Insects inhabiting freshwater and humid habitats in Finnmark, northern Norway

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A faunistic study of selected insect groups inhabiting freshwater and humid habitats in Finnmark, the northernmost part of mainland Norway was initiated in 2010. Fieldwork was conducted through three different 10–11 day excursions in the 2010-season and 107 localities were visited. Phase one of the project focused on the dipteran families Bolitophilidae, Chironomidae, Diadocidiidae, Keroplatidae, Mycetophilidae and Psychodidae as well as Trichoptera and aquatic Hemiptera, but material of other orders, especially Ephemeroptera, Neuroptera, Megaloptera and Plecoptera were also sorted out and identified. Here we present the general results of phase one and describe all visited localities. In total, 871 species were registered, 443 of these were new to Finnmark, 60 new to Norway, 12 new to Europe and at least 54 species are still unknown to science. Most species new to science were found in the families Chironomidae and Mycetophilidae, but so far only the psychodid, *Psychoda cultella* Salmela, Kvifte & More, 2012, has been described.

Key words: aquatic insects, new records, Norwegian Taxonomy Initiative, Artsprosjektet, DNA barcoding.

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Introduction

Although detailed biodiversity surveys of aquatic insects have been conducted for selected watersheds in Norway (e.g. Aagaard *et al.* 2004, Bergersen & Rubach 1986, Halvorsen *et al.* 1982, Huru 1981), studies covering large geographical areas, numerous taxonomic groups and a multitude of habitats are rare. The reasons might be many, but lack of funding opportunities for biodiversity inventories in the past certainly has played a major role. Now, projects that focus on species distributions of less known organism groups in Norway can be funded through the Norwegian Taxonomy Initiative, whose goal is to increase the knowledge of Norwegian species diversity and distribution. The results presented here and in the following eight papers (Andersen & Hagenlund

2012, Boumans 2012, Greve & Andersen 2012, Kvifte & Andersen 2012, Kjærstad *et al.* 2012, Roth & Coulianos in prep., Stur *et al.* in prep., Søli & Rindal 2012) were obtained through a project aiming to increase the knowledge on the diversity of little-known insect groups associated with aquatic habitats in Finnmark, the northernmost part of mainland Norway.

The county of Finnmark is situated between 68.5° and 71.1° North, and 21.1° and 31.1° East and covers an area of more than 48 600km^2. Finnmark has a long coastline towards the Norwegian- and the Barents Sea, but it also has large inland areas, particularly to the south, bordering Finnish Lapland. The coastal areas typically have an oceanic climate with mild winters, cold summers and high annual precipitation compared to the continental climate of the inland Finnmarksvidda (the Finnmark plateau). While the average monthly temperature in January is below -16°C at some localities on the Finnmarksvidda, it is usually above -4°C at the North Cape, 260 km further north (Table 1, Figure 1, Moen 1999). For July, this relationship is reversed, and the inland typically can have 4–8°C higher mean temperatures compared to the coastal regions. With regard to precipitation, coastal areas typically receive around 2–3 times as much rain and snow as the inland (up to 1000–1500 mm annually), with considerably higher precipitation frequency (>240 days per year) (Moen 1999). For the Finnmarksvidda, precipitation is 2–3 times higher in the summer months compared to the winter (Moen 1999). Compared to other parts of the world at the same latitude, Finnmark has a mild climate. The vegetation in most of the county is typical of the northern boreal zone and characterized by birch woodland and sparse coniferous woodland. Only in the very northernmost parts of the county (above approx. 71°N) the vegetation is typical of the southern arctic with shrubs such as juniper (*Juniperus communis*) and willow (*Salix* spp.) as well as dwarf birch (*Betula nana*), crowberry (*Empetrum nigrum*), bilberry (*Vaccinium myrtillus*) and cowberry (*Vaccinium vitis-idea*) (Moen 1999).

Surveys of aquatic insects and insects associated with wetlands and wet habitats are important for various reasons. Lakes, rivers and wetlands play a crucial role for humans as a resource for drinking water, food, recreation and as a source for hydroelectric power. The conservation of aquatic environments has therefore gained political importance in many, if not most countries. In the European Union, the Water Framework Directive (WFD, Directive 2000/60/EC) aims to monitor the health status of all fresh and brackish water habitats within the European Economic Area (EEA). The directive encompasses detailed requirements for inventorying, classification and monitoring of numerous water quality parameters, including the diversity of macroinvertebrates. Thus, projects that map and describe the diversity of insects associated with aquatic habitats are of considerable importance for future biological monitoring and assessment of water quality within the EEA.

Good baseline knowledge of species diversity in northern areas is also important for monitoring the effects of climate change (see Fernandez-Triana *et al.* 2011). Insect species diversity decrease with increasing latitude and many species reach their distributional limits as we move north towards the Arctic (Strathdee & Bale 1998). Northernmost Norway, being on the border between the northern boreal and the southern arctic zones, is home to species that are characteristic for both zones. Detailed mapping of the exact distribution of species in this area will form a baseline for future studies on distributional expansion of boreal species into the Arctic, and eventual shifts in arctic and northern boreal species communities.

The use of short DNA fragments to identify and discover species (so-called DNA barcoding) has been used increasingly in biodiversity research since its conception by Hebert *et al.* (2003). In fact, more than 1 800 articles have so far been published that relate to the topic (ISI Web of science, accessed 11.Oct.2012 using search topic "DNA Barcod*"), and there are numerous examples of how well DNA barcoding performs in identification and delineation of species, association of life stages and documentation of diversity of aquatic insects (e.g. Ekrem *et al.* 2010, Hendrich et al. 2009, Pfenninger et al. 2007, Rach *et al.* 2008, Stur & Ekrem 2011, Zhou *et al.*

TABLE 1. Average temperatures for 2009 and 2010 and the monthly normal values (average from 1961–1990) for 4 meteorological stations in Finnmark county. No data available for Alta 1961 and 1962. Data from eKlima (www.eklima.met.no).

Month	Alta 2009	Alta 2010	Alta 1963–1990	Kautokeino 2009	Kautokeino 2010	Kautokeino 1961–1990	Vardø 2009	Vardø 2010	Vardø 1961–1990	Pasvik 2009	Pasvik 2010	Pasvik 1961–1990
Jan	-4,8	-8,2	-8,7	-11,7	-15,7	-16,0	-8,8	-14,1	-15,4	-4,9	-6,5	-5,1
Feb	-9,5	-11,9	-7,9	-17,5	-19,0	-14,8	-12,7	-15,6	-13,9	-6,2	-6,9	-5,4
Mar	-3,2	-6,8	-5,2	-8,1	-13,5	-10,9	-7,0	-10,5	-8,7	-4,1	-5,5	-3,6
Apr	0,6	2,1	-0,6	-2,5	-1,5	-4,3	-1,7	1,2	-2,0	-1,8	0,7	-1,1
May	7,0	7,5	4,8	6,1	5,6	2,8	5,3	6,0	4,1	3,5	4,1	2,5
Jun	9,3	8,8	10,0	9,0	8,4	9,8	8,5	8,9	10,4	6,0	6,6	6,2
Jul	13,7	13,7	13,4	12,3	13,4	12,4	11,6	13,8	13,7	7,9	9,8	9,2
Aug	14,2	11,1	12,0	12,4	10,3	10,3	12,2	10,0	11,4	8,9	8,1	9,1
Sep	9,1	8,3	7,2	7,0	6,2	4,9	7,9	7,9	6,4	7,7	7,1	6,6
Oct	1,6	3,5	1,6	-2,7	0,5	-2,0	-0,7	2,7	0,3	1,1	3,6	2,4
Nov	-0,2	-6,2	-3,6	-4,3	-15,0	-9,3	-1,6	-9,7	-7,0	0,5	-2,3	-1,3
Dec	-7,6	-7,0	-7,0	-13,4	-14,5	-14,3	-10,9	-12,8	-12,7	-3,0	-4,5	-3,7

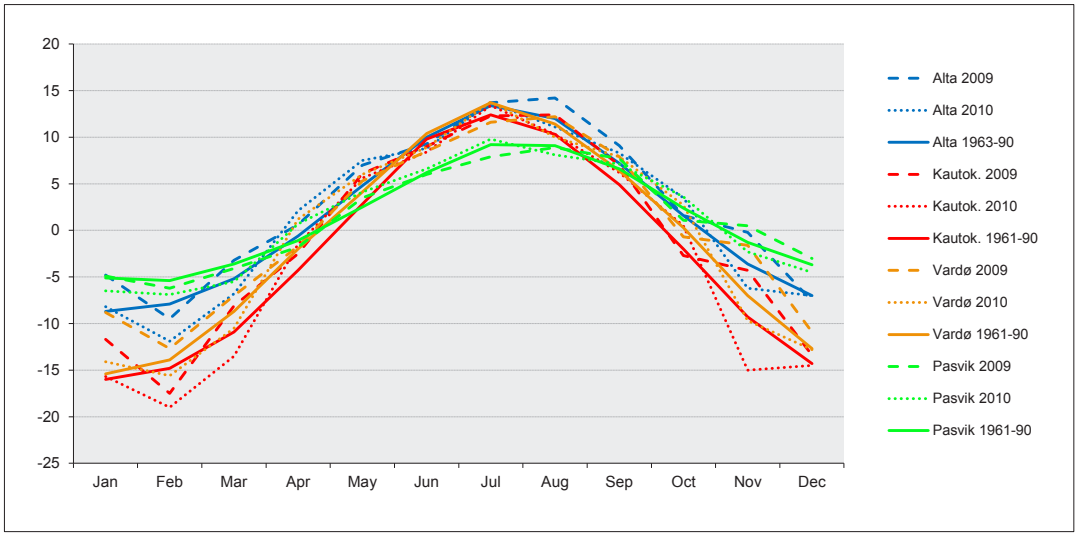

FIGURE 1. Average temperatures for 2009 and 2010 and the monthly normal values (average from 1961–1990) for 3 meteorological stations in Finnmark county. No data available for Alta 1961 and 1962. Data from eKlima (www.eklima.met.no).

2009). For taxonomic groups where species are challenging to separate based on morphology, DNA barcoding proves to be particularly useful in providing a common, objective baseline for species identification. Thus, public access to curated and vouchered genetic data from biodiversity surveys is important, since it enables direct comparison of taxonomy on a temporal and geographical scale. The Barcode of Life Data Systems (BOLD) (Ratnasingham & Hebert 2007) provides a platform for identification of species and analysis of genetic diversity data.

Although broad faunistic studies of aquatic insects in Finnmark have been infrequent, there

are publications that include insects found in freshwater or humid habitats (e.g. Collembola - Fjellberg 1988; Diptera - Nielsen 1988, Bergersen *et al.* 2004; Coleoptera - Andersen *et al.* 2000, Olsvik *et al.* 2001, Heteropetera - Huldén 1982, Trichoptera and Plecoptera - Tobias & Tobias 1976, Neuroptera and Mecoptera - Tjeder 1943, and for several taxa see Lillehammer 1967). In addition, there are a few detailed ecological studies as well as more general revisions and keys that include material from Finnmark (e.g. Holmen 1987, Lillehammer 1988, Coulianos *et al.* 2008). As a result, the knowledge of aquatic insect species diversity in Finnmark is fairly good for some taxonomic groups (e.g. Odonata, Coleoptera, Ephemeroptera and Trichoptera) while other groups are poorly or very poorly known from this part of the country (e.g. Chironomidae, Ceratopogonidae and Psychodidae) (Aagaard & Dolmen 1996). However, distributional data is often sparse even for groups that are regarded as well known, particularly in northern Norway. This may lead to erroneous interpretation of the rarity and vulnerability of individual species (cf. red list status). In phase one of this project we have focused primarily on lesser-known insect groups from Finnmark associated with freshwater and moist habitats for which we have taxonomic expertise in Norway. This comprises the dipteran families Chironomidae, Bolitophilidae, Diadocidiidae, Keroplatidae, Mycetophilidae and Psychodidae, and the aquatic Heteroptera. We have also included the supposedly well-known Trichoptera to see if additional sampling in Finnmark will increase our knowledge of the distribution and occurrence of our northern caddis flies. In addition, the results of the terrestrial Heteroptera, Neuroptera, Megaloptera, Plecoptera and Ephemeroptera collected during the project are presented.

Material and methods

Fieldwork was conducted in June–September 2010. Eight Malaise traps were employed at different localities in four different regions in the county (Figure 2). The traps used 80% ethanol for preservation of the material and were mostly emptied bi-weekly. In addition, numerous localities were visited 1–3 times through the season in connection with three separate collecting trips that all lasted for 10–11 days. These trips were conducted 11–21 June, 23 July 23–1 August and 30 August–8 September. In total, 107 different localities were visited (Figure 2, descriptions below). Participants on these trips were: Trond Andersen (trips 1, 3), Alyssa M. Anderson (trip 3), Louis Boumans (trip 2), Torbjørn Ekrem (trips 1, 2), Sondre Dahle (trip 1), Godtfred Anker Halvorsen (trip 1), Steffen Roth (trips 2, 3), Elisabeth Stur (trip 1), Geir Søli (trips 1, 3). The collecting methods involved hand-picking, sweep-netting, light-trapping, drift-netting, beating from branches and kick-sampling. All material was fixed and preserved on 80–96% ethanol and sorted to appropriate taxonomic level (order or family) before further treatment by specialists.

Tissue samples of selected taxonomic groups (Chironomidae, Mycetophilidae, Psychodidae, Ephemeroptera, Megaloptera, Neuroptera, Heteroptera and Plecoptera) were sent to the Canadian Centre for DNA Barcoding (CCDB) at the University of Guelph for genetic analyses. Standard protocols at CCDB were used to amplify and sequence the 5' end of the mitochondrial Cytochrome c oxidase subunit 1 (COI) – fragment, the most commonly used barcode-fragment for animals. All barcodes and accompanying meta-data have been deposited in the Barcode of Life Data Systems (BOLD) (Ratnasingham & Hebert 2007) and GenBank, and will be available at www.boldsystems.org through the projects CHRFI (Chironomidae of Finnmark), MYCFI (Mycetophilidae of Finnmark), PSYFI (Psychodidae of Finnmark), EPHFI (Ephemeroptera of Finnmark) and HETFI (Heteroptera of Finnmark). Stonefly data are part of the on-going barcoding project NOEPT and will be published incrementally over the coming years.

Climate data were obtained through the open access website for Norwegian climate data eKlima (www.eklima.met.no) run by the Norwegian Meteorological Institute.

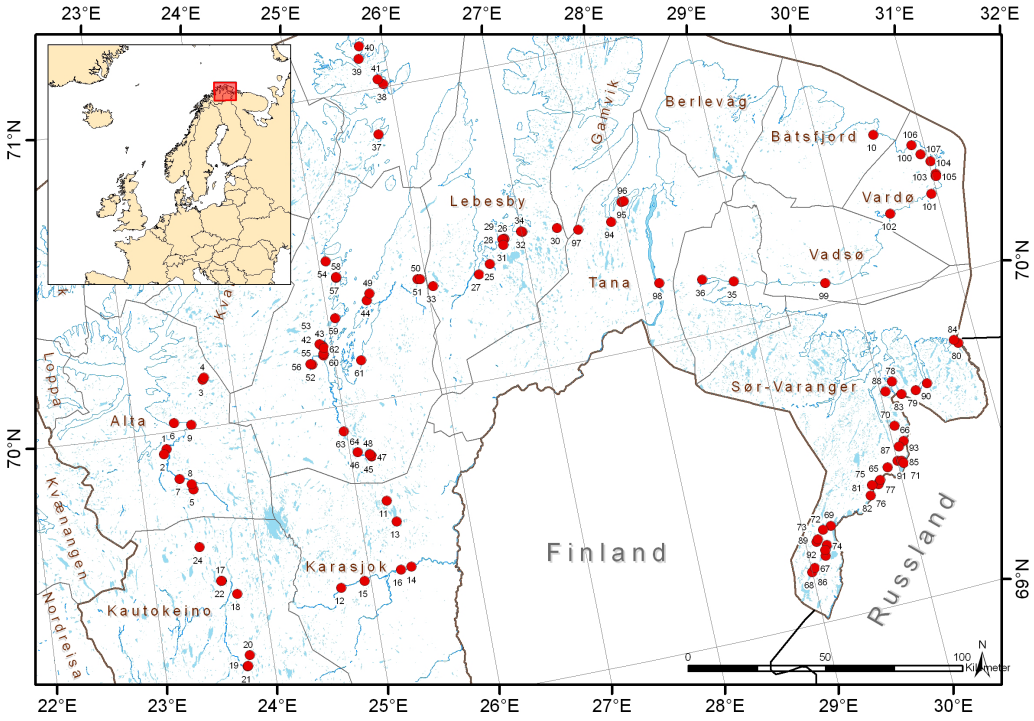

FIGURE 2. Sample sites in Finnmark 2010. Map by Marc Daverdin, NTNU Vitenskapsmuseet.

Descriptions of the localities

The short locality descriptions below are intended to characterise the sampled localities with respect to a few selected habitat parameters. Vegetation and plant species are reported to indicate natural succession (like terrestrialization), microclimatic conditions (e.g. exposure to sunlight) and to a limited degree the trophic conditions of the water bodies (measurements of nitrogen and phosphorus were not conducted). The first two letters refer to the division of Finnmark in four regions according to the revised "Strand-system" (Økland 1981): FV = western Finnmark, FI = inner Finnmark, FN = northern Finnmark and FØ = eastern Finnmark.

FinLoc01 – **FV**, Alta: Altaelva, Holmen, N69.94701° E23.29107°, 31m a.s.l. Fast running, slightly meandering part of a large river; sandy bed; bank zone with sparse pioneer vegetation.

FinLoc02 – **FV**, Alta: Altaelva, Lampe, N69.93161° E23.26088°, 32m a.s.l. Fast running, slightly meandering part of a large river; sandy and stony bed; narrow bank zone.

FinLoc03 – **FV**, Alta: Bigas, site 1, N70.15448° E23.72119°, 359m a.s.l. Part of a sub-mountainous, boreal bog and heather landscape with a 1.8 hectares lake (Bigasjavrriit); stony ground and bank zone; fast running stream nearby.

FinLoc04 – **FV**, Alta: Bigas, site 2, N70.16083° E23.73777°, 352m a.s.l. Part of a sub-mountainous, boreal bog and heather landscape; small ponds with bank vegetation.

FinLoc05 – **FV**, Alta: Gargia fjellstue (Malaise-trap 1), N69.80525° E23.48937°, 120m a.s.l. Fast running stream; stony bed; in a forest with pine (*Pinus sylvestris*), birch (*Betula pubescens*), willow and alder (*Alnus incana*).

FinLoc06 – **FV**, Alta: Gåppaelva, N70.02786° E23.39476°, 3m a.s.l. Fast running stream; stony bed; in a small woodland with birch, willow and alder.

FinLoc07 – **FV**, Alta: Sierravannet, N69.84464° E23.37346°, 43m a.s.l. About 3 hectares; willow edge zones and large areas

with terrestrializing vegetation, otherwise birch woodland at edge.

FinLoc08 (Figure 3) – **FV**, Alta: Storeng (Malaise-trap 2), N69.82277° E23.47884°, 90m a.s.l. Gargiavannet, lake-like broadening of the Gargiaelva river; sandy bed; broad vegetation zone with sedges (*Carex* spp.) and nearby woodland with birch, alder and willow.

FinLoc09 – **FV**, Alta: Sørelva, N70.01373° E23.55471°, 39m a.s.l. Fast running river flowing though dense mixed forest domiated by pine. Bottom substrate with stone and rocks; sand and gravel in backwaters. Partly with moss aufwuchs. Humic water.

FinLoc10 – **FN**, Båtsfjord: Sandfjordelva, N70.50320° E30.54902°, 15m a.s.l. Large river; stony bed; many rapids, potholes; stony bank with some bushes and pioneer vegetation.

FinLoc11 – **FI**, Karasjok: Doaresjavri, N69.67189° E25.26865°, 300m a.s.l. Lake, about 2 hectares; stony bank with sedges.

FinLoc12 – **FI**, Karasjok: Liidnebeahcannuorit, N69.41691° E24.71794°, 234m a.s.l. Fast running, meandering arm of large river; stony river bed and bank.

FinLoc13 – **FI**, Karasjok: Saddoluokta, N69.60043° E25.32822°, 290m a.s.l. Lake, about 5 hectares; shallow; part stony and part euphotic soft bottom; bog vegetation zone on bank.

FinLoc14 – **FI**, Karasjok: Vajamohkenjarga, N69.44653° E25.39124°, 129m a.s.l. Moderately fast running river; stony and sandy bed, narrow bank zone; downstream with reed and some bush vegetation.

FinLoc15 – **FI**, Karasjok: Veahkkava, N69.42701° E24.94451° 185m a.s.l. Fast running river; stony bed and bank.

FinLoc16 – **FI**, Karasjok: Haldeguolbba, N69.44373° E25.29269°, 160m a.s.l. Natural pine forest; ground with dwarf shrubs (*Vaccinium* spp.).

FinLoc17 – **FI**, Kautokeino: Gobba-Suolojavri, N69.49701° E23.63289°, 404m a.s.l. About 1.5 hectares large lake with a mosaic-zone of bank and bog vegetation. Situated in a hilly landscape with mosaic of wetlands, woodland and lakes.

FinLoc18 (Figure 4) – **FI**, Kautokeino: Kautokeinoelva, Masi, N69.44818° E23.68368°, 275m a.s.l. Moderately fast stretch of large river; stony river bed and bank with scattered willows.

FIGURE 3. FinLoc08, Alta, Gargiaelva at Storeng. Photo T. Ekrem.

FIGURE 4. Trond Andersen collecting at Kautokeinoelva near Masi (FinLoc18). Photo E. Stur.

FinLoc19 – **FI**, Kautokeino: Lahpoluoppal (Malaise-trap 3), N69.20992° E23.757661°, 320m a.s.l. Lake-like bend of the Náhlpoljohka River; standing water, soft bottom; dominance of reed, sedges and willows. Situated in complex landscape-mosaic of lakes, streams and rivers.

FinLoc20 – **FI**, Kautokeino: Lahpojavri, Jeagelnjárga, N69.24416° E23.79243°, 331m a.s.l. Deep (max. 350 m) and very large (8 km^2) lake. Sample site is characterized by stony ground, sandy bank with reed and shrubs and a small rocky ridge nearby.

FinLoc21 – **FI**, Kautokeino: Nahpoljohka (Malaise-trap 4), N69.21029° E23.76200°, 320m a.s.l. Fast running river; stony bed; bank zone with stones, sand and patches of vegetation dominated by willow.

FinLoc22 – **FI**, Kautokeino: Masi, bog on Road RV 93, N69.49695° E23.62680°, 401m a.s.l. Bog with typical vegetation; some small ponds situated in a hilly landscape with scattered wetlands, woodlands and lakes.

FinLoc24 – **FI**, Kautokeino: Sillsjavri, N69.61556° E23.46995°, 447m a.s.l. Elongated lake; stony and sandy bank with scattered patches of sedges, surrounded by bog vegetation and trees.

FinLoc25 – **FN**, Lebesby: 1 km South of Adamsfjord, N70.36983° E26.64120°, 53m a.s.l. Small lake (<1 hectare), part of bog-wetland landscape complex.

FinLoc26 – **FN**, Tana: Ammonjavrrit, lake and ponds near road RV 98, N70.42806° E27.5938°, 360m a.s.l. Samples taken in complex of wetland habitats; arctic sub-mountainous area; lake with stony bottom; bog ponds; wetland-bog vegetation with dwarf birch.

FinLoc27 – **FN**, Lebesby: Austerelva, N70.34368° E26.51974°, 11m a.s.l. Fast running river with rapids; stony bed and bank; downstream dominated by willow.

FinLoc28 – **FN**, Lebesby: pond near Baktejavri, site 2, N70.44120° E26.82233°, 95 m a.s.l. Very small pond; surrounded by large vegetation zone.

FinLoc29 – **FN**, Lebesby: small lake near Baktejavri, site 1, N70.44099° E26.80499°, 80m a.s.l. Small lake (6 hectares, max. 74m deep), stony ground; some willow on stony bank; dominant bank vegetation zone (sedges) in the outlet area of small stream.

FinLoc30 – **FN**, Lebesby: Eastorjavri, outlet of lake, N70.44271° E27.34849°, 260m a.s.l. Samples were taken in the outlet area of large (40 hectares and up to 24m deep) lake; lake and outlet-stream on stony ground.

FinLoc31 – **FN**, Lebesby: Garnvika, N70.42284° E26.73690°, 14m a.s.l. Small rock pools; some surrounded by bushes and grass, most without any vegetation; on cliff near sea.

FinLoc32 – **FN**, Lebesby: lake near Njallavarri, N70.45214° E27.01012°, 62 m a.s.l. Lake with broad mosaic of bank and bog vegetation in outlet zone.

FinLoc33 – **FN**, Lebesby: Stuorrarohtu, N70.33400° E26.05812°, 167m a.s.l. Pond imbedded in bog and wetland area.

FinLoc34 – **FN**, Lebesby: Lássájohka (1,5 km NW Lássájávri), N70.45461° E26.99669°, 60m a.s.l. Small stream; stony bed; willow-zone along bank.

FinLoc35 – **FN**, Nesseby: Bergebyelva, N70.14876° E28.90265°, 2m a.s.l. Moderately strong flowing, shallow river, 10–20m wide; stony estuary with sparse vegetation.

FinLoc36 – **FN**, Nesseby: Nyborg, N70.17750° E28.61030°, 12m a.s.l. Small stream; flowing moderately fast in willow dominated woodland, some sedges close to bridge.

FinLoc37 – **FN**, Nordkapp: Akselvatnet, N70.85215° E25.79852°, 37m a.s.l. Lake 2.5 hectares large, up to 33m deep; euphotic ground; dominated by sedges and horsetails (*Equisetum* sp.) in silt zone.

FinLoc38 – **FN**, Nordkapp: Honningsvåg, 400m E of Stornakken, N71.00983° E25.93730°, 2m a.s.l. Small temporary pond on stony ground between road and rocky shore.

FinLoc39 – **FN**, Nordkapp: Kjeftavatnet, N71.10542° E25.73548°, 77m a.s.l. Lake (40 hectares, 70m deep); stony bed and bank without vegetation; surrounded by alpine grassland vegetation.

FinLoc40 – **FN**, Nordkapp: Nordkapp-platået, N71.14461° E25.76409°, 220m a.s.l. Small shallow pond; cotton grass (*Eriophorum* sp.) in suspended bog.

FinLoc41 – **FN**, Nordkapp: Storvatnet, N71.02950° E25.88919°, 28m a.s.l. 1.5 hectares, up to 20m deep lake; stony ground and bank zone; samples taken from stream inlet; area with some willows and ruderal vegetation.

FinLoc42 (Figure 5) – **FN**, Porsanger: Baukop, site 1 (Malaise-trap 6), N70.20469° E24.90605°, 26m a.s.l. Small stream running from Vuolit Gealbbotjavri in birch-willow woodland; surrounded by grassland.

FinLoc43 – **FN**, Porsanger: Baukop, site 2, N70.20280° E24.90958°, 20m a.s.l. Situated in mosaic of abandoned grassland, ruderal vegetation and birch woodland.

FinLoc44 – **FN**, Porsanger: Børsnesdalen, N70.32580° E25.40614°, 10m a.s.l. Small, meandering stream; few willows in a grazed area with calcareous bedrocks; stream may be slightly nutrient polluted by nearby settlement.

FinLoc45 – **FN**, Porsanger: bog near Gaggavann, site 2, N69.82268° E25.19784°, 106m a.s.l. Extensive mosaic complex of heather, bog, wetland, dwarf bushes and wood with small shallow bog ponds, streams and lakes. Samples taken along small, meandering, deep stream running through the bog.

FinLoc46 – **FN**, Porsanger: near Gaggavann, site 3, N69.83034° E25.18504°, 105m a.s.l. Small, shallow lake; bank with terrestrializing vegetation continuously covered by bog plants.

FinLoc47 – **FN**, Porsanger: bog near Gaggavann, site 1, N69.82372° E25.20091°, 106m a.s.l. Extensive mosaic complex of heather, bog, wetland, dwarf bushes and wood, small shallow bog ponds, streams and lakes. Samples taken at small bog ponds surrounded by quaking boggy banks with sedges, rush (*Juncus* sp.) and cottongrass.

FinLoc48 – **FN**, Porsanger: Gaggavann, site 4, N69.83087° E25.18687°, 103m a.s.l. Large oligotrophic, regulated lake, sample site on stony bank with some trees and sparse wetland vegetation.

FinLoc49 – **FN**, Porsanger: Indre Kjerringvik, N70.34667° E25.43931°, 17m a.s.l. Small, fast running stream on calcareous, stony riverbed; bank with lush vegetation and dense bushes.

FinLoc50 – **FN**, Porsanger; Lapparjávrrit, site 1, N70.36581° E25.92327°, 138m a.s.l. Small, very shallow bog pools with typical bog

FIGURE 5. FinLoc42, Baukop in Porsanger. Drift net placed close to Malaise-trap 6. Photo E. Stur.

vegetation of sedges and peat moss (*Sphagnum* spp.).

FinLoc51 – **FN**, Porsanger: Lapparjávrrit, site 2, N70.36371° E25.94811°, 150m a.s.l. Small, very shallow bog pools with typical bog vegetation of sedges and peat moss.

FinLoc52 – **FN**, Porsanger: Lombola, car park, N70.14975° E24.78322°, 74m a.s.l. Situated in Stabbursdalen National Park; natural pine forest, ground with dwarf shrubs (*Vaccinium*).

FinLoc53 – FN Porsanger: Morssajaeggi, bog (Palsmyr), N70.21091° E24.88559°, 59m a.s.l. Large peat bog with some small bog ponds on permafrost with characteristic vegetation.

FinLoc54 – **FN**, Porsanger: Olderfjord, N70.47351° E25.07261°, 2m a.s.l. Fast running stream on stony bed; stony bank dominated by willows. Further samples in sandy outlet area towards sea.

FinLoc55 – **FN**, Porsanger: Rohkosjavri, N70.17245° E24.90380°, 12m a.s.l. About one hectare, shallow, organic lake without fish; distinctive vegetation zone amongst other with reed (*Phragmites* sp.); some deciduous birch and willow woodland on east bank.

FinLoc56 – **FN**, Porsanger: Rørkulpen (Malaise-trap 5), N70.15215° E24.76686°, 28m a.s.l. River, about 10m wide, moderately fast running, on stony bed; bank with some willow and alder. Situated in natural pine forest in the Stabbursdalen National Park.

FinLoc57 – **FN**, Porsanger: pond near Ruovddasjohka, N70.41572° E25.14807°, 50m a.s.l. Pond with fish; bank vegetation dominanted by sedges, rush and *Menyanthes trifoliata*.

FinLoc58 – **FN**, Porsanger: Russevannet, N70.41768° E25.14905°, 60m a.s.l. Lake, about 4 hectares large, up to 50m deep; few areas with silt vegetation; samples taken at inlet area of stream with wetland and bog.

FinLoc59 – **FN**, Porsanger: Sarvvesjavri, N70.28661° E25.07341°, 66m a.s.l. The eastern of two closely set lakes with road in between, each about 1 hectare large. Sample site with euphotic bottom; bank with birch and willow woodland.

FinLoc60 – **FN**, Porsanger: Stabbursdalen Feriesenter, N70.17782° E24.90735°, 10m a.s.l. The River Stabburselva; broad, very fast running

with wild water rapids; bed and bank with stones and gravel; bank with pioneer vegetation with German tamarisk (*Myricaria germanica*), willow, and mountain sorrel (*Oxyria digyna*).

FinLoc61 (Figure 6) – **FN**, Porsanger: Store Bjørnelva, N70.13668° E25.25187°, 13m a.s.l. Broad, very fast running river; rapids, bed and bank with stones and gravel; bank with sparse pioneer vegetation.

FinLoc62 – **FN**, Porsanger: Stornes, N70.19622° E24.91839°, 3m a.s.l. Costal salt-marsh; beach; sand, mud and some small ponds.

FinLoc63 – **FN**, Porsanger: Nedrevann (Volitjávri), N69.91856° E24.97994°, 67m a.s.l. Very large lake (>5 km^2); stony ground and bank.

FinLoc64 (Figure 7) – **FN**, Porsanger: Øvrevatn, N69.84383° E25.07607°, 76m a.s.l. Very large lake; part of a complex of connected lakes; sandy, beach-like bank.

FinLoc65 (Figure 8) – **FØ**, Sør-Varanger: Pasvik, Russevann (Malaise-trap 7), N69.44497° E29.89904°, 60m a.s.l. Lake, about 4 hectares large, max 50m deep; mosaic of pine forest and blanket bog on bank.

FinLoc66 – **FØ**, Sør-Varanger: Pasvik, 500 N of Bjørnstrand, N69.51552° E30.10419°, 38m a.s.l. Slow, calmly running part of River Pasvik; stony bank with birch, willow and some horsetails.

FinLoc67 – **FØ**, Sør-Varanger: Pasvik, Ellenelva, N69.21323° E29.15357°, 67m a.s.l. Partly fast, partly slowly running river on stony ground; surrounded by birch- and willow-dominated woodland.

FinLoc68 – **FØ**, Sør-Varanger: Pasvik, Ellijohki, N69.16989° E29.00161°, 101m a.s.l. Partly fast, partly slowly running river on stony ground; surrounded by birch- and willow-dominated woodland. Sampling site upstream from FinLoc67; large area of almost standing water with terrestrializing vegetation (*Carex*, *Equisetum*) nearby.

FinLoc69 – **FØ**, Sør-Varanger: Pasvik, Emanuelbekken, N69.30367° E29.26350°, 51m a.s.l. Part of River Pasvik; sandy and stony beach with adjacent woodland; small, longish formed bay with creek inlet; terrestrializing vegetation abundant.

FinLoc70 – **FØ**, Sør-Varanger: Guhkesjavri ,

FIGURE 6. FinLoc61, Store Bjørnelva in Porsanger. Photo T. Ekrem.

FIGURE 7. FinLoc64, beach bank of Øvrevatn in Porsanger. Photo E. Stur.

FIGURE 8. FinLoc65, Malaise-trap 7 at Russevann in Porsanger (near 96-høyden). Photo T. Ekrem.

69.57064° E30.05602°, 62m a.s.l. Lake, about 90 hectares large; narrow, stony bank with wetland vegetation and trees.

FinLoc71 – FØ Sør-Varanger: Pasvik, Indre Loken, N69.45719° E30.00216°, 23m a.s.l. Very shallow lake with soft bottom; euphotic ground, some stony areas. Bank vegetation characterized by bog species, birch and willow.

FinLoc72 – FØ Sør-Varanger: Pasvik, Karalampi, N69.29613° E29.18719°, 134m a.s.l. About 7 hectares large lake; heterogeneous topology (island, peninsula); mosaic ground of

stony and organic soft bottom; bank vegetation dominated by heather (Ericaceae), dwarf birch, willow and pine.

FinLoc73 – **FØ**, Sør-Varanger: Pasvik, small lake NE of Lakevannet, N69.26376° E29.10287°, 159m a.s.l. About 2 hectares large lake; both stony ground and organic soft bottom; bank vegetation dominated by heather, dwarf birch, willow and pine.

FinLoc74 – **FØ**, Sør-Varanger: Pasvik, Lyngbukta near Elveli, N69.24628° E29.18761°, 60m a.s.l. Samples from two different habitats: 1) small bay with nearly standing water in the River Pasvik; bank with sand, stones, some mud and terrestrializing vegetation with adjacent woodland. 2) shallow pond; bank dominated by wetland and bog vegetation.

FinLoc75 – **FØ**, Sør-Varanger: Pasvik, Melkefoss near River Passvik, site 1, N69.40509° E29.79536°, 29m a.s.l. Stony river bank; sparce vegetation on bank; some muddy areas with rush and sedges; nearby woodland.

FinLoc76 – **FØ**, Sør-Varanger: Pasvik, Melkefoss near River Passvik, site 2, N69.39857° E29.78201°, 40m a.s.l. Stony river bank; sparse vegetation and adjacent woodland.

FinLoc77 – **FØ**, Sør-Varanger: Pasvik, Mikkelstad, N69.41121° E29.80667°, 83m a.s.l. Very small stream in woodland; vegetation dominated by willow.

FinLoc78 – **FØ**, Sør-Varanger: Vuolit Nieidajavri, Svartakslavatnet, N69.71095° E30.13530°, 17m a.s.l. Northern end of about 1,8km^2 large, shallow (max 13m deep) lake; stony ground and sandy shore.

FinLoc79 – **FØ**, Sør-Varanger: Pandurvatnet, N69.66525° E30.33207°, 35m a.s.l. Lake, 5 hectares large, up to 30m deep; soft bottom; bank vegetation dominated by sedges and willow.

FinLoc80 – **FØ**, Sør-Varanger: Jacobselv, estuary, N69.77921° E30.82573°, 2m a.s.l. Patchy salt marsh vegetation on mud and sand.

FinLoc81 – **FØ**, Sør-Varanger: Pasvik, Sametijohka near Sameti (Malaise-trap 8), N69.40106° E29.71923°, 43m a.s.l. Trap in birch-dominated woodland on bank of a stream with variable current and a stony bed.

FinLoc82 – **FØ**, Sør-Varanger: Pasvik, 0.7km S Skogfoss, N69.36857° E29.68500°, 43m a.s.l. Large bay of River Pasvik; slowly running with sandy and stony bank and dense reed-zone.

FinLoc83 – **FØ**, Sør-Varanger: Sollia, Camping site near Road E105, N69.66478° E30.19085°, 17m a.s.l. Situated at large lake with stony and rocky bank; vegetation charaterized by birch and ruderal plants.

FinLoc84 – **FØ**, Sør-Varanger: Grense Jakobselv, N69.79157° E30.79580°, 7m a.s.l. Small ponds with patchy bank vegetation; part of a mosaic-complex of ruderal, wetland and bog habitats in hilly area close to sea.

FinLoc85 – **FØ**, Sør-Varanger: Pasvik, Svanhovd Research Station, N69.45403° E30.04057°, 46m a.s.l. Mosaic of meadows, ruderal areas, garden, park alley with birch and patches of woodland.

FinLoc86 – **FØ**, Sør-Varanger: Pasvik, Svanekulpen, N69.1824° E29.0323°, 80m a.s.l. About 1000m^2 large bay of the River Ellijohki; shallow standing water on stony bed, surrounded by natural pine forest.

FinLoc87 – **FØ**, Sør-Varanger: Pasvik, Svanvik near church, N69.45403° E30.04057°, 46m a.s.l. Small temporary pond; surrounded by muddy zone and low rush vegetation.

FinLoc88 – **FØ**, Sør-Varanger: Ternevatnet, N69.68475° E30.05284°, 93m a.s.l. Lake, about 5 hectares, up to 90m deep; stony and soft bottom; bank dominated by birch and willow.

FinLoc89 – **FØ**, Sør-Varanger: Pasvik, Tormajavri, N69.26996° E29.11843°, 146m a.s.l. Large lake (>20 hectares) on stony ground in natural pine forest.

FinLoc90 – **FØ**, Sør-Varanger: Tårnelven, N69.67786° E30.44941°, 17m a.s.l. Very fast running stream with gravel and larger stones; sparse bank vegetation with some willows.

FinLoc91 – **FØ**, Sør-Varanger: Pasvik, Utnes, N69.44515° E30.05262°, 35m a.s.l. Slowly running part of the River Pasvik; stony bank with dominance of willow, sedges and reed.

FinLoc92 (Figure 9) – **FØ**, Sør-Varanger: Pasvik, Steinbekken (Vaggatem), N69.23103° E29.16092°, 63m a.s.l. Backwater area of stream inlet to bay in the River Pasvik; stony bed and banks with some willow.

FIGURE 9. Godtfred A. Halvorsen collecting a drift sample from Steinbekken in Pasvik (FinLoc92). Photo E. Stur.

FinLoc93 – **FØ**, Sør-Varanger: Fyllingsvatn, N69.50142° E30.04980°, 83m a.s.l. Pond with distinct floating mat of peat moss and sedges along bank.

FinLoc94 – **FN**, Tana: Vestertana, Kjørebekken, N70.42588° E27.87454°, 6m a.s.l. Fast running stream on stony bed, bank with gradient from birch dominated woodland and willow to sandy and muddy areas with salt marsh vegetation towards estuary area.

FinLoc95 – **FN**, Tana: Šerresgieddi (Searesgieddi), N70.48173° E28.01378°, 42m a.s.l. Small lake in bog with soft bottom; muddy bank zone with sedges.

FinLoc96 – **FN**, Tana: Šerresgiedjávri (Searesgieddjavri), N70.48196° E28.03773°, 68m a.s.l. Lake, about 60 hectares large, up to 65m deep; on stony ground; some terrestrializing vegetation (*Equisetum*).

FinLoc97 – **FN**, Tana: Stuorrajohka, N70.42210° E27.54452°, 290m a.s.l. 5m wide, rapidly running stream; stony bed and bank dominated by willow.

FinLoc98 – **FN**, Tana: Tanaelva, N70.19799° E28.20236°, 20m a.s.l. Large river with sandy and stony bed; bank with some willow.

FinLoc99 – **FN**, Vadsø: Rica Hotel, N70.07457° E29.75030°, 10m a.s.l. Samples taken in window of hotel room.

FinLoc100 – **FN**, Vardø, Bardvikvatnet, N70.40242° E30.94328°, 43m a.s.l. Lake, 30 hectares large, about 40m deep; situated in arctic area with bog and wetland vegetation.

FinLoc101 – **FN**, Vardø: Indre Kiberg, N70.26936° E30.94540°, 3m a.s.l. Small rock pools, mostly without vegetation; on rock bluffs towards sea.

FinLoc102 – **FN**, Vardø: Komagelva, near outlet, N70.24129° E30.51538°, 5m a.s.l. Fast running river, many rapids on stony bed; bank with small bushes and some muddy areas with rush.

FinLoc103 – **FN**, Vardø: Larsenvatnet, near Nedre Domen, N70.32058° E31.03214°, 114m a.s.l. About 2 hectares large lake; part of sub-arctic wetland- and bog-complex.

FinLoc104 – **FN**, Vardø: bog near Nedre Domen, site 1, N70.32354° E31.04177°, 91m a.s.l. Bog with small ponds and typical vegetation (*Sphagnum, Carex, Eriophorum*); part of sub-arctic wetland- and bog-complex.

FinLoc105 – **FN**, Vardø: Nedre Domen, site 2, N70.32152° E31.03407°, 120m a.s.l. Small, shallow pond and nearby lake; terrestrializing vegetation; part of sub-arctic wetland- and bog-complex.

FinLoc106 (Figure 10) – **FN**, Vardø: Næringselva, N70.43801° E30.88202°, 16m a.s.l. Fast running river with many rapids; large stones and gravel; sparse bank vegetation.

FinLoc107 – **FN**, Vardø: Sanden, N70.37228° E31.019431°, 1m a.s.l. Patchy dune-vegetation on sandy, partly stony beach; small creek and temporary ponds.

Results

The fieldwork generated a generous amount of material of most target groups. The numbers of recorded species was particularly high for Chironomidae and Mycetophilidae, but also Trichoptera are well represented in our species lists (Table 2). New records for Finnmark county and Norway was also highest for Chironomidae and Mycetophilidae; while the Chironomidae comprised most of the species unknown to science (Table 2). Further details on the results for all focus groups are given in this issue of Norwegian Journal of Entomology (Andersen & Hagenlund 2012, Boumans & Brittain 2012, Greve & Andersen 2012, Kvifte & Andersen 2012, Kjærstad *et al.* 2012, Roth & Coulianos in prep., Stur *et al.* in prep., Søli & Rindal 2012).

FIGURE 10. FinLoc106, Næringselva in Vardø municipality. Photo E. Stur.

TABLE 2. Overview of recorded species diversity in the studied taxonomic groups. *Indicates that barcode cluster analysis as well as morphology is used to delineate species. Numbers in parenthesis indicate possible additional new species that cannot be determined due to a lack of taxonomic revisions.

Taxon	Species number	New records Finnmark	New records Norway	New records Europa	Species new to Science
Diptera					
Bolitophilidae	6	6	0	0	0
Chironomidae*	385	196	41	12	33 (60)
Diadocidiidae	1	1	0	0	0
Mycetophilidae*	240	182	15	0	20 (19)
Psychodidae*	18	11	3	0	1
Ephemeroptera*	39	2	0	0	0
Heteroptera	39	11	0	0	0
Megaloptera	4	0	0	0	0
Neuroptera	13	7	0	0	0
Plecoptera	28	0	0	0	0
Trichoptera	98	27	1	0	0
Total	**871**	**443**	**60**	**12**	**54 (79)**

Discussion

Although there are more local studies focused on freshwater invertebrates from river systems in Finnmark (e.g. Huru 1981, Bergersen & Rubach 1986), this project is the first comprehensive study with respect to diversity of habitats, geographical distribution and taxa.

As shown in Table 2, the results from the project have added considerably to the knowledge of the occurrence and distribution of aquatic insect species in Finnmark, and new records for the region and for Norway have been discovered even for supposedly well-known groups like Trichoptera. There may be various explanations for this, but few equally comprehensive studies on aquatic insects have previously been conducted in the region. It is perhaps tempting to relate new records to potential environmental change. However, this is not possible since no comparable studies have been done in the areas we investigated. The results presented here contribute to the baseline knowledge of aquatic insects in northern Norway, enabling future biological monitoring of environmental change in freshwater and humid habitats in northern Norway.

For two of the focus groups (Mycetophilidae and Chironomidae), a number of species new to science were also detected. We did anticipate some new taxa to be recorded when we started the project, but the number exceeded our expectations. Moreover, only parts of the Malaise-trap material of these taxa have been analyzed in detail, thus the number of records and new species is expected to increase further through phase two of the project. There is a rather substantial uncertainty in the exact number of new species for Chironomidae. This is related to the lack of taxonomic revisions for certain species-rich genera and the need to consult type material of previously described species from Central Europe and Russia. Moreover, results from DNA barcoding of the Chironomidae from Finnmark indicate a substantial number of cryptic species that need detailed morphological and/or molecular description and analysis before the taxonomic status of these can be established (Stur *et al.* in prep.). For Psychodidae one species new to science was discovered. The species is now described and named *Psychoda cultella* and proven to be distributed both in Finland and

Norway (Salmela et al. 2012).

The fieldwork for this project started mid-June 2010. A very mild and early spring that year (Table 1, Figure 1) might have influenced the actual number of species collected, since we most likely missed species with early emergences. This is particularly true for chironomids, as some species start emerging as soon as the ice opens on lakes and rivers (e.g. Thienemann 1941). Thus, even more aquatic insect species are expected to be recorded from Finnmark if early spring emergences are investigated.

Phase two of this project is currently running and focusing on taxonomic groups that were not treated in phase one, as well as continuing work on Chironomidae. Of particular interest are the remaining families of Diptera, a group with comparatively high diversity in northern regions.

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