The traffic of adult Trichoptera above the city of Copenhagen (Denmark)

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In 1994 and 1995 adult Trichoptera were captured from May to October in a light trap located at the roof of the Zoological Museum of Copenhagen 17.5 m above the ground. Although the museum is situated in an urban area, lakes, ponds, and even streams are found within a radius of 5-10 km. A total of 3017 and 5499 specimens were obtained in 1994 and 1995, respectively, belonging to 44 species and 9 families. Only 8-9 species made up about 97% of the total catch. Species composition differed considerably between years, the most abundant species in 1994 and 1995 being *Oecetis ochracea* (61.9%) and *Leptocerus tineiformis* (67.0%), respectively. More than 99% of the specimens belonged to species inhabiting lentic waters.

Flight periods of the dominant species ranged from 4 to 6 weeks in *L. tineiformis* to 19-26 weeks in limnephilids entering summer diapause. Flight activity of the most abundant species was not correlated with meteorological factors like air temperature, wind, or precipitation. Thus, the wheather was exceptionally warm during their flight periods, temperature obviously far exceeded the threshold of flight.

Several species showed significant deviations from the expected 1:1 sex ratio: an excess of females was found in *Agraylea multipunctata* and four lepotocerid species. Literature data on sex ratios and present observations indicate that an excess of females is the rule in European Leptoceridae. Moreover, the proportion of females is higher far from, than close to, the potential breeding places. We suggest a behavioural explanation: females show a higher degree of dispersal than males, and in the dominant species in our study (*L. tineiformis* and *O. ochracea*) this probably reflects a long-distance dispersal in order to colonize new potential breeding sites.

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Introduction

Light trapping of adult Trichoptera often provides valuable information about distribution, life-cycle, behaviour and dispersal. It is an effective way to obtain a broad impression of the species richness of a given area, but the results depend on the catchability (night-active flyers) and dispersal potential of the species (e.g. Malicky, 1987; Wiberg-Larsen, 1996). The pre-adult stages of all Danish species except one are aquatic or semiaquatic, and the habitats include lakes, ponds, springs and streams, and even brackish waters. With knowledge of larval ecology and environmental properties of both nearby and more distant water bodies, it is sometimes possible to make conclusions regarding the dispersal potential of the adults.

In most previous light trapping studies the traps have been located either in the near vicinity of a freshwater site or in open land with several potential larval habitats. Only in a few studies have the traps been placed in urban areas, where light trapping might be influenced by the overwhelming illumination by city lights. On the other hand, buildings and consolidated areas (e.g. roads) during sunny summer days accumulate considerable amount of heat which releases to the air during the night. As flight activity of adult Trichoptera is mainly dependent on air temperature (e.g. Waringer 1989), cities may have an accumulating effect on flying specimens.

The present study focuses on the species composition, flight periods, flight behaviour (sex ratio) and dispersal capacity of adult Trichoptera inside an urban area. Moreover, we also make some comparisons with simultaneous catches of Lepidoptera in the trap.

Study area and methods

Light trapping was performed at the Zoological Museum of Copenhagen. The Museum is situated in the northern part of Copenhagen (Northeast Zealand) (fig. 1). The vicinity of the museum is a rather densely built-up area of mainly 4-5 floored buildings. A park (The Fælledpark) is situated 250-700 m to the east. The park which covers an area of approximately 65 hectars includes green lawns, groups of trees and bushes, and a small lake.

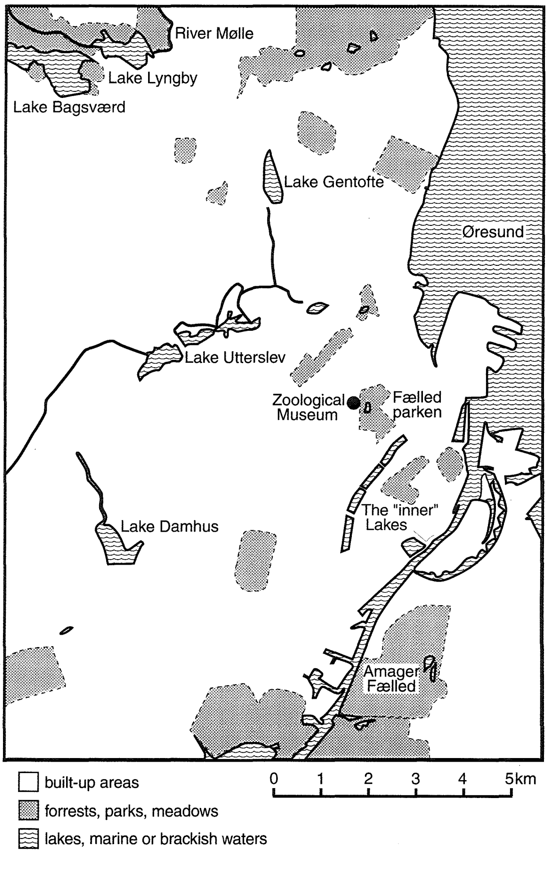

Fig. 1. Map of Copenhagen showing the light trapping site and potential breeding sites for Trichoptera.

The Fælledpark lake was pumped dry in summer 1992 and the top sediment removed in order to improve the quality of the lake. The lake was water-filled during 1994 and 1995 and is now with a growth of submersed macrophytes (*Chara* sp., *Potamogeton crispus*). Other freshwater habitats including 5 lakes ("The Inner Lakes", Lake Emdrup, Lake Utterslev, Lake Gentofte and Lake Damhus), a few small ponds and a small canal are located in urban areas within a radius of 5 km from the museum. Only Lake Gentofte and Lake Damhus have growth of submersed macrophytes including *Chara* spp., *Ceratophyllum demersum* and *Myriophyllum spicatum*. The nearest large stream is the River Mølle located at least 9.3 km to the north of the museum. In addition the Amager Fælled situated at least 7.8 km to the south contains numerous permanent and temporary water bodies, some of which are slightly brackish.

A modified Robinson light trap (fig. 2) (Karsholt, 1992) was operated at the roof of the Zoological Museum, 17.5 m above the ground. A 250 W mercury lamp was used as the light source. The trap was placed in the northeastern corner of the building. With wind directions from west and south, the trap was sheltered and insects might become accumulated around it, whereas with strong winds from north and east, flying insects might have passed the trap without being caught.

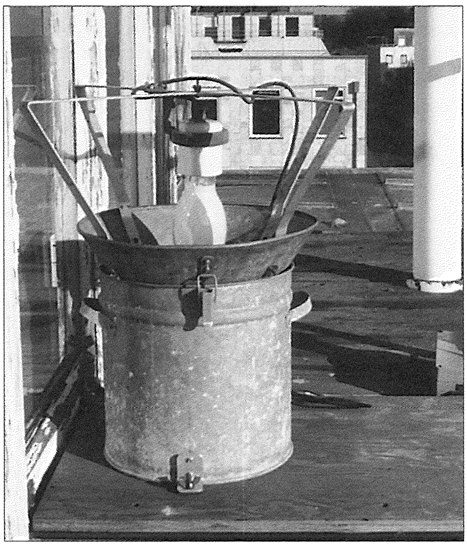

Fig. 2. Left: The Zoological Museum of Copenhagen. The light trap is situated close to the flag pole on the roof. Right: Close-up of the trap in its position.

The light trap has been operated since 1992 in order to study the night-flying Lepidoptera of Copenhagen and its vicinity (Karsholt, 1995). During 1994 and 1995 all Trichoptera captured were sorted from the samples and stored in 70% ethanol. During these two years the trap was operated continuously from April to October, but emptied at irregular intervals ranging between one day and three weeks, to a certain degree depending on the amount of trapped insects. A very large amount of Lepidoptera was captured and identified, but this material has not yet been analyzed quantitatively. However, some general trends will be presented and compared with the Trichoptera results in this paper.

Meteorological data including air temperature, wind speed and direction, and precipitation were obtained from the Danish Meteorological Institute. We used measurements from the nearest meteorological station at Kastrup Airport, situated very close to the sea about 10 km southeast of the museum. Measurements were made every third hour.

Deviations from an expected 1:1 sex-ratio was evaluated by Chi square test (with Yates correction). Correlations between percent females and period, and between catches and meteorological factors were tested using Spearman Rank Correlation. We analysed available data on light trap catches of Leptoceridae from literature and the present study in order to evaluate general trends in sex ratio and dependence of distance from potential breeding places on female proportion, using Wilcoxon matched-pairs signed-ranks test and Mann Whitney U-test, respectively. In all tests significance was accepted at $P<0.05$.

Results

A total of 3017 and 5499 specimens of Trichoptera were captured in the years 1994 and 1995, respectively (Table 1). Forty-four species belonging to 9 families were recorded 1994-1995, ranging 35 and 37 species in 1994 and 1995, respectively. Jaccard's coefficient of similarity (using only presence/absence data) between catches of the two years was 0.64.

Tabel 1. List of Trichoptera caught in a light trap at the Zoological Museum (Copenhagen) 1994-1995. The total number of individuals (m-males/f-females), the probable breeding habitat of each species (s-streams, p-ponds, l-lakes, d-ditches or swampy areas along streams, t-temporary pools, b-brackish waters), and the recorded trapping periods are presented. The species are arranged in accordance with Andersen & Wiberg-Larsen (1987). Asterisks indicate significance of deviation from a 1:1 sex ratio (χ^2-test, * $P<0.05$, ** $P<0.01$, NS not significant) for the abundant species (catch ≥ 10 individuals $year^{-1}$).

Taxa	1994 m/f	1995 m/f	Breeding site	Flight period
HYDROPTILIDAE				
Agraylea multipunctata (Curtis)	117/345**	178/749*	*l,p	May 20-September 13
Agraylea sexmaculata Curtis	1/0	6/1	l,p	July 10-August 16
Orthotrichia costalis (Curtis)	0/1	0/2	l	August 4-13
Oxyethira flavicornis (Pictet)	11/7NS	7/3NS	l,p	June 29-August 28
Hydroptila sparsa Curtis	0/1		s	July 27
PSYCHOMYIIDAE				
Tinodes waeneri (Linnaeus)	5/0	22/0**	l	May 22-September 20
POLYCENTROPODIDAE				
Cyrnus crenaticornis (Kolenati)	1/0	81/47*	l,p	June 20-September 12
Cyrnus flavidus McLachlan	1/0	3/0	l,p	July 10-August 13
Holocentropus picicornis (Stephens)	1/2	5/5NS	p	July 17-August 18
Polycentropus flavomaculatus (Pictet)		0/1	l,s	August 10-13
ECNOMIDAE				
Ecnomus tenellus (Rambur)	4/5NS	2/13NS	l	June 20-August 23
HYDROPSYCHIDAE				
Hydropsyche angustipennis (Curtis)	0/3	0/1	s	July 17-24
Hydropsyche siltalai Döhler	1/0	0/1	s	July 27-31
PHRYGANEIDAE				
Agrypnia pagetana Curtis	1/0	1/1	l,p	July 29-August 6
Agrypnia varia (Fabricius)	2/0		l,p	August 11-25
LEPIDOSTOMATIDAE				
Lepidostoma hirtum (Fabricius)	1/0		l,s	August 2-4
LIMNEPHILIDAE				
Limnephilus affinis Curtis	64/54NS	71/65NS	p,t	April 24-October 22
Limnephilus auricula Curtis	34/6**	96/24**	t	May 10-November 1

Limnephilus binotatus Curtis		1/0	p	June 12-19
Limnephilus bipunctatus Curtis		1/0	t,s,d	October 1-22
Limnephilus decipiens (Kolenati)	2/0	1/0	p	September 1-30
Limnephilus elegans Curtis		0/1	p	June 30-July 3
Limnephilus flavicornis Fabricius	85/18**	68/6**	l,p,t	June 8-November 1
Limnephilus griseus (Linnaeus)	33/4**	77/11**	t	May 19-November 1
Limnephilus ignavus McLachlan		1/0	s,d	September 21-30
Limnephilus lunatus Curtis	1/1	1/1	l,p,s	June 24-July 27
Limnephilus marmoratus Curtis	3/1	4/1	l,p	July 18-September 12
Limnephilus sparsus Curtis		3/1	p,t	September 1-30
Limnephilus vittatus (Fabricius)	5/0	4/3	p,t	May 30-October 8
Colpotaulius incisus (Curtis)	1/0		p	July 29-31
Glyphotaelius pellucidus (Retzius)	3/0	16/12NS	t	May 22-October 12
Grammotaulius nigropunctatus (Retzius)	3/0	6/1	t	September 1-28
Halesus radiatus (Curtis)		1/0	l,s	September 21-30
LEPTOCERIDAE				
Athripsodes aterrimus (Stephens)	0/1		l,p	July 12-14
Athripsodes cinereus (Curtis)	4/2	2/2	l,s	June 20-August 31
Ceraclea senilis (Burmeister)	0/2		l,p	June 24-July 27
Leptocerus tineiformis Curtis	28/158**	759/2924**	l,p	June 20-August 16
Mystacides azurea (Linnaeus)	0/3		l,p,s	June 8-August 7
Mystacides longicornis (Linnaeus)	9/29*	1/9NS	l,p	June 24-September 13
Mystacides nigra (Linnaeus)		1/0	l	July 10-13
Oecetis furva (Rambur)	0/2	4/11NS	l,p	July 18-August 9
Oecetis lacustris (Pictet)	13/69**	2/6	l,p	June 24-September 13
Oecetis ochracea (Curtis)	262/1607**	50/119**	l,p,b	May 22-September 13
Ylodes reuteri (McLachlan)		0/1	b	July 10-13
Total	696/2321	1475/4024		

Only a single species dominated the catch each year: *Oecetis ochracea* (61.9%) in 1994 and *Leptocerus tineiformis* (67.0%) in 1995. The second most abundant species both years was *Agraylea multipunctata*, making up 15.3-16.9% of the total catch. None of the other species made up more than 4% of the total catch. Only 9 and 8 species contributed with more than 1.0% each in 1994 and 1995, respectively. They made up 97.2 and 96.7% of the total catch in 1994 and 1995, respectively. Twenty-one species were only represented by 1-3 specimens each both years included. Among these, *Limnephilus elegans, Mystacides nigra* and *Ylodes reuteri* are included in the latest Danish "Redlist" of endangered plant and animals (Wiberg-Larsen, 1998).

Species inhabiting permanent lakes and ponds made up 57.6 and 35.6% of the total catch (individuals), respectively, both years included, whereas species from temporary ponds amounted to 6.6% and stream species only to 0.2%. *L. tineiformis* and *Cyrnus crenaticornis* which inhabit dense stands of submersed macrophytes like *Chara* spp., *Ceratophyllum* spp. and *Myriophyllum spicatum* L. (Czachorowski, 1993; Czachorowski & Kornijów, 1993; Wiberg-Larsen, unpublished) made up 69.3% of the total catch in 1995, but only 6.2% in 1994.

Flight periods (fig. 3) could only be established for the most abundant species (i.e. those representing > 1.0% of the total catch). *L. tineiformis* had a relatively short flight period during June-August, this species being predominantly captured during 4-6 weeks. Longer flight periods (10-14 weeks) were found in *A. multipunctata, C. crenaticornis, Mystacides longicornis, Oecetis lacustris* and *O. ochracea*, whereas even longer flight periods (19-26 weeks) occurred in *Limnephilus affinis, L. auricula, L. flavicornis* and *L. griseus*. Flight periods ap-

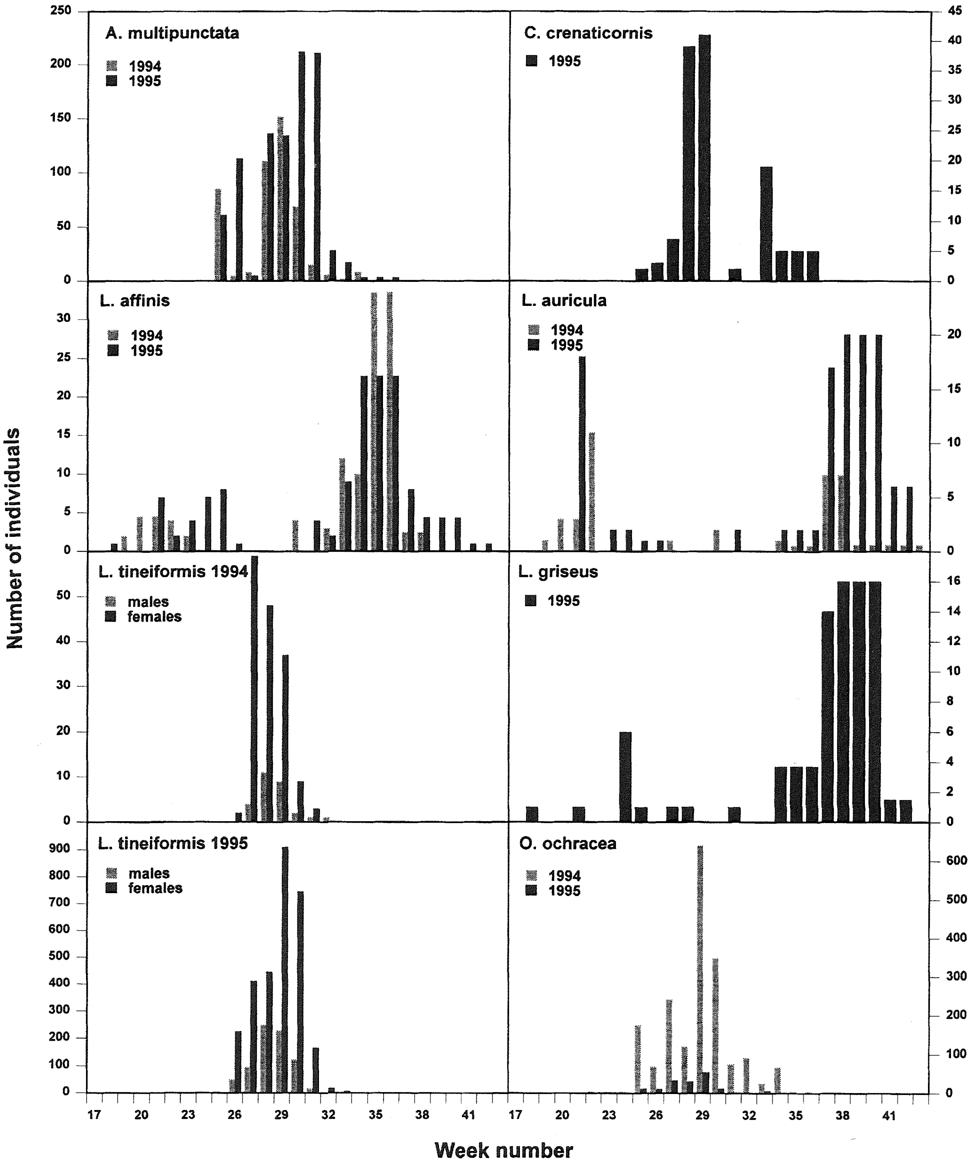

Fig. 3. Catches of the seven most abundant Trichoptera species in the light trap at the Zoological Museum of Copenhagen during May-October 1994 and 1995. Catches are the total number of individuals, except in *L. tineiformis* for which numbers of both males and females are presented.

parently showed bimodality in *A. multipunctata, C. crenaticornis, L. affinis, L. auricula* and *L. griseus.*

The number of captured individuals of the dominant species *A. multipunctata, L. tineiformis* and *O. ochracea* was not correlated with either air temperature (mean/maximum), wind direction (mean), wind speed (mean/maximum) or precipitation (Spearman Rank Correlation, P>0.05). Air temperature and wind speed was highly negatively correlated in 1995 during the flight periods of *A. multipunctata* and *L. tineiformis* (r_s=-0.61/-0.64, P<0.001), whereas the correlation during the flight periods of *A. multipunctata* and *O. ochracea* in 1994, although negative (r_s=-0.35/-0.40), was not significant (P=0.11/0.18). Only one abundant species, *Limnephilus affinis*, appeared in a sex-ratio not significantly different from 1:1 (Table 1). There was a significant deficiency of females in five species, belonging to the families Psychomyiidae, Polycentropodidae and Limnephilidae, and an excess of females in other five species, being either hydroptilids or leptocerids. In 1995 the proportion of female *L. tineiformis* increased during the flight period (r_s=0.64, P<0.001), the number of males peaking about one week before the females.

A compilation of leptocerid sex-ratios published in several light trap studies and the present study (Table 2) shows the proportion of females to be higher far from than close to the potential breeding sites (Mann Whitney U-test, P<0.001). Moreover, there was an overall excess of females independent of distance between trapping site and the nearest potential breeding site (Wilcoxon matched-pairs signed-ranks test, P<0.01).

Discussion

Species composition

Light traps operated during the flight period of Trichoptera normally attract a large number of these species. It has been shown for Lepidoptera that species composition and number of individuals caught depend on the type and bulb of light trap (Leinonen et al., 1998). We are not aware of such studies focusing on Trichoptera. However, catches of Trichoptera may depend on factors like region, diversity of larval habitats, and the distance to these habitats, more than on characteristics of the light trap (e.g. Wiberg-Larsen, 1996; Wiberg-Larsen & Birkholm, 1998).

So far 125 the 168 Danish species of Trichoptera are recorded from Zealand (Wiberg-Larsen, unpublished). In the present 2-year study we obtained 35 % of the possible species of this region. A 4-year light trapping study at the northwest coast of Zealand revealed 36% of the species of the region, whereas 54% of the regional species pool was recorded in a one-year light trapping study at central Funen. The relatively low number of species in both Zealand studies might be explained by the relatively long distances to the nearest larval habitats and the scarcity and low diversity of stream localities, resulting in only very few (and little abundant) true stream-dwelling species.

In contrast to most other light traps studies of Trichoptera, our trap was located well above the ground. In a Swedish study, many species were regularly found to travel near the ground and also at tree-top level (11 m a.g.) in a coniferous woodland, and 5 species were even found in a light trap fitted to a balloon 50 m above the ground (Svensson, 1974). Thus, the relatively high number of species and specimens caught in our study confirm that there might be a rather dense traffic of Trichoptera well above ground level.

Compared with other Danish studies (Wiberg-Larsen, 1996; Wiberg-Larsen & Birkholm, 1998) where Limnephilidae was the most prominent group (84-99% of the individuals), we found a striking dominance of leptocerid and hydroptilid species totalling 88% of the catch each year. The three dominating species, *A. multipunctata*, *L. tineiformis* and *O. ochracea* are typical inhabitants of lentic waters. There are several lakes within a distance of 4-5 km from the trap. These lakes are potential habitats for the three species. Moreover, *O. ochracea* might also breed in brackish waters at the coast of Amager. Thus, larvae have been found in the coastal water Bøgestrømmen (Southeast Zealand) at depths of 1.0-9.5 m and salinities up to 8-16‰ (S. Aagaard, pers. comm.).

Only two of the nearby lakes, Lake Damhus and Lake Gentofte, support a dense vegetation of submersed macrophytes and associated populations of *L. tineiformis* and *C. crenaticornis* (Wiberg-Larsen, unpublished). In 1995 there was a luxurious growth of *Chara globu-*

Table 2. Proportion of females in leptocerid species in different light trap studies. Indicated position of the traps in relation to the nearest potential breeding site: N – nearby breeding site; D – distant from breeding site.

Species	Trap position	Percentage of females	Reference
Athripsodes aterrimus (Stephens)	N	21	Crichton (1960)
	D	91	Mey (1981)
	D	100	Wiberg-Larsen & Birkholm (1998)
Athripsodes cinereus (Curtis)	N	73.7	Gullefors & Sjöberg (1987)
	N	52	Crichton (1960)
Ceraclea alboguttata (Hagen)	N	32.5	Gullefors & Sjöberg (1987)
	N	61.2	Waringer (1991)
	N	61.5	Olsson (1971)
Ceraclea annulicornis (Stephens)	N	73.3	Waringer (1991)
	N	73.9	Gullefors & Sjöberg (1987)
	N	75.7	Olsson (1971)
Ceraclea dissimilis (Stephens)	N	45.7	Olsson (1971)
	N	58	Crichton (1960)
	N	80.5	Gullefors & Sjöberg (1987)
Ceraclea nigronervosa (Retzius)	N	14.1	Ulfstrand (1970)
	N	73.9	Gullefors & Sjöberg (1987)
Ceraclea senilis (Burmeister)	N	26	Crichton (1960)
Leptocerus tineiformis Curtis	N	80	Crichton (1960)
	N	96.9	Wiberg-Larsen (1996)
	D	79	Present study
	D	83	Mey (1981)
	D	85	Present study
Mystacides longicornis (Linnaeus)	N	20	Crichton (1960)
	D	50	Mey (1981)
	D	76	Present study
	D	94.2	Malicky (1987)
Oecetis furva (Rambur)	D	74	Mey (1981)
Oecetis lacustris (Pictet)	N	52	Crichton (1960)
	D	84	Present study
	D	87	Mey (1981)
Oecetis ochracea (Curtis)	N	37	Crichton (1960)
	D	33	Mey (1981)
	D	70	Present study
	D	86	Present study

laris in Lake Damhus, and large populations of both Trichoptera species (Helle Bjerg Sørensen, pers. comm.). Indeed, swarming adult *L. tineiformis* males were a nuisance at a cottage situated close to the lake (Marga Sørensen, pers. comm.). Thus, the dominance of *L. tineiformis* and the relatively high numbers of *C. crenaticornis* in the trap in 1995 might be due to dispersal from Lake Damhus (see later).

The relative scarcity of species inhabiting temporary pools (e.g. *L. affinis, L. auricula, Limnephilus sparsus, Limnephilus vittatus, Glyphotaelius pellucidus* and *Grammotaulius nigropunctatus*) is remarkable in the present study. Thus, considerably higher numbers of these species were found in two other Danish studies conducted in open land (Wiberg-Larsen, 1996; Wiberg-Larsen & Birkholm, 1998). Species from temporary pools are known to disperse far from their breeding sites in search for mates and suitable places to deposite their eggs (Svensson, 1972). Potential breeding sites are located at Amager Fælled south to the trapping site, but the dispersal from here might have been restrained by the obvious unattractiveness of the city.

Although stream species were scarse in our trap, there was a remarkable catch of a single egg-bearing female of *Hydroptila sparsa*. In Denmark this species is confined to larger streams (Wiberg-Larsen, 1985; Wiberg-Larsen et al., in press). The nearest probable breeding site seems to be the River Mølle, situated at least 9 km from the trap. A similar dispersal over at least 8 km has been reported by Wiberg-Larsen (1996).

In contrast to most light trap studies of Trichoptera, including the present, no species of Lepidoptera represented more than 10% each year during the operation of the trap at the Zoological Museum during the period 1992-1999. In all 873 species of Lepidoptera were captured, representing 36% of the species hitherto known from Denmark (Karsholt & Stadel Nielsen, 1998). Surprisingly, microlepidopterans dominated over macrolepidopterans both in number of species and individuals, although the former are supposed to be relatively weak flyers and therefore not expected to be found high above the ground (Karsholt, unpublished).

Flight periods

The flight periods found in the present study coincide well with those of several other studies. A short period primarily in July was described for *L. tineiformis*, whereas long flight periods (June-September) were found for *O. lacustris* and *O. ochracea* in England (Crichton, 1960), Germany (Mey, 1981) and Austria (Waringer, 1991). A bimodal flight period has been recorded for *A. multipunctata* in both England (Crichton, 1960) and Denmark (Jonsson, 1987), indicating two generations a year. As in our study, Mey (1993) found a long bimodal flight period (maximum in June and August) in *C. crenaticornis*. It is unclear whether this pattern can be explained by a bivoltine life cycle. Bimodal flight periods in *L. affinis, L. auricula, L. flavicornis, L. griseus* and *G. pellucidus* were also recorded by Svensson (1972), Crichton (1988) and Wiberg-Larsen & Birkholm (1998). These species all enter quiescence or diapause during summer (Svensson, 1972); for several of them this is an adaptation to a larval development in temporary pools that regularly dry up during summer.

In the present study the largest number of species and individuals of Lepidoptera were captured from mid-June to mid-August, almost no specimens being captured in April and October-November.

Flight activity and weather

Several light trap studies of Trichoptera have pointed to the importance of meteorological factors (e.g. Crichton, 1960; Nimmo, 1966; Andersen, 1978; Waringer, 1991; Wiberg-Larsen, 1996). Waringer (1991) found air temperature to be far more important than wind speed and precipitation, whereas Nimmo (1966) found temperature and wind to be important, but humidity to be without importance. Reversely, Crichton (1960) related large autumn catches of limnephilids to rainfall. In the study of Waringer (1991) with dominance of non-limnephilid species, the highest correlation was found to be with maximum temperature, as about 50% of the specimens were trapped in the first third of the night, when maximum temperature was recorded. In contrast, limnephilids were most abundant from 23.00 and 03.00 hrs in the study of Andersen (1979). Consequently, light trap catches of Limnephilidae might be correlated to other temperature measures, e.g. mean night temperature (Andersen, 1978) or weekly means of minimum temperatures (Wiberg-Larsen, 1996). The temperature threshold for Trichoptera flight varies according to species and is apparently negatively correlated with latitude (Andersen, 1978; Waringer, 1991; Wiberg-Larsen, 1996).

In the present study, the interpretation of the meteorological observations should be made with caution, as the climate at Kastrup Airport where measurement were made no doubt differs from that of the city where the trap was situated. Thus, cities accumulate more solar radiation than open land, resulting in 1-5 °C higher minimum air temperatures throughout the year (Lysgaard, 1968). Air temperature several metres above the ground may also be higher inside than outside cities, although the opposite may be the case some 50 m above the ground. Wind speeds at Kastrup Airport measured at the ground may be lower than those at the top of the Zoological Museum, as wind speed increases with distance above the ground (Lysgaard, 1968). Moreover, the airport is sheltered by the city against the prevailing westerly winds.

We found no correlations between catches of the three dominant species and air temperature, wind or precipitation, respectively. A possible explanation could be the generally warm weather during July and August both years. Thus, July 1994 was the warmest month recorded in this century, and in addition less windy and rainy than normal, whereas July 1995, August 1994, and August 1995 were warmer than normal. As maximum night temperature exceded 17.5°C during July and August both years (except for two dates in July 1995), even reaching values above 24°C, we suggest that temperatures were well above the threshold for flight activity for all species involved. Waringer (1991) suggested a threshold of 22.1°C (maximum temperature) for *L. tineiformis* in Austria. We trapped high numbers of this species at maximum temperatures in the range of 14.7-20.8°C. Taking into acount that the actual temperatures might have been 1-5°C higher at the trapping site (see above), the threshold for flight of Danish *L. tineiformis* is apparently lower than for Austrian populations.

Although catches of *L. tineiformis* were not correlated to wind direction, westerly winds prevailed during the main occurrence of this species in 1995. These winds may have facilitated the dispersal of the large populations at Lake Damhus west of our trap. In 1994 wind directions were predominantly from the east and south during the main occurrence of *O. ochracea*. We suggest that southern winds might have facilitated the dispersal of the species from „The Inner Lakes“ or potential habitats at Amager.

There are, however, other possible reasons for the lack of correlation between meteorological factors and catches. Thus, the trap was often emptied at intervals of several days, and weather might change suddenly even during a single night. Moreover, several nights with temperatures above normal may have an accumulating effect on the catches, the catch of a single night far exceeding that of a whole week.

Sex ratios

Theoretically, the sex ratio of adult Trichoptera should be 1:1. Using emergence traps Moretti et al. (1966) demonstrated such an equal sex ratio in *L. tineiformis*, the most abundant species in our study. Other emergence trap studies, however, have shown that there might be significant deviations (e.g. Tobias, 1967; Mey, 1992; Wagner, 1993), although some of these deviations are related to the sexes not being uniformly distributed during the aquatic stages, others to a higher mortality of juvenile females.

Several studies indicate that sex ratios in light traps reflect behavioural differences in activity rather than one sex being more strongly attracted to light than the other (Ulfstrand, 1970; Crichton et al., 1978; Malicky, 1987; Usseglio-Polatera, 1987; Wiberg-Larsen, 1996). Dominance of male Limnephilidae has been found in many studies (Corbet et al., 1966, Crichton, 1971, 1988; Svensson, 1972; Wiberg-Larsen, 1996; Wiberg-Larsen & Birkholm, 1998), although a sex ratio close to 1:1 is found in *L. affinis* (Crichton, 1988; Wiberg-Larsen & Birkholm, 1998; present study). Most male Limnephilidae do not seem to aggregate in swarms to attract females but rather search for them in order to mate, and long-distance pheromones that attract males are known in this family (Kelner-Pillault, 1975; Resh & Wood, 1985).

In contrast, males in several leptocerid species aggregate in swarms to attract the females prior to mating, each species having a typical swarming pattern and site (e.g. Solem, 1984; Gullefors & Petersen, 1993). Attracted females are grasped by the males and mating follows immediately. The overall dominance of female Leptoceridae in light trap studies and the increase in proportion of females with the distance from the breeding sites, as indicated in our study, apparently has nothing to do with mating. At a Funen pond male *L. tineiformis* were observed swarming above bushes and trees along the banks in warm and calm evenings before sunset, whereafter females took off after sunset ascending high above the ground (Wiberg-Larsen, unpublished). Moreover, the females of *L. tineiformis* and *O. ochracea* carried egg masses ready to be laid. Female dominance in light traps may therefore rather be a result of dispersal following mating and the high numbers of *L. tineiformis* and *O. ochracea* trapped in our study may reflect long-distance dispersal in order to colonize new potential breeding sites. Leptocerids are strong fliers, being peculiar among Trichoptera in having their fore- and hindwings efficiently coupled (Malicky, 1973).

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Dansk resumé

Hvert år siden 1992 har Ole Karsholt fanget flyvende insekter i en lysfælde udstyret med en 250 W kviksølvpære og placeret på taget af Zoologisk Museums bygning i København (fig. 2). Fælden har været placeret i en højde af 17,5 m over jorden og været i funktion fra april til oktober/november. Fælden er blevet tømt med intervaller fra 1 dag til 3 uger. Selvom formålet primært har været at studere forekomsten af nataktive Lepidoptera i og over et tæt bebygget område, blev også Trichoptera udsorteret blandt det righoldige insektmateriale i 1994 og 1995. Det er primært resultaterne herfra, som præsenteres i denne artikel.

Der blev ialt fanget 3017 og 5499 voksne vårfluer i hhv. 1994 og 1995. De fordelte sig på 44 arter og 9 familier (Tab.1). Det svarer til 35% af det antal arter, som kendes fra Sjælland. Kun 8-9 arter tegnede sig for den langt overvejende del af fangsterne (ca. 97%). Artsammensætningen varierede imidlertid betydeligt mellem de to år med dominans af *Oecetis ochracea* (61,9%) og *Leptocerus tineiformis* (67,0%) i hhv. 1994 og 1995. Næsthyppigst begge år var *Agraylea multipunctata* (15,3-16,9%), mens ingen af de øvrige arter udgjorde mere end 4% af de samlede fangster. Blandt de fåtallige arter er *Limnephilus elegans*, *Mystacides niger* og *Ylodes reuteri* opført på den seneste danske rødliste.

Til sammenligning med vårfluerne blev der for perioden 1992-1999 fanget 873 sommerfuglearter eller 36% af de arter, som er kendt fra Danmark. Overraskende nok dominerede Microlepidoptera i forhold til Macrolepidoptera både med hensyn til arts- og individantal. Ingen sommerfuglearter var så dominerende som tilfældet var blandt vårfluerne.

Lysfældefangster afspejler hvilke potentielle ynglesteder, der findes i omegnen af en lysfælde. På nær én gennemfører samtlige danske vårfluearter deres larveudvikling i forskellige typer ferske vande eller for enkeltes vedkommende endog også i brakvand (Tab. 1). I vores undersøgelse repræsenterede 99% af de fangne individer arter, som yngler i stillestående vand (søer, damme og evt. brakvandområder). Fåtalligheden af arter fra vandløb skyldes den helt udprægede mangel på sådanne levesteder i hovedstadsområdet. En enkelt vandløbsart, *Hydroptila sparsa* (1♀ fuld af æg), stammer således sandsynligvis fra Mølleåen, som ligger mindst 9 km fra fælden. Arter, som yngler i sommerudtørrende vandhuller, var bemærkelsesværdigt fåtallige, selvom disse normalt talrigt forekommende arter kan sprede sig over store afstande i søgen efter egnede ynglesteder. Det er muligt, at de ikke umiddelbart finder bymiljøet attraktivt.

Flyveperioderne for de vigtigste arter varierede fra 4-6 uger hos *L. tineiformis* til 19-26 uger hos flere limnephilider (fig. 4). Enkelte arter udviste en to-toppet flyveaktivitet. Hos *A. multipunctata* er forklaringen sandsynligvis, at der er to adskildte generationer, mens der hos visse limnephilider er tale om, at arterne går i sommerdvale (diapause). Flyveaktiviteten var generelt ikke afhængig af meteorologiske faktorer som lufttemperatur, vindhastighed eller nedbør, selvom disse faktorer vides at kunne have betydning for størrelsen af lysfældefangster. En sandsynlig forklaring er, at lufttemperaturen i de sommermåneder, hvor de dominerende arter havde deres flyveperiode, generelt var langt højere end den temperatur, som er den nedre grænse for, om arterne overhovedet flyver. Desuden blev fælden undertiden tømt med flere dages mellemrum, hvorfor en beregnet middeltemperatur mellem to tømninger ikke nødvendigvis er repræsentativ for den gjorte fangst.

Flere arter viste en signifikant afvigelse fra den forventede 1:1 kønsratio (Tab. 1). Der var således overskud af hunner hos *A. multipunctata* og fire leptocerider. På baggrund af en sammenstilling af litteraturoplysninger og vore egne undersøgelser kan vi sandsynliggøre, at der generelt er en overvægt af leptoceridehunner i lysfælder. Andelen af disse hunner synes desuden at være større, når fælden står langt fra de potentielle ynglesteder, end når fælden står tæt herved (Tab. 2). Det fortolker vi således, at hunnerne i langt højere grad end hannerne spreder sig ud over landskabet og derved får mulighed for at kolonisere nye egnede ynglesteder. Begge køn er normalt dygtige flyvere, bl.a. via sammenkobling af deres for- og bagvinger, men hannerne er muligvis mest bundne til ynglestedet, hvor de udfører karakteristiske danse i luften for at tiltrække parringsmodne hunner. I vores fælde stammer det store antal *L. tineiformis* i 1995 formodentlig især fra Damhussøen. De nærmeste steder, hvor larvernes krav om tæt undervandsvegetation (f.eks. Hornblad, Tusindblad eller kransnålalger) er opfyldt, og hvor larverne er meget talrige, er Damhussøen og Gentofte Sø. De ligger ca. 5 km hhv. sydvest og nord for fælden. Vestlige vinde var særlig fremherskende i 1995, hvilket sandsynligvis har lettet spredningen fra Damhussøen i retning af fælden.