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The semi-aquatic fly fauna (Diptera) of wetlands of the Åland Islands

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Semiaquatic flies (Diptera, Nematocera: Limoniidae, Tipulidae, Pediciidae, Cylindrotomidae, Ptychopteridae, Psychodidae and Dixidae) of wetlands in the Åland Islands were collected from 19 sites with Malaise traps. Sites included open mires, wooded mires, rich fens, Baltic shore meadows, ditches and a grove. A total of 104 species were found of which 58 were recorded for the first time from the Åland Islands. Baltic shore meadows were the most species rich habitat type with 44 species. They were followed by ditches (41 spp.). However, local nematoceran communities of the Åland Islands are on average composed of fewer species than in other parts of southern Finland. Also the known total number of species is lower in the region of Åland than in the other regions of southern Finland. The theory of island biogeography may partly explain this. Åland is situated about 40 km from the nearest continental area. However, the best explanation for the observed species number may be that the islands are lacking some of the most species-rich habitats, for example, brooks and springs.

1. Introduction

The province of the Åland Islands (Alandia, A) is an exception among biogeographical provinces of Finland. This is especially because the province is in the form of an archipelago on the Baltic Sea. The archipelago consists of a main island and ca. 6,500 smaller islands (Government of Åland 1997). The main island, which is situated about 80 km from the mainland of Finland and 40 km from the mainland of Sweden, is 50 km long in south-north direction and 45 km in east-west direction. Its total area covers 685 km^2 (Statistics Finland 2008).

The province of the Åland Islands is situated on hemiboreal vegetation zone. Besides the main island of Åland, the zone includes only the south-westernmost parts of continental Finland. The climate of Åland is mild compared to the Finnish mainland; the average July temperature is 15,9 °C and in February –2,5 °C (Norden 2009). Annual precipitation (1971–2000) is 553 mm. The main island is flat with the exception of rocky areas of northern and eastern parts. The highest point of Åland reaches 129 m. The coastline is broken with long bays extending to far inland. Special environmental characteristics of the main island are heaths, extensive exposed bedrock areas, agricultural landscapes and diverse wetlands. Luxuriant hardwood groves are also a typical biotope of the main island.

The purpose of this research is to study the semiaquatic nematoceran fly fauna (Diptera) of wetlands of the main island of the Åland biogeographical province. The main goal of the study was to examine diversity and community structure of

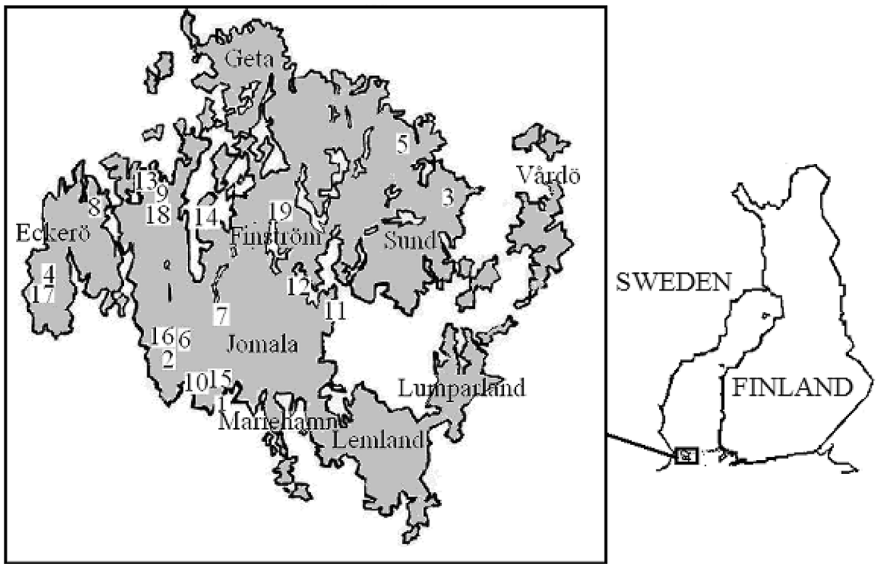

Fig. 1. Map of the main island of the archipelago of Åland. The numbers on the map express the locations of the study-sites. For numbering, check the left-hand column in Table 1.

nematoceran flies. The nematoceran families examined were Limoniidae, Tipulidae, Pediciidae, Cylindrotomidae, Ptychopteridae, Psychodidae and Dixidae. With the exception of a mire survey by Krogerus (1960), no systematic study of these families had been performed in the Åland Islands and knowledge of their local diversity was inadequate. Nematoceran flies are a very diverse dipteran group and in Finland the mentioned families currently include 416 species (Salmela, J. unpublished). Limoniidae, Tipulidae and Psychodidae are the most species rich semiaquatic fly families.

The majority of the species in this study are tied to wetland habitats. The larvae of semiaquatic flies mostly develop among detritus, mosses or minerogenous substrates. The adult stage of flies is short and takes at most few weeks. Identification of larvae is very challenging because immature stages of several species are unknown. Different wetland habitats accommodate specific species compositions related to their trophic status (i.e. availability of nutrients and amount of hydrogen ions) and water regime (e.g. Salmela and Ilmonen 2005, Salmela 2008). The semiaquatic fly fauna of the Finnish wetlands has been widely examined in the last 10 years, although there are great differences in the study effort between biogeographical provinces or ecoregions. Hence, the present study was performed in order to improve the knowledge of the distribution and ecology of the fly species and to compare species richness and assemblage composition of wetland habitats in Åland to those situated on the Finnish continent.

Area of wetlands has decreased remarkably especially in southern Finland. Wetlands have been drained mainly for forestry, agricultural use and peat harvesting (Vasander et al. 2003, Raunio et al. 2008). In the Åland Islands, 71% of the peatland area has been altered by draining activities (Stén 2006).

The study was performed on wide scale of different wetland habitats. 19 studied sites included three open mires (>3 ha in area), two wood-growing mires (<1 ha in area), four rich fens, five Baltic shore meadows, four ditches and one grove (Table 1). Besides these, Uddhagarna spring brook in Eckerö municipality was studied with sweep net in June.

2. Material & methods

2.1. On collection and handling of insect material

Only adult insect material was collected in this study. The material was collected mainly by using Malaise traps (height 140, length 110, width 70 cm). The Malaise trap is a passive, non-attractive trap model which is an efficient way to collect low flying insects. The traps were set on 19 research sites (Table 1, Fig. 1). One trap was set on each of

Table 1. Studied sites, municipality, biotope type, North (N) and South (S) coordinates (Grid 27°E), number of species (S) and number of specimens (n).

Site	Municipality	Biotope type	N	E	S	n
1. Burskatan	Jomala	Open mire	6686455	3103434	11	115
2. Stormossen	Jomala	Open mire	6689981	3097828	8	57
3. Bredmossen	Sund	Open mire	6704547	3125437	9	107
4. Stormossa	Eckerö	Wooded mire	6697213	3087872	10	27
5. Långbergsöda	Saltvik	Wooded mire	6707613	3121328	24	130
6. Nyhaga	Jomala	Rich fen	6689576	3099362	11	38
7. Moren	Jomala	Rich fen	6694611	3103880	21	134
8. Holmträsket	Eckerö	Rich fen	6705169	3092433	19	274
9. Ångesjö	Hammarland	Rich fen	6707204	3098414	11	34
10. Gottbyviken	Jomala	Baltic shore meadow	6688586	3101390	18	83
11. Österviken	Jomala	Baltic shore meadow	6693341	3113701	23	1,829
12. Björsby	Jomala	Baltic shore meadow	6696277	3111044	16	123
13. Holmviken	Hammarland	Baltic shore meadow	6707990	3097582	15	35
14. Holmsjön	Finström	Baltic shore meadow	6702597	3102951	11	109
15. Kungsö	Jomala	Ditch	6688606	3101930	15	68
16. Timmermyran	Jomala	Ditch	6689945	3098475	4	9
17. Sinnträsk	Eckerö	Ditch	6695874	3086810	24	139
18. Ångesjö ditch	Hammarland	Ditch	6706908	3098360	18	357
19. Prästgårdsnäset	Finström	Grove	6703678	3109354	16	57

17 sites, and two traps on each of two sites. The traps were set on the study sites at the end of April and they were removed at the end of September. The exception was the grove of Prästgårdsnäset, where the traps were present only from April to June due to pasturage of the area. Other traps were emptied at six week intervals. 50% ethylene glycol with a small amount of salt and detergent was used as preservative in the traps. The collected insect material was finally preserved in 70% ethanol and the nematoceran families to be studied were sorted out and identified in a laboratory. In addition to traps, adult flies were collected from one site with a sweep net in June.

2.2. Study sites

Many valuable open natural mires can be found in different reaches of the main island. Those are typical plateau bogs (Lindholm & Heikkilä 2006, Stén 2006). The most representative plateau bogs are situated in south-western, eastern and northern parts of the main island. Those mires have mosaic-like surface structure with low hummocks and irregular flarks. Middle parts of the mires are flat with only slight elevation compared to edges. Their bottom vegetation consists mainly of *Sphagnum papillosum* and *S. balticum*. The open mires studied were Burskatan and Stormossen in Jomala municipality and Bredmossen in Sund. Those were classified as plateau bogs. The mires were characterized by oligo-mesotrophic vegetation with patches of ombrogenous vegetation. Vascular plant communities of the open mires in this study were quite species poor. *Carex lasiocarpa* was the dominant species on Bredmossen. Low-growing common reed (*Phragmites australis*) was abundant on Burskatan and Stormossen.

The wooded mires studied were Långbergsöda in Saltvik and Stormossa in Eckerö. Oligo- and mesotrophic vegetation (e.g. *Carex echinata* and *C. rostrata*) dominated in Långbergsöda. There was also a permanent pool filled with water which was marked as a spring on the map. Vegetation related to springs was not found, however. Stormossa was a narrow mesotrophic mire, about 5 acres in area, with very wet bottom layer which was low in the amount of vegetation (e.g. mesotrophic species *Sphagnum subsecundum*), and *Myrica gale* was the dominant vascular plant there.

The rich fens of the Åland Islands are especially valuable habitats from the perspective of the

whole of Finland. Considering all wetland types, the area of rich fen has declined the most dramatically and all the subtypes (i.e. specific site types of rich fens) have been assessed as endangered or critically endangered (Raunio et al. 2008). The rich fens of the Åland Islands are habitats for many southerly distributed, calcium-carbonate-demanding vascular plant species, which have their Finnish distribution restricted to this area. Rich fens of Åland are typically very wet and their bottom layer is characterised by Bryales mosses. The rich fens of this study were mainly in a natural state with the exception of a few ditches and nearby logged areas. The rich fens in this study were Moren and Nyhaga in Jomala, Holmträsket in Eckerö and Ängesjö in Hammarland. The site of Moren was a combination of rich fen and spruce mire whereas the three other were more open fens. A character of all the four rich fens was dominance of eutrophic mosses (e.g. *Scorpodium scorpioides*, *S. cossoni, S. revolvens* and *Campylium stellatum*). Moren was very rich in vascular plant species (for example *Dactylorhiza maculata*, *Epipactis palustris* and *Sesleria caerulea*). The vascular plant communities of the other rich fens were dominated by common reed among which rare species like *Cladium mariscus*, *Carex hostiana* and *Schoenus ferrugineosus* were growing. The water level remained high on every site during the summer.

Baltic shore meadows (or Baltic coastal meadows) have developed as a result of traditional pasturage of cattle on low-lying Baltic Sea shores. Besides the impact of farming, Baltic shore meadows are exposed to both physical and chemical impacts (Airaksinen & Karttunen 2001). Physical impacts are related to waves and occasional flooding, whereas chemical impact is caused by the salinity of sea water, which is low (4–6 ‰) as a consequence of the brackish nature of the Baltic Sea. This kind of shore habitat may have very diverse flora (Nieminen 2008). In recent decades seashore pasturage has become uncommon and the consequence has been the closing of those open shores by common reed. Reed-growing shores are often classified as swamps according to Finnish mire typology. Many species living in Baltic shore meadows have been considered as endangered (Rassi et al. 2001). Sea-shore meadows have also been protected by EU legislation because of their exceptional conservation value (Airaksinen & Karttunen 2001). The Baltic shore meadows surveyed in this study were Gottbyviken, Björsby and Österviken in Jomala, Holmviken in Hammarland and Holmsjön in Finström. The bottom layer of those meadows was mainly without mosses consisting of remains of common reed. Only Österviken could be classified as truly open due to continuous cattle grazing. The other four sites were more or less closed up by dense stands of common reed. The species was also dominant in Österviken but there its shoots were shorter and its occurrence was sparser than in the other sites. Vascular plants such as *Carex vulpina* and *Orchis mascula* were growing in Österviken and *Primula farinosa* and *Carex hostiana* were found on the open margin of Holmviken, for example.

Natural state brook is a very rare biotope within the Åland Islands, and only a few exist. Instead, plenty of ditches made by humans can be found. Though they are poor in flora, they can provide habitats for a diverse insect fauna. The bottom material of ditches is most usually composed of organic matter and detritus. Moss communities are often growing on their banks, which improves the diversity of these habitats. The ditches studied were Kungsjö and Timmermyran in Jomala, Sinnträsk in Eckerö and Ängesjö ditch in Hammarland. The ditch of Kungsjö was about four meters wide, while the others were a maximum of one meter wide. All the ditches had at least some water flow through the summer except for Sinnträsk which was totally dry between the end of June and the end of September. The ditch of Kungsjö had been dug about three meters deep. The ditch flowed through agricultural landscape but there was a dense, grove-like forest islet of bird cherry (*Prunus padus*) on the study site. Around the Timmermyran study site there was pine mire with some eutrophic mosses (*Campylium stellatum*). The ditch studied near Ängesjö fen was surrounded by a plant-rich heath with tall *Betula* spp., *Picea abies* and *Pinus sylvestris*. The site of Sinnträsk was surrounded by a clear-felled area of 10 hectares. Near the ditch however, there were some mosses growing which are typical of rich fens (e.g. *Fissidens* sp.).

Two Malaise traps were set in the grove of Prästgårdsnäset in Finström. Near the study site (<300 m) there were pasturage areas and Baltic shore meadows. The immediate surroundings of

the study site consisted of old oaks (*Quercus robur*) and European hazel (*Corylus avellana*).

3. Results

Total of 3,726 specimens belonging to 104 species (Limoniidae 50 spp., Tipulidae 20, Pediciidae 3, Cylindrotomidae 2, Ptychopteridae 1, Psychodidae 25 and Dixidae 3) were identified from the study sites (Table 2). The five most abundant semiaquatic fly species, *Parajungiella consors* (1,428 exx), *Clytoceris ocellaris* (357), *Panimerus albomaculatus* (322), *Erioptera nielseni* (212) and *Parajungiella pseudolongicornis* (205) comprised 68% of the total number of individuals.

Baltic shore meadows were the most species rich biotope with 44 species (cumulative species number). They were followed by ditches (41), rich fens (37), closed mires (31), open mires (19) and the grove (16). The most species-rich sites were Sinnträsk and Långbergsöda (24 spp.) followed by Österviken (23 spp.) and Moren (21). The lowest species numbers were collected from Timmermyran (4), Stormossen (8) and Bredmossen (9).

1,829 specimens (49% of total number of individuals) were collected from Österviken. This was caused by the mass occurrence of *P. consors*. It was followed by Ångesjö ditch (357 exx) and Holmträsket (274).

Two species, the psychodids *Copropsychoda brevicornis* and *Ypsychoda setigera*, were recorded for the first time from Finland. 58 of the 104 species were recorded for the first time from the biogeographical province of Åland. All the members of families Psychodidae and Dixidae were new to the province.

4. Discussion

4.1. Characteristics of the semiaquatic fly fauna of the Åland Islands

The semiaquatic nematoceran fauna of the Åland Islands is poorer than in other Finnish hemiboreal provinces (Regio Aboënsis, Ab and Nylandia, N). Including all the old records, a total of 115 species belonging to these families are now known from the islands. There are 221 species known from Ab and 191 from N (Salmela, J. unpublished). The α-diversity (i.e. site-specific species richness) of some biotopes, for example rich fens, is also smaller in the Åland Islands compared to continental Finland. As a comparison, Salmela et al. (2007) found 68 semiaquatic fly species from Ruottaniitty rich fen (Ta), Salmela and Autio (2007) identified 34 species from mesoeutrophic swampy spruce mire of Kivineva (Tb) and Salmela (2008) reported 30–56 (41 spp. on average) from eight rich fens situated in northern boreal Finland (Lkoc, southern subzone). In this study Moren was the most species rich eutrophic fen site with 21 species. It was followed by Holmträsket with 19 species. One explanation for the low total species number detected in Åland and the low α-diversity may be made by using the theory of island biogeography (MacArthur & Wilson 1963). According to this theory, the number of species reduces in relation to distance from the mainland. However, due to the relatively short distance to Sweden and nearly continuous chain of islands between Finland and Åland, dispersion of species to the main island of Åland should not be hindered by mere distance from the mainland.

The best explanation for the observed species number may be the fact that Åland is lacking some known species-rich habitats. The most significant of those are springs and natural state brooks (Salmela et al. 2007). The authors know only one spring and spring brook system from the islands (Uddhagarna), and, to our regret, systematic exploration of this site was not possible. Although there are chains of islands between the Åland Islands and continental Finland, those islands are also lacking the most species-rich habitats. Thus there are no possible stepping stones for insects dispersing from the continental areas.

4.2. On the semiaquatic fauna of the studied biotopes

4.2.1. Open mires

The nematoceran communities of the open mires of Åland are species-poor, and, in general, are composed of the same species as in continental Finland. These species, discussed in more detail in the following, are distributed widely in Finland,

Table 2. Semiaquatic fly species found from the Åland Islands. Numbers refer to study sites from which each species have been found. They relate to Table 1 and Figure 1. The site numbers have been **emboldened** if the number of specimens of the species from the given site has exceeded 20.

Limoniidae	
Dicranophragma (Brachylimnophila) separatum (Walker, 1848)	16, **17**
Epiphragma (Epiphragma) ocellare (Linnaeus, 1760)	7, 13, 15, 17, 18, 19
Euphylidorea dispar (Meigen, 1818)	13
Euphylidorea meigenii (Verrall, 1886)	1
Euphylidorea phaeostigma (Schummel, 1829)	2
Phylidorea (Paraphylidorea) fulvonervosa (Schummel, 1829)	1, 2, 3, 4, 17, 18
Phylidorea (Phylidorea) abdominalis (Staeger, 1840)	8, 9
Phylidorea (Phylidorea) bicolor (Meigen, 1804)	7, 11
Phylidorea (Phylidorea) ferruginea (Meigen, 1818)	6, 8, 10, **11**, 12, 14
Phylidorea (Phylidorea) heterogyna (Bergroth, 1913)	**1**, 2, 4, 8
Phylidorea (Phylidorea) squalens (Zetterstedt, 1838)	**1**, 2, **3**, 4, 5, 8, 9, 13, 15
Pilaria decolor (Zetterstedt, 1851)	19
Pilaria discicollis (Meigen, 1818)	12, 17
Pilaria scutellata (Staeger, 1840)	9
Cheilotrichia (Cheilotrichia) imbuta (Meigen, 1818)	19
Cheilotrichia (Empeda) cinerascens (Meigen, 1804)	5, 10, 19
Erioptera (Erioptera) beckeri Kuntze, 1914	1, 3
Erioptera (Erioptera) flavata (Westhoff, 1882)	17
Erioptera (Erioptera) lutea Meigen, 1804	17
Erioptera (Erioptera) nielseni de Meijere, 1921	1, **2**, 3, **8**
Erioptera (Erioptera) sordida Zetterstedt, 1838	8
Gonomyia (Gonomyia) simplex Tonnoir, 1920	17
Molophilus (Molophilus) flavus Goetghebuer, 1920	5
Molophilus (Molophilus) griseus (Meigen, 1804)	**17**, 18, 19
Molophilus (Molophilus) ochraceus (Meigen, 1818)	5, **17**, 18
Ormosia (Ormosia) depilata Edwards, 1938	12
Ormosia (Ormosia) lineata (Meigen, 1804)	4, 12, 15, 18, 19
Ormosia (Ormosia) pseudosimilis (Lundström, 1912)	5
Ormosia (Ormosia) ruficauda (Zetterstedt, 1838)	4, 17
Rhipidia (Rhipidia) maculata Meigen, 1818	5, 10, 14
Rhipidia (Rhipidia) uniseriata Schiner, 1864	19
Symplecta (Psiloconopa) stictica (Meigen, 1818)	10, **11**, 12, 13, 15
Symplecta (Symplecta) hybrida (Meigen, 1804)	11
Tasiocera (Dasymophilus) exigua Savchenko, 1973	18
Atypopthalmus (Atypopthalmus) inustus (Meigen, 1818)	13
Dicranomyia (Dicranomyia) autumnalis (Staeger, 1840)	8, 11, 12, 13
Dicranomyia (Dicranomyia) cf. *mitis* (Meigen, 1830)	19
Dicranomyia (Dicranomyia) frontalis (Staeger, 1840)	15
Dicranomyia (Dicranomyia) modesta (Meigen, 1818)	10, 11, 12, 14, 15, 17
Dicranomyia (Dicranomyia) sera (Walker, 1848)	1, 8, 11, 12, 13
Dicranomyia (Dicranomyia) terraenovae Alexander, 1920	4
Dicranomyia (Dicranomyia) ventralis (Schummel, 1829)	8, 9, 12
Dicranomyia (Idiopyga) sticmatica (Meigen, 1830)	6
Helius (Helius) flavus (Walker, 1856)	7
Limonia flavipes (Fabricius, 1758)	13
Limonia macrostigma (Schummel, 1829)	11
Limonia phragmitidis (Schrank, 1781)	15
Limonia trivittata (Schummel, 1829)	10
Metalimnobia (Metalimnobia) quadrinotata (Meigen, 1818)	11, 19
Metalimnobia (Metalimnobia) zetterstedti (Tjeder, 1968)	5, 17, 18
Tipulidae	
Dictenidia bimaculata (Linnaeus, 1760)	5, 6, 8, 14, 17
Dolichopeza (Dolichopeza) albipes (Ström, 1768)	17
Nephrotoma analis (Schummel, 1833)	6, 10, 16, 17

Table 2, continued

Nephrotoma scurra (Meigen, 1818)	11, 12
Nigrotipula nigra (Linnaeus, 1758)	1, **12**, 17
Prionocera pubescens Loew, 1844	3, 8, 9
Tanyptera (Tanyptera) atrata (Linnaeus, 1758)	3, 6, 8, 13
Tipula (Beringotipula) unca Wiedemann, 1817	17
Tipula (Lunatipula) fascipennis Meigen, 1818	1, 5, 11
Tipula (Platytipula) luteipennis Meigen, 1830	6, 7, 8, 9
Tipula (Platytipula) melanoceros Schummel, 1833	1, **2**
Tipula (Pterelachisus) varipennis Meigen, 1818	7, 10, 15, 17
Tipula (Savtshenkia) interserta Riedel, 1913	7, 9
Tipula (Savtshenkia) subnodicornis Zetterstedt, 1838	2, 3, 5
Tipula (Tipula) maxima Poda, 1761	Uddhagarna, Eckerö
Tipula (Tipula) paludosa Meigen, 1830	5, 17
Tipula (Tipula) luna Westhoff 1879	7
Tipula (Vestiplex) hortorum Linnaeus, 1758	19
Tipula (Vestiplex) scripta Meigen, 1830	17, 19
Tipula (Yamatotipula) lateralis (Meigen, 1804)	7
Pediciidae	
Pedicia (Pedicia) rivosa (Linnaeus, 1758)	3, 7, 8
Tricyphona (Tricyphona) immaculata (Meigen, 1804)	2, 3, 4, 5, 6, 7, 8, 18
Tricyphona (Tricyphona) schummeli Edwards, 1921	5, 17, 18
Cylindrotomidae	
Cylindrotoma distinctissima (Meigen, 1818)	10, 15
Diogma glabrata (Meigen, 1818)	5, 14, 18
Ptychopteridae	
Ptychoptera minuta Tonnoir, 1919	11
Psychodiidae	
Clytocerus ocellaris (Meigen, 1818)	4, 5, 6, 7, 9, **10**, 11, 12, 13, **14**, **15**, 16, **17**, **18**
Clytocerus tetracorniculatus Wagner, 1977	**6**, 7, **8**
Pericoma rivularis Berdén, 1954	4, 8
Pneumia trivialis (Eaton, 1893)	7, 15, **18**
Tonnoiriella nigricauda (Tonnoir, 1919)	9
Chodopsycha lobata (Tonnoir, 1940)	5
Copropsychoda brevicornis (Tonnoir, 1940)	5
Logima satchelli (Quate, 1955)	7, 11, 14, 19
Psycha grisescens (Tonnoir, 1922)	5, 19
Psychoda phalaenoides (Linné, 1758)	4, **5**, 7, 10, 11, 13, 14
Psychoda uniformata Haseman, 1907	11
Psychodocha gemina (Eaton, 1904)	5, 10, 15, 19
Psychodocha itoco (Togunaka & Komyo, 1954)	5, 17
Psychomora trinodulosa (Tonnoir, 1922)	**5**, 7, 11, 14, 17, 18
Tinearia lativentris (Berdén, 1952)	1, 7, 10, 11, 12, 13
Ypsydocha setigera (Tonnoir, 1922)	**5**
Panimerus albomaculatus (Wahlgren, 1904)	10, **11**, 12, 13, 14
Panimerus notabilis (Eaton, 1893)	12
Parajungiella consors (Eaton, 1893)	6, 7, 9, 10, **11**, 13, 14, 19
Parajungiella pseudolongicornis (Wagner, 1975)	6, **7**, **8**, 9, 10, 15, 17, **18**
Paramormia polyascoidea Krek, 1971	5, 8
Paramormia ustulata (Walker, 1856)	10, **11**, 12
Peripsychoda fusca (Macquart, 1826)	18
Philosepedon humerale (Meigen, 1818)	7, 10, 15, 19
Telmatoscopus similis Tonnoir, 1922	11
Dixidae	
Dixella aestivalis (Meigen, 1818)	7
Dixella autumnalis (Meigen, 1838)	11
Dixella hyperborea (Bergroth, 1889)	7

ranging from hemiboreal to northern boreal zones (Salmela 2008). The most abundant open mire specialists were limoniids *Phylidorea squalens*, *Erioptera nielseni* and *Phylidorea heterogyna*. *Erioptera nielseni* can be found from oligo-mesotrophic to eutrophic habitats (Boyse 2004, Salmela & Autio 2007, Autio, O. unpublished). *Phylidorea squalens* is found mostly from minerotrophic mires being very abundant on oligotrophic and mesotrophic habitat (Salmela & Ilmonen 2005). *Phylidorea heterogyna* is also abundant on ombrotrophic habitats and of these three species it is the least discriminating about the trophic status of the mire (see 4.2.3 for details). Common open mire tipulids *Prionocera pubescens*, *Tipula subnodicornis* and *Tipula melanoceros* were scarcely met in this study. *Tipula subnodicornis* and *Tipula melanoceros* are restricted to, or strongly prefer barren (ombro-oligotrophic) mires. *P. pubescens* can be found from every kind of open mires. Relatively rare but wide-ranging mire limoniid species *Euphylidorea meigenii* and *Erioptera beckeri* were found from the Åland Islands for the first time. Only one specimen of *Euphylidorea meigenii* was found from Burskatan, while *Erioptera beckeri* was found from both Burskatan and Bredmossen. All the species mentioned are restricted to, or prefer mires with a constant hydrology and flark vegetation (Brunhes & Villepoux 1990, Salmela & Ilmonen 2005, Salmela & Autio 2007).

4.2.2. Wooded mires

The species composition of the two wooded mires was diverse consisting of open mire and forest specialists and ubiquitous species. 24 species were found from Långbersöda and 10 from Stormossa. The mire specialist *Phylidorea heterogyna* was found from Stormossa and *Tipula subnodicornis* from Långbergsöda. *Phylidorea squalens* was found from the both sites. Limoniid *Metalimnobia zetterstedti* and tipulid *Tipula fascipennis* were collected from Långbergsöda. Both are common forest species (Salmela 2006). The effect of ground water may explain the presence of limoniid *Molophilus flavus* in Långbergsöda, the larvae of which are dwellers in springs and cold water brooks (Salmela 2006, 2008, Salmela et al. 2007). The pediciid *Tricyphona schummeli*, which was found from Långbergsöda, is also considered to be associated with springs and cold headwater streams (Salmela 2008). 10 psychodid species were found from Långbergsöda, which is a sign of the diversity of the site. In addition to these species, a number of other ubiquitous wetland species were recorded (e.g. *Phylidorea fulvonervosa*, *Tricyphona immaculata*, *Molophilus ochraceus*, *Clytocerus ocellaris* and *Psychoda phalaenoides*).

Two psychodid species from Långbergsöda, *Copropsychoda brevicornis* and *Ypsychoda setigera*, are here reported as new for Finland. The former species is European in its distribution, the latter is also known from the nearctic (Quate 1955). According to Wagner (2004) the species has a cosmopolitan distribution. Both species have also been recently collected from the southern parts of continental Finland (Salmela, J. unpublished).

4.2.3. Rich fens

The mineral-rich fens were also rich in nematoceran species. The communities were composed mainly of minerotrophic fen-dwelling species (e.g. *Erioptera nielseni* and *Phylidorea abdominalis*) and swamp-dwelling species (e.g. *Phylidorea ferruginea* and *Erioptera sordida*). *Phylidorea heterogyna*, which was found from Holmträsket, seems to be a widely distributed species. Salmela and Ilmonen (2005) found *Phylidorea heterogyna* from ombro-mesotrophic sites within a large mire complex in western Finland, and in a study covering northern boreal wetlands (Salmela 2008), the species was an indicator of rich aapamires in the southern subzone (Perä-Pohjola in Finnish). As noted before, *Phylidorea heterogyna* has a wide distribution in Finland, but it is most probably absent from the subalpine subzone, i.e. the northernmost part of Finland (Salmela 2008). The species occurs in mires ranging from ombrotrophic to eutrophic, and most likely its presence is determined by hydrological conditions and a suitable *Sphagnum* layer (Autio 2008a), rather than cation concentrations or related factors. It should be noted that the species has a relatively small area of distribution in Europe (Oosterbroek 2009) It is rare in most parts of its range and, fur-

ther, a threatened species in Czech Republic (Starý & Bartak 2005) and Great Britain (Boardman 2007). Thus, the species should be regarded as an international responsibility species for Finland.

A species encountered from all the four rich fens surveyed was the psychodid *Parajungiella pseudolongicornis*, which occurs in eutrophic fens, springs and lake shores with luxuriant vegetation (Salmela, J. unpublished). According to this survey and the study performed by Salmela et al. (2007), the species is confined to rich fens and springs. Limoniid *Helius flavus* and tipulid *Tipula interserta* are both southerly distributed in Finland, and inhabitants of rich fens and springs (Salmela 2006, Salmela & Autio 2007, Salmela et al. 2007).

4.2.4. Baltic shore meadows

The nematoceran communities of Baltic shore meadows were characterized by the occurrence of species associated with, or having a preference for, coastal meadows and species living on swamp biotopes. In addition to these, the meadows were inhabited by ubiquitous wetland species.

Halophilous and halobiontic species are the most interesting inhabitants of Baltic shore meadows. These include limoniids *Dicranomyia sera* and *Symplecta stictica* and psychodid *Panimerus albomaculatus*. *Dicranomyia sera* and *Symplecta stictica* have been recorded from the whole Finnish coastal area southwards from the Gulf of Bothnia (Nieminen 2008). These species have been reported to prefer coastal marshlands also in England (Stubbs 2003). *Panimerus albomaculatus* is a rare European psychodid, most likely a halophilous species, known from the shores of the Baltic Sea and the North Sea (Barendrecht 1934, Nielsen 1961). In addition to the localities of the present study, the species is known from a coastal meadow of the northernmost part of the Gulf of Bothnia (Nieminen 2008) and from one inland locality in the southern boreal zone, some 20 km from the Baltic Sea (J. Salmela, unpublished). It should be noted, that the taxonomic status of the species is somewhat uncertain, due to the holotype being a female, and the redescription by Tonnoir (1922), especially the figures depicting the male hypopygium, have historical value only. One of the authors (JS), however, has seen the Dutch material studied by Tonnoir and it can be safely concluded that specimens collected from the Netherlands and Finland are conspecific.

Psychodids *Parajungiella consors* and *Paramormia ustulata* prefer Baltic coastal meadows as their habitats, but both species are also known from inland localities; the former may be found in rich fens and eutrophic lake shores, whereas the latter is a poorly known species, known only from the margin of one pond with luxuriant vegetation, and an oligotrophic fen. A third psychodid species with a possible association or preference for coastal areas is *Psychoda uniformata*, which is known from only four sites in Finland. Also the tipulid *Nigrotipula nigra* has a preference for coastal meadows, but the species also occurs rarely on lake shores and fens inland (Salmela, J. unpublished).

4.2.5. Ditches

The surveyed ditches had great differences in the abundances of species and specimens (Table 1). Ditches are very unstable habitats and this is reflected in their insect fauna. It is a remarkable and also surprising result that the ditch of Sinnträsk was the most species rich of the ditch sites studied. The ditch was dry most of the summer and it was surrounded by a wide clear-cut area. In brooks there are great inter-annual differences in species compositions and abundances of nematoceran flies related to precipitation (Autio 2008b). The larvae of typical brook- and ditch-inhabiting species like *Dicranophragma separatum* and *Molophilus griseus* can probably tolerate long dry periods. Mortality rate of craneflies is, however, very high in the earliest stages of their life cycle but gets lower as they develop (Hadley 1971).

Communities of the ditches in this study were composed mostly of ubiquitous species. Also some brook specialists like the southerly distributed limoniid *Tasiocera exigua* and rather common brook tipulid *Dolichopeza albipes* were found. The limoniid *Gonomyia simplex* was found at Sinnträsk. The species is known to be quite rare and most of its localities are seepages or spring-fed brooks (Salmela, J. unpublished). The tipulid *Tipula maxima* was collected with sweep net from

Uddhagarna spring brook. In Finland the species is southerly distributed with a preference to spring habitats (Salmela et al. 2007).

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