Cranefly (Diptera, Tipuloidea & Ptychopteridae) fauna of Limhamn limestone quarry (Sweden, Malmö) – diversity and faunistics viewed from a NW European perspective

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This article elucidates a cranefly assemblage of special interest, a limestone quarry of Limhamn, a man-made habitat in southernmost Sweden (Skåne: Malmö). The studied material was collected with two Malaise traps, situated in close proximity to each other in the western part of the quarry. The traps were placed near groundwater-fed ponds, ditches and vertical seepages on limestone. A total of 2613 specimens and 69 species were identified (67 Tipuloidea and 2 Ptychopteridae). Five of the most abundant species (all limoniids) accounted for 71% of the total catch. Species richness of the study site was compared to four other Fennoscandian localities that had been sampled with similar sampling effort. According to rarefaction analysis, the cranefly assemblage of Limhamn was inferior to two species rich sites of southern Finland but superior to a high altitude site and equal to another high latitude assemblage. Limoniids *Idiocera (Idiocera) bradleyi* (Edwards, 1938) and *Dicranomyia (Idiopyga) melleicauda complicata* de Meijere, 1918 are reported for the first time from Sweden; the former species is also new for Fennoscandia. The studied site harbored several rare and ecologically demanding species, including species of calcareous seepages and brackish water habitats; three of the tipulids are currently red-listed in Sweden.

Keywords: Species richness, Fennoscandia, calcareous habitats, semiaquatic dipterans

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Introduction

Craneflies (Diptera, Tipuloidea) are small to large sized nematoceran insects, occurring in all major biogeographic realms, except Antarctica (de Jong et al. 2008). Craneflies are the most species rich dipteran family in the world, having over 15 000 valid species or subspecies (de Jong et al. 2008, Oosterbroek 2010). Systematic classification of the craneflies has been rather controversial. Most European workers have recognized four families (Tipulidae or long-palped craneflies, Limoniidae or short-palped craneflies, Pediciidae or hairy-eyed craneflies and Cylindrotomidae or long-bodied craneflies), whereas most North American authors have supported a classification of one family, Tipulidae, with corresponding subfamilies or tribes (e.g. Limoniinae, Pedicini) (Byers 1992, Petersen et al. 2010). According to a recent phylogeny of craneflies, based on molecular and morphological data, Limoniidae and its subfamilies sensu Starý (1992) are not considered to be monophyletic taxonomic groups (Petersen et al. 2010). Instead, limoniids are part of the Tipulidae clade together with cylindrotomids. Thus, only Tipulidae and Pediciidae are held as valid families (Petersen et al. 2010). However, for practical reasons, and due to long history of usage in Fennoscandian literature, the "old" four family Tipuloidea classifications are used in this text.

Craneflies vary considerably with respect to their larval habitats. A majority of the species are dwellers of moist or wet biotopes, inhabiting a moisture gradient from aquatic habitats to moist soil. Most species inhabit freshwater environments, some species tolerate or demand brackish water and some species dwell in marine coastal habitats. Tipuloid larvae are also represented in decaying wood, fruiting bodies of fungi, sandy substrates, aquatic and terrestrial mosses and vascular plants (e.g. Alexander 1920, Theowald 1957, Brindle 1960, 1967, de Jong et al. 2008). Only a few species are harmful pests to agriculture (Alexander 1920, Blackshaw & Coll 1999) or to recreational facilities (Taschereau et al. 2009). Tipuloid larvae may attain high densities in soil or wetlands and, due to their abundance and large size, are probably of great importance for the functioning of food-webs (shredders of detritus, invertebrate predators, food items for vertebrates) (Freeman 1967, MacLean 1973, Pritchard 1983).

Fennoscandian or NW European cranefly fauna can be roughly divided into three distribution types: species of European lowlands, boreo-alpine or boreo-montane species, boreal and arctic species (Theowald & Oosterbroek 1983, 1985). Distributions and range-sizes of tipulids are better known than that of other cranefly families, especially species rich limoniids, and such a biogeographic assessment as is available for tipulids (Theowald & Oosterbroek 1983, 1985), does not exist for other families. A total of 406 species are known from Nordic countries (excluding Iceland). Of these, 59 species (15 %) are currently recorded from only a single country (25 from Finland, 15 from Sweden, 13 from Denmark and 6 from Norway (Table 1). Had Kola Peninsula and Russian Karelia been included, number of NW European species would have exceeded 410. Only eight species (2% of the total) are endemic to Fennoscandia (i.e. only known from one or more Nordic countries; *Rhabdomastix parva* (Siebke, 1863), also known from Iceland, is included). Seven Fennoscandian endemics are known from Finland, six from Sweden, two from Norway and none from Denmark (Table 1). Sweden and Finland harbor the most diverse cranefly faunas (355 and 334 species, respectively), whereas Denmark and Norway house a lesser cranefly richness (261 and 243 species, respectively) (Table 1). Most likely explanations for the greater number of species in Sweden and Finland are that these two countries have been better inventoried and are also larger in geographic extent, and perhaps include more environmental heterogeneity within their boundaries than Norway and Denmark. The cranefly faunas of Finland and Sweden show the greatest degree of compositional similarity (Jaccard coefficient 0.78); similarity coefficients between other countries range from 0.53 to 0.65 (Table 2). Only 16 cranefly species are recorded from Iceland (Oosterbroek 2010); all except one species (*Limonia hercegovinae* (Strobl, 1898), doubtful record) are also known from the continental Nordic countries.

Considering taxonomic knowledge, Fennoscandian cranefly fauna is relatively well known, since only 29 species (7% of the Fennoscandian species pool) with NW European occurrence have been described since 1950. However, occurrences of most species are poorly mapped and ecological information is still scarce and incomplete. For example, in recent red-list evaluations of Norway (Gammelmo et al. 2006) and Sweden (Cederberg et al. 2010), craneflies were either totally ignored or the most species rich family Limoniidae was not evaluated, respectively. Only a few detailed and quantitative eco-faunistic surveys have been published, most of these within 2001–2009 in Finland (see Salmela 2008 for details).

The limestone quarry of Limhamn is situated in South Sweden (Skåne: Malmö), being famous for its size, history and importance for geological studies. Further, the site is known to harbor populations of several rare and threatened plants and animals, and is now a nature conservation area. Professor emeritus Bo-W. Svensson and his colleagues in the Lund Zoological Museum collected adult insects from the quarry by using two Malaise traps. I was offered an opportunity to identify craneflies and ptychopterids from this material, a task which proved to be very interesting and fruitful. Thus, this paper is a description of the quarry's cranefly fauna based on the Malaise trap material. In addition, Limhamn's fauna is compared to four other Fennoscandian assemblages that had similar sampling efforts.

TABLE 1. Cranefly (Diptera, Tipuloidea) species richness in Nordic countries. Unique species (spp.) are only known from one country, endemic species are only known from Fennoscandia[1]. Data from Oosterbroek (2010) and J. Salmela, unpublished.

	Number of spp	Number of unique spp	Number of endemics
Sweden	355	15	6
Finland	334	25	7
Denmark	261	13	0
Norway	243	6	2
Total	**406**	**59**	**8**

[1]*Rhabdomastix parva* (Siebke, 1863), included in the figures, is also known from Iceland.

TABLE 2. Compositional similarity (Jaccard coefficients) of cranefly (Diptera, Tipuloidea) faunas between Fennoscandian countries. Data from Oosterbroek (2010) and J. Salmela, unpublished.

	Sweden	Finland	Denmark
Finland	0.78		
Denmark	0.65	0.55	
Norway	0.63	0.62	0.53

Materials and methods

The limestone quarry of Limhamn (ca. 55°61'N, 12°93'E) is situated in the city of Malmö, in southernmost Sweden. The environmental conditions of the site have been illustrated by Molander (2009) and Wirén (2009), and the short site description provided here is based on these two sources. The quarry is large in its extent, covering some 100 ha, being dug up to 58 m below sea level and being composed of Paleocene deposits. The site is mainly characterized by limestone steppes, with sparse vegetation. There is also an extensive wetland dominated by *Phragmites australis* (Cav.) Trin. ex Steud., roughly in the centre of the pit. In the western side of the quarry are two ponds, which are deep and nourished by groundwater. In order to avoid the quarry's filling with water, groundwater is continuously pumped away. Due to the proximity of the Baltic Sea (only ca. 1 km distance), water in the quarry is partly brackish. Water chemistry strongly reflects the calcareous and brackish influence, since pH of surface waters range between 8.1–8.5, conductivity ranges between 80–517 mS/m, calcium concentration is between 75–170 mg/l and chloride concentration 51–1400 mg/l. Climate in the study area is maritime; mild winters (average temperature in January −0.2°C) prevail. Average monthly temperature in July is 16.8°C and annual precipitation ranges from 500–800 mm (http://press.skane.com/en/content/skanes-geography-and-climate).

Malaise traps were set in the western part of the quarry, near the southern pond. Trap number 1 was at the western side of the pond; its environment was characterized by moist and swampy soil, with numerous decaying *Salix* sp. trees. Trap number 2 was at the southern side of the pond. There was a ditch with slowly flowing water within 3–4 meters from the trap. Environment of the trap was characterized by dry soil, *Salix* sp. bushes and *Betula pubescens* Ehrh. Distance between the traps was ca. 55 meters. Within some 30–50 m from the traps were vertical groundwater seepages upon a cliff covered by bryophytes and algae.

Collecting of the adult insects was year round in 2009, through the winter months. Ethanol was used as a preservative in the traps and the collecting jars were emptied in circa two-week intervals. Two samples of trap 1 (11–27.V. and 11.–25.VI) were not complete. Craneflies were sorted out from the material, stored in ethanol and were later identified to species. All studied material is deposited in the Zoological Museum, University of Lund.

Jaccard and Bray-Curtis indices of compositional similarity were calculated between the two traps. Jaccard index is based on presence-absence information, whereas Bray-Curtis takes abundance of each species into account. Absolute abundances were used in the calculation of Bray-Curtis similarity. Both indices are interpreted in a similar way: 0–no common species, 1–identical samples (Magurran 2004). EstimateS 8.2.0. (Colwell 2009) was used in the calculation of similarity indices. Individual based rarefaction was calculated for the combined trap material of Limhamn. Rarefaction method can be used in the comparison of two or more assemblages if sampling effort (i.e. collected number of specimens) has varied (Krebs 1998). In order to evaluate the richness and sampling efficiency of Limhamn, four other Fennoscandian cranefly assemblages were included in the rarefaction analysis. Common features for all sites are equal sampling effort (two Malaise traps per site) and presence of lotic water or groundwater influence. One of the sites is in Norway, Dovrefjell National Park (Raubekken, 55°61’N, 12°93’E, 900 m a.s.l., subalpine vegetation zone; 31 spp, 435 specimens); data from Raubekken was obtained from Hofsvang et al. (1987, Tipulidae, years 1980–1983) and Mendl et al. (1987, Limoniidae and Pediciidae, year 1980). Three sites are in Finland: Galddasjohka (69°52’N, 27°49’E, 185 m a.s.l.; 50 spp, 1164 specimens) in northernmost Finland, subalpine zone (Salmela 2008), Ruottaniitty (61°50’N, 24°04’E, 150 m a.s.l.; 64 spp, 1088 specimens) in southern Finland, southern boreal zone (Salmela et al. 2007) and Ohkolanjoki (60°33’N, 25°10’E, 55 m a.s.l.; 70 spp, 809 specimens) in southernmost Finland, near hemiboreal zone (J. Salmela, unpublished). Because ptychopterids were not reported from Dovrefjell, they were excluded from the analysis. According to Magurran (2004, page 145) and references therein, markedly different species abundance distributions of the assemblages being compared can greatly bias rarefied species richness estimations. Rank-abundance distributions of the five assemblages were very similar, all resembling logseries distribution (data not shown here). Hence, rarefaction was concluded to reveal non-artifact differences in the cranefly diversity of the sites. PAST 1.94b (Hammer et al. 2001) was used in the calculation of rarefaction.

Results and discussion

A total of 2613 specimens and 69 species were identified (Appendix 1). Limoniidae was the most species rich family (45 spp), followed by Tipulidae (20), Ptychopteridae (2), Cylindrotomidae (1) and Pediciidae (1). Trap 1 yielded 756 specimens and 47 species, respective figures for the trap 2 were 1857 and 53. Five of the most abundant species (*Pseudolimnophila (Pseudolimnophila) sepium* (Verral, 1886), *Molophilus (Molophilus) appendiculatus* (Staeger, 1840), *M. (M.) obscurus* (Meigen 1818), *M. (M.) bifidus* Goetghebuer, 1920 and *Idiocera (Idiocera) bradleyi* (Edwards, 1939) accounted for 71% of the total catch (Figure 1). Twenty-three and 15 species were present only in trap 1 and 2, respectively. Twenty-one species (30%) in the material were singletons. The cranefly catches of the traps were rather similar (Jaccard similarity 0.45, Bray-Curtis similarity 0.42), but dissimilar enough to indicate within-habitat environmental variation in the vicinity of the traps.

The number of observed species within trapping periods was rather high between end of May–end of August (20–34 spp), peaking in the end of July–middle of August (Fig. 2a). The number of observed species was lower in early (April–early May) and in the late (end of September–November) season. The number of observed specimens within trapping periods followed the same pattern, but with a pronounced peak of abundance in midsummer (end of May–middle of August, Fig. 2b). Cumulative number of species as a function of time increased steadily from the beginning of April to the middle of August (from 2 to 63 spp), thereafter reaching

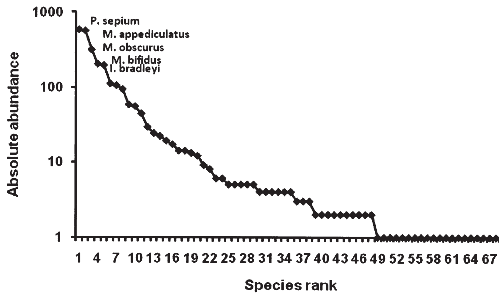

FIGURE 1. Rank-abundance distribution of the studied cranefly (Tipuloidea and Ptychopteridae) assemblage, combined material from two Malaise traps (69 spp, 2613 specimens). Five of the most abundant species are named.

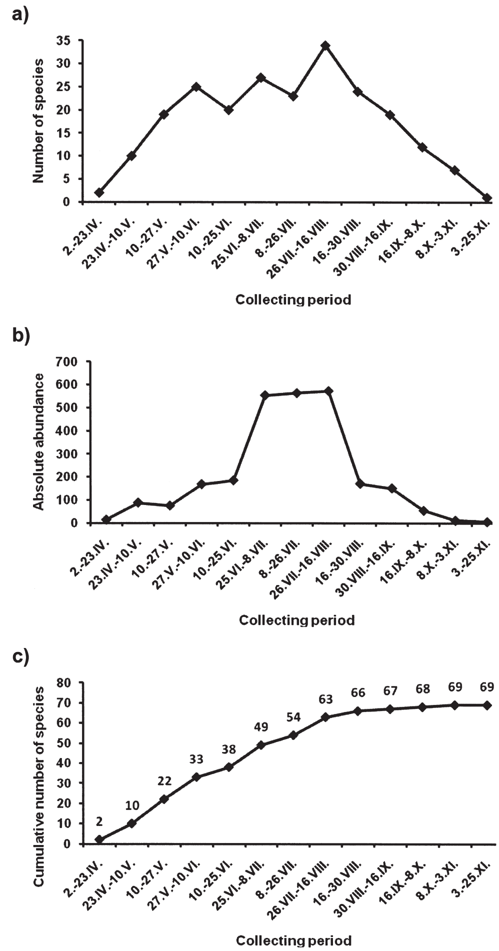

FIGURE 2. Temporal variation **a**) in the number of species within collecting periods, **b**) in the total number of specimens within collecting periods and **c**) cumulative number of species as a function of time in the studied cranefly (Tipuloidea and Ptychopteridae) assemblage in 2009.

an asymptote (Fig. 2c). *Symplecta (Psiloconopa) stictica* (Meigen, 1818) (Fig. 3a) had a peak of abundance in the early season (April–May), followed by a long flight period. *Pseudolimnophila sepium* and *I. bradleyi* were most numerous in July, whereas *Ormosia (Ormosia) hederae* (Curtis, 1835) had apparently two generations; in spring and autumn (Fig. 3a). Three abundant *Molophilus* species had largely overlapping temporal occurrences and long flight periods (Fig. 3b). *Molophilus appendiculatus* was most numerous in July–middle of August, as was also *M. bifidus*. *Molophilus obscurus* had two peaks of abundance, first in the end of June–beginning of July and second in the end of August–middle of September (Fig. 3b). Flight periods of the two congeneric ptychopterid species were somewhat differentiated. *Ptychoptera (Ptychoptera) albimana* (Fabricius, 1787) had a low abundance from April to end of July, with slight increase in numbers in August, whereas *P. (P.) contaminata* (Linnaeus, 1758) had a shorter flight period with a clear maximum peak in the end of July–middle of August (Fig. 3c).

According to individual based rarefaction, species accumulation had not completely leveled off with the present sampling effort (Fig. 4a). Thus, further sampling would probably have increased the observed number of species. However, the total number of cranefly specimens caught is relatively large, compared to four other Fennoscandian localities with similar Malaise trapping scheme, and rarefaction curve of Limhamn indicates relatively representative sampling effort. Compared to Limhamn, rarefied species richness is consistently higher among Ohkolanjoki and Ruottaniitty, and higher in Galddasjohka until ca. 780 specimens are caught. However, if rarefied down to 435 specimens

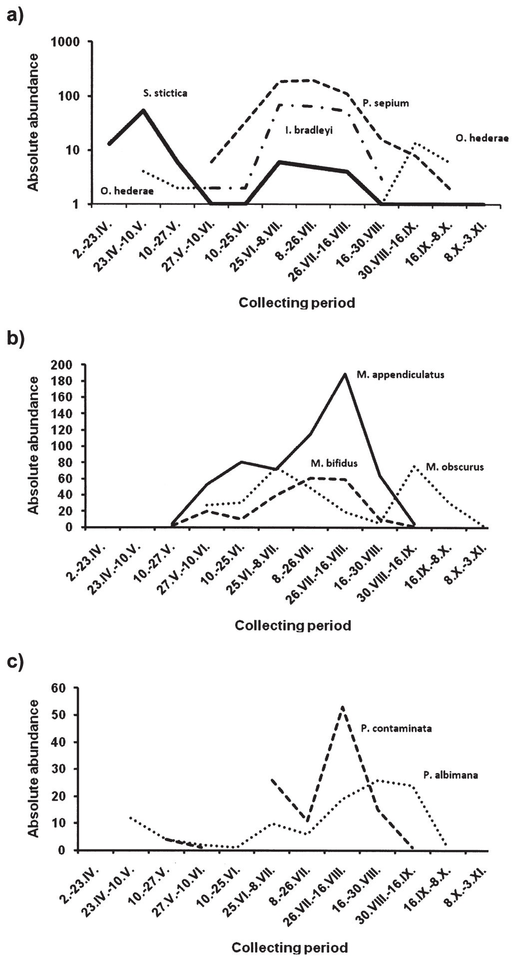

FIGURE 3. Temporal variation in the abundance of **a**) four limoniid species, **b**) three Molophilus (Limoniidae) species and **c**) two ptychopterid species of the studied assemblage in 2009. Note the logarithmic scale in Fig. 3a.

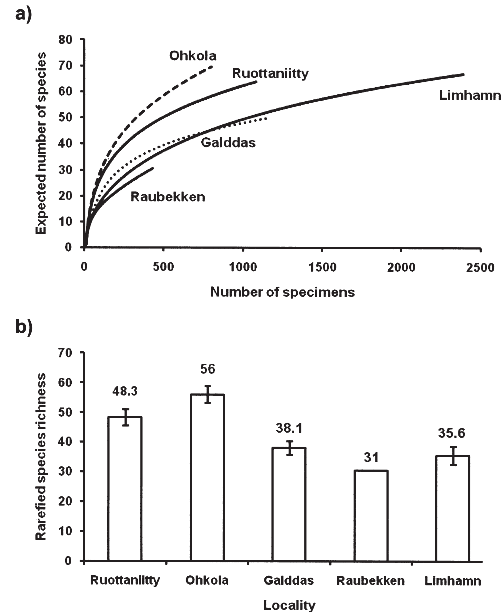

FIGURE 4. **a**) Individual based rarefaction curves of five Fennoscandian cranefly (Tipuloidea) assemblages (95 % confidence limits are not shown) and **b**) rarefied species richness of each assemblage for 435 specimens (except Raubekken, which was the least species rich locality with 435 specimens). Rarefied mean species richness and 95 % confidence limits are shown. Galddas=Galddasjohka.

(abundance in Raubekken, the least species rich locality), 95% confidence limits of Galddasjohka and Limhamn overlap, indicating similar richness of these two sites (Fig. 4b). Rarefied richness of Raubekken is the lowest. Both Ohkolanjoki and Ruottaniitty are among the most species rich cranefly habitats in Finland so far examined, being characterized by flowing water, seepages, rich fen vegetation, moist and herb-rich forests, decaying wood and near pristine conditions. Although regional richness of craneflies in southernmost Sweden is perhaps higher than that of southern Finland (no valid and updated data is available from Sweden), microhabitat diversities in Ohkolanjoki and Ruottaniitty are higher than in Limhamn, perhaps best explaining the observed pattern. In addition, rarefaction curves indicate that sampling effort has likely been inadequate to reveal real richnesses of these sites. Due to its high latitudinal position, Galddasjohka may be assessed as a northern hot-spot of cranefly richness (see Salmela 2008 for further discussion). Raubekken, being situated in southern Norway at high elevation, is characterized by similar ecological conditions as Galddasjohka. Despite climatic and vegetational similarities, species richness of Raubekken is much lower than in Galddasjohka.

Most of the recorded species are inhabitants of swamps or moist soil. Some species have aquatic (e.g. *Helius* spp, *Tipula (Acutipula) maxima* Poda, 1761) or saproxylic (e.g. *Dictenidia bimaculata* (Linnaeus, 1760), *Tipula (Dendrotipula) flavolineata* Meigen, 1804) larvae. With regard to nature conservation and faunistics, most valuable and ecologically demanding species are confined to seepages (i.e. groundwater fed springs with thin water column), calcareous substrates or brackish water habitats. *Paradelphomyia (Oxyrhiza) senilis* (Haliday, 1833), *Gonomyia (Gonomyia) recta* Tonnoir, 1920, *G. (Prolipophleps) abbreviata* Loew, 1873, *Idiocera bradleyi, M. bifidus* and *Orimarga (Orimarga) juvenilis* (Zetterstedt, 1851), at least, are spring specialists (Boyce 2002, Boardman 2007, Reusch & Hohmann 2009); *G. recta, G. abbreviata, I. bradleyi* and *O. juvenilis* are also indicators of calcareous soil or bedrock (Falk 1991, Boyce 2002, Boardman 2007). *Erioptera (Mesocyphona) bivittata* (Loew, 1873), *Symplecta stictica, Dicranomyia (Dicranomyia) sera* (Walker, 1848), *D. (Idiopyga) melleicauda* complicata de Meijere, 1918 and *Nigrotipula nigra* (Linnaeus, 1758) are brackish species or dwell in saline habitats (Falk 1991, Wrage 1978, Szadziewski 1983, Nieminen 2008). *Nephrotoma quadristriata* (Schummel, 1833), at least in certain parts of its range, is confined to coastal areas, being associated with sandy substrates (Oosterbroek 1979).

From a Fennoscandian perspective, the cranefly assemblage of Limhamn has a prominent component of the Central European fauna. There are several species which are either absent (e.g. *Dicranophragma (Brachylimnophila) nemorale* (Meigen, 1818), *Paradelphomyia senilis, Erioptera bivittata, Gonomyia abbreviata, Nephrotoma flavipalpis* (Meigen, 1830)) or rare (e.g. *Molophilus bifidus, Helius (Helius) pallirostris* Edwards, 1921) in Finland and more northern areas of Sweden. Some of the species are widespread and common in most of Fennoscandia (e.g. *Dicranophragma (Brachylimnophila) separatum* (Walker, 1848), *Erioptera (Erioptera) sordida* Zetterstedt, 1838, *Molophilus appendiculatus, Helius longirostris* [Meigen, 1818], *Tipula (Schummelia) variicornis* Schummel, 1833, *Tricyphona (Tricyphona) immaculata* (Meigen, 1804)). Quite interestingly, most of these widespread and usually abundant species occur in low numbers in Limhamn (*M. appendiculatus* and *T. variicornis* were exceptions; they were numerous in Limhamn). Apparently the local conditions met the niche requirements of several rare species (in this context, low regional frequency and area of occupancy within Fennoscandia), favoring their abundance in Limhamn. Such species include *Pseudolimnophila sepium, Gonomyia recta, Idiocera bradleyi, Molophilus obscurus* and *Ormosia hederae*. Some of these species may be more abundant or frequent in the core areas of their distribution (Central Europe). For example, *O. hederae* and *M. obscurus* were among the most abundant species in Breitenbach, Germany (Mendl 1973) and *P. sepium* was not rare in a faunistic study performed in Świętokrzyskie Mountains, Poland (Wiedeńska, 1992).

Idiocera bradleyi is new for Fennoscandia and *Dicranomyia melleicauda complicata* is new for Sweden. The former species is known from the Central Europe, Great Britain and the Caucasus, while the latter taxon is known from coastal areas of Western Europe (Oosterbroek 2010). *Nephrotoma quadristriata* (VU), *T. flavolineata* (VU) and *T. (Savtshenkia) rufina* Meigen, 1818 (DD) are red-listed in Sweden (Cederberg et al. 2010). From a Fennoscandian perspective, the limestone quarry of Limhamn harbors a unique cranefly fauna, which is composed of species with limited distributions (confined to the nemoral zone of Sweden) and specific habitat preferences (limestone seepages, brackish water), being thus worth of conservation and monitoring.

Some notes to the list of identified species:

Cheilotrichia (Empeda) sp. Female specimens from July to late summer may belong to *C. cinerascens* (Meigen, 1804) (if two generations within a season), but *C. neglecta* (Lackschewitz, 1927) is also a possibility (adults found in August-

September in Finland)

Erioptera (Erioptera) cf. *lutea* (Meigen, 1804). A female specimen that might possibly be *E. pederi* Tjeder, 1969.

Dicranomyia (Dicranomyia) cf. *chorea* (Meigen, 1818) and *D.* cf. *mitis* (Meigen, 1830). Species centered around *D. chorea* and *D. mitis* are in a need of taxonomic revision.

Dicranomyia (Idiopyga) melleicauda complicata. Only a female specimen was present in the samples. Identification of *Dicranomyia* females is notoriously difficult in many cases, but there is no doubt about the identity of this specimen (Fig. 5). It should be mentioned here that an earlier report of *D. m. complicata* from Finland was erroneous. The species was reported by Nieminen (2008) as a new for Finland. I have re-examined this material from northern Baltic (Oulunsalo and Hailuoto), and these specimens actually belong to *D. esbeni* Nielsen, 1940. The latter species is very poorly known, only collected from Denmark (almost 100 years ago, type material [1♀1♂] of *D. esbeni*, Nielsen 1940, Starý 2007) and Mongolia (Podenas & Gelhaus 2001, as *D. sineloba*, 1♂). Reliable identification of this species became possible after the publication of figures drawn by B. Tjeder, which he had prepared by studying the Danish type material (Starý 2007). Females of *D. m. complicata* are generally dark and stout-bodied, femora are widen toward the apices (Fig. 5); females of *D. esbeni* are more brightly colored and slender-bodied.

Dicranomyia (Idiopyga) sp. Only a female specimen was present in the samples (October). Several *Idiopyga* species are on the wing in the late season.

Tipula (Lunatipula) sp. Only a female specimen was present in the samples.

Tipula (Pterelachisus) sp. Only a female specimen was present in the samples.

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FIGURE 5. Females of *Dicranomyia melleicauda complicata* de Meijere (above, Limhamn) and *D. esbeni* Nielsen (below, Finland).

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APPENDIX 1. Craneflies (Diptera: Tipuloidea & Ptychopteridae) recorded from the limestone quarry of Limhamn (Sweden, Skåne: Malmö) in 2009. Total number of specimens for each species is given for both Malaise traps and their sum.

	Malaise 1	**Malaise 2**	∑
Limoniidae			
Dicranophragma (Brachylimnophila) nemorale (Meigen, 1818)		4	4
Dicranophragma (Brachylimnophila) separatum (Walker, 1848)	1	1	2
Epiphragma (Epiphragma) ocellare (Linnaeus, 1760)	1		1
Paradelphomyia (Oxyrhiza) senilis (Haliday, 1833)	2	6	8
Phylidorea (Phylidorea) ferruginea (Meigen, 1818)	6	11	17
Pilaria discicollis (Meigen, 1818)	1	5	6
Pseudolimnophila (Pseudolimnophila) lucorum (Meigen, 1818)	12	10	22
Pseudolimnophila (Pseudolimnophila) sepium (Verrall, 1886)	179	382	561
Cheilotrichia (Empeda) cinerascens (Meigen, 1804)	8	11	19
Cheilotrichia (Empeda) sp. ♀	3		3
Erioconopa trivialis (Meigen, 1818)	2		2
Erioptera (Erioptera) cf. *lutea* Meigen, 1804 ♀	1		1
Erioptera (Erioptera) sordida Zetterstedt, 1838		1	1
Erioptera (Mesocyphona) bivittata (Loew, 1873)	1		1
Gonomyia (Gonomyia) recta Tonnoir, 1920	10	34	44
Gonomyia (Gonomyia) tenella (Meigen, 1818)	31	27	58
Gonomyia (Prolipophleps) abbreviata Loew, 1873	1	13	14
Idiocera (Idiocera) bradleyi (Edwards, 1939)	155	40	195
Ilisia maculata (Meigen, 1804)	2	3	5
Molophilus (Molophilus) appendiculatus (Staeger, 1840)	62	520	582
Molophilus (Molophilus) bifidus Goetghebuer, 1920	72	131	203
Molophilus (Molophilus) griseus (Meigen, 1804)	4		4
Molophilus (Molophilus) obscurus (Meigen, 1818)	27	287	314
Molophilus (Molophilus) ochraceus (Meigen, 1818)	1		1
Ormosia (Ormosia) clavata (Tonnoir, 1920)	1		1
Ormosia (Ormosia) hederae (Curtis, 1835)	4	25	29
Symplecta (Psiloconopa) stictica (Meigen, 1818)	62	31	93
Symplecta (Symplecta) hybrida (Meigen, 1804)	1		1
Atypophthalmus (Atypophthalmus) inustus (Meigen, 1818)		1	1
Dicranomyia (Dicranomyia) cf. *chorea* (Meigen, 1818)	8	1	9
Dicranomyia (Dicranomyia) didyma (Meigen, 1804)	1	1	2
Dicranomyia (Dicranomyia) cf. *mitis* (Meigen, 1830)		3	3
Dicranomyia (Dicranomyia) modesta (Meigen, 1818)	9	5	14
Dicranomyia (Dicranomyia) sera (Walker, 1848)	5	1	6
Dicranomyia (Dicranomyia) ventralis (Schummel, 1829)	5		5

Appendix 1. continued

	Malaise 1	Malaise 2	∑
Dicranomyia (Idiopyga) melleicauda complicata de Meijere, 1918	1		1
Dicranomyia (Idiopyga) sp. ♀	1		1
Dicranomyia (Melanolimonia) morio (Fabricius, 1787)		2	2
Helius (Helius) longirostris (Meigen, 1818)		2	2
Helius (Helius) pallirostris Edwards, 1921		1	1
Limonia phragmitidis (Schrank, 1781)	2	3	5
Metalimnobia (Metalimnobia) quadrinotata (Meigen, 1818)	2		2
Neolimonia dumetorum (Meigen, 1804)		1	1
Orimarga (Orimarga) juvenilis (Zetterstedt, 1851)	13		13
Rhipidia (Rhipidia) maculata Meigen, 1818	1	1	2
Tipulidae			
Dictenidia bimaculata (Linnaeus, 1760)		5	5
Nephrotoma appendiculata (Pierre, 1919)	1		1
Nephrotoma cornicina (Linnaeus, 1758)		1	1
Nephrotoma dorsalis (Fabricius, 1781)		1	1
Nephrotoma flavescens (Linnaeus, 1758)	2	2	4
Nephrotoma flavipalpis (Meigen, 1830)		12	12
Nephrotoma quadrifaria (Meigen, 1804)		1	1
Nephrotoma quadristriata (Schummel, 1833)		2	2
Nigrotipula nigra (Linnaeus, 1758)		1	1
Tipula (Acutipula) maxima Poda, 1761		4	4
Tipula (Acutipula) vittata Meigen, 1804		2	2
Tipula (Beringotipula) unca Wiedemann, 1817		1	1
Tipula (Dendrotipula) flavolineata Meigen, 1804		5	5
Tipula (Lunatipula) sp. ♀	1		1
Tipula (Pterelachisus) sp. ♀		1	1
Tipula (Savtshenkia) rufina Meigen 1818	1	3	4
Tipula (Schummelia) variicornis Schummel, 1833	10	45	55
Tipula (Tipula) oleracea Linnaeus, 1758	2	2	4
Tipula (Tipula) paludosa Meigen, 1830	1	2	3
Tipula (Yamatotipula) lateralis Meigen, 1804		2	2
Pediciidae			
Tricyphona (Tricyphona) immaculata (Meigen, 1804)	7	17	24
Cylindrotomidae			
Phalacrocera replicata (Linnaeus, 1758)		1	1

Appendix 1. continued

	Malaise 1	Malaise 2	∑
Ptychopteridae			
Ptychoptera albimana (Fabricius, 1787)	10	95	105
Ptychoptera contaminata (Linnaeus, 1758)	23	88	111
species per trap	**47**	**53**	**69**
specimens per trap	**756**	**1857**	**2613**