feed on it but not reproduce there (Mound 1997). Additionally, too many other unknown factors influence whether or not an attack leads to damage (Skinner & Parker 1995).

The current information on occurrence and host plant choice of the thrips species that can cause damage in cereals in Norway thus seems unclear. The aim of this study was to promote a better understanding of the occurrence of thrips and their importance as pests on cereals in Norway, and thereby contribute to later studies on damage thresholds.

MATERIALS AND METHODS

Plant material was sampled in Ås, Akershus in southeastern Norway during the summer of 1996. One sample was taken once a week from each of 14 cereal fields, where no insecticides had been used. The fields were in an open and flat agricultural area. The soil has a high content of clay and the climate is semi-coastal. The cereal fields investigated were winter rye (n=2), winter wheat (n=2), triticale (n=2), barley (n=3), spring wheat (n=2) and oats (n=3). The results are given as averages of these and no further statistics are used. A reduced number of samples (in rye and oats and every second week only) were taken in addition in 1998.

Sweep-netting has been the most common collecting method used, and the species composition presented in some papers (eg. Johansen 1938, Köppä 1967) therefore contains several thrips species living in dicotyledons only. In this work we washed the collected plant material, a method which is highly effective (Lewis 1973), thus avoiding flowerthrips species living on weeds.

The washing method is therefore better than sweep-netting, but suboptimal for recording thrips in cereals. Some species, *L. denticornis* in particular, spend most of their time within the leaf sheaths, and may be trapped there during the washing process. In a method study, 60% of the imagoes were recorded after washing, compared to freezing the plant material.

Each sample consisted of 25 straws cut at their bases. The plant material was stored in plastic bags during transport to the laboratory, where water with a drop of detergent was added. After at least 30 minutes and gently shaking a few times, the plant material was removed from the bag, and the water filtered through a nylon cloth (Kobro 1996). Thrips were stored in AGA (60% ethanol + glycerol + acetic acid = 10 + 1 + 1) until identification. The numbers of thrips were used as an indication of occurrence.

Correct identification of thrips may be complicated due to an elaborate preparation technique and the need for a good microscope. The cereal thrips species recorded in Norway are very different morphologically. As the collecting in our study was performed by the selective method of sampling and washing plant material, the thrips species can easily be distingiushed by characters clearly visible without preparation, in a binocular microscope with 40 times magnification. A simplified identification key has been made (Kobro 1997). Imagoes were identified according to this key, and the nymphs identified according to Köppä (1970) and Larsson (pers. comm.).

RESULTS

Thrips were recorded in low numbers only. *L. denticornis* and *F. tenuicornis* accounted for 92.6% of the total number of imagoes, and *S. graminum* for 6% of the imagoes. Almost all nymphs found belonged to these three species. The few pupae that were collected were not identified. Imagoes of *A. obscurus, Chirothrips hamatus* Trybom, 1895 and *C. manicatus* were also recorded, but in low numbers.

L. denticornis. Occurrence of imagoes was similar in rye and triticale (Figure 1), while very low numbers were found in winter wheat (not shown). No nymphs were found in winter cereals, while barley contained some imagoes and a few nymphs in July and August (Figure 2).

F. tenuicornis. A small peak of imagoes was recorded in May in the winter cereals (Figure 3), while in July they were evenly distributed in winter cereals (Figure 3) and barley (Figure 4). The highest number of nymphs were recorded in winter cereals in June (Figure 3) and in barley in July and August (Figure 4). Only a few nymphs were found in spring wheat and oats (not shown).

S. graminum. In spite of very low numbers of imagoes, this species represented the highest number of nymphs in the cereals investigated and were found in oats (Figure 5). More than 95% of these were *S. graminum* nymphs.

The occurence of *L. denticornis* and *S. graminum* in the additional samples in rye and oats in 1998 (not shown) confirmed these results, except that there were *L. denticornis* males in rye in June in 1998.

DISCUSSION

No high number of thrips was found as compared to the threshold of damage suggested by Larsson (1995).

Imagoes of *L. denticornis* appeared in similar numbers in the winter cereals rye and triticale (Figure 1), but no nymphs were found. The abundance of imagoes indicates that two generations were completed, which was expected (Köppä 1970), but as nymphs were found mainly in July and August in barley (Figure 2), most of the reproduction must have occurred outside the cereal fields. However, a low number of males were found in rye and triticale, and as the males are wingless, they must have developed on the sampled plants (Köppä 1970), indicating that some reproduction must have taken place there.

In the additonal samples of rye in 1998, however, a few nymphs and some males of *L. denticornis* were found in June. Thus there was reproduction in rye in 1998, in contrast to 1996, and the reproductive behaviour of *L. denticornis* was different in the two years. This behaviour may have several explanations, but might be a response to the presence or absence of an oviposition stimulant (Terry 1997) such as pollen. If they do not find the right stimulus on a plant, thrips do not remain there. Such a selective behaviour must be important in predicting consequences of an observed attack.

In barley, imagoes of *L. denticornis* also showed a two-peaked occurrence possibly indicating two generations, but nymphs were found mainly in July (Figure 2).

For many thrips species the true host plant, that is where the breeding occurs, is not fully known. Most records of «host plants» are only finding-places (Mound 1997). Our results indicate that rye and triticale had little importance as reproductive hosts for *L. denticornis*. This contradicts the information from Finland (Köppä 1970).

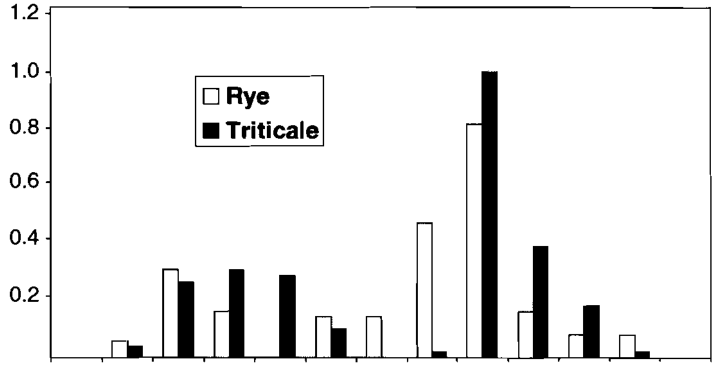

Figure 1. Imagoes of *Limothrips denticornis* in rye and triticale.

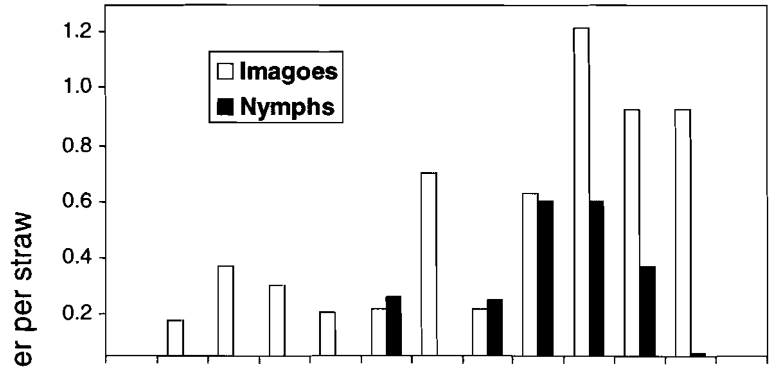

Figure 2. Imagoes and nymphs of *Limothrips denticornis* in barley.

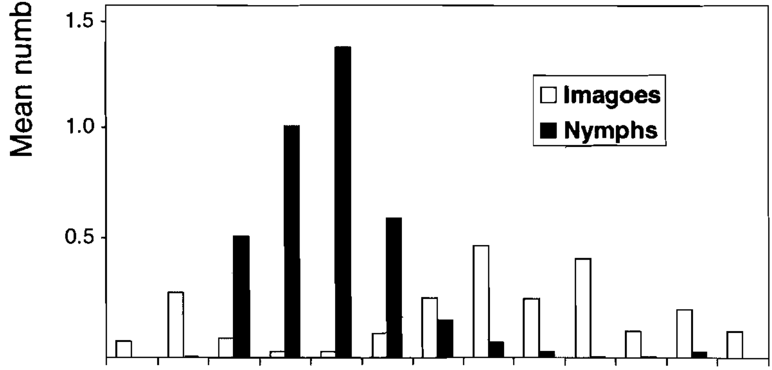

Figure 3. Imagoes and nymphs of *Frankliniella tenuicornis* in winter cereals.

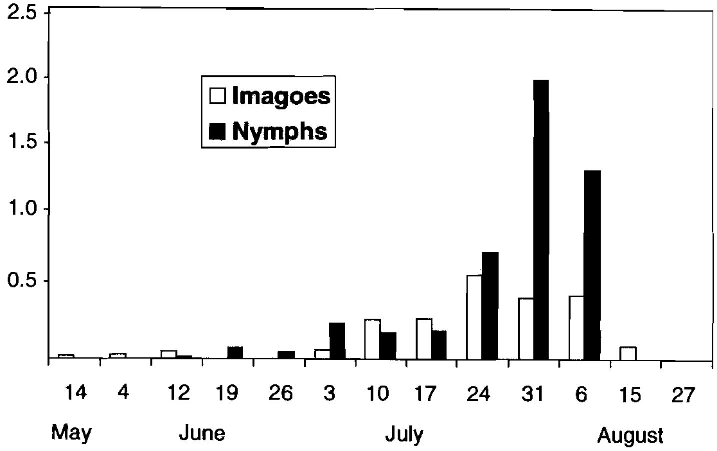

Figure 4. Imagoes and nymphs of *Frankliniella tenuicornis* in barley.

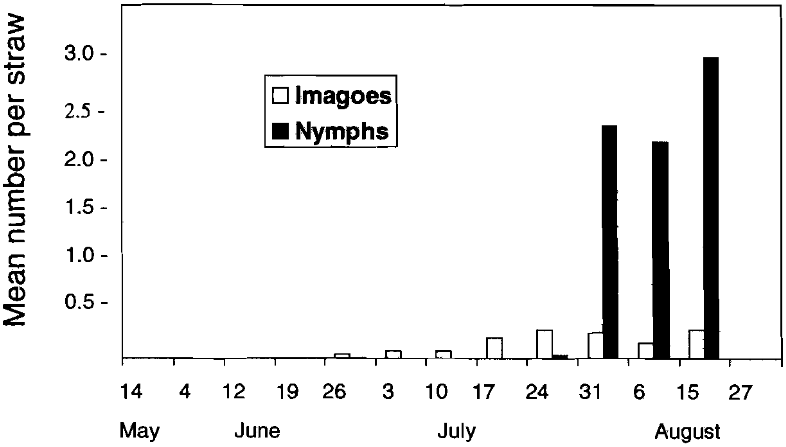

Figure 5. Imagoes and nymphs of *Stenothrips graminum* in oats.

Imagoes of *F. tenuicornis* had an early appearance of overwintered females, though in very low numbers in barley (Figure 4). Similar numbers of imagoes were seen in winter cereals and barley during July and August (Figure 3 and 4). In contrast to *L. denticornis, F. tenuicornis* reproduced twice in the cereal fields, with a first generation in winter cereals (Figure 3) and a second one in spring cereals, mainly in barley (Figure 4). This is well in agreement with information from Finland (Köppä 1970) and Sweden (Johansen 1938).

Johansen (1938) stated that *S. graminum* is common in Denmark, but rare in southern Sweden. The species is presently common in southern Sweden (Larsson 1995), and is spreading northwards (Larsson pers. comm.). It was first registered in Norway in 1995 (Kobro unpublished), and is reported here for the first time, and in considerable numbers (Figure 5).

CONCLUSION

The recorded numbers of thrips were very low, and far below a risk of damage in the cereals.

Reproduction of *L. denticornis* was different from *F. tenuicornis* and *S. graminum,* as all three species were abundant in cereals, but *L. denticornis* had a low reproduction rate there, in contrast to the two other species.

To evaluate the true danger of injury by thrips in cereals in Norway, more detailed information is needed on the distribution of the species and on oviposition preferance.

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Contribution to the knowledge of Norwegian Coleoptera

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The following 34 species of Coleoptera are reported as new to Norway: *Hydroporus nigellus* Mannerheim, 1853, *Bembidion fumigatum* (Duftschmid, 1812), *Dromius linearis* (Olivier, 1795), *Leiodes inordinata* (J.Sahlberg, 1898), *Colon pseudolatum* Palm, 1941, *Omalium littorale* Kraatz, 1858, *Bibloplectus tenebrosus* (Reitter, 1880), *Bibloplectus spinosus* Raffray, 1914, *Stenus latifrons* Erichson, 1839, *Stenus ochropus* Kiesenwetter, 1858, *Philonthus pseudoparcus* Brunne, 1976, *Mycetoporus eppelsheimianus* Fagel, 1965 (*brucki* auct. nec Pandelle, 1869), *Philhygra pinegensis* Muona, 1983, *Falagrioma thoracica* (Stephens, 1832), *Gyrophaena transversalis* Strand, 1939, *Placusa suecica* Johnson & Lundberg, 1977, *Cypha suecica* (Palm, 1936), *Ernobius pini* (Sturm, 1837), *Meligethes tristis* Sturm, 1845, *Psammoecus bipunctatus* (Fabricius, 1792), *Enicmus lundbladi* Palm, 1956, *Stilbus atomarius* (Linnaeus, 1767), *Stilbus oblongus* (Erichson, 1845), *Meloe proscarabaeus* Linnaeus, 1758, *Bruchus affinis* Frölich, 1799, *Longitarsus curtus* (Allard, 1860), *Asiorestia transversa* (Marsham, 1802), *Asiorestia interpunctata* (Motschulsky, 1859), *Apion columbinum* Germar, 1817, *Apion melancholicum* Wencker, 1864, *Barynotus moerens* (Fabricius, 1792), *Coeliodes nigritarsis* Hartmann, 1895, *Gymnetron labile* (Herbst, 1795), *Taphrorychus bicolor* (Herbst, 1793). Notes on ecology and distribution in the neighboring countries are given for each of the species. *Ampedus rufipennis* (Stephens, 1830) is deleted as a Norwegian species. Some possible explanations for the continuous addition of new species to the Norwegian fauna are discussed.

Key words: biogeography, Coleoptera, geographical distribution, faunistics, new species in Norway.

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INTRODUCTION

The beetle fauna of Norway is far from completely known. The number of beetle species recorded from Norway has increased from 3091 species in 1961 to 3430 species in 1997 (Bakke 1961, Hanssen et al. 1997). Accordingly, more than 9 new species are registered every year on average (339 species/36 years). The estimated number of Norwegian beetle species is 3800 (Ottesen 1993). This paper summarizes data on 34 beetle species previously not published as new to Norway although some of the species are mentioned in reports or other sources (e.g. Vik 1995, Hanssen et al. 1997, Tømmerås et al. 1997, Hanssen & Hansen 1998, Direktoratet for Naturforvaltning 1999). Data and circumstances around the records in such publications are often hardly available or incomplete. Thus, we find it important to publish separate notes on species new to the country. The material is mostly collected during the last decade. Unless anybody else is mentioned, the identifications of the material are performed by the authors. The nomenclature follows Lawrence & Newton (1995) at family level and Lundberg (1995) at species level.

The following abbreviations are used in the text: BT=Barber trap, WT=Window trap, FØD= Frode Ødegaard, NINA=Norwegian Institute for Nature Research, OHA= Oddvar Hanssen, SLI=Sindre Ligaard, ZMB=Zoological Museum, University of

Bergen, ZMO=Zoological Museum, University of Oslo. Provincial abbreviations follow Økland (1981).

DYTISCIDAE

Hydroporus nigellus Mannerheim, 1853

Ø Hvaler: Asmaløy, Viker (EIS 12), several exx., leg. & coll. SLI. Hvaler: Ørekroken (EIS 12), one ex., leg. & coll. SLI. Fredrikstad: Torsnes (EIS 20), several exx., leg. & coll. SLI. All specimens were collected in coastal rock pools.

The *H. nigellus*-complex was revised by Nilsson (1994). *H. nigellus* is hard to separate from *H. geniculatus,* however, their ecology is very different. While *H. geniculatus* is a common species in temporary pools in higher altitudes (frequently occurring above the tree line), *H. nigellus* is restricted to coastal rock pools with fresh water (Nilsson & Holmen 1995). The species is expected to be more widely distributed in Norway due to the recent clarification of the species complex.

CARABIDAE

Bembidion fumigatum (Duftschmid, 1812)

VE Tjøme: Moutmarka (EIS 19), 29 May 1993, leg. & coll. FØ. One single female was found in a salt marsh at the edge of a pool with rich vegetation.

It is unknown whether the record represents a permanent population or an accidentally introduced specimen. The specimen was found in its natural habitat, a fact that indicates a wider occurrence of the species. However, several collectors have searched for the species at the same locality without luck. On the other hand, the species is now and then collected in wind drift at seashores (Lindroth 1985). One hypothesis is that the Tjøme-specimen has arrived with wind drift and eventually found its natural habitat in the vicinity. This record is mentioned in Hanssen & Hansen (1998) as a representative of a locality of very high conservation value. The species is common and widely distributed in Denmark, but it is only known from the furthest south in Sweden (Sk, Bl) (Lundberg 1995, Hansen 1996). If there are breading populations in Norway, the species has to be considered as vulnerable (Direktoratet for Naturforvaltning 1999).

Dromius linearis (Olivier, 1795)

We can report new records of *Dromius linearis* from several Norwegian localities: **VAY** Lyngdal: Korshavn (EIS 2), 23 July 1992, leg. & coll. SLI & FØD. Two specimens found among dense vegetation in a salt marsh dominated by *Triglochin maritima, Plantago maritima* and grasses (Poaceae). This habitat is not typical for *D. linearis* whose normally occurs in dunes at coast (Lindroth 1986). However, the species apparently reproduce at the locality because ten individuals were found during a revisit in May 1994, leg & coll. SLI. **Ø** Hvaler: Ørekroken (EIS 12), 28 May 1993, leg. FØD. Two specimens found among scattered vegetation in sand dunes. In addition, one specimen was observed at the same locality 9 July 1997 (J. Andersen pers. comm.). **VE** Tjøme: Moutmarka (EIS 19), 7 Sept. 1993, leg. & coll. OHA. **TEY** Kragerø: Stråholmen (EIS 11), June 1993, leg. & coll. OHA. At both localities, several specimens were found by beating stems of *Rumex crispus* on gravelly ground (OHA pers. comm.). One old, record of *D. linearis* is reported from AK Oslo, Tøyen, leg. N. G. Moe (Schøyen 1879). However, this record was considered as uncertain by Th. Münster and A. Strand (Hellén 1939). Regarding the collection of N.G. Moe, see Münster (1923-24, pp. 267-268).

The localities for this species in the Oslofjord-area are of very high conservation value (Hanssen & Hansen 1998). *D. linearis* is common and widespread in Denmark and south Sweden and, thus, the species was expected to occur in Norway. However, it is somewhat remarkable that the species was found at four separate localities during a period of two years. Especially, because some of the localities were very well investigated during the 1980s without any record of this easy traceable species. Therefore, it seems reasonable to propose that the species has expanded its range. If the old report from Tøyen is true, it may indicate a wider range at that time. At a larger temporal scale, the range of the species may fluctuate continuously in accordance with climatic changes.

The present localities should be revisited in order to see if the species has established permanent populations, or if the records only represent temporal fluctuations in the outer margins of its range.

LEIODIDAE

Leiodes inordinata (J.Sahlberg, 1898)

NTI Lierne: Skograudberga (EIS 103), WT 17 July - 21 Aug. 1986, 1 ex., leg. & coll. OHA. The trap was situated in a south faced gap in an old spruce forest. Mosvik: Kilen (EIS 97), BT 1-24 July 1994, 1 ex., leg. NINA, coll. FØD. The trap was situated in an old spruce forest (Tømmerås & Breistein 1995, Tømmerås et al. 1997).

This is one of the most characteristic *Leiodes*-species due to the irregular rows of puncture of the elytra (Strand 1957). In Sweden, the species is distributed in the boreal zone from Värmland and northwards (Lundberg 1995), where the species is normally caught in traps in dense forests (Stig Lundberg pers. comm.). Due to the subterranean way of living, the *Leiodes*-species are rarely collected and most species are probably strongly overlooked. These relations and the fact that the ground fauna of dense forests, such as bilberry woodland, are poorly investigated, makes it reasonable to believe that *L. inordinata* is continuously distributed throughout the Southern and Middle boreal zone in Norway.

Colon pseudolatum Palm, 1941

FI Karasjokk: Anarjåkka (EIS 159), BT July - Aug. 1996, 5 exx., leg. H. Rinden, coll. SLI.

The species belongs to the Northern boreal vegetation zone, where it is found among grass roots on dry, gravelly ground (Palm 1941). The species is known from northern Sweden southwards to Hälsingland and from Finland (Lundberg 1995).

STAPHYLINIDAE

Omalium littorale Kraatz, 1858

VE Tjøme: Hvasser, Sønstegård (EIS 19), BT Aug. 1985, several exx., leg. T. Andersen, coll. SLI. The traps were situated in a salt marsh. **Ø** Hvaler: Ørekroken (EIS 12), 6 June 1995, leg. & coll. SLI. Several individuals collected under wrack beds (sea-weeds) on sandy banks.

O. littorale was earlier considered as a variety of *O. caesum* (Palm 1948), and the status of the species was debated in the 1950s (Palm 1962). Eventually, Lohse (1960) showed that *O. littorale* is a valid species. For identification, see Palm (1962), Freude et al. (1964) or Palm & Lundberg (1993). The species is restricted to wrack beds (Palm 1948) and thus, it is more specialised than its closest relatives. There are scattered records of the species along the Swedish coastline (Lundberg 1995).

Bibloplectus tenebrosus (Reitter, 1880)

AK Nes: Israelsmosen (EIS 37), BT Aug. 1992, 1 ex., leg. & coll. FØD. The trap was situated in an ombrotrophic mire.

In Sweden, there are rather few localities of this species. It dominates in the southern provinces, however, it is recorded as far north as Norrbotten (Lundberg 1995). There is a certain probability that the species have been overlooked in Norway due to the small size and the rather concealed habit. Moreover, mire and fen habitats are not satisfactory investigated regarding invertebrates.

Bibloplectus spinosus Raffray, 1914

Ø Hvaler: Arekilen (EIS 12), 28 May 1993, leg. & coll. FØ & SLI. Two specimens were collected in wet mosses at the shore of an eutrophic pool dominated by *Phragmites*-vegetation.

This record is mentioned in Hanssen & Hansen (1998) as a representative of a locality of very high conservation value and the species is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999). The species was expected to occur in Norway because it is widely distributed in southern parts of Sweden, and it is also known from the adjacent province Värmland (Lundberg 1995).

Stenus latifrons Erichson, 1839

Ø Hvaler: Arekilen (EIS 12), 19 May 1990, 1 ex., leg. & coll. SLI, 28 May 1993, 4 exx., leg. & coll.

FØ, 28 June 1993, several exx., leg. & coll. SLI. All specimens collected at the shore of an eutrophic pool dominated by *Phragmites*-vegetation.

This is the first verified record of this species from Norway. There is a report of *S. latifrons* from NSI, Storjord (leg. Hageman) (Strand 1946). However, this specimen could not be found in any of the Norwegian museums. The report from NSI is probably a mistake and should therefore be omitted (Torstein Kvamme pers. comm.). The records from Arekilen are mentioned in Hanssen & Hansen (1998) as representatives of a locality of very high conservation value. The species is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

Stenus ochropus Kiesenwetter, 1858

TEI Seljord: Heggeneset (EIS 17), BT 8 April - 30 May 1998, 1 ♂ and 1 ♀, BT 25 July - 6 Sept 1998, 1 ♀, leg. & coll. FØD. The traps were put out in steep and open slopes towards the lake, Seljordsvannet.

This record is somewhat surprising because the nearest localities are situated in SE Sweden, where the species is found on dry, sandy or gravelly calcareous soils, often on so called «Alvarmark» (Palm 1961). The hilly topography in Telemark county, causing extremely warm microclimate in the south faced slopes at summertime. In this locality natural stone- and soil-slides keep the locality open and sun exposed. Combined with calcareous soil types, such localities are probably functionally very similar to the areas in SE Sweden. The record of *S. ochropus* is probably another example of relicts from warmer periods in post-glacial time in Norway. The species has to be considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

Philonthus pseudoparcus Brunne, 1976

The describtion of *Philonthus pseudoparcus* is based, among others, on 35 specimens from **AK** Asker: Brønnøya (EIS 28), June 1967, and June 1971, leg. A. Strand (Brunne 1976). However, the species has never been registered as Norwegian in the catalogues on Nordic Coleoptera (Silfverberg 1979, Lundberg 1986, Vik 1991, Silfverberg 1992, Lundberg 1995). Accordingly, this species needs to be added to the Norwegian list of Coleoptera.

Mycetoporus eppelsheimianus Fagel, 1965 (*brucki* auct. nec Pandelle, 1869)

MRI Sunndal: Gravem (EIS 79), WT 2 June - 12 July 1986, 1 ex., leg. & coll. OHA. The trap was situated in a deciduous forest dominated by aspen *(Populus tremula)* in a steep, south-faced slope. **ON** Nord-Fron: Hesteskobakken (EIS 62), 11 July 1988, leg. & coll. FØD, det. J. Muona. One specimen sifted from decaying leaves in an old alder forest. **AK** Asker: Skaugumåsen (EIS 28), WT July 1991, 1 ex., leg. J. Stokland, coll. FØD, det. J. Muona. The trap was situated in a thermophilous, deciduous forest.

The species is normally found among decaying leaves and mosses on the forest-floor (Palm 1966). In Germany, the species is found among decaying leaves at the basis of old oaks, in rotten stumps, and especially in *Polyporus*-fungi (Koch 1989a). It is scattered distributed in southern parts of Scandinavia and evidently rare everywhere (Lundberg 1995, Hansen 1996). The species has to be considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

Philhygra pinegensis Muona, 1983

FØ Sør-Varanger: Nyrudmyra (EIS 160), 8 July 1998, leg. & coll. FØ. One female sifted from drift material washed up after a flood in a small river. The vegetation in the flooded area was dominated by willow thickets *(Salix* spp.), *Betula nana, Carex*-spp and grasses (Poaceae). The locality lies in association with a larger bog-complex in the Øvre-Pasvik area in Finnmark.

This species was described as late as in 1983 after one male from Pinega in NW Russia (Muona 1983). Later, several individuals were found in Oulanka National Park in Kuusamo, Finland (Muona 1995). The female is described by Muona (1995). Due to many independent records the last 20 years, there is reason to believe that the species has expanded its range towards the west recently. On the other hand, range expansions are a rare phenomenon in natural habitats. Accordingly, it will be interesting to see further reports on the species.

Falagrioma thoracica (Stephens, 1832)

TEI Seljord: Heggeneset (EIS 17), BT 30 May - 6 Sept. 1998, ca.100 exx., leg. & coll. FØD. Although the species was abundant throughout the summer, no specimens were caught in the period from 8 April to 30 May, indicating that the species is a summer breeder.

The species is only recorded from Skåne and Gotland in Sweden (Lundberg 1995), although in Denmark it is recorded from most provinces (Hansen 1996). Similar to the present record, Palm (1968) reports that the species often occurs in large numbers. Elsewhere in Scandinavia, the species is mostly collected near the coast under sea-weeds or in plant roots on moist, sandy soils (Hansen 1954, Palm 1968). In this regard, the Telemark-record is very strange. Obviously, its occurrence in Norway has to be seen in association with the relict argument proposed for *Stenus ochropus* (see above). In addition, there are probably unrevealed facts attended with the ecology of the species which tie together the different circumstances of the records. Koch (1989a) reports that the species is hygrophilous in northern parts of its range while thermophilous elsewhere. The species is also found in association with ants (Koch 1989a). The species has to be considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

Gyrophaena transversalis Strand, 1939

STI Melhus: Melhus (EIS 92), 12 April 1992, leg. & coll. FØD. Several specimens were sifted from old, dry leaves of *Tussilago farfara* lying on silty banks of the river Gaula. One specimen was caught at the same locality by car-netting 18 May 1993, leg. & coll. FØD. Several individuals collected by sifting from decaying leaves of *Salix triandra* on silty ground at the same locality 21 April 1996, leg. & coll. OHA. Furthermore, one specimen was found in decaying drift material washed up at the riverside of Gaula at **STI** Melhus: Udduvoll bru, 10 June 1997, leg. & coll. FØD.

The species is new to the Nordic countries, and it was described after 13 specimens collected in Niederösterreich (Strand 1939). Later, it is only recorded from Hamburg, Rheinland in Germany, and from The Czech Republic. The species can easily be identified in Strand (1939). In Central Europe, the species is collected in the fungi *Boletus scaber* (Koch 1989a). The Norwegian specimens were found under decaying leaves on silty ground in the spring, a habitat that probably represents the hibernating site of the population. The species is mentioned in Andersen & Hanssen (1994) as a representative of the rich and peculiar insect fauna along the riversides of Gaula. The species has to be considered as vulnerable in Norway (Direktoratet for Naturforvaltning 1999).

Placusa suecica Johnson & Lundberg, 1977

NTI Mosvik: Kilen (EIS 97), WT June - Sept. 1994 and 1996, 4 exx., leg. NINA, coll. FØD. The traps were situated in an old coniferous forest dominated by Norway spruce (*Picea abies*) (Tømmerås & Breistein 1995, Tømmerås et al. 1997).

In Sweden, the species is collected in window traps around timber-piles (Johnson & Lundberg 1977), and at present, it is recorded from several provinces in Central Sweden (Lundberg 1995). *Placusa*-species are fungivorous in subcortical habitats (Ashe 1991). The biology of *P. suecica* is probably similar to that of congeneric species (Lundberg 1995). The species is apparently rather common and widespread in Scandinavia. Perhaps it was overlooked before window traps became commonly used for collecting swarming insects.

Cypha suecica (Palm, 1936)

Ø Hvaler: Arekilen (EIS 12), 19 May 1990, leg & coll. SLI, and 28 May 1993, leg. & coll. SLI & FØD. Several specimens collected among wet mosses and *Phragmites*-vegetation at the shore of an eutrophic pool.

The distribution of this species in Scandinavia is restricted to central parts of Sweden (Palm 1966, Lundberg 1995). Thus, the Norwegian occurrence of this species is apparently not surprising. However, the species is also recorded in Denmark recently (Hansen et al. 1991). In that regard, it is likely that the species has expanded its range. The record from Arekilen is mentioned in Hanssen & Hansen (1998) as a representative of a locality of very high conservation value. The species is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

ELATERIDAE

Delete *Ampedus rufipennis* (Stephens, 1830)

The only report on this species from Norway is from **TEY** Porsgrunn: Eidanger (EIS 11), leg. Th. Münster, coll. ZMO. This specimen, however, is a misidentified *Ampedus hjorti*, det. FØD 1998. *A. rufipennis* should, therefore, be deleted as a Norwegian species. Consequently, TEY should be added as a new provincial record for *A. hjorti* that also recently is recorded from the same province (Bakke 1999).

PTINIIDAE

Ernobius pini (Sturm, 1837)

Ø Hvaler: Ørekroken (EIS 12), 28 May 1993, leg. & coll. FØD. Three specimens were beaten from Scots pine *(Pinus silvestris)*. The pine-trees grew in scattered stands on open established sand-dunes. The next year several specimens were recorded in pine-cones at the same locality (leg. & coll. SLI).

This record is mentioned in Hanssen & Hansen (1998) as a representative of a locality of very high conservation value. The *Ernobius* species develop in cones or in thin twigs of coniferous trees (Freude et al. 1969). A systematic review of the genus is given by Johnson (1966). In Sweden, the species is found northwards to Dalarna (Lundberg 1995).

NITIDULIDAE

Meligethes tristis Sturm, 1845

AK Bærum: Ostøya (EIS 28), 24 June 1996, leg. & coll. SLI. Bærum: Fornebu (EIS 28), 9 July 1997 and 9 June 1998, leg. & coll. FØD. Oslo: Gressholmen (EIS 28), 18 June 1999, leg. & coll. FØD. Several exx. found at each locality.

This species seems to be obligatory on its host plant, *Echium vulgare,* in the inner parts of Oslofjorden. Since this area is rather good investigated in the first half of this century, it is not reasonable that the species has been overlooked by previous collectors. Probably the species has expanded its range towards the north recently. In southern Sweden the species is common and a new northern limit was reported from Västmanland recently (Erichson 1999). The climatic conditions in these areas are not very different from the localities in Norway, so perhaps the only hurdle for the progress of this species is the distribution of the host plant. Remarkably, *Meligethes planiusculus* (Heer, 1841) another congeneric species associated with *Echium vulgare,* has expanded in Denmark and Sweden recently (Hansen et al. 1992, Erichson 1999). *M. tristis* is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

SILVANIDAE

Psammoecus bipunctatus (Fabricius, 1792)

AK Oslo: Østensjøvann (EIS 28), 15 Aug 1992, leg. & coll. SLI. Several specimens collected among decaying *Phragmites*-straws at the margin of an eutrophic lake. **AK** Vestby: Kjennstjern (EIS 28), 20 Aug. 1996, leg. & coll. SLI. Five specimens collected in swampy vegetation. **Ø** Aremark: Gjølsjø (EIS 21), 14 May 1994, leg. & coll. SLI & FØD. Several specimens collected among decaying *Phragmites*-straws at the margin of a mesotrophic lake.

The records from Østensjøvann and Gjølsjø are mentioned in Hanssen & Hansen (1998) as representatives of a locality of high conservation value. The species is probably associated with decaying *Phragmites* where it is normally found (Hansen 1964). In Sweden, the species is recorded northwards to Värmland (Lundberg 1995).

CORTICARIIDAE

Enicmus lundbladi Palm, 1956

The species is reported from VE in Vik (1995). The details around this record are the following: **VE** Tjøme: Mostranda (EIS 19), 30 June 1985, leg. & coll. SLI. One specimen sweep-netted in shrub-vegetation.

All stages of this species are found in large amounts under the thin outer bark of recently broken trunks of aspen *(Populus tremula)* (Lundberg 1964). The species lives in association with the fungi *Hypoxylon mammatum* (Wg) Millar (Pyrenomycetes) which gives the bark a characteristic black appearance in the point of attack. This may be seen from long distance, and it resembles injuries from fire (Lundberg 1969). There are scattered records of this species in southern parts of Sweden and in Finland (Lundberg 1995). The species is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

PHALACRIDAE

Stilbus atomarius (Linnaeus, 1767)

Ø Råde: Visterflo (EIS 20), 29 Aug. 1992, leg. & coll. SLI. Five specimens collected in very wet vegetation dominated with *Sparganium* spp. at the shore of an eutrophic pool.

Little is known about the biology of *Stilbus*-species but maybe they feed on algae (Koch 1989b). *S. atomarius* is always found in association with freshwater-shore vegetation. Either on grasses, flowers, or in decaying plant material (Koch 1989b). The occurrence of *S. atomarius* in Norway is not surprising, because the species is widespread in southern parts of Sweden. It is also recorded from the Swedish provinces adjacent to SE Norway.

Stilbus oblongus (Erichson, 1845)

VE Tønsberg: Prestrødkilen (EIS 19), 14 Oct. 1984, 1 ex., leg. & coll. OHA. Tjøme: Sunnane (EIS 19), 10 July 1985, 1 ex., and 14. June 1987, 1 ex., both leg. & coll. SLI. Tønsberg: Akersvannet (EIS 19), 14 June 1989, 1 ex., leg. & coll. SLI. Stavern: Lydhusstranda (EIS 19), 24 June 1989, 4 ex., leg. & coll. FØD. Tjøme: Kulebekkilen (EIS 19), 28 July 1992, 1 ex., leg. & coll. FØD. **Ø** Hvaler: Arekilen (EIS 12), 28 May 1993, 1 ex., leg. & coll. FØD. All specimens are found in association with *Phragmites*-vegetation. The many recent records indicate that this species is well established at least in the outer Oslofjord-area. The species is also common and widespread in southern parts of Sweden.

MELOIDAE

Meloe proscarabaeus Linnaeus, 1758

SFI Lærdal: Bjørkum (EIS 51), 5 June 1995, leg. & coll. SLI. One dead specimen collected under a stone in a south faced slope with scattered vegetation cover.

According to Andreas Strand's diary (ZMB), there are uncertain records of *M. proscarabaeus* from TEY Kragerø, leg. E. Berg, Ø Halden, leg. Printz, AK Oslo, leg. Siebke. These records are probably the basic data for the uncertain records from Norway reported in Lindroth (1960). In ZMO, there are three labeled specimens of *M. proscarabaeus,* det. SLI, leg. Siebke, Esmark and Berg, respectively. Specifications of localities are lacking, however. We expect that the specimens of Siebke and Berg are identical with those seen by A. Strand. The uncertainty attended with these records is, therefore, probably due to the lack of locality reports rather than to the identifications. In ZMB, there are three additional specimens of *M. proscarabaeus,* det. OHA, FØD, labeled BØ Modum, leg. N. G. Moe. These specimens are never reported from Norway, and it is hard to know whether they are overlooked or disregarded by former collectors. According to Münster (1923-24, pp. 267-268), several of the specimens collected by N.G. Moe are doubtful, due to insufficient labeling and uncritical mixing of Norwegian and foreign material. Consequently, we choose to consider the specimens from Modum as uncertain. All the uncertain specimens are probably collected during the 19th century due to the main activity periods of these collectors.

The species is known to parasite the bee-species *Anthophora retusa, A. acervorum,* and *Andrena jacobi* (Hansen 1973). *M. proscarabaeus* is recorded from all Danish provinces (Hansen 1996), and northwards to Dalarna in Sweden. The species is considered as vulnerable in Norway (Direktoratet for Naturforvaltning 1999).

CHRYSOMELIDAE

Bruchus affinis Frölich, 1799

Ø Hvaler: Ørekroken (EIS 12), 28 June 1993, leg. SLI, coll. SLI & FØD. Five individuals recorded on *Lathyrus japonicus*. **AK** Asker: Vollen (EIS 28), 26 July 1998, 1 ex., leg. & coll. FØD. One individual sweep-netted in calcareous meadow vegetation. **TEI** Seljord: Heggeneset (EIS 12), 8 July 1997, 30 May 1998, and 25 July 1998, leg. & coll. FØD.

Collected in large amounts in reproductive parts of the host plant at the site, *Lathyrus silvestris*, which was growing in large stands on base-rich soils along a roadside. The locality is south-faced and very warm. *B. affinis* breeds in *Lathyrus* spp. and are probably spreading in Northern Europe (Hansen 1988).

Longitarsus curtus (Allard, 1860)

ON Nord-Fron: Hesteskobakken (EIS 62), 20 July 1994, 1 ex., BT 9 Sept. - 10 Oct. 1998, 2 exx. Sel: Otta, Solgjem (EIS 62), 21 July 1993, 7 exx., leg. & coll. FØD. **SFI** Luster: Ornes (EIS 50), 28 Sept. 1991, 1 ex., 29 May 1992, 1 ex., 15 Sept.1992, 1 ex., leg. & coll. FØD.

The species is oligophag on Boraginaceae, and it is known from *Symphytum* spp., *Pulmonaria* spp. (Koch 1992), and *Mysotis arvensis* (Hansen 1964). In Gudbrandsdalen (ON), we have found the species on *Lappula* sp. in dry meadows on base rich sandy soils.

Asiorestia transversa (Marsham, 1802)

Ø Hvaler (EIS 12), 27 June 1915, 1 ♀, leg. Hanssen, coll. ZMB, det. FØD. **AK** Bærum: Fornebu (EIS 28), 27 July 1998, leg. & coll. FØD. One single female sweep-netted on *Cirsium arvense*.

The preferred host plant of *A. transversa* is *C. arvense*, but the species is also found on *C. oleraceum* and *Carduus acanthoides* (Hansen 1929, Koch 1992). The species is recorded north to Dalarna in Sweden (Lundberg 1995). The Norwegian occurrence of *A. transversa* was, therefore, expected when the Swedish distribution was extrapolated westwards.

Asiorestia interpunctata (Motschulsky, 1859)

AK Fet: Nordre Øyeren (EIS 29), 9 Aug. 1996, leg. & coll. FØD. One ♀ sweep-netted on swampy wetlands dominated by large *Carex* spp. and grasses (Poaceae).

This species was published as new to Norway by Strand (1965), however later, the record was deleted for unknown reasons (Strand 1977). A revision of this specimen showed that it was an *A. transversa* (see above). *A. interpunctata* is not recorded from Sweden (Lundberg 1995), but two recent records are registered from Denmark (Hansen et al. 1992, Hansen et al. 1993). The species is considered as declining, care demanding in Norway (Direktoratet for Naturforvaltning 1999).

BRENTIDAE

Apion columbinum Germar, 1817

TEI Seljord: Heggeneset 8 July 1997, 30 May 1998, 25 July 1998, 6 Sept. 1998, BT 8 April - 30 May, and BT 30 May - 25 July 1998, leg. & coll. FØD. The species was found in large amounts on its host plant, *Lathyrus silvestris*, which occurred in large stands along a roadside on base-rich soils.

In the Nordic countries, *A. columbinum* is monophagous on the host plant and the larvae develop in rolled leaflets (Gønget 1997). The species is very rare and local in Scandinavia, but often abundant where it occurs. The species is known from a few localities in southern Sweden and one locality in Denmark in recent times (Gønget 1997). The species has to be considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

Apion melancholicum Wencker, 1864

TEI Seljord: Heggeneset, 8 July 1997, 30 May 1998, 6 Sept. 1998, leg. & coll. FØD. Found together with *A. columbinum* on the host plant, *Lathyrus silvestris*. Although several specimens were found, *A. melancholicum* was not as numerous as *A. columbinum*.

The species is monophagous on the host plant in the Nordic countries, and the larvae develop in young fruits (Gønget 1997). The distribution pattern and occurrence of this species is very much like that of *A. columbinum*. However, we have seen no report on that the two species occur together. *A. melancholicum* is only known from two Danish (SZ, NWZ) and two Swedish (Sk, Up) provinces (Gønget 1997). The records of these two *Apion*-species confirm the potential of these areas of Norway for inhabiting northern outpost populations of heat-loving species with distribution centers much longer south. The species is considered as declining and care demanding in Norway (Direktoratet for Naturforvaltning 1999).

CURCULIONIDAE

Barynotus moerens (Fabricius, 1792)

HOY Bergen: Sverresborg, Skuteviken, Sandviken (EIS 39), 19 and 22 June 1996, leg. J. Skartveit, coll. ZMB. Two individuals were found among dense vegetation of shrubs and weeds (e.g. *Rubus idaeus, Urtica dioica, Aegopodium podagraria,* and *Anthriscus sylvestris)* in a small park surrounded by close settlements (J. Skartveit pers. comm.). **Ø** Spydeberg: Hemnes (EIS 29), BT Aug. 1996, 1 ex., leg. & coll. SLI. The trap was situated in a small bog close to the lake Lyseren.

The species is polyphagous on different herbs, and it is most commonly recorded in deciduous forests. The adults are active at night and are normally found under stones or at the base of plants at daytime (Palm 1996). *B. moerens* is local and rare in Denmark and southern parts of Sweden (Palm 1996). The species is considered as a declining, monitor species in Norway (Direktoratet for Naturforvaltning 1999).

Coeliodes nigritarsis Hartmann, 1895

STI Oppdal: Nerskogmyra (EIS 86), 13 June 1993, leg. & coll. FØD. Two ♂♂ and one ♀ were sweep-netted among *Salix* spp. *Betula nana,* and *B. pubescens* at the margins of a rich fen. The locality represents one of the largest remaining bog-systems in the middle of Norway. **FN** Nesseby: Rei'kejåkguolba (EIS 176), 7 July 1998, leg. & coll. FØD. One male sweep-netted among *Betula pubescens* and *B. nana*-thickets at the margin of an omprotrophic bog with dominance of *Sphagnum* spp. in wetter parts.

Whilst *C. rubicundus* is a generalist on *Betula* spp. in different habitats, *C. nigritarsis* is restricted to bogs (Heijerman 1993). In Central Europe, the species is monophagous on *Betula pubescens* where the larvae probably develop in female catkins (Koch 1992). The species is recorded northwards to Torne Lappmark in Sweden (Lundberg 1995). A more closely investigation of the bog systems in eastern parts of the country will probably reveal that the species is more widespread in Norway.

Gymnetron labile (Herbst, 1795)

Ø Hvaler: Asmaløy (EIS 12), 21 July 1995, 1 ex., leg. & coll. SLI, primo Aug. 1995, 8 exx., leg. & coll. SLI. The specimens were sweep-netted on *Plantago lanceolata* in a salt marsh.

The species develops in stem galls or in the stem base of *Plantago lanceolata* (Hansen 1965). *G. labile* is recorded in southern Sweden northwards to Bohuslän and Västmanland (Lundberg 1995). The species is considered as a declining, monitor species in Norway (Direktoratet for Naturforvaltning 1999).

Taphrorychus bicolor (Herbst, 1793)

RI Suldal: Lomatjern (EIS 24), WT 24 May - 25 June 1991, 1 ex., leg. J. Stokland, coll. FØ. The trap was situated in a west-faced forest dominated with *Betula pubescens*, but also with occurrences of *Fraxinus exelsior, Sorbus aucuparia,* and *Alnus incana.* **RI** Suldal: Sandvika (EIS 24), WT 25 June - 25 July 1991, 1 ex., leg. J. Stokland, coll. FØ. The trap was situated in woodland dominated by Scots pine *(Pinus silvestris). Betula pubescens* and *Sorbus aucuparia* occurred scattered between the Scots pines. The two localities lie 7 km from each other (Stokland pers. comm.).

The primary host tree of *T. bicolor* is *Fagus silvestris.* However, there are also host records from *Quercus, Populus, Carpinus,* and *Betula* (Hansen 1956, Palm 1959). The host tree of the species in Norway may be *Betula pubescens.* In Sweden, the species is restricted to the south (Lundberg 1995), while in Denmark and in England it is widespread but rare (Hansen 1956). The species probably represents a nemoral element in the Norwegian fauna, and it is considered as a declining, monitor species in Norway (Direktoratet for Naturforvaltning 1999).

DISCUSSION

Most species mentioned in this paper are restricted to areas in the Oslofjord-area in SE Norway. As pointed out in Hanssen & Hansen (1998), this area has the highest species richness of invertebrates in Norway, and many of them live in habitats of restricted range such as old growth forests, sandy seashore habitats, large bogs, and wetlands. The conservation value of these habitats in this area is very high and many of the species and the localities are threatened (Hanssen & Hansen 1998, Direktoratet for Naturforvaltning 1999). A more intensive documentation of the entomological values in these localities during the last decade is a main reason why new beetle species are found in Norway

Many species are obviously overlooked by previous collectors for other reasons. One aspect is that we are more mobile today, and hence, we are able to visit attractive localities that earlier were hardly accessible.

A hilly topography causes warm microclimate in south and west faced slopes in the valleys of southern Norway at summertime. Combined with favorable soil types and scattered growth of trees, such localities may be very similar to certain areas in Denmark and southern Sweden, climatically. Many of these slopes serve as suitable habitats for thermophilous species. The records of *Stenus ochropus, Apion columbinum* and *A. melancholicum* are examples of species that probably have survived in isolated populations since warmer periods in post-glacial time in Norway. Several similar localities in other valleys of southern and western Norway are still not satisfactory investigated. Thus, there are reasons for expecting that more species showing disjunct distribution patterns are present in these areas. Furthermore, new collection methods, especially the window traps, have shown that many species are more abundant than previous collectors did believe. *Leiodes inordinata* and *Placusa suecica* are typical species detected as a result of extensive trapping regimes. In addition, the knowledge of the biology of rare beetle species accumulates. This knowledge makes collectors more selective in their choice of investigation areas and searching methods. There is a series of examples that collectors find rare species after revealing their biology.

Moreover, new species are recorded as results of new systematic knowledge. As complex species groups are revised and clarified, revisions of existing material often add new species to the country. An example of that in this paper is *Philonthus pseudoparcus.* Revisions of complex groups may also stimulate to investigations if the separated species differ from the original ones in their biology. This is probably the reason why we found *Hydroporus nigellus* and *Omalium littorale.*

The composition of the fauna will always be a process of change (Semb-Johannson 1988). Accordingly, many new Norwegian species are found as results of range expansions. There is good evidence that *Meligethes tristis* and *Bruchus affinis* are species whose occurrence in Norway results from a northward dispersal. Many species living in eutrophic freshwater habitats, and especially species associated with *Phragmites australis* and *Typha latifolia,* probably belong to this group. These plant species have expanded their range and have been more abundant in SE Norway during the last decades as freshwater habitats have become more eutrophic (Lid & Lid 1994). The occurrence of *Cypha suecica, Stilbus oblongus, Psammoecus bipunctatus* (in the present paper), and also *Demetrias imperialis* (Lindroth 1973, Hansen 1994), and *Alianta nigella* (Hansen 1994) in Norway, therefore, may be caused by a recent increase in host plant or habitat range.

Many species occur at the outer edge of their distribution range in Norway. It can be expected that the boundary zones of the ranges of such species fluctuate due to e.g. variation in climate. After repeated seasons with favorable climate, some species may expand their range. Eventually, the same species may drop out if climate worsen. Perhaps *Dromius linearis* belongs to this group of species. Several other species reported in this paper are recorded from the Norwegian provinces adjacent to localities in our neighboring countries where the species is present. The Norwegian records of those species may be a result of range fluctuations. On the other hand, they may very well be overlooked previously due to their small and patchy distribution areas in Norway. Random wind dispersal is probably important for the spread of these species. Sometimes we may observe that individuals are blown far away from their area of origin. A likely example of that in the present paper is *Bembidion fumigatum*.

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Hansen, Michael. 1999. World Catalogue of Insects. Volum 2. Hydrophiloidea (s. str.) (Coleoptera). 416 s. Apollo Books, Kirkeby Sand 19, DK-5771 Stenstrup, Denmark. ISBN 87-88757-31-5. DKK 690,- + porto. Ved abonnement på serien gis 10% rabatt.

Det danske forlaget Apollo Books har nå utgitt andre bind i serien med den ambisiøse tittelen World Catalogue of Insects. Denne gangen er det vannkjærene (Hydrophiloidea) som er katalogisert. Forfatteren er den svært produktive danske entomologen Michael Hansen.

Det er meget hyggelig at det igjen er blitt fart i utgivelsene av verdenskataloger på biller. Apollo Books har jo nå utgitt både Hydraenidae og Hydrophiloidea, mens kataloger på Ptiliidae, Cryptophagidae og Cryptocephalinae er under bearbeidelse. Wroclaw, Polen har også nylig utgitt verdenskataloger på gruppene Histeridae og Cassidinae. I disse tider med fokus på global biodiversitet og bevaring av artsmangfold må det sies at grunnleggende oversikter av dette slaget er meget viktige bidrag til fremdriften innen dette enorme fagfeltet.

Verdenskatalogene inneholder basisoversikter over taksonomisk status og utbredelse på global basis for den gruppen som er behandlet. En slik katalog utgjør med andre ord et fundamentalt dokument som kan tjene til inspirasjon og enorm arbeidsbesparelse for alle som vil jobbe videre innen gruppen enten det er snakk om systematiske, økologiske eller rent faunistiske arbeider. Katalogene vil derfor være av interesse for museer og andre vitenskapelige institusjoner over hele verden og er en forutsetning for entomologer som ønsker seg inngående oversikt over bestemte grupper innen større geografiske regioner.

Den forrige fullstendige katalogen over Hydrophiloidea kom ut i 1924. Den gang inneholdt katalogen 1370 kjente arter. Med Michael Hansens katalog er 2803 arter registrert i denne overfamilien, noe som skulle understreke hvor kjærkommen denne katalogen er for den som ønsker å jobbe med vannkjær på regional basis.

Boken har en kort og konsis introduksjon som forklaring til katalogdelen. De nomenklaturiske endringene som er gjort samt en klassifiseringstabell med antall arter i hvert høyere takson (over artsnivå) finnes også i innledningen, noe som er svært nyttig. Selve katalogdelen er basert på inngående studier av hele 2000 vitenskapelige artikler om systematikk hos Hydrophiloidea. Katalogen består av en systematisk liste over alle høyere taksa og alfabetiske lister over alle gyldige arter innen hver slekt. For alle taksa refereres originalbeskrivelsen og for slektsnavnene refereres i tillegg typearten og kjønnet. Artsnavnene refererer typelokalitet, eventuelle lectotyper eller neotyper og referanse til første bruk av ulike kombinasjoner med slektsnavn. Alle synonymer samt de viktigste feilstavinger er listet kronologisk. Et lite minus er at det ikke er nevnt hvor typematerialet for hver enkelt art befinner seg. Slik informasjon hadde vært til stor nytte for taksonomer som har behov for å studere typene. Til slutt, under hvert artsnavn, listes artens nåværende utbredelse på landsbasis innenfor hver biogeografiske region. Når det gjelder store land, som for eksempel Australia, Canada, Kina, Russland og U.S.A er utbredelsen mer detaljert angitt. Etter katalogdelen finnes tre appendix som inneholder lister over 1) fossile arter, 2) nomina nuda, dvs. navn som ikke refererer til synonymer av arter i gruppen, og 3) arter som opprinnelig ble beskrevet under Hydrophiloidea, men som er ekskludert fra denne overfamilien.

En slik grundig revisjon av nomenklaturen innenfor en taksonomisk gruppe innebærer ofte at noen arter må skifte navn. Mange entomologer fortviler over slike navnebytter, men dette er en nødvendighet for å oppnå målsettingen med vitenskapelige navn, nemlig stabilitet, universalitet og unikhet. Trøsten får være at nomenklaturen tross alt konvergerer mot det som virkelig er riktig i følge ICZN (International Code of Zoological Nomenclature), som er regelverket for zoologisk navnsetting. Nytten og kompleksiteten av et slikt «opprenskningsarbeid» synliggjøres om en setter seg inn i det nomenklaturiske virvaret som følger mange av de vanlige artene. Det er ikke uvanlig at en art har mer enn 10 synonymer.

Michael Hansens katalog innebærer tre navneendringer for norske vannkjær i forhold til Silfverbergs Enumeratio fra 1992. *Laccobius biguttatus* Gerhardt, 1877 skal nå hete *L. colon* (Stephens, 1829) pga. prioritetsprinsippet, dvs. at det første publiserte navn skal være gyldig; *Cercyon atricapillus* (Marsham, 1802) skal hete *C. nigriceps* (Marsham, 1802) pga. første revisors prinsipp, dvs. at synonymi skal avgjøres av første revisor hvis navnene er publisert samtidig; *Megasternum obscurum* (Marsham, 1802) skal hete *M. concinnum* (Marsham, 1802) pga. primær homonymi, dvs. at da arten ble beskrevet var det allerede en annen art som hadde samme navn.

Katalogen er ikke helt oppdatert på utbredelse når det gjelder Norge pga. at Silfverbergs Enumeratio fra 1992 er brukt som referanse for norske arter. Etter 1992 har tre nye vannkjær blitt publisert fra Norge, *Helophorus fulgidicollis* (Fauna norv. Ser B 41:45-47), *Helophorus obscurus* (Fauna norv. Ser B 45:79) og *Laccobius colon (L. biguttatus)* (Fauna norv. Ser B 41:45-47). Det kan imidlertid ikke forventes at en katalog av et slikt omfang skal ta hensyn til nasjonale faunistiske artikler. Det er på mange måter mer ryddig å forholde seg til de regionale utbredelseskataloger som referanser i denne sammenhengen.

Prisen på boka har dessverre blitt mer en det dobbelte av bind 1 noe som imidlertid kan forsvares ved at prisen per side faktisk er lavere. Mer enn 700 NKR er sannsynligvis allikevel i overkant av hva den generelt interesserte entomolog vil legge i denne type litteratur.

I sum så er dette et enormt omfattende arbeide av meget høy kvalitet og av stor vitenskapelig verdi som sikkert vil stå som en av de mest sentrale referanser på Hydrophiloidea i mange tiår fremover. Jeg kan derfor bare gratulere Michael Hansen så mye med nok en kjempeflott innsats. All honnør også til Apollo Books som har tatt på seg denne krevende og meget viktige oppgave å publisere verdenskataloger på insekter.

Frode Ødegaard

Norw. J. Entomol. 47, 21-23. 2000

A new species of *Archisotoma* Linnaniemi, 1912 from the Baltic coast of Latvia (Collembola, Isotomidae)

Arne Fjellberg & Edite Jucevica

Fjellberg, A. & Jucevica, E. 2000. A new species of *Archisotoma* Linnaniemi, 1912 from the Baltic coast of Latvia (Collembola, Isotomidae). Norw. J. Entomol. 47, 21-23.

Archisotoma martae sp. n. is described from a sandy seashore habitat near Ventspils, Latvia. The small species resembles *A. theae* Fjellberg, 1980, but is easily identified by an exceptionally strong mucro which is half as long as the dens.

Key words: Collembola, Isotomidae, *Archisotoma martae* sp.n., Latvia.

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INTRODUCTION

The genus *Archisotoma* has a worldwide distribution with about 20 species in marine littoral habitats. The larger species are active on the surface and may sometimes be observed in huge numbers on mudflats and rocky shores at low tide. The smaller species are interstitial among sand and gravel, and some may live in sandy beach meadows well above the high tide mark (Thibaud & Christian 1997). The present paper reports a new species which was detected among sand on the Baltic coast of Latvia.

Archisotoma martae Fjellberg & Jucevica, sp. n.

Type material: Holotype. Female (slide) from «Latvia. Ventspils. 27.VI.1998. In gravel at seashore. E. Paulina leg.», deposited at Natural History Museum, Department of Entomology, London. Paratypes. 15+2 specimens (2 slides) together with holotype, 4+4 specimens (in 2 slides) at Institute of Biology, University of Latvia, Salaspils.

Etymology. We dedicate our new species to Mrs. Marta Paulina, the mother of the second author.

DESCRIPTION

Size of reproductive adults 0.5 mm. Colour diffusely brownish gray, eyespots black. Ocelli 8+8, of which two are smaller. PAO elongate, about 3 times longer than nearest ocellus (Figure 1H). Body slender, of tubular shape, extremities short. Mouth cone prominent, swollen. Body hairs short, without differentiated macrochaetae. Integument with small sharp granules, appearing like sandpaper at high magnification. Antennae with a normal set of sensilla. Ant.1 with 13 setae. Labrum with 5-5-4 setae, the two anterior rows set near apex. Frontoclypeal field with 2 prelaral setae only (Figure 1E). Maxillary outer lobe with simple palp and 4 sublobal setae which are set close together in a bundle. Maxillae long and narrow (Figure 1G). Capitulum is reduced to a small hook-like tooth, and 5 lamellae are recognised. The longest lamella bears a row of strong cilia along its dorsal edge and a row of very thin cilia along the ventral edge, in addition to some fine ciliation near apex. A broad, almost smooth lamella is located ventrally to the longest lamella. Two very short lamellae, one with fine marginal ciliation - the other almost smooth, are situated near the hook-like tooth. Proximally to these there is a small membraneous

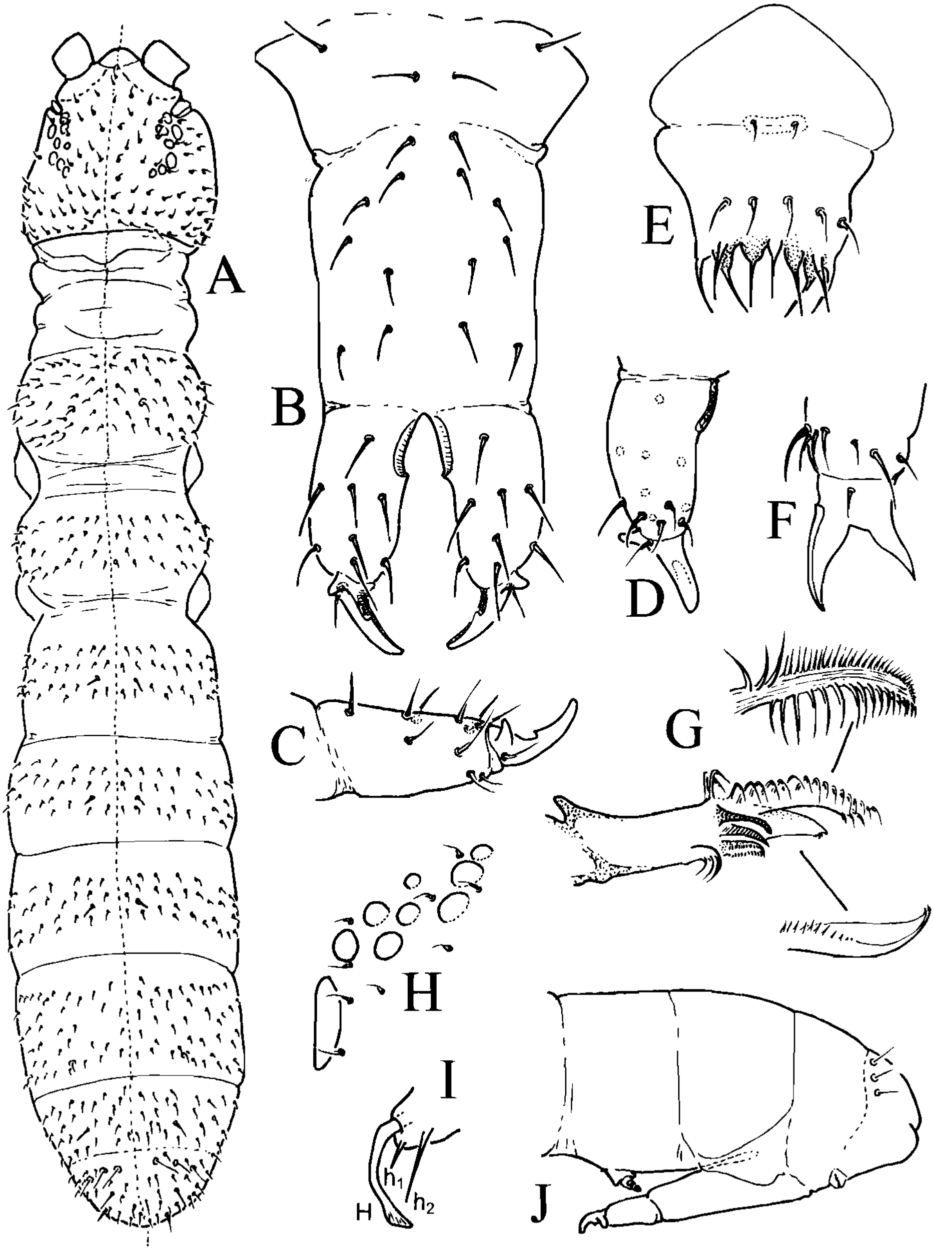

Figure 1. *Archisotoma martae* sp. n. A. General chaetotaxy; B. Furca, dorsal view; C. Left dens and mucro, lateral view; D. Right dens and mucro, ventral view; E. Labrum and frontoclypeal field, prelabral setae encircled; F. Claw and tip of right tibiotarsus 3; G. Dorsal side of left maxilla, with alternative views of the two longest lamellae; H. Left eyefield with PAO; I. Labial hooks (hypostomal setae); J. Abdominal segments 3-6, profile.

lamella with a few long serrations. Mandibles normal, with strong molar plate and 3-4 apical teeth. The labial palp is not analysed in detail, but appears normal for the genus (Fjellberg 1999). Proximal field with 3 setae only. Labial hooks (hypostomal setae, H) strongly curved, apically flattened (Figure 1I). Basomedian field of labium with 4 setae, basolateral with 5. Head with 4 postlabial setae on each side along the ventral line. Dorsal chaetotaxy as Figure 1A. Head with 3-4 unpaired median setae in anterior part. Abd.1-3 with 3+3 axial setae. Sensilla hardly differentiated from ordinary setae, except a lateral sensillum on Th.2 and a pair of dorsomedian sensilla on Abd.4. Abd.6 bears 3+3 erect dorsomedian sensilla (Figure 1J). Ventral setae absent on thorax. Ventral tube with 4+4 distal (lateral) setae. Furca as Figure 1B-D. Dens short, with 8 dorsal setae and 4 ventral ones in apical part only. Mucro strongly developed, incurved, about half as long as dens. The inner basal tooth appears as a small hook in the middle of the dorsal edge. Lateral seta present. Retinaculum with 4+4 teeth, no seta on corpus. Tibiotarsi with 9 or 10 setae in the apical whorl. Tib.1 and 3 with a curved, thickened dorsoapical seta in assymmetric position. Femur of last pair of legs with an apical fleshy spur. Claws short, unarmed (Figure 1F).

DISCUSSION

The new species is very similar to *A. theae* Fjellberg, 1980, which differs by having only 6 dorsal setae on dens and a smaller mucro which lacks the lateral seta. The exceptionally large mucro, being half as long as dens, immediately identifies *A. martae* from all other species of the genus.

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Mitostoma chrysomelas (Hermann, 1804) (Opilionida, Nemastomatidae), a harvestman new to Norway

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Olsen K.M. 2000. *Mitostoma chrysomelas* (Hermann, 1804) (Opilionida, Nemastomatidae), a harvestman new to Norway. Norw. J. Entomol. 47, 24.

The opilionid *Mitostoma chrysomelas* has on two occasions been collected at a locality in Engalsvik in Østfold county, Norway. Both adult and juvenile specimens were present.

Key words: *Mitostoma chrysomelas*, Opilionida, Norway.

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It has now been some years since last time a new harvestman was reported from Norway, viz *Trogulus tricarinatus* (L., 1767), discovered by Solhøy (1982). Stol (1993) proposed to exclude *Opilio parietinus* (De Geer, 1778) from the Norwegian list, but as Olsen (1995 and unpubl.) has demonstrated, the species has been found on several occasions in later years, and this leaves the statements by Strand (1900) reasonably credible. Sixteen species of harvestmen have so far been published from Norway (Stol 1993).

Mitosoma chrysomelas (Hermann, 1804) has so far been collected from a single locality in Norway, viz. Engalsvik, Fredrikstad, Østfold county, UTM(WGS84) 32V NL991695 (EIS 19). One juvenile was collected on 18 April 1996 and two specimens (1 juv., 1 adult ♂) on 7 June 1998. The finding site is close to sea level, and strongly influenced by human activity.

M. chrysomelas is easily separated from other Norwegian species: it is a member of the Nemastomatidae, with no pedipalpal claw and capitate setae on the long pedipalpae, and it has silvery or golden spots on the abdomen. Adults also have rows of distinct bifid or trifid tubercles on the cephalothorax and tergites. The species is present in many European countries, including Denmark and Sweden (Meinertz 1964, Roewer 1911).

Acknowledgements. The juvenile specimen from 1996 was sent to Jürgen Gruber in Austria, who kindly verified my determination.

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Acid rain and the disappearance of the Apollo butterfly (*Parnassius apollo* (L., 1758)) from coastal areas in Norway

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Gogstad, G.O. 2000. Acid rain and the disappearance of the Apollo butterfly (*Parnassius apollo* (L., 1758)) from coastal areas in Norway. Norw. J. Entomol. 47, 25-28.

Sedum maximum, the major host plant for lowland *Parnassius apollo*, was sampled from current and previous locations for the Apollo, and pH was measured after suspending the plants in deionised water. The plants were generally 0.3-0.5 pH-units more acidic in current than in previous Apollo-locations. Also, the buffer capacity of the plants was measured by titration with HCl-solution. The buffer capacity increased from June to September, probably reflecting accumulation of organic material, and hence the nutritional value of the plants. The buffer capacity developed considerably more throughout the summer in plants from current Apollo locations, than in plants from previous coastal Apollo locations and locations near Oslo. A correlation between buffer capacity of the host plants, and the current appearance of Apollo is thus indicated. Since the lowest pH and highest buffer capacity is found at current Apollo locations, the study indicates that other explanations than acid rain should be sought to explain Apollo's retraction to inland locations. More local factors may have influenced on the nutritional value of *Sedum maximum* and thus caused Apollo's disappearance.

Key words: *Parnassius apollo, Sedum maximum*, acid rain .

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INTRODUCTION

The population of the Apollo butterfly (*Parnassius apollo* (L., 1758)) was gradually reduced from the early 1900's in the coastal regions in Southern Norway. At about 1960, but no later than 1970, the butterfly had totally disappeared from these districts (Opheim 1969, Bakke 1975). Apollo has, however, a stable and may be also increasing population in inner districts of Norway (Hansen 1993). A similar situation is found in Sweden where Apollo disappeared from most coastal locations from 1900 to 1970. (Nordstrøm 1955, Janzon and Bignert 1979, Henriksen & Kreutzer 1982). One remarkable exception from Sweden is the frequent appearance of Apollo at Gotland.

Numerous causes for the disappearance of Apollo have been suggested: parasites, infectious agents, cat attacks, traffic related destruction, pesticides, butterfly collectors, lack of host plants, chemical pollution, and acid rain (Bengtsson 1989), as well as climate changes, agricultural and forestry activities/expansion, and human activities (Hansen 1993).

The most frequently mentioned cause for the reduction of the Apollo population, is acid rain, although there also are many contradictions to this hypothesis (Hansen 1993). Acid rain may cause liberation of toxic aluminium from the rocks and soil (NIVA 1998, 1999), which in turn may influence on the survival of the caterpillars. We have measured the pH in Apollo's host plant *Sedum maximum* from various districts of southern Norway throughout 1998 and 1999 in order to investigate this possibility.

MATERIALS AND METHODS

Sedum maximum, was sampled from previous and current Apollo locations in August 1998, and from

June to September 1999. The coastal collection sites where Apollo have been previously reported were Sandefjord (VE) (appearance of Apollo as late as 1959 (Sverre Sandberg, personal communication)), and Engelsviken in Fredrikstad community, (Ø) (assumed previous location). Host plants were also collected from Maridalen, Oslo (AK) which is assumed to be a previous location, since Apollo was regarded as common in the Oslo district until about 1920 (Hansen 1993). Collections were also made from Begnadalen in Sør-Aurdal community (OS), which is another previous inland Apollo location and assumed to still have populations (Hansen 1993). Examinations from Begnadalen to Bagn in August 1998 and 1999 did not, however, result in any observations. The collection sites from current Apollo locations were Flå and Nesbyen in Hallingdal (BV), and one collection from Kviteseid (TEI) was also made.

Each collection included three different plants at each date and location. All samples were kept frozen at -20°C until analysed.

Analyses were performed by adding 10.0 g of leafs to 200 mL of de-ionised water produced by a MilliQ system. The water had no detectable buffer capacity upon addition of 0.1 mol/L HCl. The leafs were suspended in the water using a Warren Blendor until a homogenous mixture with no major particles or fibres were left.

The pH was measured using a Hanna HI 8417 pH-meter, after adjustment with standard buffer solutions of pH 4.00 and 7.00.

The suspensions were also examined for buffer capacity by titration with 1.0 mL portions of 0.1 mol/L HCl. Plant material is expected to buffer added H^{+}-ions. The pH-values will therefore differ from the values obtained when the same amount of acid is added to water. The differences between pH in plant suspension added acid, and the expected pH if the same amount of HCl was added to a non-buffering system, were collected as a measure of buffer capacity.

RESULTS

Table 1 shows the pH in suspensions of *Sedum maximum* from various locations. The pH values from plants sampled at the same location on the same date showed negligible variations (0.03 pH units or less) and are not listed separately. The values obtained with plants from the two coastal locations and from Maridalen, Oslo, all demonstrated higher pH than in the plants from the inland location of Flå and Nesbyen, and from Kviteseid. Thus, plants from current Apollo locations were generally more acidic than plants from non-Apollo-locations. The values obtained from Sør-Aurdal resembled the values from the other inland locations. The pH showed some variations over time (June-Sept) in the year 1999. However, the general tendency throughout the year was that the pH was 0.3 to 0.5 units lower at current Apollo-locations.

To investigate the plant's buffer capacity, the suspensions were titrated with 0.1 mol/L HCl. The results are shown in Table 2.

The plants collected in June demonstrated a markedly lower buffer capacity than plants collected later in the summer. It is also seen that plants from the current Apollo locations in Flå and Nesbyen, and Kviteseid, as well as from the inland location in Sør-Aurdal, developed a better buffer capacity during the summer than the plants from the other locations. The plants from Maridalen, Oslo, demonstrated the lowest buffer capacity. The plants from Sandefjord demonstrated values in between those from inland and from Maridalen, Oslo.

A further observation was that some of the plant suspensions changed from a green to a strikingly red colour when titrated below a pH of about 3.0. There is, however, not possible to see any relation with this colour shift and collection date, pH, buffer capacity, or the presence of Apollo.

DISCUSSION

This study shows that the pH in *Sedum maximum* is more acidic at current Apollo locations than at locations from which Apollo has disappeared.

The study also indicate a relation with respect to buffer capacity in *Sedum maximum*, and the presence of Apollo, in various districts investigated. Since the buffering substances in biological material are dominated by proteins, phospholipids,

Table 1. pH in suspensions of *Sedum maximum* collected from various locations in Southern Norway 1998-1999. Each value is the average from three individual plants.

Period	Hallingdal	Sandefjord	Maridalen	Fredrikstad	Sør-Aurdal	Kviteseid
Aug. 1998	5.51	5.85	6.18	5.81	5.43	–
Jun. 1999	5.65	5.93	5.66	–	5.45	–
Jul. 1999	5.55	5.82	5.88	–	5.34	5.45
Aug. 1999	5.48	5.78	5.92	5.85	5.28	–
Sept. 1999	5.53	5.83	6.08	–	5.38	–
Average	**5.54**	**5.82**	**5.94**	**5.83**	**5.36**	**5.45**

Table 2. Buffer capacity in suspensions of *Sedum maximum* collected from various locations in Southern Norway. Buffer capacity is measured as the difference in pH of 200 mL plant suspensions containing 10g leaf material, after addition of 1 mL 1 mol/L HCl, and the value calculated if the same amount of HCl was added to a non-buffering system.

Period	Hallingdal	Sandefjord	Maridalen	Fredrikstad	Sør -Aurdal	Kviteseid
Aug. 1998	0.76	0.78	0.49	0.44	0.82	–
Jun. 1999	0.41	0.38	0.15	–	0.39	–
Jul. 1999	1.05	0.65	0.23	–	0.97	1.02
Aug. 1999	1.33	0.82	0.34	0.41	1.17	–
Sept. 1999	1.45	1.14	0.38	–	1.32	–

and certain glycans, the buffer capacity also reflects the contents of nutrients per volume of the plant leafs. Since the plants' buffer capacity were found to increase throughout the year, this appear to reflect an accumulation of organic substances.

The pH in the plants is reflected by three factors: 1) the pH in the precipitation, 2) the buffer capacity of the ground, and 3) the buffer capacity of the plants. Acid rain will liberate toxic aluminium ions which may be absorbed by the plants. The exposure of host plants to aluminium ions will be directly dependent on the amount of H^+-ions exposed to the ground, and the ground's buffer capacity.

Direct measurement of host plant pH does not alone justify conclusions related to various levels of aluminium toxicity. However, since the most acidic plants also show the highest buffer capacity, this total picture indicates that they have been exposed to more H^+-ions, and hence more toxic aluminium ions than the plants with higher pH.

A lower pH does not in itself seem to have any influence on Apollo caterpillars since the pH is generally lower in districts were Apollo is currently found. The variations in observed pH is at the level of 0.3-0.5 pH units, which in a biological context is a quite large difference. However, the variation in the plants' buffer capacity, and thus the plants' contents of organic material correlates to the presence of Apollo, and may be the factor critical to survival of Apollo caterpillars.

Some factor may have influenced on *Sedum maximum's* ability to accumulate organic material, and this factor may be the basic cause of Apollo's retraction from coastal districts of Norway. This factor has apparently not influenced on the plants' survival since they are flourishing and widespread at all the location investigated, as well as over large parts of the southern Norway.

Acid rain is a decreasing, but still quite abundant environmental problem. (NIVA 1998, 1999). This study can not totally exclude that acid rain is the long term cause for the effects on *Sedum maxi-*

mum. Conditions in previous periods may as well have been different from the short observation period in this study. Studies on distribution of acid rain in Norway also show that the coastal regions of Southern Norway are most heavily exposed, and that acidity in rain gradually decreases in the northern direction (NIVA 1998, 1999). It is, however, remarkable that Apollo also has disappeared in coastal regions with calcified, buffering ground (Hansen 1993), and that Apollo is frequently found at Gotland which suffers hard from acid rain from eastern Europe. These observations together with the present study thus leaves us with an apparent negative conclusion to the theory that acid rain is the major cause of Apollo's disappearance.

What other potential causes should be sought? As pointed out by Hansen (1993), it is less likely that traffic, butterfly collectors, or agricultural or forestry activities causing fauna changes, are of any significance. We certainly agree to Hansen's arguments. It may be added that if traffic death was a major cause, it should be more abundant at the current inland locations with heavy summer traffic at the roads, and closely located railways, than in the far less trafficked coastal locations. It has also been described that Apollo caterpillars prefer the reddish version of *Sedum maximum*, and that this could be linked to a critical factor for Apollo's survival (Langer 1963). Our studies did not, however reveal any correlation between red coloured plant and pH, nor between red coloured plants and buffer capacity.

It is striking that all current Apollo locations are more scarcely populated than the locations from which Apollo has disappeared. It is also striking that Apollo seems to have disappeared in parallel with development of modern industry and oil heating systems. The lowest buffer capacity we found in *Sedum maximum* was from Maridalen, close to Oslo, and from Engelsviken, close to the cities in Østfold. Both places have high degree of pollution from industry and other human activities. Thus, other pollutants having a more local effect may also be involved in the disappearance of Apollo. Since air and water pollutants have been reduced considerably over the last decade (NIVA 1998, 1999), it is possible that coastal *Sedum maximum* may regain its potential to serve as qualified food for the Apollo caterpillars.

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Saproxylic beetles (Coleoptera) of Troms and western Finnmark, northern Norway with exceptional distribution in Fennoscandia

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Andersen, J., Olberg, S. & Haugen, L. 2000. Saproxylic beetles (Coleoptera) of Troms and western Finnmark, northern Norway with exceptional distribution in Fennoscandia. Norw. J. Entomol. 47, 29-40.

Saproxylic beetle species in Troms and western Finnmark generally have a continuous distribution in Fennoscandia or their occurrences are more closely connected with the distribution in Finland and/or Sweden than in the rest of Norway. Six species constitute notable exceptions to this general pattern. Among these *Scaphisoma boleti*, *Enicmus lundbladi* and *Corticaria pineti* are southern or eastern species with isolated, northern occurrences in continental parts of Troms and western Finnmark (Dividalen, Målselvdalen, Alta). *Orthocis festivus* is more or less continuously distributed throughout Norway north to Troms, whereas *Hapalarea vilis* and *H. ioptera* are distributed in coastal areas of the country. These three species have a southern distribution or are absent in Sweden and/or Finland, except for a find of *H. ioptera* in northern Finland. The reasons for these distributional patterns are discussed. *C. pineti* is reported for the first time from Norway.

Key words: saproxylic beetles, Coleoptera, distribution in Troms and Finnmark.

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INTRODUCTION

Approximately 260 obligatorily saproxylic beetle species (live beneath bark, in wood, or in tree-inhabiting fungi of debilitated or dead trees) have been recorded in Troms and western Finnmark in northern Norway (Lindroth 1960, Strand 1946, 1970, 1977, Vik 1995, Huse 1997, Haugen 1999, S. Olberg & J. Andersen unpublished data). Nearly all of them are confined to, or may use birch (*Betula pubescens* Ehr., incl. *B. tortuosa* (Ledeb.) Nyman) and/or pine (*Pinus sylvestris* L.) as hosts directly or indirectly (via tree-inhabiting fungi). Birch invaded Scandinavia soon after the Weichsel glaciation and was later followed by pine. Pine colonized Troms and western Finnmark from the S and SE, birch also from the E and NE (Gjærevoll 1992). These tree species are now distributed through most of Fennoscandia (Hultén 1971, Lid 1985) and many of the beetle species confined to them also have a more or less continuous distribution within the area.

However, although most of the saproxylic beetle species of Troms and western Finnmark also are present in South Norway, relatively few species have been recorded in Nordland county, and several have not been found in the counties of Trøndelag (ST, NT) (Huse 1997). These apparent disjunctions in Norway may be due to insufficient investigations in the areas of concern, but for a number of species the break is thought to be real (Huse 1997).

Most of the current species have a much more continuous distribution in Finland and/or Sweden. The occurrences in Troms and western Finnmark seem often to be more closely connected with those in Lule Lapmark (Lu) and/or Torne Lapmark (To) in Sweden or Lapponia Enontekiensis (Le) in Finland as is the case for Enicmus rugosus (Herbst)

Figure 1. The distribution of *Enicmus rugosus* in Fennoscandia. Specific localities are only mapped for northern Norway: TRI Skibotn (Leg. S. Olberg); FØ Øvre Pasvik (Leg. S. Olberg & J. Andersen).

(Figure 1). It is likely that such species invaded Troms and western Finnmark from Finland and/or Sweden. However, some of the saproxylic beetle species present in Troms and western Finnmark have a distribution in Fennoscandia which deviates remarkably from the usual pattern. These cases are presented and discussed in the present paper which is part of a work dealing with the ecology and distribution of saproxylic beetles in northern Norway.

METHODS

Information about the distribution of the species was taken from Lysholm (1937), Strand (1946, 1953, 1961, 1977), Hansen (1964), Lindroth (1960), Johnson (1967), Lucht (1987), Bíly & Mehl (1989), Vik (1995) and Lundberg (1995). O. Hanssen, S. Ligaard, H. Rinden and F. Ødegaard provided additional, unpublished information concerning the occurrence of species in various parts of Norway whereas H. Silfverberg gave us information about their distribution in Finland. Our own investigations (reported with collector) have mainly been made at several localities in **TRI** Dividalen (EIS 147) and around **TRY** Tromsø (EIS 162, 163) using various collecting methods, e. g. catching with window traps and billet traps, rearing from sporocarps of fungi (Huse 1997, Brattli et al. 1998, Fossli & Andersen 1998), picking by hand and sieving. These investigations were conducted in 1994-1999. In May and June 1999, a

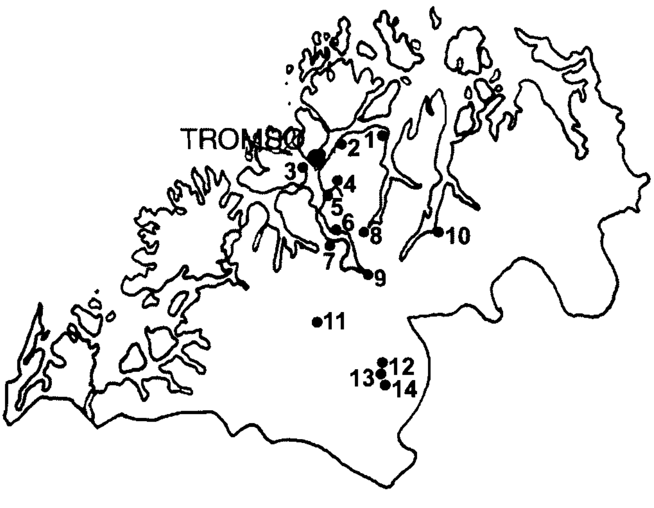

Figure 2. Map of Troms showing the localities where the occurrence of the fungus *Stereum rugosum* was investigated. 1. Oldervikdalen; 2. Tønsvika; 3. Håkøybotn; 4. Andersdal; 5. Breivikeidet; 6. Svartnes; 7. Middagsbukt; 8. Laksvatn; 9. Nordkjosbotn; 10. Skibotn; 11. Rundhaug; 12. Dividalen, loc. 1; 13. Dividalen, loc. 2; 14. Dividalen, loc. 3.

special survey of the occurrence of the fungus *Stereum rugosum* (Pers.: Fr.) Fr. (Corticiaceae), which is a host of *Orthocis festivus* (Gyllenhal), was made at a number of localities in Troms county from the coast in the NW of the county to the inland areas in SE (Figure 2). All dead, standing or lying logs (> 10 cm in diameter at the base) of *Alnus incana* (L.) Moench and *Betula pubescens* were examined for occurrence of this fungus species. The size of the areas varied, but at least 50 dead logs of *A. incana* were examined at each locality. At places where *S. rugosum* had not previously been looked for, samples were collected and examined for beetles in the laboratory according to the procedure of Fossli & Andersen (1998).

Investigations were made at Frihetsli in Dividalen in May, June and October 1999 to unveil the habitat (host) selection of *Enicmus lundbladi* Palm. Stems of dead, standing or lying logs of deciduous tree species (*B. pubescens*, *A. incana*, *Salix* spp., *Sorbus aucuparia* L.) - with or without visible infections of various types of fungi - were examined. The bark, sometimes also the wood, was loosened and thoroughly sifted through Reitter sieves (ca. 5.5 mm mesh size). The fine fractions of the sifted material were examined in the laboratory under 5 or 10 X magnification.

For most of the species we have only mapped specific localities for the counties of Trøndelag and northern Norway. The province division is according to Økland (1981) whereas the nomenclature of the species follows Lundberg (1995). New records according to the district division of Økland (1981) are marked with an asterisk. Some species present in Troms have their northernmost known occurrences in Sweden in the district Norrbotten (Nb). These species may, in fact, have rather isolated occurrences in Troms, but since it is unknown to us where they have been found in the very large district Nb (between lat. 65 and 68.5 ° N) we have not treated these species in further detail.

We have omitted introduced species and species that are doubtfully established in the areas of concern.

THE SPECIES

Hapalaraea vilis (Erichson)

Distribution in Fennoscandia (Figure 3): Distribution in Troms: **TRY** Måkeskjær (EIS 170); Tromsø (EIS 162); Tønsvika (EIS 162), leg. J. Andersen, Oldervikdalen (EIS 163), leg. J. Andersen. Nearest records in Norway: **NNV** Melbu (EIS 137), Bø (EIS 143) and **NSI** Mosjøen (EIS 118). Nearest record in Sweden: Södermanland (Sö) (Lundberg 1995). Not reported from Finland (Lundberg 1995). Widely distributed, but rare in Denmark (Hansen 1964). Total distribution: Large parts of Europe eastwards to Poland, Tunisia, Algeria, Asia Minor, Tbilisi, Yerevan (Strand 1961, Lucht 1987).

Ecology. The individuals from Oldervikdalen were collected in window traps whereas the two specimens from Tønsvika were found under the bark of a standing, rotten stem of *Alnus incana*. Although Koch (1989a) reported *H. vilis* from compost and in burrows of rodents, the species seems to be obligate saproxylic, at least in Scandinavia

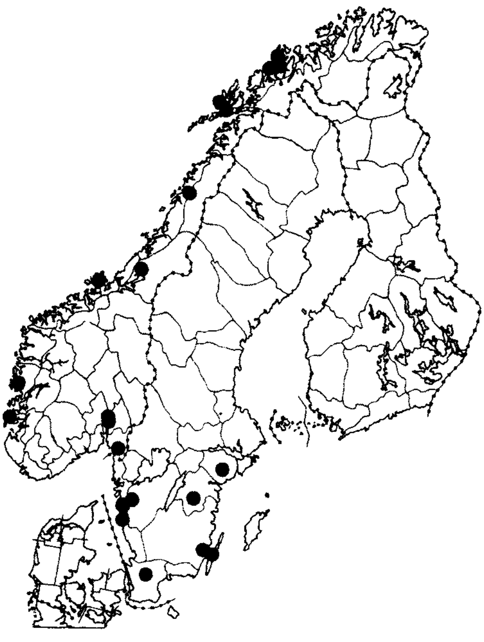

Figure 3. The distribution of *Hapalarea vilis* in Fennoscandia. The map gives specific localities.

(Strand 1946). It is found beneath bark or moss of deciduous trees as well as conifers (Hansen 1964, Koch 1989a), according to Strand (1946) also beneath bark of bushes.

H. ioptera (Stephens)

Distribution in Fennoscandia (Figure 4): Distribution in Troms: **TRY** Oksfjorddal (172); ***TRI** Svartnes (EIS 162), leg. J. Andersen. Nearest record in Norway: **NNV** Melbu (EIS 137). Nearest record in Sweden: Jämtland (Jä) (Lundberg 1995). Nearest record in Finland: Lapponia inarensis (Li). Also recorded in the district Lps which now belongs to Russia (Lindroth 1960). Distributed throughout Denmark (Hansen 1964).

Ecology. A single specimen was collected under the bark of a rotten, standing stem of *Alnus incana* infected with *Stereum rugosum* at Svartnes. It was found together with *Orthocis festivus*. According to Strand (1946), Palm (1959) and Koch (1989a) the species lives beneath the bark of deciduous trees as well as conifers, and on tree-inhabiting fungi. *H. ioptera* also visits flowers (Hansen 1964).

Scaphisoma boleti (Panzer)

Distributon in Fennoscandia (Figure 5): Distribution in northern Norway: **TRI** Rundhaug (EIS 154). **FV** Mattisdalen, Alta (EIS 173), leg. H. Rinden. Nearest record in Norway: **STI**. Nearest record in Sweden: Ångermanland (Ång) (Lundberg 1995). Nearest record in Finland: Ostrobottnia kajanensis (Ok) (Silfverberg in lit.). Distributed throughout Denmark (Hansen 1964).

Ecology. Although Koch (1989a) mentioned an occurrence in *Sphagnum*, information from Scandinavia indicates that the species is obligate saproxylic (Strand 1946, Palm 1959, Hansen 1968). As the other members of the family, *S. boleti* is mycetophagous, but it is probably catholic as regards host selection (Palm 1959).

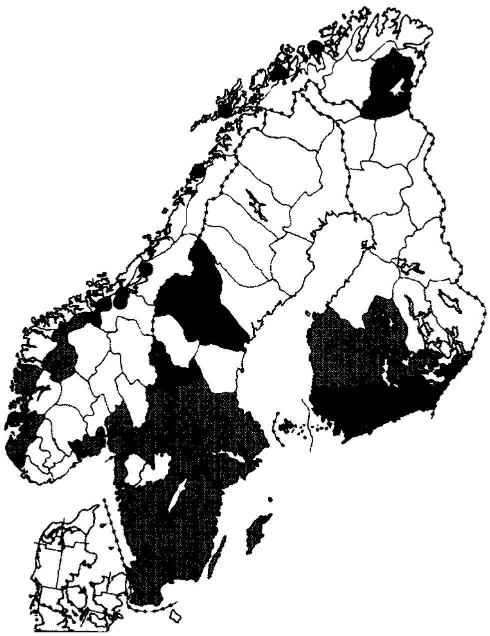

Figure 4. The distribution of *Hapalarea ioptera* in Fennoscandia. Specific localities are only mapped for Sør-Trøndelag, Nord-Trøndelag and Northern Norway.

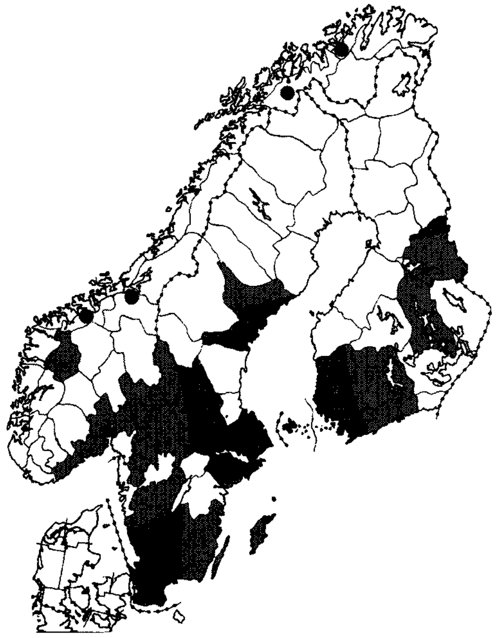

Figure 5. The distribution of *Scaphisoma boleti* in Fennoscandia. Specific localities are only mapped for Møre, Sør-Trøndelag and Troms.

Enicmus lundbladi Palm

Distribution in Fennoscandia (Figure 6): Distribution in northern Norway: ***TRI** Dividalen, Frihetsli and 3 km N of Frihetsli (EIS 147), leg. L. Haugen and J. Andersen. In Norway otherwise only known from **VE** Tjøme (EIS 19). Nearest record in Sweden: Ång (Lundberg 1995). Only recorded in southernmost part of Finland: Nylandia (N) and Tavastia australis (Ta) (Silfverberg in lit.). The species has not been reported from other neighbouring countries, nor in Central Europe.

Ecology. Fourteen specimens were collected in window traps in Dividalen. A majority of them were found at Frihetsli. The locality is situated in a SW-W-facing slope in the valley. The area is forested with *Alnus incana*, *Betula pubescens*, *Salix* spp., and *Sorbus aucuparia*. The soil at the site was moist or wet and had a luxuriant herbaceous vegetation. The forest contained much dead logs infected with various species of fungi such as *Stereum hirsutum* (Willd.: Fr.) Gray, *Plicatura nivea* (Fr.) Karst., several species of Polyporaceae and mycelia of unidentified species.

According to Lundberg (1964, 1969) *E. lundbladi* lives beneath the bark of aspen (*Populus tremula* L.) infected with the imperfect stage of the fungus *Hypoxylon mammatum* (Wahlenb.) J. H. Mill. (= *Entoleuca mammatum* (Wahlenb.) J. D. Rogers & Y.- M. Ju) (Ascomycetes, Xylariaceae). However, aspen was not observed at the localities of concern in Dividalen and the imperfect stage of *H. mammatum* has not yet been found in Norway (A. Granmo pers. comm.). Imperfect stages of other more or less closely related taxa occur on various species of deciduous trees in northern Norway (A. Granmo pers. comm.) so there is a possibility that one of them may be the host of *E. lundbladi* in Troms. However, despite our repeated investigations in Dividalen, we have not been able to find *E. lundbladi* associated with its host. In any event, it is quite obvious that the host selection of the species is different in Troms than further south. We find it unlikely, however, that the

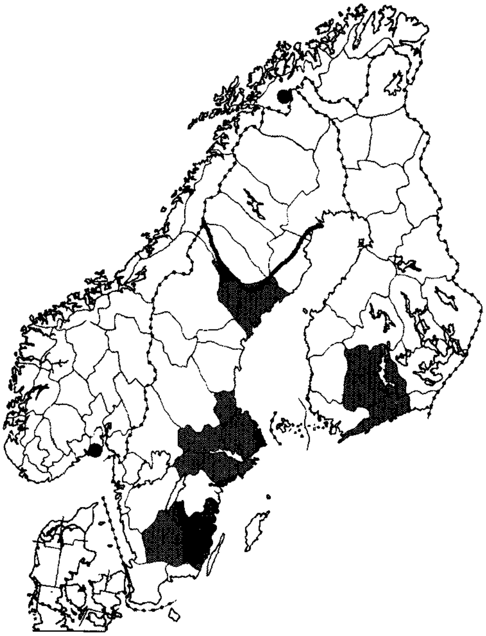

Figure 6. The distribution of *Enicmus lundbladi* in Fennoscandia. Specific localities are mapped for Norway. The approximate -11° C isotherme for January (period 1961-90) in Sweden is drawn, based on Alexandersson et al. (1996). For winter temperatures of Troms and Finmark see Table 2.

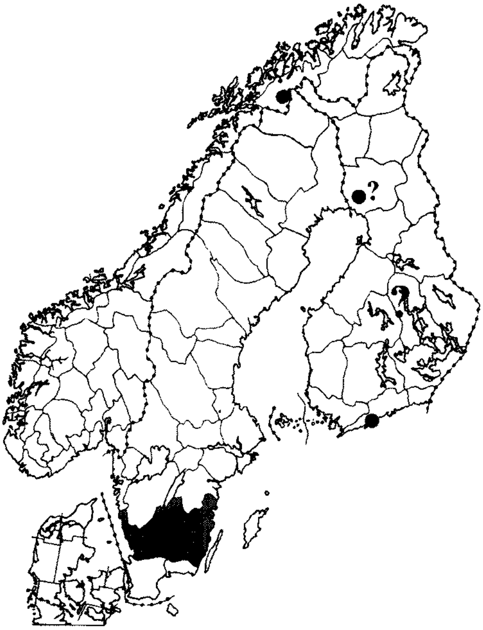

Figure 7. The distribution of *Corticaria pineti* in Fennoscandia. Specific locality is mapped for Norway.

species should be confined to a single fungus species with an isolated occurrence in Troms.

Corticaria pineti Lohse

Distribution in Fennoscandia (Figure 7): Distribution in northern Norway: ***TRI** Dividalen, 3 km N of Frihetsli (EIS 147), 18 August 1997, 1 ♂, leg. J. Andersen. Not recorded elsewhere in Norway. Distribution in Sweden: Halland (Ha), Småland (Sm) (Lundberg 1995). Distribution in Finland: Nylandia: Helsinki and a few places in the north (ObN: Rovaniemi?, details unpublished) (Silfverberg in lit.). Not reported from Denmark. In Central Europe reported from Germany and Austria.

Ecology. The specimen collected in Dividalen was found by sifting old, dry wood of trunks of pine on the ground, infected with the resupinate polypore *Antrodia xantha.* (Fr.) Ryvarden. *C. pineti* was found together with numerous specimens of *Rhyncolus ater* (L.). The rather open forest at the site was of a primeval type with many fallen logs of pine and some dead, standing or fallen logs of birch. The locality is situated in a SW-facing slope in the valley. According to Koch (1989b) *C. pineti* lives on twigs, in heaps of bark etc. of pine, which suggests that the species is independent of *A. xantha*, at least in Central Europe.

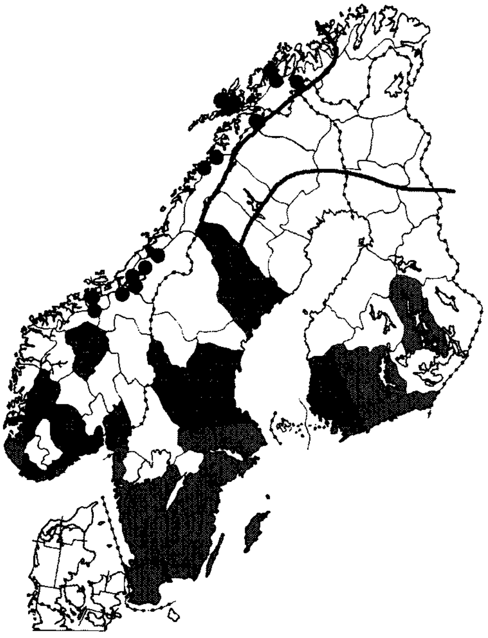

Figure 8. The distribution of *Orthocis festivus* in Fennoscandia. Specific localities are only mapped for Central (MRI, STI, NTI) and northern Norway. The lines show the approximate northern (Finland, Sweden) and eastern (Norway) limit for common occurrence of *Alnus incana* (Hultén 1971).

Orthocis festivus (Gyllenhal)

Distribution in Fennoscandia (Figure 8): *O. festivus* has neither been found in the coastal districts nor in the most continental parts of Troms, whereas it is common in the central fjord districts of the county: ***TRI** Four localities in Balsfjord (Middagsbukt, Sandøyra and Lakselvbukt (EIS 154); Svartnes (EIS 162), leg. S. Olberg & J. Andersen for all localities. Skibotn (EIS 155), leg. J. Andersen. Nearest records in Norway: **NNV** Sortlandseidet (EIS 144), leg. J. Andersen. Erikstadfjord (EIS 138), Bø (EIS 143): ***NNØ** Skjomen (EIS 139,140, leg. T. E. Fossli. Nearest records in Sweden: Ång and Åsele Lapmark (Ås) (Lundberg 1995). Nearest record in Finland: Savonia borealis (Sb) (Lindroth 1960). Distributed throughout Denmark (Hansen1964).

Ecology. In Nordland and Troms the species has been found along brooks, small rivers or on S-facing slopes in forests dominated by *Alnus incana* and *Salix* spp. It has been collected exclusively in *Stereum rugosum* on *Alnus incana* at the localities in Balsfjord, Bø and Skjomen. In South Norway (**AK** Oslo) we have found *O. festivus* scattered in *Stereum hirsutum* on birch and in *S. sanguinolentum* (Alb. et Schw. ex Fr.) Fr. on spruce (*Picea abies* (L.) Karst.) although the species was most abundant in *S. rugosum*. There was no indication of reproduction (occurrence of larvae, pupae or tenerals) in *S. hirsutum* or *S. sanguinolentum* whereas larvae have frequently been found in *S. rugosum*. It is likely, therefore, that *S. rugosum* is the preferred host as stated by Koch (1989b); see also Hansen (1964). Table 1 gives the results of registrations of *Stereum rugosum* at a number of localities in Troms county from NW to SE. The data indicate that *S. rugosum* is much more common on *Alnus* than on *Betula* within the area. Furthermore, whereas the fungus is quite common at the coast and in central fjord districts, it occurs very scatterly in the innermost parts of the fjords and in the valleys of the county.

DISCUSSION

Reliability of the distribution pattern

There is a seemingly weak break in the distribution of *Orthocis festivus* between Troms/northermost Nordland and the occurrences further south in Fennoscandia (Figure 8). It is likely, however, that the species is more continuously distributed throughout Norway since Nordland is incompletely investigated. The present known distribution of *Hapalarea vilis* in Fennoscandia is very scattered (Figure 3), but it is probably more continuous since coastal parts of Norway are incompletely investigated. The species is supposed to be limited to the west- and south coast of Norway, SE Norway and the southernmost parts of Sweden. It is also likely that *H. ioptera* is more continuously distributed in western parts of Norway for the same reason. Since parts of Norway are insufficiently investigated it is likely that the rest of the species may also be found in other districts in the country. However, Sweden and parts of northern Finland are so well investigated that we regard the distributional gaps in S-SE to be reliable.

Causes of the distribution pattern of the species

Species mainly with western distributions

The fennoscandian distribution of *Orthocis festivus* is probably linked to the presence of *Alnus incana*, the host of *Stereum rugosum* in which the beetle lives. Our investigations indicate that *S. rugosum* has a strong preference for *A. incana* in Troms (Table 1), and, since this also is the case in northern Sweden (Strid 1975, Ryman & Holmåsen 1992) it is probable that it applies to northern Fennoscandia in general. Solheim (1979) reported *S. rugosum* to be common in Dividalen. Our data (Table 1), as well as those of Iversen (1997) indicate, however, that *S. rugosum* is rare or absent in continental parts (innermost fjord districts and the valleys) of Troms although *A. incana* is common

Table 1. Per cent logs of *Alnus incana* and *Betula pubescens* infected with *Stereum rugosum* (S) along a transect from the coast to inland in Troms county (see Figure 2). Occurrence of *Orthocis festivus* (O) on *S. rugosum* (per cent logs with infection of *O. festivus* of total number infected with *S. rugosum*) and of *Dryocoetes alni* (D.a.) on *A. incana* is also given. N= no. of logs.

			Alnus incana		Presence		*Betula pubescens*	
Areas	Locality	N	%(S)	%(O)	of D.a.	N	%(S)	%(O)
Coast	1. Oldervikdalen	145	9.7	0	+	68	2.9	0
	2. Tønsvika	98	14.3	0	+			
	3. Håkøybotn	56	16.1	0	+	15	0	
	4. Andersdal	80	17.5	0	+	3	0	
	5. Breivikeidet	78	14.1	0	?	73	0	
Fjord	6. Svartnes	95	14.7	+	+	3	0	
	7. Middagsbukt	139	18.7	84.6*	+	30	0	
	8. Laksvatn	136	7.4	100	?			
	9. Nordkjosbotn	100	2.0	0	?			
	10. Skibotn	139	1.4	0	+			
Inland	11. Rundhaug	113	0.9	0	+			
	12. Dividalen loc.1	162	0	-	+	44	0	
	13. Dividalen loc.2	52	0	-	+			
	14. Dividalen loc.3	107	0.9	0	+			
Mean	1,3,4,5,7,9		14.8**				1.0**	

* Data from Fossli & Andersen (1998)

** Difference in infection rate significant ($p < 0.01$; $\chi^2_{(1)} = 10.55$)

within the same areas. In accordance with Eriksson et al. (1984) and Ryman & Holmåsen (1992) we therefore conclude that *S. rugosum* must be rare in the continental parts of northernmost Sweden and Finland especially because *A. incana* is weakly represented or nearly absent within a large part of that area (Figure 8). Since it is uncertain whether *O. festivus* is able to establish successfully in species of Corticiaceae other than *S. rugosum*, there is a possibility that the distributional gap of the beetle in continental parts of northern Fennoscandia in part is due to the scarcity or absence of a suitable host there.

Other beetles (*Epuraea longiclavis* Sjöberg, *Dryocoetes alni* (Georg)) as well as fungi (*Plicatura nivea*) which are associated with *A. incana* (Lekander et al. 1977, Eriksson et al. 1981, Koch 1989b, Ryman & Holmåsen 1992, Audisio 1993) also have distributional gaps or are scatterly distributed in northern Sweden. As for *O. festivus*, this may be explained by absence or scarcity of their host.

The distribution of *Hapalarea vilis*, *H. ioptera*, *Scaphisoma boleti*, *Enicmus lundbladi*, and *Corticaria pineti* can not be explained by means of their host selection since they either are poorly host specific or the host (*Pinus sylvestris*) of the species is distributed throughout most of Fennoscandia. Some reservations may be taken for *E. lundbladi* since its host in Troms is unknown.

Strand (1946) and Lindroth (1949) proposed that *H. vilis* survived the Weichsel Glaciation on refugia in western Norway. However, ice-free areas had an arctic climate during the Weichsel maximum and were consequently uninhabitable for trees (Vorren et al. 1988, Alm & Birks 1991, Dahl 1992). Since *H. vilis* mainly lives beneath bark of trees, it is unlikely that it survived the last glaciation on refugia in western Norway. Contrary to the opinion of Strand (1946) and Lindroth (1949) we find that *H. vilis* has a subatlantic distribution matching that of some species of plants (e. g. *Carex pulicaris* L.) and terrestrial snail species (e. g. *Arion ater* (L.)) (Dahl 1950, Hultén 1971, Kerney & Cameron 1979). *H. vilis* is absent in continental parts of Europe (E and NE of Poland) which, among others, are characterized by low winter temperatures (see e. g. Fig. 11 in Dahl 1998). There are indications that poikilothermic animals may be excluded from continental areas due to low temperatures during the coldest part of the year (Andersen & Halvorsen 1984, Ødegaard 1994). Potential habitats (beneath bark of standing or fallen trees) of *H. vilis* in continental areas would frequently be uncovered by snow because of low precipitation in the winter months (Førland 1993). Consequently, such habitats would have temperatures close to those of the air, although temperature conditions in dense stands are dampened in comparison with those on open ground (Munn 1966). It is therefore possible that *H. vilis* is excluded from continental areas due to very low winter temperatures.

H. vilis most probably immigrated to Scandinavia from the S and SW, as did several other species previously regarded as Weichsel Glaciation survivors (see Coope 1969), and spread along the coast of Norway.

The distribution pattern of *H. ioptera* in Fennoscandia is enigmatic. The species avoids areas with a markedly continental climate in most of its range. However, the occurrence of the species in the districts Li and Lps may break this pattern. Although generally low, winter temperatures vary from locality to locality within these districts, so it is uncertain whether the absence of the species further south in Finland and Sweden is due to too low winter temperatures.

Southern or southeastern species

S. boleti, *E. lundbladi*, *C. pineti* and *M. linearis* probably immigrated to Troms and western Finnmark from Sweden and/or Finland. Like these species, the southern, tree-inhabiting fungi *Ceriporia purpurea* (Fr.) Donk, *Dichomitus campestris* (Quél.) Dom. & Orlicz, *Stereum subtomentosum* Pouzar and *Steccherinum ochraceum* (Pers.: Fr.) S. F. Gray also occur isolated in the valleys and/or fjords of Troms and/or Finnmark (Ryvarden 1971, 1976, Eriksson et al. 1981, 1984, Solheim 1979, Olofsson 1996, Iversen 1997). Thus, isolated occurrences of southern or southeastern species in northernmost Norway may have some biogeographic generality.

There are two features which may partially explain the isolations of the beetles: 1) Continental parts of Troms and the fjord districts of Finnmark have higher ambient summer temperatures than the coastal districts and appreciably higher ambient winter temperatures than northern Sweden and Finland (Table 2). Only in the coastal districts of the Gulf of Bothnia south of about 65° N are winter as well as summer temperatures higher than in the current areas in northern Norway (Table 2, Figure 6, see also Dahl 1998). Furthermore, the meteorological stations at Øverbygd and Bardufoss are situated in the bottom of valleys. Winter temperatures are higher on the side of valleys than in the bottom (see 2) below). Since the beetles of concern are saproxylic and live on or in stubs or standing or lying trees, it is likely that they would be frequently exposed to temperatures close to the ambient temperature in the most continental areas of Fennoscandia (see former discussion). Tenow & Nilssen (1990) demonstrated that the differences between the winter climate of the fjord districts of Finnmark and the areas further south and east may be of great importance for insects hibernating above the snow cover. Several soil-dwelling terrestrial snail and slug species are also absent in this northfennoscandian «cold center». Such species are e. g. *Columella aspera* Waldén, *Clausilia bidentata* (Strøm), *Limax marginatus* (Müller), *L. tenellus* (Müller) and *Arianta arbustorum* (L.) (Kerney & Cameron 1979, Andersen 1982, Andersen & Halvorsen 1984). 2) North Norway has a high topographic relief whereas the terrain becomes successively flatter from the Norway-Sweden border to the Gulf of Bothnia. In Dividalen *E. lundbladi* and *C. pineti* were found on SW-facing sides of the valley. S and SW-facing slopes have favourable microclimates with a higher minimum and daytime temperature than

Table 2. Climatological data from meteorological stations in northernmost Norway and Sweden. Data are from the period 1961-1990 and are taken from Aune (1993), Førland (1993), Alexandersson et al. (1996). Tc: mean temperature in coldest month; Tw: mean temperature in July.

Area	Station	Tc °C	Tw °C	Precipitation (mm) May-August
Troms, coast	Torsvåg	-1.1	10.8	206
	Sommarøy, Senja	-1.9	11.9	245
	Tromsø	-4.4	11.8	266
Troms, inland	Dividalen	-9.4	12.8	147
	Bardufoss	-10.4	13.0	182
	Øverbygd	-10.2	13.2	207
Finmark, fjords	Alta	-9.0	13.5	157
	Banak	-10.0	12.7	164
Finmark, inland	Kautokeino	-16.1	12.4	185
	Karasjok	-17.1	13.1	194
	Pasvik	-15.4	13.7	191
Sweden, northernmost part	Abisko	-11.7	11.3	134
	Karesuando	-16.0	12.8	208
	Kiruna	-13.8	12.1	240
	Kvikkjok	-15.2	12.6	262
	Jokkmokk	-16.6	14.2	235
	Pajala	-14.8	14.1	225
Coast of Gulf of Bothnia	Haparanda	-12.1	15.4	187
	Luleå	-11.5	15.5	185
	Piteå	-11.0	16.0	190
	Umeå	-9.1	15.2	218

N-facing slopes and flat areas, e. g. bottom of valleys. The former may therefore support a thermophilic fauna and flora (Krogerus 1960, Geiger 1965, Munn 1966, Hultén 1971, Andersen & Hanssen 1989, Voisin 1990). In addition, low precipitation in summer (May-August) in the current areas (Table 2) may also contribute to a favourable microclimate since sparse rainfall means less wetting and, consequently, reduced cooling of the substrate.

Thus, in continental parts of Troms and the fjords of Finnmark, comparatively favourable microclimate in summer and moderately low winter temperatures may constitute an unique combination within an area which otherwise either has low summer temperatures or very low winter temperatures.

What has been proposed here may partly be tested experimentally. The cold hardiness (e. g. supercooling point) of *H. vilis*, *S. boleti*, *E. lundbladi* and *M. linearis* should be tested with that of more or less close relatives which occur in the most continental parts of Fennoscandia, for instance *Hapalarea linearis* (Zetterstedt), *Scaphisoma subalpinum* Reitter and *Enicmus fungicola* Thomson. Furthermore, studies of cold hardiness and further investigations of host selection of *O. festivus* should be made. A comparable species might be *O. alni* (Gyllenhal) which is distributed throughout Fennoscandia. More studies of most of the species in the field are needed.

CONCLUSION

Six saproxylic species of Troms and western Finnmark have exceptional distributions in Fennoscandia. Three of them have their main distribution in the western part of this area. *Orthocis festivus* may be absent in northern Sweden and Finland because of scarcity/absence of the host, *Stereum rugosum* there. *Hapalarea vilis*, which has an atlantic distribution, may avoid continental areas due to susceptibility to low winter temperatures. The distribution pattern of *H. ioptera* is enigmatic. The isolated northern occurrences of *Scaphisoma boleti*, *Enicmus lundbladi* and *Corticaria pineti* in the fjords of western Finnmark and/or continental parts of Troms may be explained by these areas having comparatively favourable summer climate in combination with only moderately low winter temperatures.

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A review of the terrestrial and freshwater invertebrate fauna of the High Arctic archipelago of Svalbard

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The terrestrial and freshwater invertebrates of Svalbard (Spitsbergen) are reviewed. In order to provide as complete an overview of the invertebrate fauna as possible this article is not restricted solely to the Insecta, but includes the phyla Rhizopoda, Rotifera, Tardigrada, Nematoda, Annelida, Crustacea and also the classes Collembola and Arachnida. Population densities and dynamics, as well as physiological responses to the high arctic environment, are discussed. Species diversity is poor on Svalbard by comparison with other arctic regions. It is suggested that this is due to a combination of the extreme isolation of the archipelago, the high Arctic climate and the ecologically young age of the ecosystem. The distribution of the invertebrate species throughout the islands is dependent on factors such as microclimate, vegetation, bed rock and water quality. The majority of the invertebrate species have wide circumpolar distributions and there are few endemics. The four principle methods of dispersal to islands; i) wind currents (and frontal systems), ii) oceanic currents (drift wood etc.), iii) animal vectors and iv) human introductions, are discussed with relation to the current Svalbard fauna. The inhabitation of glacial refugia on Svalbard during the last glaciation is considered.

Key words: invertebrate, Svalbard, Spitsbergen, dispersal, Arctic.

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INTRODUCTION

Svalbard is a High Arctic archipelago situated between 74°N to 81°N and 10°E to 35°E. The islands have an area of approximately 63,000 km^2, 60% of which is permanently covered by ice or snow (Hisdal 1985, Mangerud & Svendsen 1992). The climate of Svalbard is unusually mild despite the high latitude location due to the warming influences of the Atlantic current and southerly air streams (Hisdal 1985, Mangerud & Svendsen 1992, Fogg 1998, Danks 1999). This, combined with the geographic isolation of the islands, has resulted in a faunal assemblage that is quite distinct from other arctic regions. This article which is based on the checklist of Coulson & Refseth (in press) presents the most complete overview of the invertebrate species and ecology since Sømme (1979) and highlights key aspects of this fauna.

Such an overview is required due to the rapidly increasing number of known species, the abundance of synonyms in the literature and the rising number of invertebrate ecological and ecophysiological studies being undertaken on Svalbard (for example Leinaas & Ambrose 1992, Strathdee et al. 1993a, Hertzberg et al. 1994, Holmstrup & Sømme 1998, Hobæk & Weider 1999, Sømme & Birkemoe 1999, Coulson et al., in press). Some of the first collections of insect from the region of Svalbard were taken in 1836 (Boheman 1865 in Sømme (1993)) and by 1930 some 300 species of

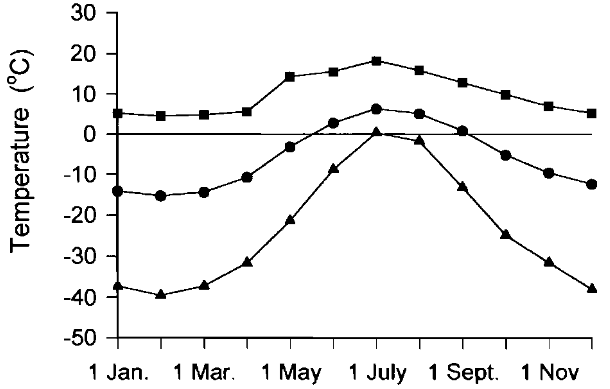

Figure 1. Mean 30 year monthly air temperatures (1957-76) at Longyearbyen airport (●), maximum monthly air temperatures (■) and minimum monthly air temperatures (▲) during the same period. (Data from Førland et al. 1997b).

terrestrial or freshwater invertebrate known from Svalbard (Thor 1930). This number has since grown to 1040 (Coulson & Refseth, in press). This is however, far from being a complete description of the actual total number of invertebrate species present due to i) the majority of collections have been made at, or in the vicinity of, only three locations on the west coast of Spitsbergen (Longyearbyen, Ny-Ålesund and Hornsund; but see for example Summerhayes & Elton 1928, Dastych 1985, Fjellberg 1997, Hauge & Sømme 1997 for exceptions), ii) the likelihood of a bias towards those species easily identified to the detriment of those species difficult to collect and/or identify, iii) concentration on those taxa that have caught the interest of arctic taxonomists, and iv) misidentifications, confusion over synonyms and inconsistency in reference works.

This article seeks to provide a general overview of the invertebrate species assemblage found on Svalbard, discuss unusual aspects of this fauna and present possible explanations for species presence and absence.

Physical features of Svalbard

Climate

The summer period is short and only four months have positive mean air temperatures (Figure 1). Mean normal summer air temperatures in the warmest months (July and August) are in the order of 4 to 5°C (Førland et al. 1997b) but on rare occasions much higher peak temperatures have been recorded, for example 21.3°C at Svalbard airport (Longyearbyen) in July 1979 (Førland et al. 1997b). The upper soil layers are typically thawed for only three months, mid-June to mid-September, (Coulson et al. 1995) with a total temperature sum of between 200 to 400 degree days by late August (Coulson et al. 1993). Soil temperatures are partially dependent on air temperature but also on insolation (Coulson et al. 1993). Temperatures in the upper 3 cm are often above 10°C (Coulson et al. 1993) while temperatures above 20°C in the soil surface/vegetation interface are not uncommon and can peak at over 30°C (Coulson et al. 1993, Hodkinson et al. 1996b, Coulson, Leinaas & Ims, unpub. data).

Mean winter air temperatures on the west coast of Svalbard are seldom below -20°C (Figure 1) and soil temperatures are typically between -5 and -20°C (Coulson et al. 1995, Coulson et al., in press). This is partly due to the warm West Spitsbergen current (>3°C), a northwards extension of the North Atlantic Drift, flowing up the west coast (Fogg 1998) (Figure 2), but in addition, the passage of low pressure weather systems over Svalbard also transport large volumes of comparatively warm air from more southerly latitudes (Hisdal 1985). By comparison, mean winter air temperatures in Greenland are below -30°C for several months each year (Fogg 1998). Minimum winter soil temperatures on Svalbard are dependent on the depth of the snow cover but typically vary from -30°C (no snow cover) to -5°C (snow cover) (Coulson et al. 1995, in press). The period of the

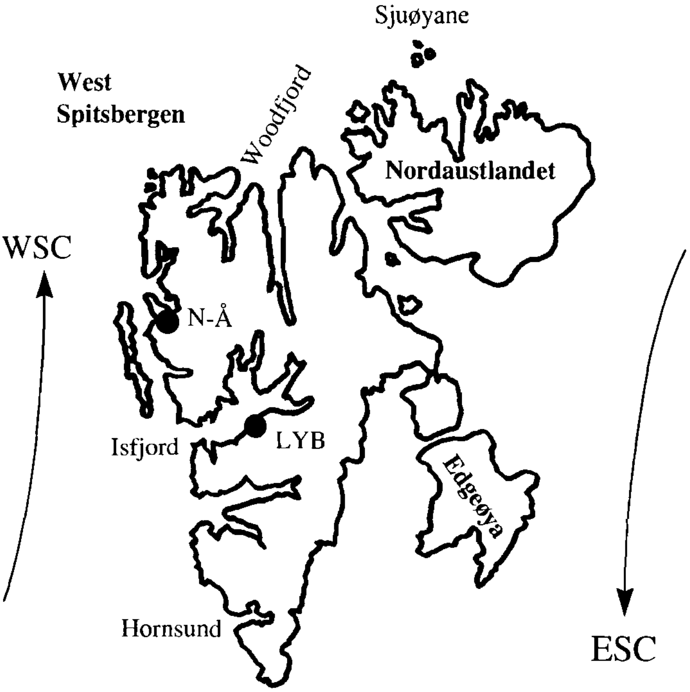

Figure 2. Map of Svalbard with the ocean currents marked and positions of the three principal study areas, Longyearbyen (LYB), Ny-Ålesund (N-Å) and Hornsund indicated. WSC = West Spitsbergen current, ESC = East Spitsbergen current.

midnight sun is from mid-April to late August (Hisdal 1985). The east coast of Svalbard is colder by virtue of a cold southerly flowing current that originates in the Russian arctic as the Transpolar Drift (Fogg 1998). Mean monthly summer air temperatures along the east coast are between 1.5 to 2.5 deg. C lower than on the west coast (Hisdal 1998).

Precipitation in the arctic is generally low (Førland et al. 1997b). On the west coast of Svalbard annual precipitation is between 190 mm and 480 mm (at Svalbard airport and Isfjord Radio respectively). Note the large local variation in precipitation. Isfjord Radio is only 50 km distant from Svalbard airport. Large differences can also occur on a more local scale. Førland (et al. 1997a) measured 60% greater precipitation on the Austre Brøggerbreen (East Brøgger glacier) than at the settlement of Ny-Ålesund only 2.5 km distant. Such differences have implications for soil moisture contents, temperature and vegetation type with consequent effects on the distribution of the invertebrate fauna.

Vegetation, soils and water quality

Although 2885 species of plants, algae, fungi and cyanobacteria are known from Svalbard (Elvebakk & Prestrud 1996) much of the coastal region can be described as either polar semi-desert or tundra heath type vegetation assemblages. The polar semi-desert is characterised by large areas of bare soil and or stones with a thin surface covering of cyanobacteria and lichens with vascular plants such as *Dryas octopetala*. Organic soils are thin, often less than 1 cm thick. Such habitats are typical of well drained glacial moraines (Coulson et al. 1993). In contrast, the tundra heaths are often moister with a better developed organic soil up to 10 cm in depth. Vascular plants such as *Cassiope tetragona* are emergent through a layer of moss (often *Racomitrium* spp.) (Coulson et al. 1993). In low lying poorly drained areas there is often a thick layer of cold wet moss. For instance, beneath the Stuphallet bird cliffs the moss layer is ca. 10 cm thick (Cooper 1996).

The majority of the mineral soils are gravels formed from eroded glacial moraine during the recent Quaternary. Sand and clays are only found in the river valleys (Hjelle 1993). The active layer is thin, often about 1.5 m in depth, over a permafrost which extends to a depth of between 100 to 460 m (Hjelle 1993). Periglacial landforms such as solifluction lobes, rock glaciers and sorted ground are common.

INVERTEBRATE TAXA

Phylum Rhizopoda

The testate amoebae are represented by 190 species on Svalbard (Table 1) inhabiting aquatic, moss and soil habitats (Beyens et al 1986a,b, Balik 1994). By comparison with more temperate regions this is a low total and is comprised largely of cosmopolitan species (Beyens et al 1986a, b, Beyens & Chardez 1995, Beyens & Chardez 1997), with the genus *Centropyxis* dominating (Beyens & Chardez 1995). Note however the greater species richness of Svalbard compared to some Antarctic island groups (Balik 1994). Chardez & Beyens (1987) comment on both the low species number and low diversity indices of samples from Edgeøya. This they attribute to the extreme high arctic conditions and the fact that the samples came from a wet moss habitat which represents the most favourable habitat available.

Table 1. Number of freshwater and terrestrial invertebrate species from Svalbard and including the number of insect families from Svalbard and Greenland. (*dubious record, Jørgensen and Eie (1993), **total includes the dubious ephemeropteran).

Phyla	Class	Order	Total number of species on Svalbard
Rhizopoda			190
Actinopoda			3
Ciliophora			6
Apicomplexa			1
Rotifera			153
Gastrotricha			1
Nematoda			108
Platyhelminthes			8
Annelida			34
Tardigrada			83
Chelicerata	Arachnida	Acari	116
		Araneae	18
Mandibulata	Collembola		59
	Insecta	Anoplura	2
		Hemiptera	4
		Mallophaga	37
		Dictuoptera	0
		Dermaptera	0
		Coleoptera	19
		Diptera	128
		Lepidoptera	11
		Hymenoptera	26
		Siphonaptera	2
		Trichoptera	1
		Ephemeroptera	*1
Crustacea	Branchiopoda		9
	Copepoda		10
	Malacostraca		9
	Ostracoda		2
		Total	****1040**

Phylum Rotifera

A total 153 species of Rotifera have been recorded from Svalbard (Table 1). Studying *Keratella quadrata* Amrén, (1964) found that the animals from Svalbard had a higher specific metabolism than temperate strains. The metabolism of two common rotifers from Svalbard, *Macrotrachela musculosa* and *Trichotria truncata*, have a low temperature dependency over a range of temperatures typical of Svalbard water temperatures (Opalinsky & Klekowski 1989). Amrén (1964) also observed morphological differences in the generations of *K. quadrata.* The animals overwinter as dormant eggs and the first generation has a distinctive morphology. Eggs are produced in a set sequence beginning with amictic eggs resulting in a rapid population increase, but with mictic eggs later in the season. Due to high overwintering egg survival, initial densities are ca. 40 individuals per litre (Amrén 1964). Cryoconite holes form on the surface of glaciers due to localised melting following solar warming of dark detritus. Large populations of Rotifera often occur in such holes, for example *Macrotrachela insolata* and *Philodina acuticornis odiosa,* which are predated by larger Rotifera (de Smet & van Rompu 1994). de Smet (1993) commented on how well the Rotifera are adapted to maximise dispersal. A high reproductive rate, parthenogenicity and the production of desiccation resistant eggs all favouring dispersal by both wind and birds.

Phylum Tardigrada

The Tardigrada is a widely distributed group on Svalbard with 99 species recorded (Table 1). Closely situated and similar habitats may reveal dissimilar species assemblages (Dastych 1985, Maucci 1996, van Rompu & de Smet 1996). Dastych (1985) demonstrated that the species composition at a locality is dependent on a combination of bedrock type and habitat altitude. Tardigrade species can be classified into five groups based on bed rock preferences from eucalciphilous (e.g. *Macrobiotus willardi*) through mesocalciphilous (e.g. *Hypsibius oberhaeuseri*) to acalciphilous (e.g. *H. dujardini*). Furthermore, numbers of both individuals and species decrease on an altitudinal gradient, many species having a distinct altitudinal distribution (Dastych 1985). For example, *Ramazzottius cataphractus* (*Hypsibius cataphractus*) is only found at altitudes below 100 m while *Hebesuncus conjungens* (*Diphascon conjugens*) is restricted to areas above 1100 m. Dastych (1985) comments on the similarities in the distribution with species assemblages from the Tatra mountains. Each cryoconite hole can be considered an individual ecosystem and can possess distinct faunas of Rotifera and Tardigrada (such as *Diaphascon recamieri* and *Isohypsibius granulifera*) which often occur in large numbers (de Smet & van Rompu 1994). There are few records of tardigrade density but Wüthrich (1992) observed densities below 5,000 m^{-2} in oligotrophic tundra.

Phylum Nematoda

There have been no quantitative ecological or physiological studies of the nematodes from Svalbard. However, Loof (1971) identified 74 species of free-living or plant parasitic nematode from an extensive sampling program on West Spitsbergen. Including the vertebrate parasites the total nematode fauna numbers 108 species (Table 1). Loof (1971) highlights the lack of diversity between habitats and the absence of many families and genera on Svalbard that are widespread in Europe. For example, the family Rhabditidae and genus *Rotylenchus.* For reasons that are unclear, the nematode *Geocenamus microdorus* is restricted to the small islands of Eskjeret and Juttahl (small islands opposite Ossiansarsfjellet in Kongsfjord) where it often forms the dominant species (Loof 1971). The nematode fauna of Svalbard appears to have close affinities to that of northern Canada (Loof 1971).

Cestode and nematode parasites

The parasitic Cestoda and Nematoda are discussed as one group due to their mode of life although they do not belong to one taxon.

In addition to man, the terrestrial mammal fauna of Svalbard is restricted to five species (Mehlum 1990); reindeer (*Rangifer tarandus platyrhynchus*), arctic fox (*Alopex lagopus*), polar bear (*Ursus maritimus,* more strictly a marine mammal), the vole (*Microtus rossiameridinalis)* and dogs

(*Canis domesticus*, largely Greenland sled dogs). Several other species, the muskox (*Ovibos moschatus*), arctic hare (*Lepus arcticus*), mountain hare (*L. timidus*), Norwegian rat (*Rattus norvegicus*), mouse (*Mus musculus domesticus*) and one fish, the trout (*Salmo trutta*), have all been introduced during the last century but have failed to establish viable populations (Gjertz & Lønø 1998). While many of these species have invertebrate parasites the total number of parasite species is low, one reason being the lack of suitable intermediate hosts. For example, the lack of trematodes and metastrongyloid nematode species among non-migrating host species can be explained by the lack of gastropods on Svalbard (Halvorsen & Bye 1999).

Cestoda

Eight cestodes (Platyhelminthes: Cestoda) parasitising the arctic charr (*Salvelinius alpinus*) or the reindeer (*R. tarandus platyrhynchus*) are known from Svalbard; five from the arctic charr and two from the reindeer. Furthermore, *Echinococcus multilocularis* (Cestoda: Taeniidae) has been recently observed amongst the voles *(Microtus rossiameridinalis)* at the derelict Russian mining settlement of Grumant (Isfjord) (R.A. Ims & H. Henttonen, pers. comm.). The definitive host of this parasite is the fox, the vole forming the intermediate host. On occasion man can form the intermediate host and in such instances infection with the cyst usually results in alveolar hydatid disease and gradual destruction of the liver.

Nematoda

A total of 10 trichostrongyloid nematodes (Nematoda: Strongylida) have been recorded, nine from the reindeer and muskox (note that the muskox is no longer present on Svalbard) (Alendal & Helle 1983, Halvorsen & Bye 1999), and one from the glaucous gull (*Larus hyperboreus*) (Sagerup et al. 1998). *Trichinella spiralis* and *T. nativa* (Nematoda: Adenophorea) are prevalent in both the polar bear (*Ursus maritimus*) (Kjos-Hanssen 1984) and the arctic fox (*Alopex lagopus*) (Prestrud et al. 1993).

The continued transmission of nematode reindeer parasites on Svalbard during autumn and late winter has been recently demonstrated and is the first such observation during winter in High Arctic environments (Halvorsen et al. 1999). It should be noted that many of the trichostrongyloid nematodes are now considered to be dimorphic or trimorphic species with major and minor morphotypes (Halvorsen & Bye 1999). Infection rates of *Trichinella* spp. can be high, infection rates in the polar bear vary between 23 and 58% and from 3 to 67% in the fox. However no infection was reported in samples from 252 ringed seals (*Phoca hispida*) and 84 bearded seals (*Erignathus barbatus*) (Larsen & Kjos-Hanssen 1983). Extensive freeze resistance has been demonstrated in *Trichinella* isolates with live specimens being obtained from polar bear muscle after either 38 months at -18°C or 7 weeks at -70°C (Kjos-Hanssen 1984). In contrast, *Trichinella* from more temperate regions is far more cold susceptible. Pork is routinely frozen at -15°C for 20 days to kill *Trichinella* cysts and prevent transmission of the nematode (Kjos-Hanssen 1983). Nematode infection of the glaucous gull (*L. hyperboreous*) has a positive relationship with tissue polychlorinated biphenyl (PCB) concentrations (Sagerup et al. 1998). Suppression of the immune system by the PCB load is thought to increase susceptibility to parasite infection.

One additional parasitic nematode, *Philonema oncorhynchi*, occurs in conjunction with the arctic charr (Kennedy 1978, Sobecka & Piasecki 1993). The free-living and plant parasitic nematodes from a wide ranging sampling program covering most of West Spitsbergen have been detailed by Loof (1971).

Phylum Annelida

There are no lumbricid worms on Svalbard. One immature form has been reported (Nurminen 1965) but this must be considered a dubious record considering the large number of soil samples since taken and no further records emerging. However, 34 species of enchytraeid are known from Svalbard (Dózsa-Farkas 1999). The species present have a wide circumpolar distribution, but there is considerable nomenclature confusion in the literature on the Enchytraeidae largely due to the identification problems. Dózsa-Farkas (1999) has recently published a review that resolves these confusions.

There are few reports dealing with the ecology and physiology of the enchytraeids (Birkemoe 1995, Sømme & Birkemoe 1997, Birkemoe et al. submitted). The life cycle typically takes two years to complete on Svalbard, for example *Henlea glandulifera*. Other species such as *Henlea perpusilla* have the ability to mature in one year. In less extreme environments *H. perpusilla* can complete two generations a year (Dash & Cragg 1972). The cocoon is an important overwintering stage and, although cocoons are produced throughout the year, cocoon hatch is synchronised in the spring by low winter temperatures breaking a form of quiescence (Birkemoe et al. submitted). Birkemoe et al. (submitted) also failed to observe reproduction by fragmentation amongst the five species of enchytraeid studied. Overwintering enchytraeids are freezing susceptible (Sømme & Birkemoe 1997). However, the enchytraeids can cold acclimate and desiccate, loosing up to 73% of the body water content, and overwinter in this anhydrobiotic state (Sømme & Birkemoe 1997).

Phylum Chelicerata

Order Acari

There are 116 species of Acari on Svalbard (98 Acariformes and 18 Parasitiformes) (Table 1). The oribatid mites (Oribatida) are perhaps the best known group with 63 species. However, due to synonyms and misidentifications, the actual number of species present on Svalbard is possibly only half this number (T. Solhøy, pers. comm.). *Diapterobates notatus* appears to be one of the most widespread species (Neidbala 1971).

Mite densities are in general low when compared to the Collembola (Table 2). For example, while Bengtson et al. (1974) recorded mite densities of between 16,000 and 248,000 mites m^{-2}, Wüthrich (1992) found densities below 2,000 m^{-2}. Prior to moulting mites enter a quiescent stationary stage. It is unknown how this may effect density estimates that are based on samples from MacFadyen type extractors in which the soil microarthropods are expelled and are required to be active. Little is known about the life history of many arctic mites but it seems likely that, as with some Antarctic species (Convey 1996), many species from Svalbard require several years to attain sexual maturity. Mites have a greater tolerance to climatic stresses such as high soil temperatures and drought than Collembola (Coulson et al. 1996, Hodkinson et al. 1996b), but the slow generation time will delay their response to climate change. Very little is known concerning the ecology and ecophysiology of the Acari fauna of Svalbard.

Order Araneae

The spiders are better known than the mites and 18 species from three families are represented on Svalbard, the majority from the family Linyphiidae and only single species from each of the Gnaphosidae and Hahniidae. Two species may be human introductions, *Tapinocyba insecta* (Linyphiidae) and *Hahnia helveola* (Hahniidae) (Tambs-Lyche 1967). The remaining species all have circumpolar distributions. While the total number of species may be restricted, densities can be greater than in Finnish Lapland (Koponen 1980). Spiders are common throughout Svalbard, one species (*Collinsia spetsbergensis*) even being recently collected from the isolated islands of Sjuøyane off the northern coast of Svalbard and lying at 80°N (Hauge & Sømme 1997) (Figure 2). Hågvar & Hegstad (1969) point out that the wide habitat tolerance of spiders may be considered a pre-adaptation to the Svalbard environment where the landscape consists of a mosaic of different habitats with small areal extents (Leinaas 1999a).

Phylum Mandibulata

The classes Diplura or Protura are not found on Svalbard but there are 59 species of Collembola.

Class Collembola

Of the Svalbard Collembola, 58 species have a holarctic or circumpolar distribution. For example, *Megalothorax minimus* has a largely global distribution including the Antarctic. Only *Mesaphorura jirii* has a distribution restricted to Europe and Bjørnøya (Janssens 2000). In the absence of lumbricid worms on Svalbard the remaining soil

Table 2. Density (10^3 m^{-2}) of some invertebrates on Svalbard. Note: Such density measurements are dependent on the sampling date and sampling and extraction methodologies. [a] Cryptostigmata only; [b] Collembola and Acari combined.

Habitat type	Collembola	Acari	Nematoda	Enchytraeidae	Araneae	Diptera	Coleoptera larvae	Source
Lichen tundra	9	16	-	-	0.07	0.06	-	Bengtson et al. 1974
Moss-lichen tundra	27	19	-	-	0.05	0.04	-	Bengtson et al. 1974
Wet moss tundra (birdcliffs)	243	22	-	-	-	2.5	-	Bengtson et al. 1974
Grassland	267	248	-	-	1.0	0.01	0.3	Bengtson et al. 1974
Tundra heath	-	-	-	10	-	-	-	Birkemoe et al. subm.
Polygonal tundra	5 - 35	5 - 30	-	1.3 - 5.5	0.05	0.02	-	Byzova et al. 1995
Wet moss tundra	270 - 432	38 - 90	-	4.6 - 20	0 - 0.2	-	-	Byzova et al. 1995
Lichenous tundra	432 - 104	31 - 52	-	6.4 - 24	0.06	0.004	-	Byzova et al. 1995
Wet moss tundra, birdcliffs	266 - 592	39 - 81	-	0.2 - 7.6	0.06	0.008	0.06	Byzova et al. 1995
Polar semi-desert	30 - 83	4 - 14	-	-	-	-	-	Coulson et al. 1996
Tundra heath	14 - 40	5 - 11	-	-	-	-	-	Coulson et al. 1996
Carex tussocks	240 - 290	-	-	-	-	-	-	Hertzberg et al. 1994
Cyanobacterial ground	9 - 30	-	-	-	-	-	-	Hertzberg et al. 1994
Unknown	270	66	2.3	5.5	0.02	0.4	0.01	Klekowski & Opalinsky 1990
Tetragona-Dryadetum (inner fjord)	4	-	-	-	-	-	-	Sendstad 1976
Tetragona-Dryadetum (outer fjord)	19	-	-	-	-	-	-	Sendstad 1976
Polari-Dryadetum	8	-	-	-	-	-	-	Sendstad 1976
Caricetum ursinae	18	-	-	-	-	-	-	Sendstad 1976
Lichen tundra	27	32[a]	-	-	10	-	-	Sendstad & Sveum 1985
Wet tundra	24	37[a]	-	-	-	-	-	Sendstad & Sveum 1985
Dryas tundra	20	37[a]	-	-	7	-	-	Sendstad & Sveum 1985
Moss tundra	112	53[a]	-	-	4	-	-	Sendstad & Sveum 1985
Beach	65	20[a]	-	-	2	-	-	Sendstad & Sveum 1985
Moss-lichen tundra	-	18 - 81	-	-	-	-	-	Sendstad & Sveum 1985
Moss near beach	246	-	-	-	-	-	-	Sømme & Birkemoe 1999
Moss tundra	231	-	-	-	-	-	-	Sømme & Birkemoe 1999
Bottom of birdcliffs	80	-	-	-	-	-	-	Sømme & Birkemoe 1999
Under birdcliffs	65	-	-	-	-	-	-	Sømme & Birkemoe 1999
Rock shelves	68	-	-	-	-	-	-	Sømme & Birkemoe 1999
Birdcliffs	224	22.5	376	100	-	3	0.2	Wüthrich 1989
Oligotrophic tundra	40.2	6.7	81.1	<0.3	-	<0.03	-	Wüthrich 1989
Open ground	3.7	0.3	-	-	-	-	-	Wüthrich 1992
Oxyria zone	1.9	3.3	-	-	-	-	-	Wüthrich 1992
Saxifrage zone	1.3	1.8	-	-	-	-	-	Wüthrich 1992
Salix zone	0.6	0.3	-	-	-	-	-	Wüthrich 1992
Moss tundra	1.9	0.8	-	-	-	-	-	Wüthrich 1992
Moss tundra	8.5[b]	-	-	-	-	-	-	Wüthrich 1991
Cassiope tundra	11.8[b]	-	-	-	-	-	-	Wüthrich 1991
Salix tundra	5.3[b]	-	-	-	-	-	-	Wüthrich 1991
Festuca tundra	10.8[b]	-	-	-	-	-	-	Wüthrich 1991

fauna takes on an increased importance in decomposition processes and nutrient recycling (Lavelle et al. 1997). It is likely that the Collembola and mites have an important role in these processes but there is a dearth of polar studies. Collembola, for example *Archisotoma megalops*, may also be important as part of the diet of the breeding wader the purple sandpiper (*Calidris maritima*) (Hågvar 1970, Leinaas & Ambrose 1992, 1999).

The density of Collembola (and species dominance) varies greatly between habitats (Table 2). Hertzberg et al. (1994) observed Collembola densities of between 9,000 to 290,000 individuals m^{-2} from open cyanobacterial ground and

Carex tussocks respectively while Sømme & Birkemoe (1999) found densities of *Folsomia quadrioculata* of 85,000 m^{-2} and *F. bisetosa* of 188,800 m^{-2} from Krykkjefjellet (kittywake bird cliffs in Kongsfjord). In exceptional areas, such as wet *Carex* tundra, population densities can approach 800,000 individuals m^{-2} (pers. obs.). Although some taxa are rare on Svalbard, Bengtson et al. (1974) concluded that arthropod densities on Svalbard were little different from high alpine regions in mainland Norway. As well as varying spatially, the density of Collembola varies temporally (Birkemoe & Sømme 1998, Coulson et al. 1996, Sømme & Birkemoe 1999, Webb et al. 1998). For example, from being highly abundant in the years 1992 and 1993 (ca. 100,000 individuals m^{-2}), the density of *F. quadrioculata* collapsed in 1993 only to recover and then fluctuate in 1995 and subsequent years (Leinaas 1999b). Such temporal variation in density is largely due to the effects of stochastic environmental events. For example, the formation of a 25 cm thick winter surface ice layer, an event not uncommon in this region of the Arctic, reduced the population of *F. quadrioculata* and *Hypogastrura tullbergi* by up to 50% (Coulson et al., in press). Summer conditions can also influence population performance. A three year cloche study of the responses of the soil fauna to elevated soil temperatures resulted in a decline in Collembola densities (Coulson et al. 1996). This was attributed to the reduced soil moisture status associated with the warmed soil and the inability of the Collembola to tolerate such dry environments (Coulson et al. 1996, Hodkinson et al. 1998).

The life cycle of these high arctic Collembola appears to be extended by comparison to temperature relatives. The life cycles of two species, *F. quadrioculata* and *H. tullbergi* have been described in detail (Birkemoe & Sømme 1998). While the exact life cycle differs between habitats, *F. quadrioculata* on Svalbard usually requires two years to reach sexual maturity and juveniles are found throughout the year (Sømme & Birkemoe 1999). This is in contrast to *F. quadrioculata* from warmer more southerly latitudes where development may be fast enough to permit up to three generations per year (Gregoire-Wibo 1976). *Hypogastrura tullbergi* has a synchronised life cycle (Birkemoe & Leinaas 1999), the phenology of which is maintained by a winter diapause terminated by low winter temperatures. This ensures egg hatch after the spring thaw, a period of high nutrient availability and avoids the hatchlings overwintering (Birkemoe & Leinaas 1999).

Some species show a distinct diel periodicity. For example, *Isotoma anglicana* exhibits distinct peaks in activity, being most active in either early morning or late afternoon. In contrast, *Ceratophysella longispina* (*Hypogastrura hirsuta*) was arrhythmic (Solem & Sendstad 1978). This response is complicated, some species requiring diel temperature differences of greater than 5 deg. C to maintain synchronisation (e.g. *Sminthurides malmgreni*). It is hypothesised that the rhythmicity may have great importance in providing a temporal as well as spatial partitioning of niches. This may enable the co-existance of closely related species (Solem & Sendstad 1978). In this context, differing tolerances to environmental stresses may also result in two closely related species utilising different niches, for example the greater desiccation resistance of *F. quadrioculata* compared to *F. sexoculata* (Hertzberg & Leinaas 1998).

The physiology of the collembolan *Megaphorura arctica* (often referred to as *Onychiurus arcticus* or *Protophorura arctica*) is among the best studied of the invertebrates from Svalbard. Winter soil temperatures can decline to -30°C (Coulson et al. 1995) and such extremely low temperatures pose a potential problem to the successful overwintering of the Collembola. *M. arctica*, common in moist areas with a high nitrogen input (for example, amongst the vegetation beneath bird cliffs), has been shown to utilise a form of anhydrobiosis to survive these temperatures. It is currently the only known collembolan (Holmstrup & Sømme 1998, Worland et al. 1998) to use such a strategy. The collembolan avoids freezing even at temperatures as low as -30°C by reducing body fresh-weight water content by up to 90% (Holmstrup & Sømme 1998). The acclimatory responses of the enzyme amylase from *M. arctica* and a temperate species, *Protophorura armata (Onychuirus armatus),* show distinct differences (Sustr & Block

1998). While the temperature optimum of *P. armata* remains at 40°C, the activity of the enzyme from *M. arctica* is dependent on the thermal acclimation of the insect. The temperature optimum from warm acclimated individuals is 35°C while after nine weeks of cold acclimation (5°C) the temperature declined to 20°C (Sustr & Block 1998). This species also has a remarkably high Q_{10} of 7 between 0 and 10°C (Block et al. 1994).

The colder island of Nordaustlandet is notable for its lack of species diversity (Leinaas 1999a). Nevertheless, some species, for example the collembolan *F. quadrioculata,* are particularly abundant. The reduced number of other species may have resulted in lower interspecific competition and a form of ecological release (Leinaas 1999a). Fjellberg (1997) recently identified three collembolan species new to Svalbard which appear to be restricted to Nordaustlandet, *Bonetogastrura nivalis, Vertagopus arcticus* and *Anurida maritima.*

The Collembola fauna has been shown to be a useful system by which to model general ecological theory (in particular metapopulation dynamics and the influence of landscape heterogeneity and patchyness of population processes) (Hertzberg et al. 1994, 1998, Hertzberg 1997, Coulson et al., in press).

Class Insecta

The class Insecta consists of 29 orders (Speight et al. 1999) but only nine orders are represented on Svalbard (excluding the Ephemeroptera which consists of one species of dubious validity; Table 1) (Coulson & Refseth, in press). In common with other arctic regions, Svalbard has a low number of beetles and overwhelming preponderance of Diptera species when compared with temperate latitudes. For example, 55% of the insect species on Svalbard are Diptera while the Coleoptera form only 8% of the insect fauna. Similarly, in the North American Arctic, the Diptera comprise 53% and the Coleoptera 12% of the total species assemblage (Kevan & Danks 1986b). However, in the North American fauna (excluding the American Arctic) the positions are reversed and the Diptera and Coleoptera form 19 and 33% of the total insect species respectively (Kevan & Danks 1986b). In an article considering the ornithology of Bear Island, Münch (1962) mentions Thysanura but this is an isolated record and seems likely to be a misidentification.

Order Diptera

Of the Mandibulata, it is the Diptera which has the greatest number of species, 128 species from 21 families. However, many of the families from Svalbard are poorly known. The Chironomidae in particular require revision, Lindegaard (1997) providing the most recent and accurate checklist (K. Aagaard, pers. comm.). To date, 63 species of Chironomidae have been recorded from Svalbard but a study designed to describe chironomid population cycles revealed several new species (Hodkinson et al. 1996a) and the current total is likely to be a substantial underestimate.

Hodkinson et al. (1996a) demonstrated the temperature dependency of chironomid emergence on Svalbard and that in unusually warm years there was an initial wave of emergence early in summer with fewer individuals appearing in the second half. Chironomids form an important constituent of the diet of some arctic birds, for example the purple sandpiper (*C. maritima)* (Bengtson & Fjellberg 1975) and Hodkinson et al. (1996a) suggest that changes in the seasonal availability of chironomids may have important consequences for breeding bird populations. The reported swarming behaviour of one species of chironomid, *Smittia extrema*, is unusual. The mating swarm is orientated about pale areas of ground set amongst the more uniform dark background. The males take flight on hearing the hum of the females wings as she takes off. Once copulation has been occurred the female lands and the males follow suit (Syrjämäki 1968). This is in contrast to the swarming flights of extended duration found more generally among the Chironomidae and seems to be an adaptation to the more open landscape and the problems of flight in the typically gusty wind conditions found in the open tundra. Syrjämäki (1968) writes that he deduced the trigger to the flight of the males after observing their reaction to his humming an old Finnish folk tune.

Perhaps a rare example of the perfect fusion of art and science.

There seem to be no records of the housefly *Musca domestica*. Nevertheless, this species has a global synanthropic distribution (Skidmore 1985) and it seems quite likely that the fly is present in either Longyearbyen or Barentsburg. The dipteran parasites of the reindeer, the nose bot fly (*Cephenemyia trompe*), and the warble fly (*Hypoderma tarandi*) are not recorded from Svalbard despite a palaearctic distribution which includes arctic Canada and Greenland (Danks 1981). Both these species have obligate one year life cycles, dropping from the host as final instar larvae in May and June. Subsequent summer temperatures must be high enough to permit pupation, adult emergence and egg deposition (Nilssen 1997). Moreover, after emergence the imagines require air temperatures above 10°C in order to fly (Anderson & Nilssen 1996). Infestation of the reindeer in Northern Norway is, at least in part, dependent on summer temperatures (Nilssen 1997) and the short cool Svalbard summers may prevent colonisation by these two parasites. There is one mosquito present on Svalbard, *Aedes* (*Ochlerotatus*) *nigripes*. This species can be common in Longyearbyen and Brucebyen (Summerhayes & Elton 1923, pers. obs.).

Order Lepidoptera

The Lepidoptera fauna consists of 11 species from seven families (Table 1). However, it seems likely that the majority are wind blown migrants and do not breed on the islands while one (*Parnassius apollo*) is a dubious record. Only *Apamea maillardi* and possibly *Plutella polaris* are suspected of being resident (Kaisila 1973a, Alendal et al. 1980). Although the larvae of *A. maillardi* feed on the widely distributed tussock forming Graminae, the moth is only present in low densities and/or with a restricted distribution in western regions of Spitsbergen areas with an optimally mild climate (Alendal et al. 1980, pers. obs.). All species have a wide European distribution.

Order Hymenoptera

Five families of Hymenoptera are present on Svalbard (Table 1) with the Ichneumonidae forming the most numerous family (16 species). One individual of an unknown species of cynipid that is probably an aphid parasitoid has been collected (Hodkinson et al. 1998). The sawfly *Pontopristia amentorum* is common on the tundra heath vegetation where the larvae feed and pupate on the leaves of *Salix polaris*. Adults fly very close to the ground and seem to have two periods of diel activity, between 10:00 and 12:00 and 14:00 to 15:00, on warm July days (pers. obs.).

The ants (Formicidae) are notable by their absence, but are generally rare in Arctic regions (Kevan & Danks 1986b). Interestingly, neither species of bumble bee (*Bombus hyperboreous* and *B. polaris*: Apidae) present in Greenland (Danks 1981) have been seen on Svalbard.

Order Coleoptera

Despite forming the largest insect order on a global basis (Speight et al. 1999), the Coleoptera are generally poorly represented in Arctic regions (Kevan & Danks 1986b). The pattern is repeated on Svalbard from where only 19 species of Coleoptera have been recorded from a total of 231 species of insect. Of these, one species (*Oryzaephilus surinamensis*) was collected from stored foodstuffs and is certainly an human introduction (Kangas 1967). The remaining 18 species are distributed amongst nine families of which half belong to the Staphylinidae.

Beetles are not common on Svalbard. Some of the beetles appear highly restricted in distribution, three species of staphylinid are known from Svalbard only from the Woodfjord region (*Olophrum boreale*, *Eucnecosum brachypterum* and *Omalium casum*) (Fjellberg 1983). It is possible that *O. casum* requires the higher soil temperatures that occur in the vicinity of the warm springs (Fjellberg 1983). The staphylinids *Atheta graminicola* and *Boreophila subplana* are found in greatest numbers amongst the moist and luxuriant vegetation beneath the bird cliffs, for example the southerly facing cliffs at Kjærstranda (Brøggerhalvøya, Engelskbukta) and Grumant (Isfjord). Interest-

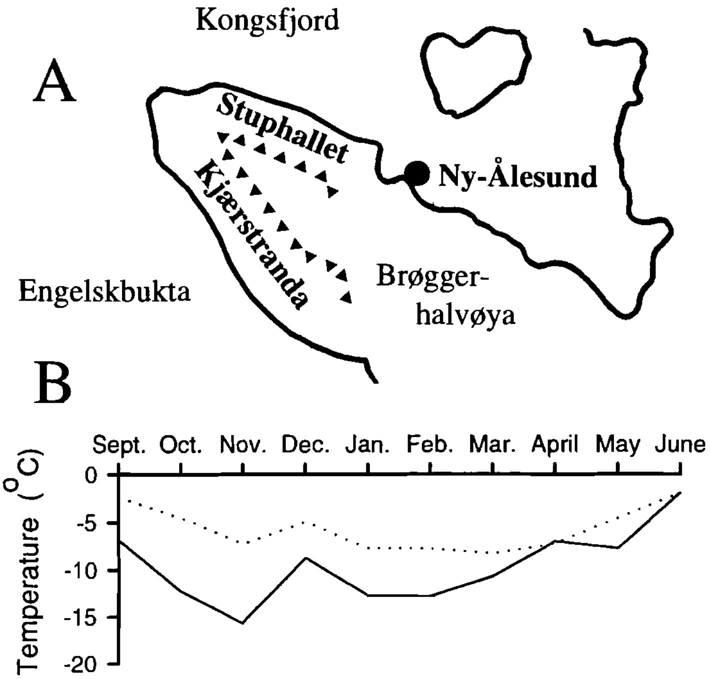

Figure 3. A. Map of the Brøggerhalvøya. The collembolan *M. arctica* is present in large numbers under stones at the base of both the Kjærstranda and Stuphallet bird cliffs. The predatory staphylinid beetle *A. graminicola* is only found at Kjærstranda. ▲ ▲ ▲ = escarpment,
B. Mean monthly temperatures recorded at a depth of 3cm 1993/94. Kjærstranda = dotted line, Stuphallet = solid line, (temperature data redrawn from Table 2, Coulson et al. 1995).

ingly, even though the collembolan prey species (*M. arctica*) is abundant, the beetles do not occur at the Stuphallet cliffs along the northern coast of the Brøggerhaløya (Figure 3). This is a region that has much lower winter and presumably summer temperatures (Coulson et al. 1995, pers. obs.). The distributions of these beetles may therefore be in part temperature limited. Hågvar (1971) points out that these species, and also *Rhynchaenus flagellum* and *Simplocaria metallica,* have been found only where the vegetation is well developed. *Micralymma marinum* is probably restricted to beach habitats (Hågvar 1971).

Physiological studies on *Amara quenseli* indicate that the beetle on Svalbard has an elevated metabolic rate compared to individuals from more southerly regions (Strømme et al. 1986). This is interpreted as an adaptation to maintain activity at the low environmental temperatures on Svalbard.

Order Hemiptera

Of the four species of Hemiptera that have been recorded from Svalbard all are Aphididae and two are endemics, *Acyrthosiphon svalbardicum* and *A. calvulus*. Only *A. svalbardicum* has been described in detail (Strathdee et al. 1993a, Strathdee & Bale 1995). The other species *A. calvulus, Cinara abieticola* and *Pemphigus groenlandicus* are only known from isolated records (Ossiannilsson 1958). While the host plant of *A. calvulus* (*Poa arctica*), is present on Svalbard, the hosts of the two other species are absent and the aphids are likely to be random migrants (Ossiannilson 1958). *Acyrthosiphon svalbardicum* (host plant *Dryas octopetala*) has a unique and genetically determined abbreviated life cycle that is highly adapted to the short Arctic summer (Strathdee et al. 1993a). Environmental cues such as short photoperiod, crowding or poor host quality have no effect on the life cycle and fail to trigger the production of alate or sexual morphs in contrast to the majority of aphid species. Despite feeding on a widespread host plant, the aphid only occurs in areas where the duration and mean temperature of the summer are sufficient to allow the insect to complete its annual life cycle. With the 'extra' generation life history strategy, the insect seems ideally situated to take advantage of global warming and increase both its density and range (Strathdee et al. 1993a, 1995). This aphid was first described from Vestpynten, Isfjord, by Ossiannilsson (1958) but has since been collected from the southern shore of Kongsfjord in the vicinity of Ny-Ålesund (Strathdee et al. 1993b) and more recently from Brucebyen (Billefjorden) in August 1999 (pers. obs.). It is interesting to note that the aphid appears relatively widespread on the *D. octopetala* surrounding Brucebyen, but that Summerhayes & Elton (1923) did not record the presence of the aphid despite extensive investigation of the flora and invertebrate fauna of the area. Whether the aphid has only recently colonised Kapp Napier and Brucebyen is open to speculation.

Orders Anoplura and Mallophaga

The sucking lice, Anoplura, has two species on Svalbard (Table 1), one, *Echinophthirius horridus*, a parasite of the ringed seal (*Phoca hispida*), the other, *Antarctophthirus tricechi*, from the walrus (*Odobenus rosmarus*) (Kaisila 1973b). A recent revision of the literature concerning the Mallophaga of Svalbard concluded that there were 35 species from two families parasitising the birds (Mehl et al. 1982).

Order Siphonaptera

The seabirds and geese are hosts to just two species of Siphonaptera. *Miotenopsylla arctica arctica* is found in the nests of the kittywake (*Rissa tridactyla*) while the second flea, *Ceratophyllus vagabundus vagabundus* parasitises the pink footed geese (*Anser brachyrhynchus*), barnacle geese (*B. leucopsis*) and gulls (Mehl 1992). Fleas were present on 5% of the adult birds but nestlings had a higher incidence of infection, up to 60% in young kittywakes and 12% in young puffins (*Fratercula arctica*). No fleas were found in the nests of fulmars (*Fulmaris glacialis*), storm petrels (*Hydrobates pelagicus*) or arctic skuas (*Stecorarius parasiticus*) although the number of nests searched was low. In northern regions on Svalbard it is only *M. arctica arctica* that is present despite both species having a circumarctic distribution (Mehl 1992).

Orders Ephemeroptera, Trichoptera and Neuroptera

The insect orders Ephemeroptera and Trichoptera are each represented by only one species, *Leptophlebia vespertina* and *Apatania zonella*, respectively. Since *L. vespertina* has only been recorded once (Jørgensen & Eie 1993), is rare above the tree line and would not be expected to be found on Svalbard it is considered a dubious record (J.E. Brittain, pers. comm.). It is unlikely that there are any species of Ephemeroptera present on Svalbard. In contrast, *A. zonella* is a typically arctic species and the only caddisfly extending into the High Arctic (Kevan & Danks 1986b). This species is probably uncommon on Svalbard being restricted to regions where the climate is less harsh, for example Woodfjord (Decamps & Voisin 1971). Early records often synonymise *A. zonella* (Trichoptera) with *Goniataulius arcticus* (Neuroptera). There are no valid species of Neuroptera currently recorded from Svalbard.

Phylum Crustacea

No terrestrial Crustacea occur on Svalbard (Coulson & Refseth, in press). However, there are four classes of freshwater Crustacea present; Branchiopoda, Copepoda, Ostracoda and Malacostraca (Table 1). The cladoceran *Chydorus sphaericus* is perhaps the most common crustacean and is found in both the pelagic and litteral zones (Jørgensen & Eie 1993). The crustacean that has attracted the greatest attention however, is the water flea, *Daphnia pulex* (Cladocera). This species has a circumarctic distribution and detailed genetic studies have shown *D. pulex* to be a species complex with two major lineage groups and two zones of overlap, one in N. Europe and the other in Canada (Hobæk & Weider 1999). As with the tardigrades (Pugh & McInnes 1998), the spread of the various *Daphnia* clones appears to generally eastwards but for unknown reasons (Roen 1981, Hobæk & Weider 1999). The authors contend that, with as much clonal diversity amongst high arctic *Daphnia* as in the temperate zone, the view of the arctic as a homogeneous biome must be re-evaluated. Two phenotypic morphs of *D. pulex* occur on Svalbard, a melanic dark form and a paler non-melanised form (Hessen 1996).

While the melanised form appears to have a slower growth rate, it also has increased tolerance to high UV-B light levels. It is possible that the frequency of melanic/non-melanic clones may be explained as a trade-off between the metabolic costs of melanin production and UV-B protection (Hessen 1996). Despite having altered their developmental rate so as to be able to complete their annual life cycle within the short arctic summer, the distribution of *D. pulex* on Bear Island remains restricted to small permanent waters since temporary ponds are too ephemeral for the crustacean to complete its life cycle and fish predators prevent colonisation of the larger lakes (Meijering & Jacobi 1981). *Macrothrix hirsuticornis* (Cladocera) appears to be partially pre-adapted to the arctic conditions since the temperature responses of individuals from Svalbard are identical to those from Europe (Meijering 1979). Jørgensen & Eie (1993) consider that the species is only present in shallow lakes that freeze to bottom in winter and that have an average July/August water temperature of 6°C. Without such temperatures the animal has insufficient physiological time to produce the overwintering eggs. *Lepidurus arcticus* (Branchiopoda: Notostraca) has a fairly widespread distribution throughout the archipelago and is indicative of cold clean freshwaters. This crustacean can form a major food source for the arctic charr (*Salvelinus arcticus*) and presence or absence can affect charr morph dynamics (Klemetsen et al. 1985). Moreover, the animal disturbs the lake beds while searching for the food, mixing the detritus with the water column and so releasing nutrients for use by the plankton fauna (Jørgensen & Eie 1993).

The four species of Cyclopidae, for example *Cyclops abyssorum*, are widespread throughout Svalbard including Bear Island. As with the Cladocera, the Cyclopidae fauna is also comprised of euryecious species (Koch & Meijering 1985). The Cyclopidae potentially have the ability to overwinter as either adults or any copepodid stage. However, the stage employed depends on the habitat type. In cold ponds where development is delayed it is the young stages that overwinter, while in warmer ponds the animals have sufficient physiological time to develop into the 4th or 5th stages (Koch & Meijering 1985). The copepod *Limnocalanus macrurus* (Copepoda: Calanoida) is present over a great part of Europe but may be a relict arctic species since it has a higher rate of development than other copepods and temperatures over 16°C are lethal to the eggs (Jørgensen and Eie 1993). One copopod parasitising the arctic charr is also present, *Salmonicola edwardsii* (Siphonostomatoida) (Kennedy 1978, Sobecka & Piasecki 1993).

DISCUSSION

Fauna

The species paucity of the invertebrate fauna of Svalbard is striking when considered against other arctic regions such as arctic Canada and Greenland. It is difficult to directly compare species diversity between regions due to differences in the current knowledge of species assemblages and the status of taxanomical revision. However, by using well known groups, for example the Araneae, some comparisons can be made. There are 18 species of spider from three families known from Svalbard but the total on Greenland stands at 43 species from ten families (Danks 1981) (Table 3). The Greenland invertebrate fauna contains 11 orders of Insecta while just nine are found on Svalbard (Danks 1981) (Table 3). Furthermore, 23 species of Cladocera were recorded from just one region of Greenland (Roen 1997) compared with only eight from the whole of Svalbard (Table 3). It is likely that this lack of species diversity on Svalbard is due to three factors operating independently and in combination: i) the remoteness of Svalbard from the nearest mainland, ii) the climate and iii) the young age of the ecosystem. Since the closest mainland is ca. 1000 km distant, immigration for many non-aerial species such as Collembola is probably infrequent. Despite the high arctic latitude of the archipelago, the winter climate of Svalbard is mild with average monthly winter air temperatures being only a little below -10°C (Førland et al. 1997b) . Moreover, the summer is also short and cool, even on the warmer west coast the soil is typically frozen for over 300 days each year (Coulson et al. 1995). An absence of intermediate island groups to act as 'stepping stones' between the mainland species source and Svalbard will both reduce the rate of species immigration and also removes the opportunity for gradual species adjustment to the Svalbard environment via the colonisation of intervening islands. Any species that is to become established on Svalbard must possess a physiology and a life history which immediately enables survival of the characteristic seasons of Svalbard. Ecosystem age may also have a role in limiting species diversity on Svalbard. While the insect fauna of Hawaii stands at 7862 species, no less than 5237 of which are endemic, there are only four endemics from Greenland from an unknown number of insects (Sadler 1999) (but 255 species are cited in Danks (1981) which is surely an underestimate of the species total). Sadler (1999) considers that a prime factor in limiting species diversity among the North Atlantic islands has been the 'largescale and periodic disturbance by Quaternary icesheets'.

Origin of the invertebrate species on Svalbard

During the Wisconsinian/Würm event (170,000-10,000 years B.P.) Svalbard was heavily glaciated, deglaciation occurring in during the Younger Dryas (11,000 to 10,000 years B.P.) (Salvigsen & Österholm 1982). The current fauna of Svalbard is either descended from a fauna that survived the glacial period in-situ in unglaciated refugia, for example, nunataks (unglaciated mountain tops above the ice sheets), or the glaciation 'wiped the slate clean' and the fauna consists of those species that subsequently spread out from more southerly unglaciated latitudes following the retreat of the ice sheets (the 'tabula rasa' hypothesis) (Ives 1974).

Dispersal of the invertebrate fauna to Svalbard

There are four means by which invertebrates from the mainland can colonise an island, via; i) wind currents (and frontal systems), ii) oceanic currents (drift wood, ice rafting etc.), iii) animal vectors and iv) human introductions (Whittaker et al. 1989, Christiansen & Bellinger 1994, Bergersen 1995).

i) wind currents. Strong low pressure systems moving over Svalbard from the Atlantic result in powerful south westerly winds. Lokki et al. (1978) records the arrival of large numbers of the butterflies *P. xylostella* and one individual of *Vanessa cardui* on Svalbard after strong south-easterly winds during a severe storm (wind velocities of

Table 3. Number of freshwater and terrestrial invertebrate families on Svalbard and Greenland (Greenland data from Danks (1981) and Holland (1985). [a] includes the Psylloidea, Hodkinson (1997), [b] plus one extra possible family, [c] dubious record, Jørgensen & Eie (1993), [d]including the dubious ephemeropteran).

Class	**Order**	Total number of families **Svalbard**	 **Greenland**
Arachnida	Araneae	3	10
Collembola		10	9
Insecta	Anoplura	1	3
	Hemiptera	1	5[a]
	Mallophaga	2	3
	Dictuoptera	0	1
	Dermaptera	0	1
	Coleoptera	10	5[b]
	Diptera	21	22
	Lepidoptera	7	11
	Hymenoptera	5	4
	Siphonaptera	1	3
	Trichoptera	1	1
	Ephemeroptera	1[c]	0
	Total	**63[d]**	**78**

24 m sec^{-1} on Spitsbergen), a 1000 km journey that took 24 h. That the airborne route may be the most important means of arrival on Svalbard is also indicated by the number of Diptera species on Svalbard. With a total of 128 species this order comes third after the Rhizopoda and Rotifera (where wind dispersal is also considered to be important) in terms of species richness. For example, Elton (1926) notes the occurrence of *Syrphus ribesii* (Diptera: Syrphidae) on Svalbard after a large depression had moved over Svalbard. The airborne route is also favoured by Holm (1958) as an explanation as to the means of arrival of the spider fauna. Holm (1958) listed just 15 species of spider from Svalbard. At the same time 21 species were known from the Scoresby sound region of Greenland alone, an area that has a similar climate. Holm (1958) concludes that aerial dispersal is the method by which the majority of the spiders have colonised Spitsbergen since this strategy is well documented for many Araneae. In support of this he cites the fact that it is the larger spider species present in Greenland, and presumably those less likely to be swept up into the aerial plankton, that are absent on Svalbard. Wind is also the most probable means of dispersal of both the Tardigrada and the Rotifera, a method that may include temporary refuge in cryoconite holes (de Smet 1993, de Smet & van Rompu 1994, Pugh & McInnes 1998). From an analysis of the circum-arctic Tardigarde species assemblages, Pugh & McInnes (1998) concluded that few, if any, tardigrades survived the Pleistocene glaciation in-situ, but that the arctic has been recolonised during the Holocene by a common non-arctic fauna originating in N. America and spread by the prevailing westerly winds during the recent Holocene.

ii) oceanic currents. While it seems possible that species have arrived on Svalbard due to ocean currents, most probably hitching a ride on driftwood, it is difficult to find much direct evidence for it. Nevertheless, the beach-dwelling beetle, *M. marinum,* probably colonised Svalbard in this manner (Hågvar 1971). Lindroth et al. (1973) demonstrated that many oribatid mites and Collembola could survive over a week on floating grass tussocks and suggest that many of the Collembola and mites that have colonised Surtsey arrived by this manner. However, Seyd (1979) points out that oribatid nymphs have been found in moss carpets from the middle of the crater. It is hard to imagine how they arrived by hydrochorous drift and Seyd (1979) considers wind transport is more likely in this particular case. Large amounts of driftwood originating in the river estuaries of north Russia arrives on the Spitsbergen coast (Johansen 1999). The recent finding that some Arctic soil invertebrates can survive several years at sub-zero temperatures (Coulson & Birkemoe submitted) opens the possibility of species being transported to Svalbard on such wood while frozen in the sea ice.

iii) animal transport. Vertebrate animals may have been responsible for the introduction of many invertebrate species. Collembola may be transported to remote islands in mud on the feet of birds, although direct evidence of this is lacking (Christiansen & Bellinger 1994). A total of 163 species of bird are recorded for Svalbard, 41 of which are known to breed on the islands, the remainder being vagrants (Mehlum 1990). Many bird species travel large distances. For example, the barnacle goose (*B. leucopsis*), the entire Svalbard population of which overwinters at Caerlaverock on the Solway Firth in Scotland, a distance of 3000 km from Svalbard (Owen 1990). During these movements the birds make use of numerous staging posts on the Norwegian mainland and coastal islands with the possibility to pick up and/or exchange hitchhiking species. However, many bird species spend time at sea before coming ashore and the salt water would kill many terrestrial or freshwater invertebrates hitchhiking on the animals body. Other birds arrive before the land has cleared of snow and the majority of eggs/animals deposited under such conditions will be washed away during the brief period of snow melt (de Smet 1993).

Many of the parasites of the vertebrates are potentially highly mobile by virtue of their hosts. The global polar bear population tends to be divided into sub-populations but there is a degree of intermixing. Tagged bears from the Svalbard population have, for example, been recaptured in Greenland (Wiig 1995) while Svalbard bears have also been identified from the Russian Arctic (Fogg

1998). Such migrations obviously have implications for the spread of organisms parasitising or travelling on the bears. The voles have recently been shown to be infected with the cestode *E. multilocularis.* Before the vole was accidentally introduced to Svalbard early this century there was no suitable intermediate host for the parasite on the islands. It is likely therefore that the parasite travelled to Svalbard with the voles which originated from the Leningrad region of Russia (Fredga et al. 1990). In addition the voles are host to two species of parasitic mites, *Laelaps hilaris* and *Haemogamasus ambulans,* that were probably introduced to Svalbard along with the rodents.

iv) human introductions. There are few reliable reports of invertebrates that have been accidentally introduced due to human activity, with the exception of the parasites associated with the introduced mammals, and none seem to have become established. Summerhayes & Elton (1928) report seeing the fly *Calliphora vicina* (Diptera: Calliphoridae) on board a ship in 1924. This is the only record of this species and it had probably arrived on board the ship. Moreover, all observations of *Phormia terrae-novae* (Diptera: Calliphoridae) have been in the vicinity of human dwellings (Nourteva 1967) and it seems likely that this species is synanthropic on Svalbard. Kangas (1967) found one dead adult of the beetle, *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) in a packet of biscuits in a field hut. This is a common pest of stored foodstuffs and is unlikely to be resident.

Glacial refugia: the nunatak hypothesis

The nunatak glacial refuge hypothesis for arctic species has received considerable attention (Ives 1974, Dahl 1987). While nunataks certainly do form refugia for Arctic and Antarctic fauna and flora (Roen 1981, Boström 1997, Cocks et al. 1998, Strong 1999), their importance in the survival of faunal and floral assemblages in high arctic regions during the Pleistocene glaciation is unclear and disputed (Dalh 1987, Andersen 1988, Birks 1996, Böcher 1997, Sadler 1998). One problem is that even if ice-free refugia existed they would have had an extreme arctic climate (Sadler 1998). Pugh & McInnes (1998) found no evidence for glacial refugia amongst extant tardigrade species assemblages, a group with extreme desiccation and cold tolerance (Sømme 1996). Opalinski & Klekowski (1992) studied the metabolic temperature relations of several freshwater invertebrate taxa from Svalbard. As few species displayed physiological temperature independence or indications of metabolic cold compensation they concluded that the ecosystem was ecologically young and that there was a predominance of pioneering ubiquitous species. However, an unusual form of refugia on Greenland has been proposed by Bergersen (1995). While considering the endemic invertebrate fauna of Greenland, Bergersen (1995) noted that the majority of these species were aquatic or moisture-loving and occur in South and South Western Greenland. Bergersen (1995) suggests that the warm springs present in this region gave additional buffering to that often provided by water (Danks 1992) to climatic extremes during the glaciations that denuded the fauna of Northern Greenland, there being no endemic invertebrate or plant from this region. It is additionally suggested that the mildly radioactive waters of these springs may have accelerated the rate of speciation. A detailed investigation of the fauna associated with the Bockfjorden warm springs on Svalbard might prove interesting. Survival in ice-free regions was also considered the best explanation of the current discontinuous distribution of the mite *Calyptozetes sarekensis* by Seyd (1979). Seyd (1979) suggested that *C. sarekensis* is an ancient species dating from the time of the Laurasian continent (60 million years BP) and that a once homogeneous range was cleaved by subsequent ice sheets.

Conclusion

In conclusion, the invertebrate fauna of Svalbard is characterised by its paucity compared to other Arctic regions. This is likely to be due to a combination of the remoteness of the islands and the ecologically young age of the ecosystem. The number of species described from the archipelago currently stands at 1040 but this number will change as new species are documented and classifications revised. The majority of the fauna consists of circumpolar species and there are relatively few endemics. Although much of the fauna has closer affinities with that of North America than Europe (Loof 1971, Pugh & McInnes 1998, Hobæk & Weider 1999) some groups, for example the Lepidoptera, are comprised mainly of European species. The focus during the last 10 years has moved away from reports dealing with the presence of invertebrate species towards articles using manipulative field and laboratory experiments to explore the ecology and physiology of the fauna.

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Haplophilus subterraneus (Shaw, 1789), a centipede (Chilopoda, Geophilomorpha) new to Norway

Kjell Magne Olsen

Olsen, K.M. 2000. *Haplophilus subterraneus* (Shaw, 1789), a centipede (Chilopoda, Geophilomorpha) new to Norway. Norw. J. Entomol. 47, 63-64.

Four specimens of *Haplophilus subterraneus* (Shaw, 1789) were collected in the close vicinity of the compost heap of the Botanical Garden, University of Oslo at Tøyen, Oslo in 1992 and 1995. Adult specimens of both sexes were present in both years, indicating a viable population at the locality.

Key words: *Haplophilus subterraneus*, Chilopoda

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INTRODUCTION

Haplophilus subterraneus (Shaw, 1789) is an exclusively synanthropic centipede in the Nordic countries. The first find in the area was made in Rosenbergs Hage, a botanical garden in Copenhagen, Denmark (Bergsøe & Meinert 1866). Large numbers were present. Later, several other Danish localities has been added to the list (Enghoff 1973, 1983), one of these is an indoor find.

In Sweden, the first specimens were found in a botanical garden in Visby, Gotland in 1913 (Porat 1913). Four males and 11 females were collected from underneath wooden flowerpots.

Four specimens (1 juv., 1 ♂, 2 ♀♀) were collected from greenhouses in southern Finland in 1947 and 1948 (Palmén 1948).

H. subterraneus can be separated from the other Norwegian species of the order Geophilomorpha by this combination of characteristics: coxal pores distributed over the whole surface of the hindmost coxa (Figure 1); head broader than long; more than 70 pairs of legs (Eason 1964).

H. SUBTERRANEUS IN NORWAY

The compost heap at the Botanical Garden and Museum, University of Oslo at Tøyen, Oslo (EIS 28) was visited twice, on 30 May and 30 August in 1992. The first visit revealed a male, approximately 36 mm long as preserved in alcohol, and with 79 pairs of legs. The second time one male, 42 mm long and with 79 pairs of legs, and one female, 41 mm long and with 81 pairs of legs, were found. The same place was visited again on 4 May 1995. This time a female, 47 mm long and with 83 pairs of legs was found. The preservation of the animals result in a shortening of the body length, as 50-60 (70) mm are normal lengths of fresh specimens (Eason 1964).

The locality is highly synanthropic, and plants are regularly introduced to the garden and the close-by greenhouses from abroad (R. Elven pers. comm.).

Members of the order Geophilomorpha usually take about three years to reach maturity (Eason 1964). The fact that adult specimens of both sexes were found suggests that a maintainable population is inhabiting the area. Geophilomorphs are mainly carnivorous, and the area is rich in suitable invertebrate prey. *H. subterraneus* is also known to occasionally feed on plant tissues (Thompson & Sankey 1961, Eason 1964). As this is a more southern species, the relatively high winter temperature inside the compost (due to fermentation) may provide the condition necessary for it to survive the winter at the locality.

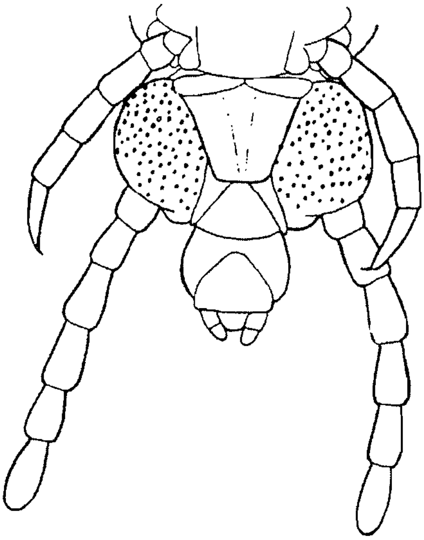

Figure 1. *Haplophilus subterraneus* (Shaw, 1789). Ventral view of posterior end of male (from Eason 1964).

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New records of Norwegian Scatopsidae (Diptera)

Jean-Paul Haenni & Lita Greve

Haenni, J.- P. & Greve, L. 2000. New records of Norwegian Scatopsidae (Diptera). Norw. J. Entomol. 47, 65–71.

Distributional data are given for 26 species of Scatopsidae, 13 of which are new records for the fauna of Norway, i. e. *Ectaetia christii* Rotheray & Horsfield, *E. clavipes* (Loew), *E. platyscelis* (Loew), *Thripomorpha bifida* (Zilahi-Sebess), *Apiloscatopse bifilata* (Haliday), *A. flavocincta* (Duda), *Apiloscatopse scutellata* (Loew), *Colobostema obscuritarse* (Strobl), *C. triste* (Zetterstedt), *Holoplagia bullata* (Edwards), *H. transversalis* (Loew), *Swammerdamella acuta* Cook and *S. adercotris* Cook. A total of 31 species are recorded from Norway and the faunistics of the family is discussed.

Keywords: Scatopsidae, Diptera, Norway.

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INTRODUCTION

Study of Norwegian Scatopsidae has been much neglected till recently. Scanty literature include older records as Zetterstedt (1838, 1850), Siebke (1877), Schøyen (1889) and Lundström (1913), as well as recent studies by Cook (1974) and Andersson (1978, 1982).

Our first faunistic article about Scatopsidae from Norway (Haenni & Greve 1995) summarised the knowledge of the family in this country, recording 19 species, of which 9 were new records. Since then, new material has been gathered and studied, allowing the discovery of several till now unrecorded species and extending the known range of some formerly recorded species. The present article follows the format of our preceding paper (Haenni & Greve 1995).

MATERIAL

Practically all the material dealt with in this study has been sorted out and assembled by LG from collections made by herself and several other collectors (see «Acknowledgements») in different parts of Norway in the course of various studies not devoted to this family. Identifications have been partly made by LG but most (including all difficult cases) have been performed or checked by JPH, who is responsible for them. All the material is deposited in the collections of the Zoological Museum of the University of Bergen (ZMB), except for few specimens retained in the collection of JPH in Muséum d'histoire naturelle de Neuchâtel, Switzerland (MHNN).

The following abbreviations are used for methods of capture: B = beating; BT = Barber trap; CN = car-netting; F = fogging; LT = light-trap; MT = Malaise trap; N = net; WT = window trap (collision trap); YT = yellow tray.

The following abbreviations are used for collectors: AN: Alf-Jacob Nilsen, BS: Bjørn A. Sagvolden, BØK: Bjørn Økland, GB & LG: Gudrun W.Bakkerud & Lita Greve, LOH & OH: Lars Ove Hansen & Oddvar Hanssen, IGK & LG: Ida Greve Korsnes & Lita Greve, KB: Kai Berggren, KJ: Kjell Arne Johanson, JA: Johannes E. Anonby, JS & LG: John Skartveit & Lita Greve, JS: John Skartveit, JS & KHL: John Skartveit & Karl H.

Thunes, LG: Lita Greve, LOH & RM: Lars Ove Hansen & Reidar Mehl, LOH: Lars Ove Hansen, LOH & BS: Lars Ove Hansen & Bjørn A. Sagvolden, OH & JB: Oddvar Hanssen & J.I.I.Båtvik, OH: Oddvar Hansen, RP: Reidun Pommeresche, SK: Sverre Kobro, TS & OA: T.Sæther & O. Austarå.

SYSTEMATIC LIST

Species that are new records for the Norwegian fauna are marked with an asterisk *

* *Ectaetia christii* Rotheray & Horsfield, 1997

AK Rælingen: Losby (EIS 29), WT, undisturbed natural forest, 25 June - 31 July 1991, 2♀♀, 1 spec., leg. BØK.

This recently described species (Rotheray & Horsfield 1997) was presently known only from few localities in Scotland. The Norwegian material has been compared with type material and found to be conspecific. The presence of this species in Norway can thus be ascertained though only females are known from this country. New for Fennoscandia and Denmark.

* *Ectaetia clavipes* (Loew, 1846)

BØ Kongsberg: Sansvær (EIS 27), 26 July 1995, 1♂, leg. BS. **BV** Rollag: Veggli (EIS 35), CN, 29 June 1995, 1♀, leg. BS.

A widely distributed species over all Central and South Europe (Krivosheina & Haenni 1986). The records from Norway are the first from Fennoscandia and Denmark.

* *Ectaetia platyscelis* (Loew, 1869)

HOI Kvam: Svevatn area (EIS 31), BT, grassy slope in *Pinus* heath woodland, 5 June - 27 July 1997, 1♀, leg. RP.

A poorly known European species, previously recorded in the region from Finland (Hackman 1980) and Sweden (Andersson 1982).

Anapausis rectinervis Duda, 1928

AK Rælingen: Losby (EIS 29), WT, undisturbed natural forest, 25 June - 31 July 1991, 1♀, leg. BØK.

A Central and North European species, which appears to be widespread in Fennoscandia (Andersson 1982).

* *Thripomorpha bifida* (Zilahi-Sebess, 1956) (= *Rhegmoclema collini* Cook, 1956)

VAY Mandal: Marnarveien at crossing to Valand, (EIS 2), MT, boggy area, 21 July - 6 Aug. 1982, 2♂♂ 1♀, leg. AN.

A widespread European species (Krivosheina & Haenni 1986), previously recorded from Sweden (Andersson 1982) in Scandinavia, where it is probably a southern species.

Thripomorpha halteratum (Meigen, 1838)

HES Elverum: Sagtjern (EIS 55), N, shore of little lake, 30 June - 1 July 1998, 1♂, leg. LG. **FØ** Sør-Varanger: near Elvenes (EIS 168), 6 Aug. 1996, 1♂, leg. JS, Sør-Varanger: Neiden, (EIS 168), N, on *Anthriscus sylvestris*, 7 Aug. 1996, 8♂♂ 3♀♀, leg. JS.

This species which is widely distributed in Europe including Fennoscandia (Andersson 1982, Krivosheina & Haenni 1986) and was recorded in our first note under the synonym name *Rhegmoclema halteratum* (Haenni & Greve 1995).

Rhegmoclemina vaginata (Lundstroem, 1910)

FØ Sør-Varanger: Neiden, (EIS 168), N, on *Anthriscus sylvestris*, 7 Aug. 1996, 1♂ 2♀♀, leg. JS (1♀ MHNN).

This is the second Norwegian locality of this boreal species previously recorded from FN by Andersson (1982).

Scatopse notata (Linnaeus, 1758)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 15 - 16 Oct.1990, 1♀, leg. SK, Asker: Bjørkås (EIS 28), 24 Aug. - 10 Oct. 1995, 1♂, leg. LOH & OH. **BV** Rollag: Veggli (EIS 35), CN, 29 June 1995, 1♂ 1♀, leg. BS. **BØ** Kongsberg: Sansvær (EIS 27), 26 July 1995, 1♀, leg. BS. **RY** Finnøy: Sevheim (EIS 14), YT, 26 May - 26 June 1995, 1 spec., MT, 8 - 27 July 1993, 1♂, 3 July - 5 Aug. 1995, 1♀, leg. JS. **HOY** Kvam:

Svevatn area (EIS 31), boggy area, 28 April - 28 May 1997, 2 spec., leg. JS. **MRY** Ørsta: near Vatnevann (EIS 68), 16 June 1995, 1♂, leg. LG.

A common cosmopolitan species, often occuring under anthropogenic conditions (Laštovka & Haenni 1981).

* *Apiloscatopse bifilata* (Walker, 1856)

STI Oppdal: Kongsvoll (EIS 79), MT, 900 m, 28 July - 12 Aug. 1992, 1♂, 12 - 19 Aug. 1992, 1♂ 1 spec., leg. JS.

This rather rarely collected species had been recorded till now only from the British Isles and several Central European countries (Krivosheina & Haenni 1986). Its presence at Kongsvoll is surprising since it is not a particularly boreal species. New for Fennoscandia and Denmark.

Apiloscatopse flavicollis (Meigen, 1818)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 3 - 4 Sept. 1995, 1♂ 2♀♀, 5 - 6 Sept. 1995, 2♀♀, 11 - 12 Sept. 1995, 1♂ 1♀, 13 - 14 Sept. 1995, 1♀, leg. SK. **OS** Gausdal: Follebu (EIS 54), 12 Aug. 1995, 5♂♂, leg. BS. **BV** Rollag: Veggli (Eis 35), 13 July 1995, 6♂♂ 16♀♀, leg. BS.

A common European species of *Apiloscatopse*, mainly bound to deciduous forests (Krivosheina & Haenni 1986). *A. flavicollis* has a southern distribution in Scandinavia.

* *Apiloscatopse flavocincta* (Duda, 1928)

STI Oppdal: Kongsvoll (EIS 79), 900 m, on *Archangelica*, 28 July 1995, 3♂♂, MT, 900 m, 28 July - 12 Aug. 1992, 3♂♂, leg. JS. **FØ** Sør-Varanger: Ytre Lid (EIS 168), 6 Aug. 1996, 1♂, leg. JS.

A. flavocincta has a wide distribution in Central and North Europe, including Fennoscandia (Sweden and Finland) (Andersson 1982, Krivosheina & Haenni 1986). Its occurrence in Norway was thus expected.

* *Apiloscatopse scutellata* (Loew, 1846)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 3 - 4 Sept. 1995, 1♂, leg. SK. BV Rollag: Veggli (EIS 35), 13 July 1995, 1♂, leg. BS.

The presence of this species in Norway based on a old record by Lundström (1913) was considered as dubious though possible in our preceding note (Haenni & Greve 1995). The finding of recent material allows to reinstate *A. scutellata* in the list of Norwegian species. This is a very common species in deciduous forests in Central Europe (Haenni 1981, Krivosheina & Haenni 1986), reaching north to Southern Scandinavia.

Apiloscatopse subgracilis Haenni & Greve, 1995

STI Oppdal: Kongsvoll (EIS 79), MT, 900 m, 28 July - 12 Aug.1992, 1♂, 12 - 19 Aug. 1992, 2♂♂, Spræenbekken (EIS 79), MT, 1300 m, 19 - 22 Aug. 1992, 1♂ 1♀, near Spræenbekken (EIS 79), MT, 1300 m, 19 - 22 Aug. 1992, hundreds of specimens ♂♂ and ♀♀, leg. JS. **NNV** Flakstad: Silsandnes (EIS 136), B, 50 m mixed forest, 14 June 1995, 1♀, leg.TS & OA.

This newly described species appears to be common in Norway. The record from the Lofoten Islands is the second one at a low altitude. Unlike most European Scatopsidae, several species of genus *Apiloscatopse* have an autumnal flight period and may present mass occurrences. This is apparently also the case for *A. subgracilis* as can be seen from one of the above-mentioned records from Spræenbekken.

Efcookella albitarsis (Zetterstedt, 1850)
(= *Cookella albitarsis Zetterstedt*)

BØ Kongsberg: Sansvær (EIS 27), 26 July 1995, 1♂, leg. BS. **RY** Hå: Ogna (EIS 7), UTM 32V LK 138903, MT, 21 June -17 July 1996, 1♂ 1♀, leg. IGK & LG, 17 July - 21 Aug. 1996, 5♂♂, 21 Aug. - 28 Sept. 1996, 1♂, leg. LG.

The second and third Norwegian records for this species which is common and widespread in Europe (Krivosheina & Haenni 1986), but seems to be restricted to the southern regions in Scandinavia.

Colobostema infumatum (Haliday, 1833)

AK Lørenskog: Losby (EIS 29), WT, 28 June - 2 Aug. 1991, 1♂, leg. BØK. **HOI** Kvam: Svevatn area (EIS 31), MT, oligotrophic bog in pine woodland, 29 July - 26 Aug. 1997, ?1♀, leg. JS & LG. **NTI** Lierne: Kveskallen (EIS 108), MT, pine forest, 7 - 26 July 1986, 4 ♂♂, leg. OH.

A mainly Northern European species (Haenni & Greve 1995). Only the HOI record represents a new Norwegian locality.

Colobostema nigripenne (Meigen, 1830)

Ø Råde: Tasken (EIS 19), MT, 24 June 1995, 1♀, leg. OH & JB. **AK** Asker: Bjørkås (EIS 28), MT, 2 July - 24 Aug. 1995, 1♂, leg. LOH & OH, Lørenskog: Losby (EIS 29), WT, 2-3 years old forest cut, 27 June - 1 Aug. 1991, 1♀, leg. BØK, Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 15 - 16 July 1990, 1♂, 17 - 18 July 1990, 1♂, 30 July - 1 Aug. 1990, 1♂, 1 - 2 Aug. 1990, 1♂, 24 - 25 June 1995, 1♂, 14 - 15 July 1995, 1♂, 18 - 19 Aug. 1996, 1♂, 27 - 28 July 1997, 1♂, 28 - 29 July 1997, 1♂, 30 - 31 July 1997, 1♂, 4 - 5 Aug. 1997, 1♂, 26 - 27 Aug. 1997, 1♂, 4 - 5 July 1998, 1♂, 23 - 24 July 1998, 2 ♂♂, 2 - 3 Aug. 1998, 1♂, leg. SK. **OS** Gausdal: Follebu (EIS 54), 12 Aug. 1995, 2 ♂♂ leg.BS. **BV** Rollag: Veggli (EIS 35), 13 July 1995, 1♂, leg. BS, Tråen saga (EIS 35), MT, Aug. 1994, 1♂ 1♀, leg.BS. **AAY** Risør: Torskeberg (EIS 11), 21 July 1995, 3♂♂, leg. SK. **VAY** Lindesnes: Lillehavn (EIS 1) UTM 32V LK 876305, LT, 19 July 1999, 1♂, leg. KJ. **RY** Hå: Ogna (EIS 7) UTM 32V LK 138903, MT, 14 May - 21 June 1996, 2♂♂, 21 June - 17 July 1996, 1♂, leg. IGK & LG, 17 July - 21 Aug. 1996, 2♂♂ 1♀, leg. LG. **HOI** 144 pp**SFI** Balestrand: Målsnes (EIS 50), MT, 1 - 29 Aug.1998, 2♂♂, leg. GB & LG, Sogndal: Lindborg (EIS 50), WT, young pine stand in deciduous forest, 7 - 21 June 1996, 1♂, leg. JA.

The commonest species of the genus, which appears to be distributed all over the southern part of Norway.

* *Colobostema obscuritarse* (Strobl, 1898)

BØ Drammen: Underlia (EIS 28), MT, pine forest with clearings, May 1994, 1♂, leg. LOH.

This species has long been synonymized with *C. triste* (Zett.) but the examination of type material by JPH has proved that it is a very distinct species, that will be redescribed elsewhere. Its distribution is still poorly known, but JPH has seen material from Central European countries, while the above record is the first from Fennoscandia and Denmark.

* *Colobostema triste* (Zetterstedt, 1850)

BØ Drammen: Underlia (EIS 28), MT, pine forest with clearings, May 1994, 1♂, leg. LOH. **BV** Rollag: Rollag (EIS 35), CN, 6 Aug. 1993, 2 ♂♂, leg. BS. **RY** Hå: Ogna (EIS 7) UTM 32V LK 138903, MT, 14 May - 21 June 1996, 1♂, leg. IGK & LG, 17 July - 21 Aug. 1996, 1♂, leg. LG.

A species widely distributed over all Europe (Krivosheina & Haenni 1986), already recorded from Fennoscandia (Sweden and Finland) and Denmark. *C. triste* seems to be restricted to southern part of Norway.

Colobostema sp.

BØ Buskerud: Sigdal, Heimseteråsen (EIS 35), F, *Pinus* top, 16 June 1998, 1♀, leg. JS & KHT.

The unique female specimen from Sigdal has peculiar genital structures, different from any other known species. However, the females of several species (including *C. obscuritarse* recorded here from BØ Drammen) are still unknown and females without associated males cannot be correctly identified at present.

* *Holoplagia bullata* (Edwards, 1925)

Ø Råde: Tasken (EIS 19) UTM 32V PL 999794, MT, natural meadow with old trees, 24 June 1995, 1♂ 1♀, leg. OH & JB.

A poorly known European species known till now from few localities in British Isles, Central Europe and Finland (Cook 1974, Krivosheina & Haenni 1986). Probably myrmecophilous.

The Norwegian locality is an untouched meadow with many large, partly hollow trees (*Tilia cordata*, *Quercus* sp., *Alnus glutinosa*) and dead trees as well. Many rare beetles have been caught there (Oddvar Hanssen, pers.comm.).

* *Holoplagia transversalis* (Loew, 1846)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 6 - 7 Oct. 1998, 1♀, leg. SK. **BØ** Kongsberg: Sansvær (EIS 27), 26 July1995, 1♂, 1♀, leg. BS. **BV** Rollag: Veggli (EIS 35), CN, 19 June 1995, 1♀, leg. BS, Veggli (EIS 35), CN, 29 June 1995, 1♂ 1♀, leg. BS (1 ♀ MHNN). **TEI** Tinn: Rjukan (EIS 26), July 1995, 2♂♂, leg. BS (1♂ MHNN). **AAI** Bygland: Heddevika (EIS 9), MT, 16 May - 11 June 1997, 2 ♂♂, leg. KB (1 ♂ MHNN). **RY** Hå: Ogna (EIS 7) UTM 32V LK 138903, MT, 17 July - 21 Aug. 1996, 1♂, leg. LG.

H. transversalis has a wide European distribution (Krivosheina & Haenni 1986). In the North this myrmecophilous species has been recorded from Finland, Sweden and Denmark (Andersson 1982) and its presence in Norway could therefore be expected.

Coboldia fuscipes (Meigen, 1830)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous / deciduous forests and grassland, 10 - 11 July 1997, 1♂, 1 - 2 Sept. 1997, 1 ♂, leg. SK. **OS** Gausdal: Follebu (EIS 54), 12 Aug. 1995, 1♂, leg. BS, Bodal (EIS 54), 12 Aug. 1995, 2♂♂, leg. BS. **BØ** Kongsberg: Sansvær (EIS 27), 26 July 1995, 1 ♂ 5 ♀♀, leg. BS. **BV** Rollag: Veggli (EIS 35), 13 July 1995, 9 ♂♂ 2 ♀♀, leg. BS, Veggli (EIS 35), CN, 29 June 1995, 3 ♂♂ 4 ♀♀, leg. BS. **TEI** Tinn: Håkanes (EIS 26), MT, Sept. 1995, 1♂, leg. BS. **RY** Finnøy: Sevheim (EIS 14), YT, 26. May - 26 June 1995, 1♂, leg. JS.

A common cosmopolitan species widespread over all Europe (Krivosheina & Haenni 1986) in both anthropogenic and natural environments. JPH has seen material from practically all European countries.

Rhexoza richardsi Freeman, 1985

AK Enebakk: Losby (EIS 29), WT, 10-15 years old forest cut, 26 June - 30 July 1991, 1♀, leg. BØK.

This poorly known species is still known only from the British Isles and Norway (Haenni & Greve 1995). Material from the same locality was reported in the preceding note (Haenni & Greve 1995).

* *Swammerdamella acuta* Cook, 1956

RY Hå: Ogna (EIS 7) UTM 32V LK 138903, MT, 14 May - 21 June 1996, 7♂♂ 5♀♀, leg. IGK & LG, 17 July - 21 Aug. 1996, 3♂♂, leg. LG.

A Central and North European species, previously recorded from Sweden and Finland (Krivosheina & Haenni 1986). Doubts about the identity of females of this species and the closely related *S. adercotris* Cook inclined us to treat them together as *Swamerdamella* sp. in our first note (Haenni & Greve, 1995). Discovery of males of both species in recently collected material allows us now to ascertain the presence of both species in Norway.

* *Swammerdamella adercotris* Cook, 1972

BØ Kongsberg: Sansvær (EIS 27), 26 July 1995, 1♂, leg. BS. **BV** Rollag: Veggli (EIS 35), CN, 29 June 1995, 1♂, leg. BS.

This poorly known species has been now recorded from several countries in Central and North Europe (Krivosheina & Haenni 1986). It is apparently more generally distributed than mentioned by Andersson (1982). See discussion under *S. acuta.*

Swammerdamella sp. (*acuta/adercotris*)

AK Enebakk: Losby (EIS 29), WT, 10-15 years old forest cut, 26 June - 30 July 1991, 1♀, leg. BØK. **OS** Gausdal: Bodal (EIS 54), 12 Aug. 1995, 1♀, leg. BS, Follebu (EIS 54), 12 Aug. 1995, 1♂ 2♀♀, leg. BS. **BØ** Kongsberg: Sansvær (EIS 27), 26 July 1995, 5♀♀, leg. BS, Buskerud: Sigdal, Heimseteråsen (EIS 35), F, *Pinus* top, 17 July 1999, 1♀, leg. JS & KHT. **BV** Rollag: Veggli (EIS 35), CN, 19 June 1995, 1♀, leg. BS, Veggli (EIS 35), CN, 29 June 1995, 6♀♀, leg. BS, Veggli (EIS 35), 9 July 1995, 1♀, leg. BS, Vårviken (EIS 35), MT, Aug. 1994, 2♀♀, leg. LOH & BS. **VE** Våle: Langøya (EIS 19), MT, basiphilous pine forest, 2 - 28 May 1991, 1♀, leg. LOH.

The above material could not be identified at species level due to confusion between females of *S. acuta* and *S. adercotris* (see note under *S. acuta*).

Swammerdamella brevicornis (Meigen, 1830)

AK Nesodden: Fagerstrand (EIS 28), LT, edge of coniferous/deciduous forests and grassland, 1 - 2 Aug. 1990, 1♀, 2 - 3 Sept. 1997, 1♀, leg. SK, Asker: Bjørkås (EIS 28), MT, 2 July - 24 Aug. 1995, 1♂, leg. LOH & OH. **OS** Gausdal: Follebu (EIS 54), 12 Aug. 1995, 1♂ 1♀, leg. BS, Bodal (EIS 54), 12 Aug. 1995, 4♂♂ 3♀♀,leg. BS. **BØ** Hurum: Tofteholmen (EIS 19), MT, dry meadow at seashore, 1 Sept. - 26 Oct. 1991, 1♀, leg. LOH, Drammen: Underlia (EIS 28), MT, pine forest with clearings, June 1992, 1♂, leg. LOH, Kongsberg: Sansvær (EIS 27), 26 July 1995, 4♂♂ 6♀♀, leg. BS. **BV** Rollag: Veggli (EIS 35), 13 July 1995, 4♀♀, leg. BS, Veggli (EIS 35), CN, 19 June 1995, 1♂, leg. BS. **TEY** Bamble: Langøya (EIS 11), MT, at seashore, 11 June - 31 July 1995, 3♂♂, leg. LOH & RM. **RY** Hå: Ogna (EIS 7) UTM 32V LK 138903, MT, 14 May - 21 June 1996, 1♂ ?1♀, leg. IGK & LG, Ogna (EIS 7), UTM 32V LK 138903, 17 July - 21 Aug. 1996, 1♂, leg. LG. **HOY** Bømlo: near Olavskolen (EIS 22), N, 18 Aug. 1992, 1♀, leg. LG.

A widespread and common species all over Europe (including Fennoscandia) and Western Palaearctic region (Krivosheina & Haenni 1986).

Swammerdamella genypodis Cook, 1972

BV Rollag: Veggli (EIS 35), CN, 29 June 1995, 2♀♀, leg. BS (1♀MHNN). **AAI** Bygland: Heddevika (EIS 9), MT, 1 - 29 July 1998, 1♂, leg. KB.

The above records are the 2nd and 3rd Norwegian records of this rare species mentioned for the first time by Haenni & Greve (1995). All known localities are located in the southernmost region of Norway.

DISCUSSION

Scatopsidae are minute unconspicuous midges usually unfrequently encountered in the field, irrespective of the method of collecting. Their lifespan is short, mass occurences are rare, except in genus *Apiloscatopse* (see under *A. subgracilis*) and in the anthropogenic species *S. notata* and *C. fuscipes,* and to collect a numerous and varied material is a large effort. Before discussing the results, it should bear in mind that the material presented in this article and in Haenni & Greve (1995) has not been collected specificly with the purpose of studying Scatopsidae. Our view of the faunistics of the family in Norway and the distribution of the different species should thus still be regarded as provisional.

Haenni & Greve (1995) recorded 19 species from Norway, and the authors supposed that the number of species occuring in this country should be around 30 species. In fact, no less than 13 additional species are present in the material dealt with in this paper, i. e. *Ectaetia christii* Rotheray & Horsfield, *E. clavipes* (Loew), *E. platyscelis* (Loew), *Thripomorpha bifida* (Zilahi-Sebess), *Apiloscatopse bifilata* (Haliday), *A. flavocincta* (Duda), *Apiloscatopse scutellata* (Loew), *Colobostema obscuritarse* (Strobl), *C. triste* (Zetterstedt), *Holoplagia bullata* (Edwards), *H. transversalis* (Loew), *Swammerdamella acuta* Cook and *S. adercotris* Cook, and the total number of species recorded from Norway is 31 approximately as expected. In comparison, 37 species have been recorded from Sweden (Andersson 1982) and 26 species from Finland (Hackmann 1980).

It is interesting to note that most of the newly recorded species are European in general distribution and seem to reach their northern limit in southern Scandinavia, including the southern parts of Norway.

Seven species (*Arthria analis, Thripomorpha halteratum, Scatopse notata, Apiloscatopse subgracilis, Colobostema infumatum, Coboldia fuscipes, Swammerdamella brevicornis*) appear to be generally distributed in Norway. Only 5 species (*Thripomorpha verralli, Rhegmoclemina vaginata, Scatopse lapponica, Apiloscatopse bifilata* and *A. flavocincta*) are apparently restricted to the northern and central parts of the country (North of Trøndelag), but two of them (*T. verralli* and *A. bifilata*) are European species whose absence in southern Norway probably reflects only insufficient collection. The remaining nineteen species appear to be restricted to the southern part of Norway (South of Trøndelag), though at least two of them (*Swammerdamella acuta* and *S. adercotris)* may probably also occur in northern part of the country.

Among the new records are several poorly known or rarely collected species: *Ectaetia christii, E. platyscelis, Apiloscatopse bifilata, Colobostema obscuritarse* and *Holoplagia bullata* which all are known from few widely separated localities. Both species of *Ectaetia* and *H. bullata* are very probably saproxylic species bound to old trees and may be indicative of biotopes of conservation value. This is also the case for *Rhexoza richardsi* and *Swammerdamella genypodis*.

Some additional species can still be expected to occur in Norway species, particularly in genus *Anapausis*, of which 5 species are known from southern Sweden (Andersson 1982) in contrast to only one recorded from Norway. Some species occurring in marshy habitats in neighbouring Sweden like *Thripomorpha paludicola* Enderlein and *Ferneiella incompleta* (Verrall), and *Parascatopse litorea* (Edwards), a halophilous species of the seashore can also be expected to occur in Norway.

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Malacomyia sciomyzina (Haliday, 1833) (Diptera, Coelopidae) recorded from Norway

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Greve, L. & Johanson, K.A. 2000. *Malacomyia sciomyzina* (Haliday, 1833) (Diptera, Coelopidae) recorded from Norway. Norw. J. Entomol. 47, 72.

The coelopid fly *Malacomyia sciomyzina* (Haliday, 1833) (Diptera, Coelopidae) is recorded for the first time from Norway. Two males were caught on light near Lillehavn in Lindesnes on 20 August 1999.

Key words: *Malacomyia sciomyzina*, Coelopidae, Diptera, Norway

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The fly *Malacomyia sciomyzina* (Haliday, 1833) is recorded for the first time from Norway. Two males were collected in **VAY** Lindesnes: Lillehavn (EIS 1), 20 August 1999 in a light-trap by K.A.J. The locality is open bedrock with patches of small numbers of *Pinus, Calluna* and different grass species. The weather was warm and rainy, with strong onshore wind. Our specimens were collected at approximately 300 m from the drift line about 10 m a.s.l. They were most probably drifted by wind.

M. sciomyzina looks very much like the species in the genus *Coelopa*, but is separated by the extensive hairing and the bristle on the anepisternum, the rounded postnotopleural ridge and the bare metasternum, in *Coelopa* the anepisternum is bare, the postnotopleural ridge is sharply margined and the metasternum is setulose.The distribution of the species in the genus *Coelopa* in Norway is treated by Greve (1999).

M. sciomyzina is mentioned as a characteristic species occurring associated with the drift line where seaweed - wrack is the major component. However, the seaweed should be moist and thick (Stubbs & Chandler 1978).

M. sciomyzina was recorded from Sweden by Wahlgren (1917) from Skåne and Bohuslän. Ardö (1957) mentions *M. sciomyzina* in his lists of Diptera from marine shore dune ecosystem, but he gives no new localities.

Gorodkov (1984) placed the genus *Malacomyia* with the single species *M. sciomyzina* in the Family Helcomyzidae together with the genera *Helcomyza* Curtis and *Heterocheila* Rondani. Here we follow McAlpine (1998) who places the genus *Malacomyia* together with the genus *Coelopa* in the family Coelopidae.

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New records of spiders (Araneae) from the Oslofjord area, SE Norway

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Hauge, E. & Hansen, L.O. 2000. New records of spiders (Aranea) from the Oslofjord area, SE Norway. Norw. J. Entomol. 47, 73–75.

The spiders (Araneae) *Theridion mystaceum* L. Koch, 1870 (Theridiidae) and *Linyphia tenuipalpis* Simon, 1884 (Linyphiidae) are reported for the first time in Norway. Interesting records of six other species are also presented, including the second Norwegian record of *Syedra gracilis* (Menge, 1866) (Linyphiidae). The distribution for each species are briefly discussed.

Key-words: Araneae, Oslofjord, *Linyphia tenuipalpis, Theridion mystaceum, Syedra gracilis.*

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INTRODUCTION

Hauge & Hansen (1991) presented a list of 99 species of spiders from six small islands in the middle of the Oslofjord. Several of these species certainly have their northwestern limit of distribution at these islands, and surprisingly, five of the species were previously not reported from Norway. The present study gives further records from these islands, together with an additional record from the mainland.

A brief account of the flora and geology of the localities are presented by Hansen & Ligaard (1992) and Hauge & Hansen (1991). The EIS-grid numbers are given according to Økland (1977) and regional abbreviations are according to Økland (1981). The second author is responsible for all the records. The following abbreviations are used in the text: MT = Malaise-trap operated in the period 2 May – 26 Oct. 1991, SN = sweep-netting in the period 1 July – 12 August 1990. The material is deposited at the Zoological Museum, University of Bergen.

THE SPECIES

Clubionidae

Philodromus dispar Walckenaer, 1825

A singe ♂ was taken at **BØ** Hurum: Tofteholmen (EIS 19), MT. This species is previously known from coastal areas of SE Norway (Strand 1901, Hauge & Midtgaard 1986), but an older record exists from **NTI** Trondheim (Storm 1898). In Sweden it is distributed in coastal areas from Skåne to Bohuslän and Uppland, including Öland and Gotland (Tullgren 1944).

Salticidae

Salticus zebraneus (C.L. Koch, 1837)

1♂ and 5♀♀ were taken at **BØ** Hurum: Tofteholmen (EIS 19), MT, and another ♂ at **VE** Våle: Langøya (EIS 19), MT. The few previous records of this species in Norway are restricted to the Oslofjord area: AK Vestby and VE Tjøme (Hauge 1989).

Dendryphantes rudis (Sundevall, 1833)

A single ♂ was taken at **BØ** Hurum: Mølen (EIS 19), SN. Only old records of this species are previously known from Norway:. AK Christiania omegn, Asker and Eidsvoll, and BØ Drammen (Collet 1875).

Agelenidae

Agelena labyrinthica (Clerck, 1757)

2♂♂ and 1♀ were taken at **VE** Våle: Langøya (EIS 19), MT, and 6♂♂ and 1♀ at Sande: Kommersøya (EIS 19), MT. In Norway this species is recorded from coastal areas from VAY Kristiansand to AK Oslo, and east to Ø Halden and Hvaler (Hauge 1989). The Norwegian records probably represent the NW limit of distribution of the species in Europe. In the Nordic countries it is restricted to S Sweden and the SW coast of Finland, as well as in Österbotten (Kronestedt 1983). This is a continental species found most frequently in sunny forest ecotones (Palmgren 1977, Heimer & Nentwig 1991).

Theridiidae

Theridion mystaceum L. Koch, 1870

A single ♂ was taken at **BØ** Røyken: Kinnartangen (EIS 28), MT. This species has previously not been recorded from Norway. It is widely distributed in Europe (Heimer & Nentwig 1991), and well known in E Fennoscandia north to Lappland (Palmgren 1974).

Linyphiidae

Linyphia tenuipalpis Simon, 1884

Two ♂♂ were taken at **BØ** Hurum: Tofteholmen (EIS 19), MT. This is the first Norwegian record of the species. It was reported for the first time in Denmark by Toft (1977), but has ølater been taken both in coastal and interior areas of the country (Toft 1980). The Finnish records are restricted to the S and SW coast including the island of Åland, and eastwards to the Karelian isthmus in Russia (Palmgren 1977, Lehtinen et al. 1979). In Sweden it is found mostly in coastal areas north to Bohuslän and Södermanland, also in some distance from the coast (Kronestedt 1983). It is widely distributed in W Europe south to Portugal, but seems to be scarcer in the NW areas (van Heldingen 1969).

Porrhomma microphthalmum (O.P.-Cambridge, 1891)

A single ♀ was taken at **BØ** Hurum: Mølen (EIS 19), SN. Recently this species was recorded as new to Norway from Akershus, i.e. AK Ski, Kroer and Ås (Folvik 1994). Palmgren (1975) reported it from the S and SW areas of Finland.

Syedra gracilis (Menge, 1866)

A single ♀ were taken at **BØ** Hurum: Ramvikholmen (EIS 19) (SN). The species has previously been recorded once from Norway (Waaler 1967), and is seemingly very rare elsewhere in Europe (Heimer & Nentwig 1991). In Britain there is a few records north to SE Scotland (Locket et al. 1974).

DISCUSSSION

A total of 118 species are recorded from these small islands (Waaler 1971, Hauge & Hansen 1991, unpubl. records). This represents more than 22% of all species of spiders hitherto recorded in Norway (Hauge 1989). These islands may be considered unique from a national point of wiew, due to a combination of favourable climate, diverse geological origin, and in beeing very little influenced by human activities. This is probably the main reasons why many species of spiders and also insects have their northwestern limit of distribution in these areas. All these islands are totaly or partly protected as nature reserves today.

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The family Signiphoridae (Hymenoptera, Chalcidoidea) in Norway

Lars Ove Hansen

Hansen, L. O. 2000. The family Signiphoridae (Hymenoptera, Chalcidoidea) in Norway. Norw. J. Entomol 47, 76.

A species of the familiy Signiphoridae has been recorded for the first time in Norway. The minute chalcid wasp *Thysanus ater* Haliday in Walker, 1840 was recorded in Drammen (BØ) in 1995 and in Oslo (AK) 1996. Biology and distribution of the species are briefly discussed.

Key words: Signiphoridae, Chalcidoidea, *Thysanus ater*, Norway.

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The family Signiphoridae has been recorded for the first time in Norway. This family includes minute chalcid wasps ranging from 0.5 to 2.0 mm in length, with compact or long and flat bodies (Tryapitsyn 1978, Gauld & Bolton 1988). The colour is normally black, but occasionally with orange or yellow areas. Wings are fully developed, usually with relative long marginal fringes.

A single specimen of *T. ater* was recorded at **AK** Oslo: Østensjøvannet, Oppsalskrenten (EIS 28), August 1996 (malaise-trap), leg. Morten Falck & LOH, and another specimen at **BØ** Drammen: Underlia (EIS 28), July 1995, (malaise-trap), leg. LOH. Both specimens are deposited in the collections at the Zoological Museum of Oslo.

Thysanus ater is recorded from Moldavia, N Caucasus, C Asia and W Europe including the British Isles (Tryapitsyn 1978, Fitton et al. 1978). However, Hansson (1991) did not include the species in his list of Swedish species, but according to Landin (1971), the family is represented by two species in Sweden.

The species is a secondary parasite of armoured scale insects of the family Diaspididae (Hemiptera, Coccoidea), probably as an endoparasitoid on other chalcids (Tryapitsyn 1978).

Acknowledgements. I am greatly indebted to Geir E.E. Söli for comments on the manuscript, to Morten Falck for help during the field work, and to Østensjøvannets Venner, Oslo, who financed a part of this study.

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New records of spiders (Araneae) from Norway with notes on epigynal characters of *Philodromus fuscomarginatus* (De Geer) (Philodromidae) and *Araneus sturmi* (Hahn) (Araneidae)

Kjetil Aakra

Aakra, K. 2000. New records of spiders (Araneae) from Norway with notes on epigynal characters of *Philodromus fuscomarginatus* (De Geer) (Philodromidae) and *Araneus sturmi* (Hahn) (Araneidae). Norw. J. Entomol. 47, 77-88.

New records are presented for a number of species collected in western and eastern parts of southern Norway. *Saaristoa firma* (O.P.-Cambridge, 1905) is new to Fennoscandia. *Dipoena torva* (Thorell, 1875), *Entelecara flavipes* (Blackwall, 1834) and *Theridion pinastri* L. Koch, 1972 are new to Norway. *Drassyllus pusillus* (C. L. Koch, ,1833), *Cercidia prominens* (Westring, 1851), *Lasaeola tristis* (Hahn, 1833), *Heliophanus flavipes* (Hahn, 1832), *Theridion mystaceum* L. Koch, 1870 and *Sisicus apertus* (Holm, 1939) are new to western Norway. The first record of *Oedothorax agrestis* (Blackwall, 1853) in south Norway and the second record of *Dendryphantes rudis* (Sundevall, 1832) in over 100 years are reported. Notes on distribution and habitat preferences of the species are given. Variable epigynal characters of *Philodromus fuscomarginatus* (De Geer, 1778) and *Araneus sturmi* (Hahn, 1833) are illustrated and briefly discussed.

Key Words: Araneae, Norway.

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INTRODUCTION

The Norwegian spider fauna is still poorly known and new species are continually discovered. New records are presented here based on collections by the author on Askøy near Bergen (Aakra 1998) and elsewhere in western Norway as well as material taken during a pine canopy fogging project in eastern Norway carried out by the forest biodiversity project «Miljøregistrering i Skog» of the Norwegian Forest Research Institute financed by the Norwegian Ministry of Agriculture. Two species found in the latter collection exhibit epigynal characters that are not in overall agreement with illustrations in the literature. These differences are illustrated and briefly discussed.

Abbreviations of the faunal provinces of Norway follow Økland (1981), nomenclature follows Platnick (1998) except for the linyphiids which follow Tanasevitch (1999). The material is deposited in the collections of the Museum of Zoology, University of Bergen, Norway.

RESULTS AND DISCUSSION

Araneidae

Cercidia prominens (Westring, 1851)

Material: **HOY** Askøy (EIS 39), 20 May–3 June 1997, 1 ♀, pitfall traps in *Sphagnum*-bog (leg. K. Aakra).

First record from Western Norway. Previously only a few records from Nordland and Troms (Hauge 1989). There are also unpublished records from inner parts of Hordaland (Hauge pers. comm., Pommeresche 1999). *C. prominens* is widespread in Sweden (Jonsson pers. comm.), not recorded from the Atlantic islands (Ashmole 1979, Bengtson & Hauge 1979, Agnarsson 1996) and rather uncommon in Britain (Locket & Millidge 1953).

Hänggi et al. (1995) reported it from several different situations, including raised bogs, moist meadows and pine forests.

Araneus sturmi (Hahn, 1833)

Material: **BV** Sigdal (EIS 35), 19 June 1999, 1 ♀, 24 June 1999, 1 ♂, 1 ♀, 25 June 1999, 1 ♂, 26 June 1999, 2 ♂♂, 8. July 1999, 3 ♀♀, 24 July 1999, 1 ♀, 25 July 1999, 1 ♀, 26 July 1999, 1 ♀, all from canopy fogging, crown of pines (leg. J. Skartveit and K. Thunes). **HOY** Osterøy: Herlandsnesjane Nature Reserve (EIS 40), 11 June 1999, 2 ♀♀, sweep netting in low vegetation (leg. K. Aakra).

The genitalia of some of these specimens (Figure 1A and 1B) correspond for the most part to drawings provided by Wiehle (1931), Tullgren (1952), Locket & Millidge (1953), Levi (1973) and Roberts (1995). The scapus of the epigyne (following the terminology of Levi 1971) is coiled as in Figure 1A and the posterior aspect of the lamellae (Figure 1B) is very similar to Figure 10 in Levi (1973), but not Tullgren (1952: Figure 21a). The median apophysis of the male palpal organs fit the description of both Levi and Tullgren. In the females two basic variations of the epigyne exists. There are differences in both the scapus which coils the opposite way (Figure 1C) as often illustrated for *A. triguttatus* (Fabricius) and the lamellae (Figure 1D) which here resemble the drawing

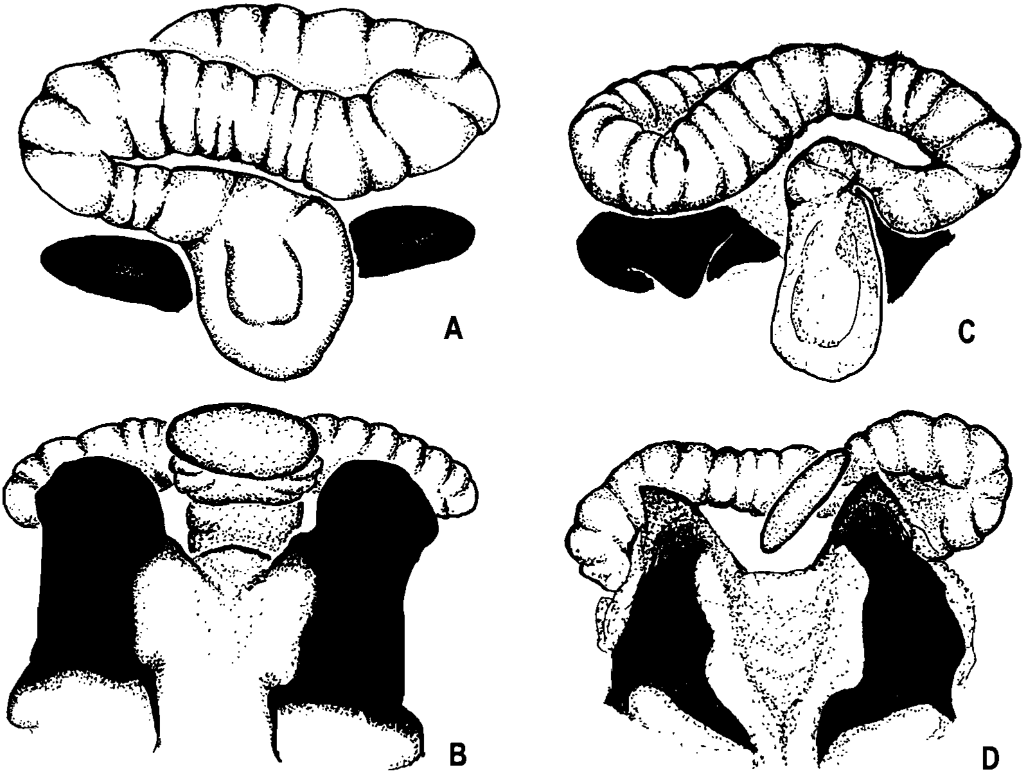

Figure 1. *Araneus sturmi*. Variation of epigynal characters in some specimens from ventral (A and C) and posterioventral perspective (B and D).

provided by Tullgren (1952) for *A. sturmi*.

The two females from Osterøy appear intermediate between the two variations noted above. Both have the scapus coiled as in a «normal» *A. sturmi* (sensu Levi 1973), one has the lamellae of a "normal" *A. sturmi*, while the lamellae of the second resemble those of the other females noted above. Apparently, both types of coiling have been recorded in the literature before, although the variation has not been commented upon. Miller (1971) indicated that the coiling in the two species was different while both Wiehle (1931) and Tullgren (1952) indicate (albeit vaguely) that the coiling in both species is similar. The illustration of Punda (1975) show a coiling similar to the one reported here (Figure 1C). The distinguishing external genital features of *A. sturmi* and *A. triguttatus* are therefore reduced to the shape of the lamellae (see Tullgren 1952, and Levi 1973).

Gnaphosidae

Drassyllus pusillus (C. L. Koch, 1833)

Material: **HOY** Askøy (EIS 39), 12 June-26 June 1996, 2 ♂♂, pitfall traps, *Sphagnum*-bog (leg. K. Aakra).

D. pusillus (Figure 2) has previously been recorded from Norway only once, in eastern parts of the country (Strand 1904). In the Øygarden archipelago west of Askøy it is relatively common (Hauge pers. comm.). There are also an unpublished record from Rogaland (Martens 1982). In Sweden it ranges north to Uppland (Jonsson pers. comm.), and is rather widespread in Finland (Palmgren 1943).

No consensus on the habitat preferences of this species seems to have been reached (Grimm 1983). It has been found in both moist fields, forests remains and meadows (Miller 1967).

Linyphiidae

Entelecara flavipes (Blackwall, 1834)

Material: **BV** Sigdal (EIS 35), 19 June 1999, 1 ♂, canopy fogging, crown of pine (leg. J. Skartveit & K. Thunes).

New to Norway. The species is known from central parts of Sweden (Jonsson pers. comm.) but has not been recorded from Finland (Palmgren 1977). In Britain there are scattered records from southern and central parts (Locket et al. 1974). Otherwise known from continental Europe and eastwards to Russia and Ukraine (Mikhailov 1997). Probably reaches its northwestern limit of distribution in SE Norway.

Usually associated with bushes and vegetation in open sites (Roberts 1987, Maurer & Hänggi 1990), but evidently also on conifers in northern Europe as the current record suggests.

Hypselistes jacksoni (O. P.-Cambridge, 1902)

Material: **HOY** Askøy (EIS 39), 21 April-2 June 1997, 4 ♂♂, pitfall traps, *Sphagnum*-bog (leg. K. Aakra).

Second record from Norway. The first was from an eutrophic low-alpine dwarf-shrub heath in Jotunheimen in Oppland, central Norway (Hauge & Refseth 1979). There are also unpublished records from a bog on Stord (Greve & Hauge 1989) and from inner parts of Hordaland county (Pommeresche 1999). *H. jacksoni* is generally a northern species, known from central and northern parts of Sweden (Jämtland to Torne Lappmark, Jonsson pers. comm.), most frequent in northern regions in Finland (Palmgren 1976) and otherwise in northern parts of Asia and America (Marusik & Leech 1993). The species is also reported from the British Isles (Roberts 1987), but apparently lacking from southern Germany (Blick & Scheidler 1991).

H. jacksoni is associated with damp, open habitats (Palmgren 1965, Snazell 1982, Platen et al. 1991) as well as lake shores, birch wood margins, wet moss (Palmgren 1976) and *Calluna* and *Erica* dominated situations (Janssen 1991). On Askøy the species was only found in a raised bog dominated by *Sphagnum* and it may be a good character species of peatlands in coastal parts of western Norway. Marusik & Leech (1993) did not give any detailed information on habitat preferences but mentioned that it could be found in different types of habitats in both lowlands and mountainous tundra. Holm (1983) reported the species as locally abundant.

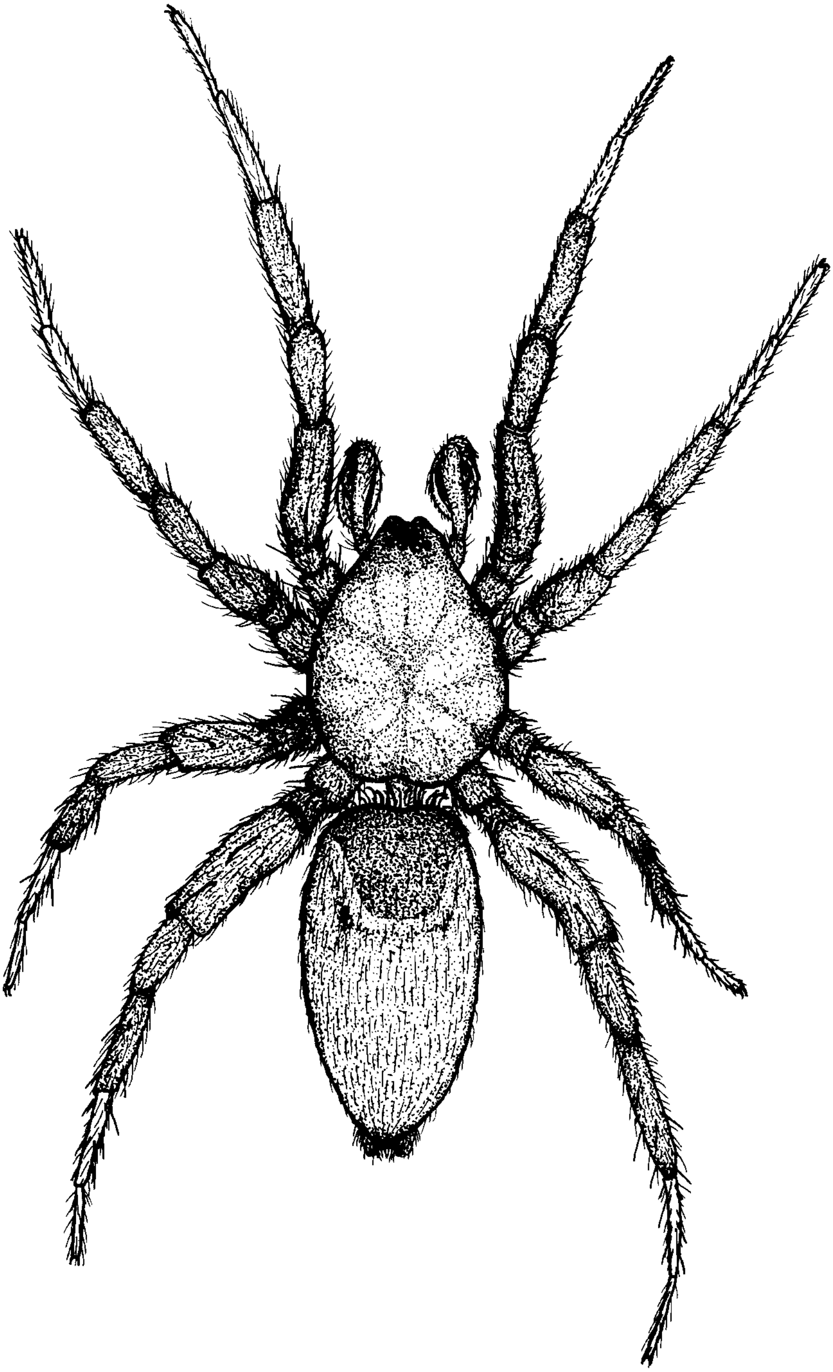

Figure 2. *Drassyllus pusillus.* Imago ♂.

Oedothorax agrestis (Blackwall, 1853)

Material: **HOY** Osterøy: Herlandsnesjane Nature Reserve (EIS 40), 13 August 1999, 2 ♂♂, 2 ♀♀, 1 juvenile, manually collected from stony lakeshore.

First record from southern Norway since Strand (1902) who reported it from Suldal in inner Rogaland. There is also one record from Finnmark (Hauge 1976). The species is widespread in Sweden (Jonsson pers. comm.), Finland (Palmgren 1976), Ireland and Great Britain (Locket et al. 1974), continental parts of Europe (Maurer & Hänggi 1990) and ranges as far east as South-Siberia (Esyunin & Efimik 1996).

The species appears to be common on stony lakeshores. Indeed, the locality in Herlandsnesjane corresponds exactly to the habitat descriptions of Palmgren (1976), Hauge (1976) and Maurer & Hänggi (1990).

O. agrestis is distinguished from other *Oedothorax* species in the region by the large ventral apophysis on the palpal tibia (Figure 3A) and by the unmodified carapace in the male (Figure 3B) while the female (epigyne in Figure 3C) is distinguished by internal genitalia (see Roberts 1987) or by association with males. A peculiar anomaly was noted regarding the male palps: the smallest tibial apophysis is reduced in length, but only on the left pedipalp (Figures 3D and 3E).

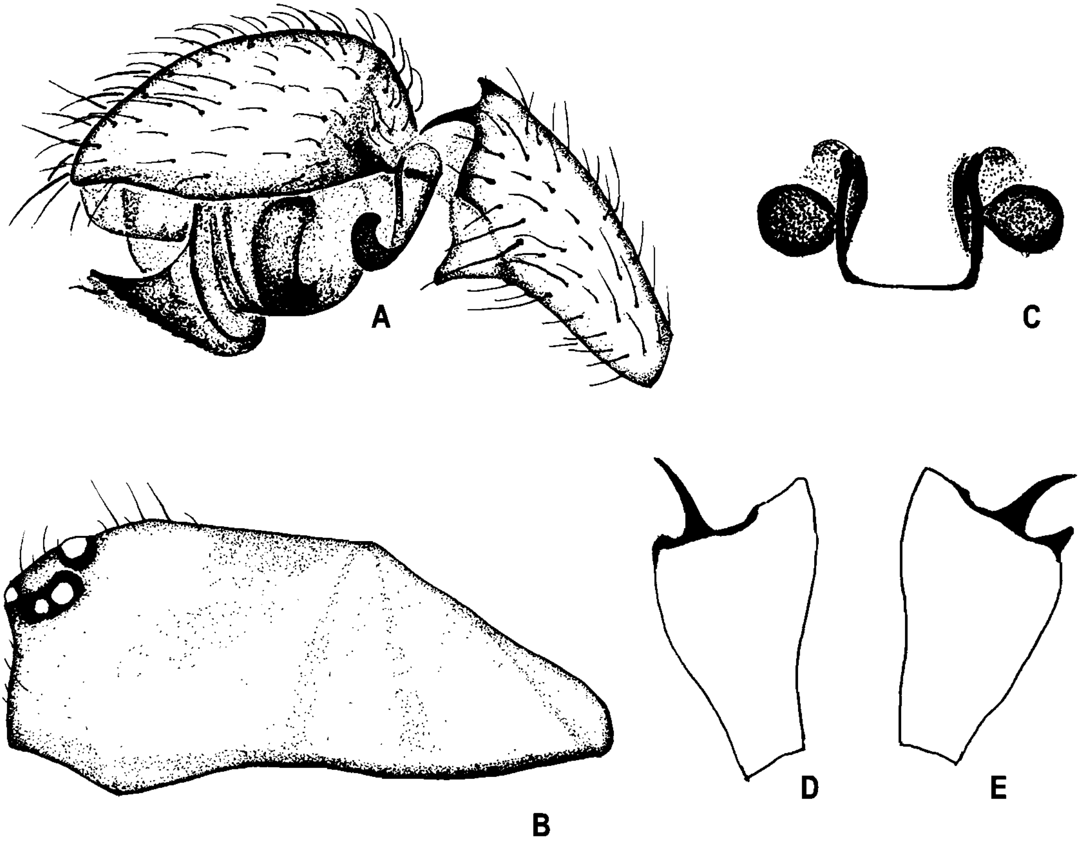

Figure 3. *Oedothorax agrestis.* ♂ palpus (A) and carapace (B) and epigyne (C). Left (D) and right (E) tibial apohyses of both ♂ specimens examined.

Saaristoa firma (O.P.-Cambridge, 1905)

Material: **HOY** Askøy (EIS 39), 22 August-21 September 1997; 2 ♂♂, 1 ♀, pitfall traps, *Alnus/Pinus* forest. Bømlo (EIS 22), 3 August 1998, 1 ♀, manually collected in deciduous forest, (leg. E. Hauge).

First record from Norway, indeed *S. firma* is new to Fennoscandia as it has not been reported from Sweden (Jonsson and Kronestedt pers. comm.), nor from Finland (Koponen pers. comm.). There are a few unpublished records from Denmark (Toft pers comm.). In central Europe the species seems to be most common in the mountainous regions including the Alps, sometimes being locally abundant (Thaler 1981). In northern Europe records tend to be more infrequent and collections sites more scattered (Locket et al. 1974). It is not known from Russia or Siberia (Tanasevitch pers. comm.).

Records from a private database (kindly made available by T. Blick) indicate that this species may be found in a range of different situations, often in *Sphagnum*-dominated sites, different humid forests types (predominantly spruce and mixed spruce forests) and caves. Casemir (1976) took *S. firma* in moist moss in spruce forests while Kropf & Horak (1996) suggested that litter of deciduous forests constitutes the principal habitat of the species.

Sintula corniger (Blackwall, 1856)

Material: **HOY** Askøy (EIS 39), 17 April-22 September 1996, 9 May-23 May 1997, 5 ♂♂, 2 ♀♀, pitfall traps, various habitats (leg. K. Aakra).

Second official record of this species from southern Norway, previously known from Tysfjord and Narvik in north-eastern Nordland (Hauge 1989). It is also known from Stord (Greve & Hauge 1989) and inner parts of Hordaland county (Pommeresche 1999). In Sweden the species has been found from Uppland to Lycksele Lappmark (Jonsson pers. comm.), in Finland north to central parts of the country (Palmgren 1975). Apparently widely distributed in most parts of Europe from the north to the south, but rarely reported (Kritscher 1971/72), although it may be locally abundant (Casemir 1976). Most records are from moist moss-dominated (predominantly *Sphagnum*) situations in various types of forests (Holm 1968, Kritscher 1971/72, Casemir 1976, Hauge 1977). On Askøy *S. corniger* was found in various habitats with lush vegetation, suggesting that it is not strictly sphagnicol as earlier records may indicate. Other authors (Casemir 1976, von Broen 1985, Hänggi et al. 1995) have reached the same conclusion.

Sisicus apertus (Holm, 1939)

Material: **HOY** Askøy (EIS 39), 2 September-23 April 1997, 4 ♂♂, pitfall traps, *Alnus/Pinus* forest (leg. K. Aakra).

First record from western parts of Norway, previously only known from SE areas of the country (Hauge 1989), reaching Torne lappmark in Sweden (Jonsson pers. comm.) and known from most parts of Finland (Palmgren 1975). It has not been recorded from Great Britain or Ireland (Merrett et al. 1985, Merrett 1995) and is rare in high-altitude areas in continental Europe (Thaler 1969, 1993). Widespread throughout northern Asia to Alaska, the Rocky Mountains and the North-American Atlantic coast (Eskov 1994).

In Norway the species has previously been taken from pine forests, mixed pine forests, *Vaccinium-Pinetum* mixed forest, a bog (Hauge & Wiger 1980, Tveit & Hauge 1983) and forest-fire areas (Hauge & Kvamme 1983). It has also been found in margins of mires and in *Sphagnum* in spruce forests (Palmgren 1975), moss-dominated coniferous forests (Thaler 1993) and *Hylocomium*-moss in a birch forest (Holm 1939).

Philodromidae

Philodromus fuscomarginatus (De Geer 1778)

Material: **BV** Sigdal (EIS 35): 5 June 1998, 1 ♀, hand collecting, beneath bark of dead pine, 10 June 1998, 2 ♂♂, canopy fogging, crown of pine, 24 June 1999, 1 ♂, canopy fogging, crown of pine (leg. J. Skartveit and K. Thunes).

The female illustrated here (Figure 4) appears to be conspecific with *Philodromus fuscomarginatus* sensu Tullgren (1944), Punda (1975) and Heimer

& Nentwig (1991) but differs in some respects in epigynal characters. The posterior lateral borders of the epigyne (Figure 4) are closer together in my specimen than indicated by Tullgren (1944) and Heimer & Nentwig (1991) and is more in accordance with the drawing of Punda. The central ridge («mittstycke» of Tullgren) does not widen towards the epigastric opening as in Tullgren (1944) and Heimer & Nentwig (1991). The presence of numerous stout hairs in the posterior half of the central ridge seems to have been overlooked or omitted in previous illustrations. The spermatheca are more or less identical with those of Tullgren (1944) and Dondal & Redner (1975). The specimen fits the description of somatic characters given by Tullgren (1944).

P. fuscomarginatus is relatively widespread in Norway, having been recorded from eastern parts of south Norway as well as Finnmark (Hauge 1989). It is also widespread in Sweden (Jonsson pers. comm.) and Finland (Palmgren 1950).

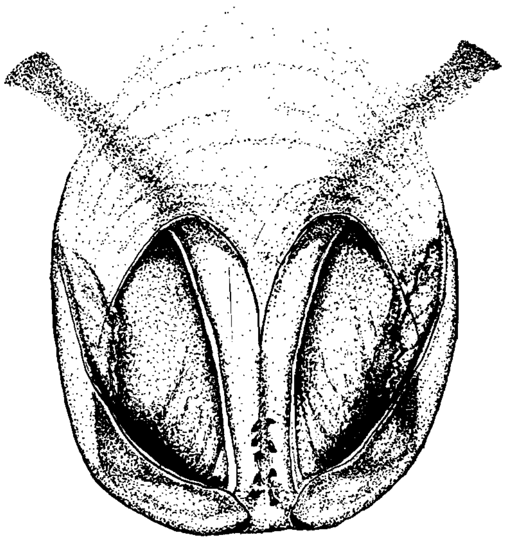

Figure 4. *Philodromus fuscomarginatus.* Epigyne. Hairs omitted from epigyne for clarity, except for the stout hairs on the central ridge.

Salticidae

Dendryphantes rudis (Sundevall, 1832)

Material: **BV** Sigdal (EIS 35), 5 June 1998, 1 ♀, canopy fogging, crown of pine (leg. J. Skartveit and K. Thunes).

Collett (1875) reported *D. rudis* from SE Norway but these records appear to have been combined with those of *D. hastatus* (Clerck, 1757) given by Collett (1875) and published under the latter name in the Norwegian check list (Hauge 1989). In addition to the record given here it has also been found on an island in the Oslofjord (Hauge & Hansen 2000). In Sweden *D. rudis* is widespread, ranging north to Norrbotten (Jonsson pers. comm.), while it is known from southern parts of Finland (Hutha & Raatikainen 1974, Palmgren 1943). It is common in Europe except Great Britain where it has not been found (Roberts 1995).

D. rudis occurs in coniferous forests (Hänggi et al. 1995), being found on tree trunks and branches (Palmgren 1943).

Heliophanus flavipes (Hahn, 1832)

Material: **HOI** Etne: Ljusnes (EIS 23), 8 July 1999, 1 ♂, handpicked from grazed pasture (leg. K. Aakra).

New to western Norway. Previously known from the Oslofjord area (Hauge 1989, Andersen & Hauge 1995). Occurs north to Medelpad in Sweden (Jonsson pers. comm.), rather common in southern and central parts of Finland (Palmgren 1943) and widespread in Britain and Ireland (Locket et al. 1974) and the rest of the Palearctic region (Maurer & Hänggi 1990, Esyunin & Efimik 1996).

H. flavipes is usually associated with open grassy fields with varying degrees of moisture (Maurer & Hänggi 1990), a thermophilous species according to Braun (1969) and Buchar (1975).

Theridiidae

Dipoena torva (Thorell, 1875)

Material: **BV** Sigdal (EIS 35), 26 June 1998, 1 ♀, canopy fogging, trunk of old pine (leg. J. Skartveit and K. Thunes).

First record from Norway. *D. torva* is known from Södermanland, Östergötland and Uppsala in Sweden (Jonsson pers. comm.), southern Finland (Palmgren 1974), northern Great Britain (Roberts 1995) and central Europe and is known as far east as Middle-Siberia (Esyunin & Efimik 1996, Mikhailov 1997), but rare throughout its known range.

The species is restricted to older trees, predominantly pines in northern Europe, where is spins a small web in deep fissures in the bark which is used to catch wood ants (Bratton 1991, Roberts 1995, Platen pers. comm.). Presence of older trees with deeply structured bark covering and wood ants would thus be necessary for this species (Roberts 1995). In consequence, there can be little doubt that modern forestry practices represent a threat to this species (Palmgren 1974). This is substantiated by the fact that the Norwegian specimen was taken on a 250 year old pine (measured at breast height) measuring 17.5 m in height and having a 8.5 m canopy diameter (Skartveit pers. comm.).

The shape of the dark markings above the central fissure of the epigyne (Figure 5) differs somewhat from the illustrations in Miller (1967) and Roberts (1995). This is probably the result of different interpretations by the various authors or variations in the level of sclerotisation.

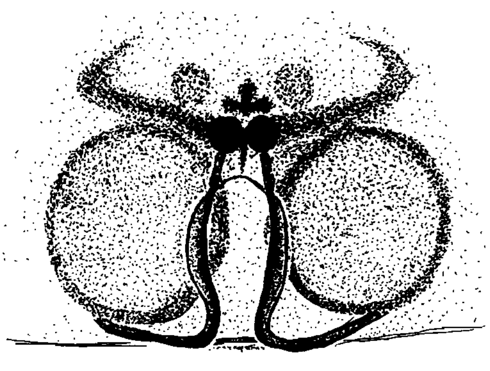

Figure 5. *Dipoena torva.* Epigyne.

Lasaeola tristis (Hahn, 1833)

Material: **HOY** Osterøy (EIS 40): Herlandsnesjane Nature Reserve, 11 June and 12 August 1999, 3 ♂♂, sweep netting from low vegetation on bogs and wetlands (leg. K. Aakra)

First record from western Norway, previously known from the Oslofjord area (Hauge 1989, Hauge & Hansen 1991, 2000). Recorded north to Norrbotten in Sweden (Jonsson pers. comm.) and approximately the same latitude in Finland (Palmgren 1974). In Great Britain and Ireland it is quite local and restricted to southern counties (Locket et al. 1974). *L. tristis* is otherwise known from continental Europe and Russia (Platnick 1998). The current record probably represent the northwesternmost limit of distribution of this species.

It is most common in *Calluna* and low vegetation although it can also be found on young conifers (Palmgren 1974).

Theridion mystaceum L. Koch, 1870

Material: **HOY** Askøy (EIS 39), 9 June 1996, 1 ♀, 15 June 1996, 2 ♂♂ and 2 ♀♀, 20 July 1996, 1 subadult ♂, 1 ♀, 31 October 1996, 2 ♀♀, all manually collected from road-cuts and vertical rock sides. Bergen: Kalfaret (EIS 39), 5 May 1999, 1 ♂, 1 subadult ♂ and 3 juveniles, manual collecting from road-cut. Bømlo, near Olavsskolen (EIS 22), 13 August 1996, 1 ♀, manual collecting in road cut (leg. K. Aakra).

New to Western Norway, the only other known record is from the Oslofjord region (Hauge & Hansen 2000).

Available evidence suggests that *T. mystaceum* has often been confused with the closely related species *T. melanurum* Hahn, at least in Sweden (Jonsson 1995). No *T. melanurum* specimens were deposited in the collections of the Zoological Museum in Bergen. Given the commonness of *T. mystaceum* in western parts of Norway (from where the single report of *T. melanurum* originated, see

Hauge 1989) the misidentification has most probably occurred in Norway as well. *T. melanurum* should therefore be omitted from the Norwegian check-list until identifyable specimens are collected.

T. mystaceum is usually found on and near buildings, *T. melanurum* preferring somewhat drier situations, although this does not seem to hold for Britain (Parker 1990). Locket et al. (1974) indicated that *T. melanurum* could also be found amongst stones on the Continent, while *T. mystaceum* is most commonly found on tree trunks, evergreen bushes and occasionally on the outside of houses and sheds. These habitat descriptions are of little value in separating the species according to Roberts (1985). In Britain *T. mystaceum* is the commonest of the two, *T. melanurum* being less frequent in the north which is consistent with the apparent absence of this species from western Norway. The current Norwegian records indicate that *T. mystaceum* is very common in road-cuts and similar natural habitats.

The distinguishing features of the epigynes of *T. mystaceum and T. melanurum* are illustrated in Figure 6. The ducts of *T. mystaceum* are characterised by the more rounded epigynal socket in which the seminal ducts may be visible. These ducts are also more extensively coiled in *T. mystaceum* than in *T. melanurum*. Detailed examination is needed to distinguish the males (Locket et al. 1974, Roberts 1985).

Theridion pinastri L. Koch, 1872

Material: **BV** Sigdal (EIS 35), 24 June 1999, 1 ♂, canopy fogging, crown of pine (leg. J. Skartveit & K. Thunes.).

New to Norway. The species occurs north to Upp-

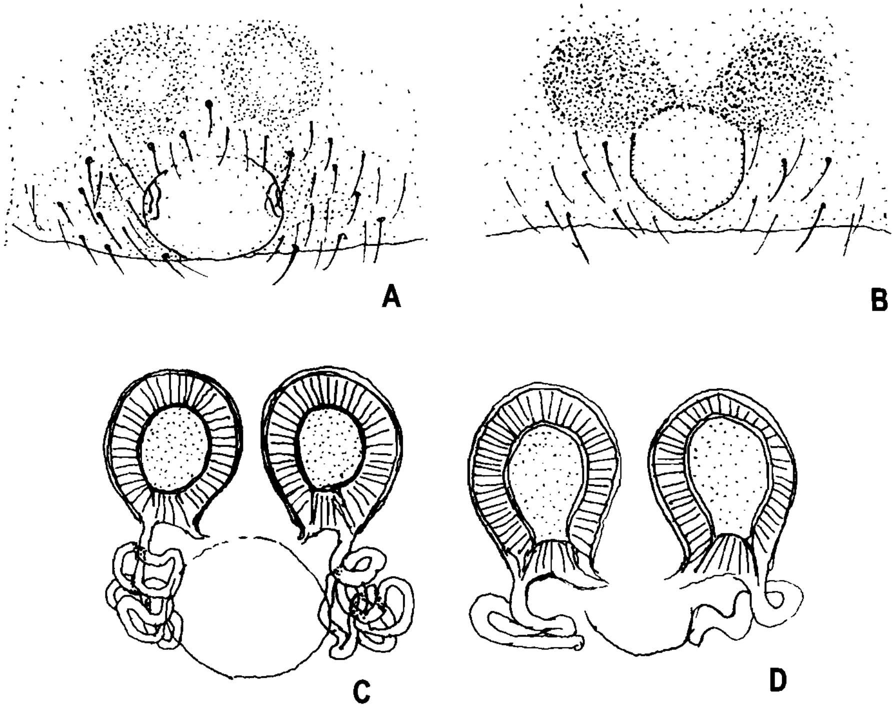

Figure 6. The epigyne and vulvae of *T. mystaceum* (A and C) and *T. melanurum* (B and D). Drawings of *T. melanurum* after Roberts (1985).

land in Sweden (Jonsson pers. comm.) and is apparently rather common in southern Finland (Palmgren 1974), but was only recently discovered in Great Britain (Murphy & Murphy 1979) where it is rare (Bratton 1991). The species is also known from southern and central Europe and throughout Asia to Japan (Esyunin & Efimik 1996).

Although it has been found in semi-open habitats with *Calluna* and *Juniperus* (Palmgren 1974, Murphy & Murphy 1979), coniferous forests appear to be preferred (Palmgren 1974, Maurer & Hänggi 1990).

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New records of Norwegian Lauxaniidae (Diptera)

Lita Greve

Greve, L. 2000. New records of Norwegian Lauxaniidae (Diptera). Norw. J. Entomol.47, 89-93.

Seven species of lauxaniid flies (Diptera, Lauxaniidae) *Homoneura tenera* (Loew, 1846), *Aulogastromyia anisodactyla* (Loew, 1845), *Lyciella decipiens* (Loew, 1847), *Lyciella platycephala* (Loew, 1847), *Lyciella subpallidiventris* Papp, 1978, *Lyciella vittata* (Walker, 1849) and *Sapromyza quadricincta* Becker, 1895 are recorded for the first time from Norway. *Lyciella subpallidiventris* and *Sapromyza quadricincta* are both recorded new to Fennoscandia and Denmark. Remarks are made on the distribution of *Tricholauxania praeusta* (Fallén, 1820) in Norway.

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INTRODUCTION

The fly family Lauxaniidae (Diptera) is still unsufficiently known from Norway. Siebke (1877) recorded twentytwo lauxanid species from Norway, not as Lauxaniidae proper, however, fifteen species were listed as genus *Sapromyza* Fallén and seven as the genus *Lauxania* Fabricius.

Number thirteen in the genus *Sapromyza* listed by Siebke was *Sapromyza flava* Lin. (= Linneus, 1758). This name is today valid as *Chyromya flava* (L.) (Chyromyidae), see Andersson (1971) and is listed as this species by Soós (1984). As number fourteen Siebke listed *Sapromyza bipunctella* Zetterstedt (= Zetterstedt, 1847). Andersson (1971) after examination of Zetterstedt's material, decided that *S. bipunctella* (Zetterstedt, 1847) is a synonym of another species in the family Chyromyidae viz. *Chyromyia femorella* (Fallén, 1820). As number fifteen Siebke listed *Sapromyza chrysophthalma* Zetterstedt (= Zetterstedt, 1847). Andersson (1971) examined the typematerial of this species which were all females. Andersson designated a lectotype from Zetterstedt's material and Andersson also states that this lectotype belongs to the same species as described by Fallén as *Sapromyza lutea* Fallén, 1820. *Sapromyza lutea* (Fallén, 1820) is today considered a synonym of a third species in the family Chyromyidae *Chyromyia oppidana* (Scopoli, 1763). Thus only nineteen species of the originally twentytwo in Siebke's check list truely belong to the family Lauxaniidae.

Due to variability in characters used in descriptions in the past, there are many species or species-groups that needs revision. A few genera have been revised like *Minettia* by Shatalkin (1998). One should also bear in mind that while males can have very distinctive characters in the genitalia, the females often do not, and females of several species are difficult to determine with certainty.

New species from Norway have in the later years been recorded by Rognes (1995), Greve (1997, 1999), Greve & Skartveit (1998) and Greve, Pommeresche & Skartveit (1998). The systematic follows Papp & Shatalkin (1998) and Papp (1984). Abbreviations used in the text are: LT= Light trap, MT= Malaise trap, CT= Collision trap, YT= Yellow tray.

List of abbreviations: AF: Arne Fjellberg, BS: Bjørn A. Sagvolden, BØK: Bjørn Økland, IG: Ida Greve Korsnes, GB: Gudrun W. Bakkerud, LG: Lita Greve, GAH: Godtfred Anker Halvorsen, LOH: Lars Ove Hansen, OH: Oddvar Hanssen, DWJ: D.W.Johansen, JK: Jostein Korsnes, SK: Sverre Kobro, FM: Fred Midtgaard, AFO: Arne Foldvik, HB: Harald Breilid, HS: Harald Solberg, JS: John Skartveit, LS: Liv Sognes, TA: Trond

Andersen.

Regional abbreviations are given in accordance with Økland (1981).

Subfamily Homoneurinae

Homoneura tenera (Loew, 1846)

Record: **TEI** Tinn: Håkanes, Håkanesodden (EIS 26), MT, July 1995, 1♂ 1♀, leg.BS.

The Malaise trap was operating the whole summer, but only two specimens were collected. The trap was situated on an open area which earlier was a small farm, and the forest around consisted of partly conifers and partly deciduous trees.

In the subfamily Homoneurinae the small black spines along the costa reach apex of vein R 4+5 while in all genera in the subfam. Lauxaniinae these spines diminish in size and stop between apices of R2+3 and R4+5. *H. tenera* is a light-yellow coloured species with dark spots on the wings, and on account of the spotted wings it superficially looks like *Lyciella decempunctata* (Fallén) in the subfamily Lauxaniinae which is a very common species in the lowlands of Southern Norway.

H. tenera is the first species of the genus *Homoneura* and of the subfamily Homoneurinae recorded from Norway. The genus *Homoneura* is the only genus of this subfamily in Fennoscandia and Denmark and four species have been recorded from Finland (Hackman1980) and three from Sweden (H. Andersson pers. comm.). *H. tenera*, however, is not recorded from Sweden.

Subfamily Lauxaninae

Aulogastromyia anisodactyla (Loew, 1845)

Records: **AK** Nesodden: Fagerstrand (EIS 28), LT, 11 - 12 Oct. 1994, 2 ♀♀, 2 - 3 Aug. 1995, 1 ♀, 3 - 4 Sept. 1995,1 ♂, 4 - 5 Sept. 1995, 1 ♀, 24 - 25 Sept. 1995, 1 ♀, 8 - 9 Oct. 1995, 1 ♀, 3 - 4 Aug. 1998, 1 ♀, 20 - 21 Aug. 1998, 1♂ 1♀, leg. SK.

Two males and 8 females of *A. anisodactyla* were sorted out from material collected in a light trap at Akershus: Fagerstrand. The trap was situated in an edge habitat between old coniferous forest, temperate deciduous forest, open grassland and a garden (Kobro 1991), and this lighttrap has been run throughout every summer since 1984. Lauxaniid flies have, however, only been sorted out for some of the latest years.

The light trap was opened in June every year, and the first specimens of *A. anisodactyla* appeared in early August. Specimens have been caught in the months between August and October which suggest a flight period in the autumn in southern Norway.

A. anisodactyla was described from Germany. It has been recorded from Sweden and Finland and is distributed in most of Europe including Italy according to Papp (1984a).The male has the outer claw of the tarsus of the third pair of legs very enlarged and can be easily recognized because of this character. The female can be recognized on the segment seven of the abdomen which is formed like a tube and somewhat enlarged. The colour of head and body is light yellow. The tip of the antenna is darkened.

A. anisodactyla is the only species in this genus in NW Europe. Shatalkin (1993) described another species *A. rohdendorfi* from Turkmenistan.

Lyciella decipiens (Loew, 1847)

Record: **AK** Nesodden: Fagerstrand (EIS 28), LT, 9 - 10 July 1997, 1 ♀, leg. SK.

For description of the locality see above. *L. decipiens* is a yellow species with a shining thorax and yellow antennae and black palpi. The eight sternum of the female abdomen is large and of a distinctive form see Remm & Elberg (1979).

L. decipiens is recorded from Sweden (H. Andersson pers. comm.), Finland (Hackman, 1980) and from Denmark (as *L. descipiens* (Loew)) by Reddersen, 1995.

Lyciella platycephala (Loew, 1847)

Records: **AK** Nesodden: Fagerstrand (EIS 28), LT, 4 - 5 Sept.1995, 1 ♂, leg. SK.

For description of the locality Nesodden: Fagerstrand, see above.

The females of *L. platycephala* have large, eversible organs in the membrane at each side of the abdomen. The hind margin of the forth terga of the abdomen have very long, strong bristles especially on the side. The males have small outer genitalia, see Remm & Elberg (1979).

L. platycephala is recorded from Sweden (H. Andersson, pers.comm.) and Finland (Hackman, 1980).

Lyciella subpallidiventris Papp, 1978

Record: **AK** Nesodden: Fagerstrand (EIS 28), LT, 28 - 29 Aug. 1997, 1 ♂, leg. SK.

For description of the locality see above. *L. subpallidiventris* is very similar to *L. pallidiventris* (Loew, 1847) and differs in characters of the male genitalia only. It was described together with *L. stylata* Papp, 1978 from Hungary and Germany (Papp, 1978). The females of *L. pallidiventris*, *L. stylata* and *L. subpallidiventris* can not be separated at present. Dr.Laszlo Papp, Budapest has verified the determination.

L. subpallidiventris has been recorded from Hungary, Germany, Estonia and the British Isles viz. England, Ireland/Eire and Scotland (Godfrey 1994), and it is here recorded new from Fennoscandia and Denmark.

Lyciella vittata (Walker, 1849)

Records: **AK** Enebakk: Nordre Bøler (EIS 29), MT, June 1996, 1 ♀, leg. HB & HS. **BØ** Nedre Eiker: Mjøndalen, Miletjern (EIS 28), LT, Ultimo June 1988, 1♀, leg. DWJ. **RY** Hå: Ogna (EIS 3), 21 May 1988, 1 ♀, leg. LG, Ogna (EIS 3), MT, 19 July - 21 Aug. 1996, 1 ♀, leg. IG & LG. **HOY** Bergen (Fana): Flesland (EIS 30), 30 May 1966, 1 ♂, leg. AF, Bergen (Åsane): Eidsvåg, Vollane (EIS 39), MT, 21 June - 10 July 1986, 1♀, leg. LG, det. Hugo Andersson, Os: Gåssand, Raudlien (EIS 30), 6 - 28 June 1990, 1 ♀, leg. GAH. **SFY** Gulen: Brekkestranda (EIS 49) 30 June 1983, 1 ♀, leg. LG, Hyllestad: Botnen 32 UTM 995917 (EIS 48), MT, 21 June - 25 July 1999, 2 ♀♀, 32 UTM 996917, MT, 21 May - 21 June, 12♂♂ 19 ♀♀, 21 June - 25 July, 3 ♀♀, leg. LS & LG, Naustdal: Naustdal (EIS 58), MT, 28 May - 3 July 1986, 1♂, 3 - 28 July 1986, 1♂ 1♀, leg. FM. **MRI** Norddal: Fjøra (EIS 77), MT, 23 June - 18 July 1993, 1 ♂, 23 June - 18 July 1993, 1♂, leg. OH. **MRY** Hareid: Håbakken (EIS 76), MT, 19 - 24 July 1991, 1 ♀, leg. LG, Hareid: Kråkholen (EIS 75), MT, 1 - 20 May 1990, 1 ♀, 20 May - 10 June 1990, 1 ♂, 10 June - 16 July 1990, 4 ♂♂ 4 ♀♀, leg. JK. **NTI** Stjørdal: Vikan (EIS 92), MT, 25 May - 28 June 1990, 1 ♀, leg. AFO.

L. vittata has frons and thorax coloured with distinct, longitudinal and alternating stripes in grey and chocolate brown. The genitalia of both sexes are distinctive, see Remm & Elberg (1979). Papp (1978b) redescribed *L. vittata*, and he also decided that *L. quadrivittata* (Loew, 1861) (=*Sapromyza quadrivittata* Loew, 1861) is a synonym of *L. vittata* (Walker, 1849).

All records are from lowlands in southern Norway where *L. vittata* seems to have a wide distribution. At Hyllestad, Botnen two MT were operating from 25 May untill 14 September 1999, and 36 specimens were collected from May to July. One trap was situated in deciduous forest, the other in groups of *Corylus avellana* L. Specimens were caught between 21 May and 25 July and none between 25 July and 14 September when the Malaise trap was taken down. At Hareid, Kråkholen one MT operating from early May untill September, 10 specimens were caught between 1 May and 16 July, and none later.

According to Papp (1984a) *L. vittata* has been recorded from both Finland and Sweden.

Sapromyzosoma quadricincta (Becker, 1895)

Synonym: *Sapromyza bipunctata* Meigen, 1830

Record: **BØ** Drammen: Underlia (EIS 28), MT, June 1994,1 ♂, leg. LOH.

The male of this species has large genitalia «curved caliper-like towards each other» according to Collin (1948). The male from Underlia was compared with material in the Hope collection, Oxford.

Papp (1984a) reports the distribution to be: Great Britain, Germany, France, Austria, Hungary, the former Czechoslovakia, Romania, Bulgaria and the former Jugoslavia, and does not mention Fennoscandia or Denmark. Thus, *S. quadricincta* is probably new to this area.

Tricholauxania praeusta (Fallén,1820)

New records: **AK** Nesodden: Fagerstrand (EIS 28), LT, 24 - 25 June 1995, 1 ♂, 5 - 6 Aug. 1995, 1 ♀, 15 - 16 Aug. 1995, 1♂, 2 - 3 Aug. 1996, 3 ♂♂ 3 ♀♀ 12 - 13 Aug. 1996, 1 ♂, 29 - 30 Aug. 1996, 1 ♂, 10 - 11 Aug. 1997, 1 ♀, 18 - 19 Aug. 1997, 1 ♂, 20 - 21 Aug. 1997, 2 ♂♂ 1 ♀, 28 - 29 Aug. 1997 1 ♀, LT, leg. SK, Asker: Bjørkås (EIS 28), MT, 24 Aug. - 10 Oct. 1995, 1 ♂ 1 ♀, leg. LOH & OH. **BV** Rollag: Tråen saga (EIS 35), MT, Aug. 1994, 1 ♀, leg. BS. **VE** Tjøme: Moutmarka (EIS 19), 22 June 1995, 2 ♀♀ leg. JS. **RY** Hå: Ogna 32 UT♂ VLK 138903 (EIS 3), MT, 17 July - 21 Aug. 1996, 2 ♂♂, 2 MT, leg. IG & LG, Finnøy: Kvitevik (EIS 14), MT, 26 June - 5 August 1995, 1 ♂ 12 ♀♀, MT, leg. JS. **HOY** Bergen: Munkebotten (EIS 39), 14 July 1987 ,1 ♂, leg. LG, Straume (EIS 30), 31 Aug. 1979, 1 ♂ 2 ♀♀ leg. TA, (Åsane) Vollane, YT, (EIS 39), 7 - 9 Sept. 1992, 1 ♀, leg. LG, Bømlo: Kalvnesset (EIS 22), 17 - 18 Aug. 1992, 1 ♂, leg. LG, Fusa: Djupvik (EIS 31), 10 July 1995, 2 ♂♂, leg. GB & LG. **HOI** Kvam: Gravdal, Svevatn (EIS 31), MT, 28 May - 1 July 1997, 32 ♂♂ 20 ♀♀, 1 - 29 July 1997, 6 ♂♂ 5 ♀♀, 29 July - 11 Sept.1997, 18 ♂♂ 9 ♀♀, 11 Sept.- 29 Oct.1997, 1♂ 1♀, leg. JS. **SFY** Hyllestad: Botnen, 32V KN 995917/996917 (EIS 48), 2 MT, 21 May - 21 June 1999, 18 ♀♀, 21 June - 25 July 1999, 4 ♂♂ 7 ♀♀, 25 July - 7 Sept. 1999, 10 ♂♂ 19 ♀♀, 7 - 14 Sept. 1999, 1 ♂ 7 ♀♀, leg. LS & LG; Naustdal: Naustdal (EIS 58), MT, 3 - 28 July 1986, 1 ♀, leg. FM. **MRI** Norddal: Fjøra (EIS 77), MT , 23 June - 18 July 1993 1 ♂ 1 ♀, 18 July - 11 Sept.1993, 2 ♀♀ leg. OH.

T. praeusta was published from Østfold: Fredrikshald, Akershus: Oslo and Enebakk and Møre og Romsdal: Gjemnes by Siebke (1877) as *Sapromyza præusta* Fallén. This material was mislabeled in the collection in the Zoological Museum, University of Oslo, and therefore overlooked by Greve & Skartveit who (1998) published *T. praeusta* as a new species for the Norwegian fauna from inner and outer Rogaland, and inner Møre og Romsdal.

However, later the following material of *T. praeusta* collected by Siebke were discovered in the collection in Oslo: **Ø** Halden: Fredrikshald 1 ♂, **AK** Oslo: Bekkelaget 19 June 1850 1 ♀ and **MRY** Gjemnes: Gjemnes (EIS 84)14 Aug. 1843 1♀.

Much new material has been collected which clearly shows that *T. praeusta* is one of the more common species of lauxaniids in the lowlands of southern Norway. The localities Gjemnes: Gjemnes and Norddal: Fjøra in the province Møre and Romsdal are the northernmost records.

T. praeusta is known from Sweden (H.Andersson pers.comm.) and Finland (Hackman, 1980).

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Agyneta mossica (Schikora, 1993) (Araneae, Linyphiidae) in Norway

Kjetil Aakra

Aakra, K. 2000. *Agyneta mossica* (Schikora, 1993) (Araneae, Linyphiidae) in Norway. Norw. J. Entomol. 47, 95-99.

All material of *Agyneta saxatilis* (Blackwall, 1844) in the collections of the Zoological Museum, Bergen, has been revised and specimens of the recently described and closely allied *A. mossica* (Schikora, 1993) identified. Illustrations of distinguishing morphological characters and notes on the distribution and habitat preferences of both species are presented. Both species are common within their known area of distribution, *A. saxatilis* apparently being restricted to southern Norway while *A. mossica* has a wide distribution having been found from Finnmark to western parts of S Norway.

Key words: Araneae, *Agyneta mossica, A. saxatilis.*

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INTRODUCTION

Schikora (1993) described *Agyneta* (*Meioneta*) *mossica* from Swedish, German and British material showing minute but distinct differences from its sibling species *A. saxatilis* (Blackwall, 1844). The two species are also ecologically separated, *A. mossica* being restricted to bogs whereas *A. saxatilis* is found in a variety of habitats. Further examinations of intra- and interpopulational morphological variation in both species showed that although intergrading specimens did exist the species could be reliably separated by the morphological differences (Schikora 1995). Schikora (1995) also elaborated on differences in habitat preferences and reported *A. mossica* from Norway for the first time (35 km south of Narvik and Vardø, Finnmark). The material of *A. saxatilis* in the collection of the Zoological Museum, University of Bergen, was not examined by Schikora, however, and the distribution of *A. mossica* in Norway was therefore uncertain at best. Furthermore, Norwegian records of *A. saxatilis* was not included in the distribution map of this species (Schikora 1995). During work with the red list proposal for Norwegian spiders (Aakra & Hauge in prep.) it became necessary to revised the aformentioned material in order to assess the status of *A. mosscia* in Norway.

METODS AND MATERIAL

The material examined includes all specimens labelled «*Meioneta saxatilis*» (Blackwall) in the collection of the Zoological Museum, a few additional specimens collected by the author in western Norway and material kindly provided by O. Hanssen and F. Ødegaard from Vardø, Finnmark. Males are differentiated by palpal characters and by differences in cheliceral shape, according to Schikora (1993, 1995). The presence of only a single paracymbial tooth in *A. mossica* (Figure 1) seems to be a reliable distinguishing character. Females can only be separated by detailed examination of epigynal characters, specifically by the degree of curvature of the copulatory ducts (Figure 2, also see Schikora 1995).

Schikora originally described the species in the genus *Meioneta* Hull, 1920 but I have chosen to follow Saaristo (1973) and Russian authors (e.g. Tanasevitch 1999) who have synonymised *Meioneta* with *Agyneta* Hull, 1911, even if this is not followed in recent catalogues (Platnick 1998). Abbreviations of faunal provinces follow Økland (1981). Unless otherwise stated all specimens were caught in pitfall traps.

RESULTS

Agyneta mossica

FN Vardø: Komagvær: Hollamyra (EIS 178), 5-10 July 1998, 4 ♂♂, 1 ♀, palsa bog (leg. O. Hanssen & F. Ødegaard). **HOY** Lindås: Fonnes (EIS 39), 3-6 June 1978, 1 ♀, bog. Stord: Iglatjødn (EIS 23), April-June 1989, 1 ♂, bog (Greve & hauge 1989). Osterøy: Herlandsnesjane Nature Reserve (EIS 40), 11 June-12. August 1999, 1 ♀, bog (Aakra & Djursvoll 2000). **MRY** Haram: Løvsøya (EIS 76), 1-18 June 1992, 1 ♀, bog. **NSI** Saltfjellet: Bjøllådalen (EIS 124), 1-22 July 1974, 2 ♂♂, 3 ♀♀, open, sloping ombotrophic bogs, (Hauge 1976); **RY** Tysvær: Kårstø (EIS 14) , 8-20 May 1981, 2 ♂♂, 1 ♀, bog (Martens 1982).

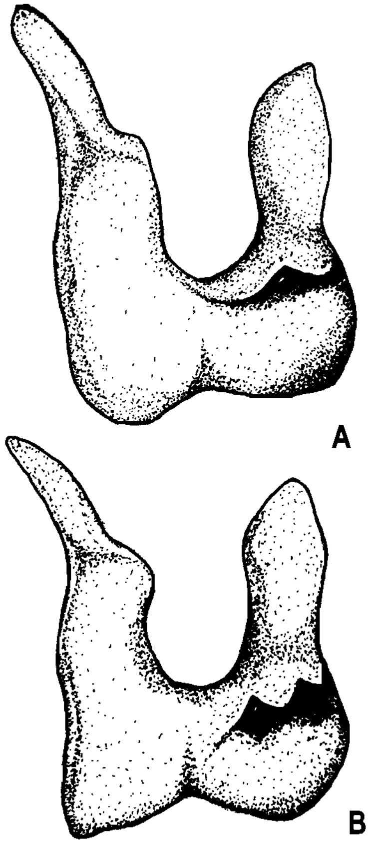

Figure 1. *Agyneta mossica* (A) and *A. saxatilis* (B). Paracymbium of male palps.

Hauge (1976) reported 2 ♂♂ and 6 ♀♀ of *Meioneta saxatilis* collected at Bjøllådalen, Nordland. In the material only 2 ♂♂ and 3 ♀♀ could be found which originated from this site (Hauge pers. comm.).

Agyneta saxatilis

AK Frogn: Håøya (EIS 28), 3-16 June 1984, 1 ♀, malaise trap, mixed deciduous forest (Hauge & Midtgaard 1986). Bærum: Ostøya (EIS 28), malaise trap 30 May-10 June 1984, 1 ♂, 1 ♀, transition sone between bog and forest (Hauge & Midtgaard 1986). **HOY** Os: Hattvik (EIS 31), 8 June 1971, 1 ♂, 1 ♀, sieving of moss, mixed forest.

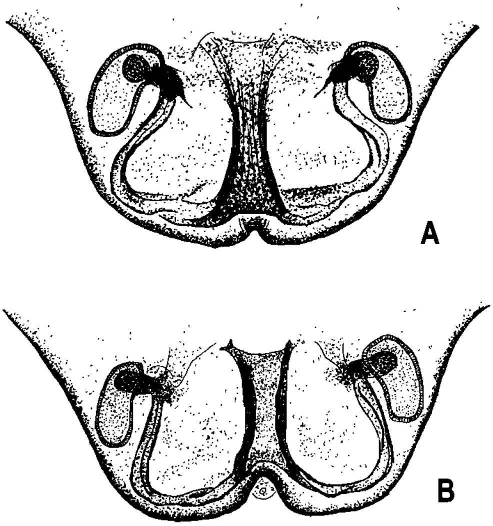

Figure 2. *Agyneta mossica* (A) and *A. saxatilis* (B). Vulval structures.

Osterøy, Lono (EIS 40), 4 May-12 June 1973, 1 ♂, 11-21 July 1973, 1 ♀, light traps, damp site (Andersen et al. 1980). Os: Bjørnåsen (EIS 31), 12 August 1975, 1 ♀, meadow, 28. May 1975, 1 ♀, sieving in meadow. Bømlo: Andal (EIS 22), 24 May-18 September 1977, 1 ♂. Bergen: Åsane (EIS 39), 26 June 1980, 1 ♀. Øygarden: Alvheim (EIS 39), 21 June - 27 July 1982, 2 ♂♂, 1 ♀, gently sloping grassy field. Øygarden: Hjelme (EIS 39), 21 June-8 July 1982, 2 ♂♂, 1 ♀, overgrown meadow. Øygarden: Sture (EIS 39), 21 June-8 July 1982, 1 ♂, deciduous forest, 8 July-21 July 1982, 1 ♂, 1 ♀, grassy meadow. Os, St. (?) (EIS 31), 27 June-11 July 1991, 1 ♂. Askøy: Skansen (EIS 39), 29. May - 12. June 1996, 2 ♂♂, raised bog, 26 June-10 July 1996, 4 ♂♂, 1 ♀, young spruce forest (Aakra 1998); **HOI** Rosendal: Veavåg (EIS 31), 10 July 1943, 1 ♀. Kvinnherad: Ænesdalen (EIS 31), 11 May-26 September 1977, 5 ♂♂, 1 ♀, mixed deciduous forest. Voss (EIS 41), 26. June 1978, 1 ♂, forest. Kvam: Geitaknottane Nature Reserve (EIS 31), 12 May-21 September 1997, 2 ♂♂, deciduous forest; (Pommeresche 1999-not examined). **RI** Hålandsdalen: Erfjord (EIS 14), 26 April-27 September 1977, 4 ♂♂, 1 ♀, mixed deciduous forest. **RY** Mosterøy (EIS 14), 5 July-25 September 1977, 6 ♂♂, 6 ♀♀, coniferous forest. Fister, 26 April-27 September 1977, 1 ♂. Tysvær: Kårstø (EIS 14), 8-30 May 1981, 1 ♂, grased pasture (Martens 1982). Klepp: Bole (EIS 7), 8 June 1990, 1 ♂, dune scrub (Folvik 1992). **STI** Trondheim: Steinan (EIS 92), 20 July 1975, i ♂, moist meadow (leg. B. Larsson). **VE** Borre: Borrevatn (EIS 19), 6 June-20 September 1979, 1 ♂, moist spruce forest. Brunlanes: Anvik (EIS 19), 7 June-20 September 1979, 1 ♂, deciduous (*Alnus*) forest. Holmestrand: Eidsfoss (EIS 19), 6 June-20 September 1979, 7 ♂♂, 2 ♀♀. **VAY** Kristiansand: Ytre Strandi (EIS 2), 25 June-25 September 1980, 3 ♂♂, 2 ♀♀, meadow (Tveit & Hauge 1983).

DISCUSSION

It is not surprising to find representatives of *Agyneta mossica* in the material examined. For instance, all records of *A. saxatilis* from the Polar Urals actually referred to *A. mossica* (Koponen et al. 1997). Our records indicate that *A. mossica* is widespread in Norway (Figure 3), probably occurring throughout the country. Most records are from coastal parts of western Norway (the most intensively investigated area in Norway), the other records are from Saltfjellet, Narvik in Northern Norway (Schikora 1995) and Finnmark. It is found throughout Sweden and Finland (Schikora 1995).

A. saxatilis on the other hand appears to be a more southern species, in Sweden found north to Uppland and restricted to southern parts of Finland (Schikora 1995). Known distribution in Norway is at present restricted to coastal areas north to Hordaland (Figure 4), but any conclusions on the northern limit are premature. Schikora (1995) suggested that this limit is represented by the northernmost records in Sweden and Finland.

In regard to habitat choice *A. saxatilis* is very eurytopic, Norwegian records span from *Sphagnum*-bogs to transition sones between forests and open biotopes to various types of forests. According to Schikora ecotones, ruderal sites and meadows seem to be preferred. *A. mossica* on the other hand is consistently found only in bogs or fens and should be considered a sphagnophilous species characteristic of these habitats.

A. mossica is red listed in Germany being threatened due to habitat loss (Platen et al. 1996). The species is not threatened in Norway given our relatively large quantities of *Sphagnum*-bogs, but its stenotopy makes it sensitive and vulnerable to habitat deterioration, especially in regard to hydrology. It would thus be an excellent indicator-species of the quality of peatland habitats.

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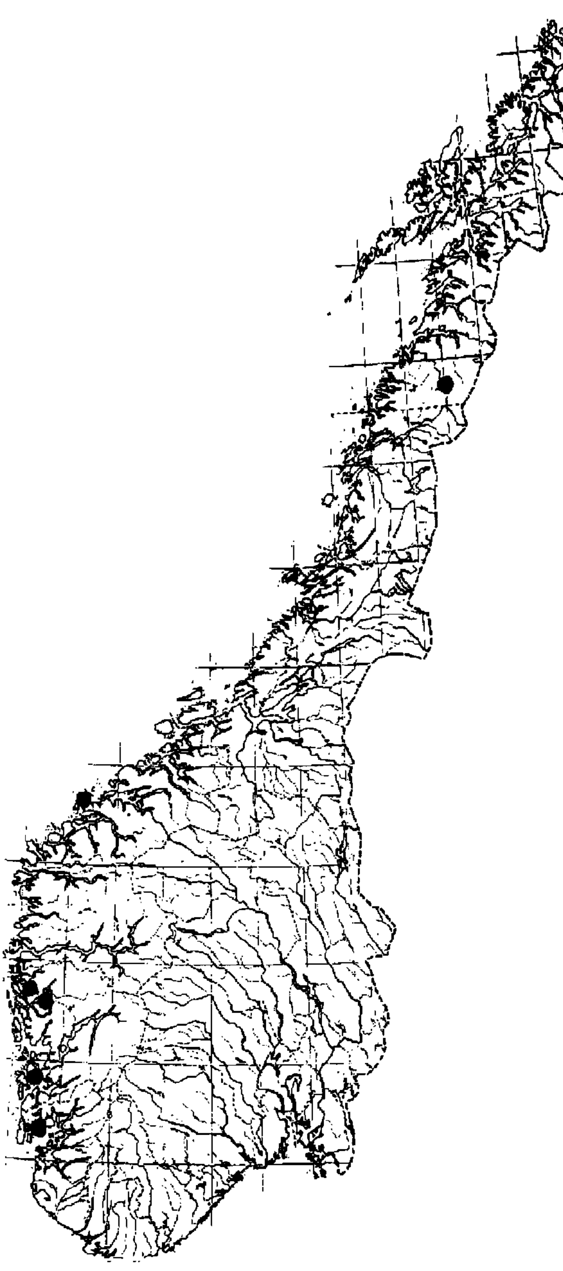

Figure 3. *Agyneta mossica.* Known distribution in Norway, the record of Schikora (1995) excluded.

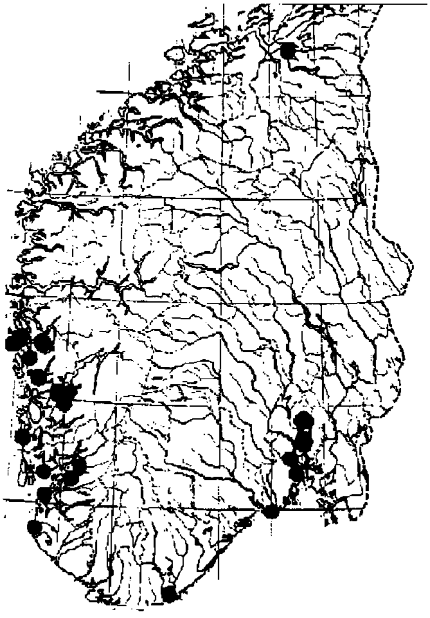

Figure 4. *Agyneta saxatilis.* Known distribution in Norway.

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INSTRUCTIONS TO AUTHORS

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.

Tables are typed on separate sheets and numbered consecutively. Each table must have a heading. Write "Table" in full both in the text and table heading. Avoid vertical lines in the table.

Figures must be numbered consecutively and all figures must be referred to in the text. Write "Figure" in full. Names(s) of the author(s) should be written in the margin of each figure. The size of the figure must not exceed 210 x 290 mm (standard A4). The author should take into consideration that most figures have to be reduced. In *line drawings* the line thickness should not be less than 0.25 mm after reduction, and capital letters not smaller than 2.0 mm. Choose contrasting patterns and avoid fine tone rasters. *Photographs* must be in black and white and of high quality with good contrasts. Maps and morphological illustrations, e.g. pictures of insects, should include a scale bar.

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, except L. for Linnaeus.

Localities. In faunistic papers the names of Norwegian localities should be according to K.A. Økland (1981), Fauna 34, 167–178, and preferably the EIS number should be added in brackets.

References. Citations in the text should be written as Black (1992), (White 1995) or (Black & White 1998). When a paper has more than two authors, it should be referred to as Smith et al. (1990). Multiple references in the text are given in chronological orders (Smith 1975, Green 1980, Black & White 1998). All references (but not any that has not been cited in the text) should be listed in alphabetical order at the end of the paper. In English reference lists, Ø is equal to O and Å is equal to Aa. Names of journals are abbreviated according to international standards, e.g. as in BIOSIS (Biological Abstracts).

Examples:

Journal papers

Chant, D.A. & McMurtry, J.A. 1994. A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). Int. J. Acarol. 20, 223-310.

Book

Borror, D.J., Tripletorn, C.A. & Johnson, N.F. 1989. An introduction to the study of insects. Sixth edition. 875 pp. Saunders College Publishing, Philadelphia

Chapter in book

Dennis, R.L.H. & Williams, W.R. 1995. Implications of biogeographical structures for the conservation of European butterflies. Pp. 213-230 in Pullin, A.S. (ed.), Ecology and conservation of butterflies. Chapman & Hall, London.

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Articles

Short communications

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