COMMUNITY ECOLOGY 4(2): 233-236, 2003
1585-8553/$20.00 © Akadémiai Kiadó, Budapest

SHORT COMMUNICATION

Light trap-collected caddisfly (Insecta: Trichoptera) assemblages reflect altitude

D. Schmera

*Plant Protection Institute, Hungarian Academy of Sciences, POB 102, H-1525 Budapest, Hungary,
E-mail: schmera@julia-nki.hu*

Keywords: Altitude, Caddisfly, Hungary, Light trap.

Abstract: It is examined whether caddisfly assemblages collected by light trapping are influenced by altitude. From twenty-nine sites, a total of 29 season's catches were obtained in 1995. The total number of caddisfly species collected was 53, and the number of individuals caught was 11,128. As a result of non-metric multidimensional scaling based on quantitative data, two groups of caddisfly assemblages could be distinguished: those collected in lowland (sites under 150 m a.s.l.) and the others from highland habitats (sites above 150 m a.s.l.). The indicator value method found assemblages and species most characteristic of the two kinds of habitats. *Ecnomus tenellus* and *Neureclipsis bimaculata* were the two significant indicator species of the lowland habitat, and *Stenophylax permistus* was the significant indicator of the highland habitat.

Nomeclature: Malicky (1983) and Nógrádi (1997).

Introduction

Due to sensitivity to water quality (Basaguren and Orive 1990), caddisfly larvae can be used as environmental indicators. In the case of adults collected by light traps, there are some problems with the interpretation of results in connection with dispersal and with catchability.

Svensson (1972, 1974) noted a species-specific dispersal pattern of adult caddisfly species, but the influence of the habitats on dispersal could also be detected Malicky (1981, 1987) claims that the flight range can be a few kilometres, but the average may be not more than 100 meters. Sode and Wiberg-Larsen (1993) confirmed Svenssons observations. They classified some caddisfly species into two groups: low dispersal species and high dispersal ones. Adult caddisflies occurred with the highest probability close to their water habitat. The probability of occurrence decreased as the distance from the water increased. Overall, these results suggest that adult caddisflies, similar to other aquatic insects, stay close to the water (Peterson et al. 1999).

The second problem is the catchability of adult caddisflies by artificial light. Crichton (1976) collected only six common day-flying species, which had not been collected in the light trap network of the Rothamsted Insect Survey in England. The six common day-flying caddisfly species represent only three percent of the total Trichoptera fauna of the British Isles.

We examined the hypothesis that caddisfly assemblages depend on altitude. If collections from lowland areas form one group, and those from highland areas represent a different one, the hypothesis receives support. Based on other studies, caddisfly species show preferences for specific altitude (Pitsch 1993). However, whether this preference could serve as an indicator of altitude has not yet been confirmed. Furthermore, the question whether assemblage structure reflects the altitude has not been determined either.

Material and methods

Caddisflies were recorded from twenty-nine sites in a Hungarian light trap network (Fig. 1). The purpose of the network was to study changes of insect population in agricultural areas, with particular reference to pest species (Szentkirályi 2002). Few light traps are in the immediate vicinity of water, but there are often aquatic habitats in moderate proximity. Light traps were operated from March to the end of October, 1995. Twenty-nine total season's catches were obtained. At each site of the light trap network, a 100W normal bulb was positioned 2 m above ground level. For the analysis of catches, the sites were grouped into two types of habitat: lowland areas (*L*, <150

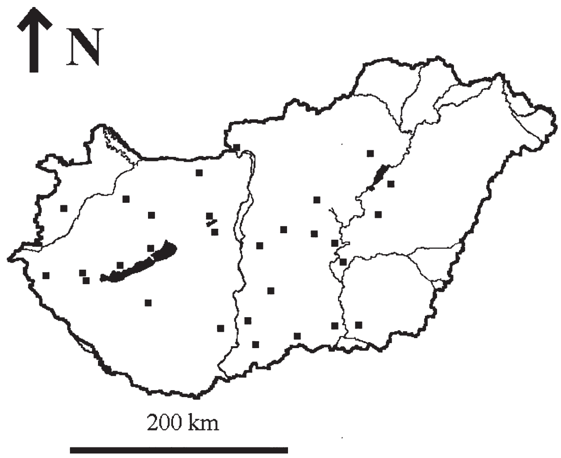

Figure 1. Map showing the geographic position of light traps in Hungary.

m a.s.l.) and highland areas (*H*, >150 m a.s.l.). The highest elevation is less than 500 m above sea-level. There were seventeen sampling sites in lowland habitats and 12 in highland habitats.

The relative frequency (F_{hi}) of caddisfly species *i* for habitat *h* was calculated according to

$$F_{hi} = 100 \times x_{hi} / x_{h.}$$

where x_{hi} is the number of individuals of species i and $x_{h.}$ is the total number of individuals in habitat *h*.

The proportional occurrence (*O*) of the collected species (the number of sampling sites, where the given species was present over the total number of sampling sites) was calculated for the two habitats by the following formula:

$$O_{hi} = 100 \times n_{hi} / n_{h.}$$

where n_{hi} is the number of occurrences of species *i* and $n_{h.}$ is the total number of occurrences in habitat *h*.

Non-metric multidimensional scaling with Bray-Curtis resemblance coefficient (Podani 2000) was used to explore the similarity pattern of caddisfly assemblages of the different sites. Raw data were *log*(*x*+1) transformed. The computations were performed by SYN-TAX (Podani 1993). The indicator value method of Dufrene and Legendre (1997) was used to find species or assemblages as indicators of lowland and highland habitats. The indicator value (*IndVal*, or *IV*) was calculated by PC-ORD (McCune and Mefford 1997). Monte Carlo method (Duferne and Legendre 1997) with 1000 permutations was used to reveal the significance of the observed maximum indicator value for each species.

Results

The total number of collected caddisfly species was 53 (Table 1), and the total number of individuals collected by light traps was 11,128. The number of species in lowland habitats was 43 (mean: 11.94, standard deviation: 7.48), in highland habitats 40 (mean: 11.25, standard deviation: 6.74). The most frequent (more than 10%) caddisfly species in lowland habitats were *Ecnomus tenellus*, *Neureclipsis bimaculata* and *Hydropsyche* sp. female. The most frequent caddisfly species in highland habitats were *Hydropsyche* sp. female and *Hydropsyche contubernalis*. Widespread species (with proportional occurrence greater than 75%) were *Ecnomus tenellus*, *Hydropsyche* sp. female, *Neureclipsis bimaculata* and *Hydropsyche contubernalis* in lowland habitats, and *Hydropsyche* sp. female, *Hydropsyche contubernalis*, *Ecnomus tenellus* and *Stenophylax permistus* in highland habitats. In lowland habitats, the mean number of individuals was 365.23 (*N*=17, *SD*=684.37), in highland habitats the mean number of individuals is 422.66 (*N*=12, *SD*=764.94).

In the ordination by non-metric multidimensional scaling (Fig. 2), most lowland assemblages are found close to the origin, their scatter surrounded by assemblages collected in highland habitats. Only three species were found as statistically significant indicator species (Table 1). *Neureclipsis bimaculata* (*IV*=84, *p*<.018) and *Ecnomus tenellus* (*IV*=83, *p*<.028) were indicator species of the lowland habitats and *Stenophylax permistus* (*IV*=68, *p*<.004) was an indicator species of the highland habitats.

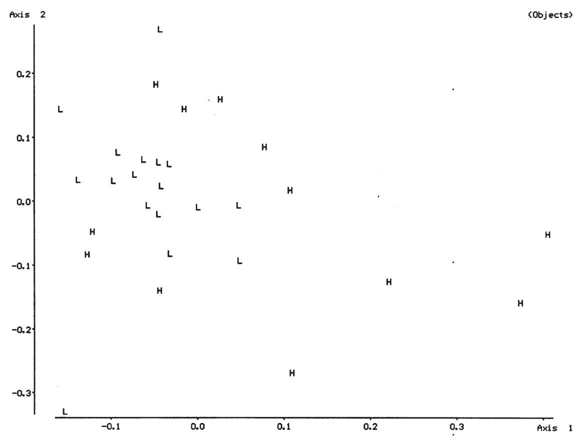

Figure 2. Non-metric multidimensional scaling of caddisfly assemblages (*L*: assemblages collected in lowland habitats, *H*: assemblages collected in highland habitats).

Table 1. The list of collected species in alphabetical order and their relative frequency (*F*) and proportional occurrence (*O*) in percent and indicator value (*IV*) at lowland and highland habitats. (*S*: statistical significance of the *IV*, *NS*: non significant, *: significant at p=0.05, **: significant at p=0.01).

	Lowland				Highland			
Species	*F*	*O*	*IV*	*S*	*F*	*O*	*IV*	*S*
Agraylea sexmaculata Curtis, 1834	1.02	41.18	39	*NS*	0.04	16.67	1	*NS*
Agrypnia pagetana Curtis, 1835	0.02	5.88	6	*NS*	0	0	0	*NS*
Agrypnia varia (Fabricius, 1793)	0	0	0	*NS*	0.02	8.33	8	*NS*
Anabolia furcata Brauer, 1857	0.02	5.88	2	*NS*	0.02	8.33	5	*NS*
Ceraclea alboguttata (Hagen, 1860)	0	0	0	*NS*	0.04	8.33	8	*NS*
Ceraclea dissimilis (Stephens, 1836)	0.73	29.41	7	*NS*	2.03	58.33	45	*NS*
Ceraclea senilis (Burmeisler, 1839)	0.08	17.65	18	*NS*	0	0	0	*NS*
Cheumatopsyche lepida (Pictet, 1834)	0.07	11.76	12	*NS*	0	0	0	*NS*
Cyrnus crenaticornis (Kolenati, 1859)	0.28	11.76	12	*NS*	0	0	0	*NS*
Cyrnus trimaculatus (Curtis, 1834)	0.06	17.65	9	*NS*	0.06	8.33	4	*NS*
Ecnômus tenellus (Rambur, 1842)	40.50	100.00	83	*	6.86	75.00	13	*NS*
Glyphotaelius pellucidus (Retzius, 1783)	0.067	17.64	6	*NS*	0.10	25.00	16	*NS*
Goera pilosa (Fabricius, 1775)	0	0	0	*NS*	0.02	8.33	8	*NS*
Grammotaulius nigropunctatus (Retzius, 1783)	0.12	29.41	13	*NS*	0.12	25.00	14	*NS*
Grammotaulius nitidus (Müller, 1764)	0.08	5.88	5	*NS*	0.02	8.33	2	*NS*
Holocentropus dubius (Rambur, 1842)	0.02	5.88	6	*NS*	0	0	0	*NS*
Hydropsyche angustipennis (Curtis, 1834)	0.26	17.64	2	*NS*	1.99	25.00	22	*NS*
Hydropsyche bulbifera McLachlan, 1878	0	0	0	*NS*	0.04	8.33	8	*NS*
Hydropsyche bulgaromanorum Malicky, 1977	2.05	70.59	52	*NS*	0.61	41.67	11	*NS*
Hydropsyche contubernalis McLachlan, 1865	5.73	88.24	15	*NS*	24.41	75.00	63	*NS*
Hydropsyche modesta Navás, 1925	0.10	23.53	8	*NS*	0.18	41.67	28	*NS*
Hydropsyche pellucidula (Curtis, 1834)	0.13	5.88	2	*NS*	0.20	58.33	37	*NS*
Hydropsyche sp. indet females	20.72	94.11	23	*NS*	55.09	100.00	76	*NS*
Hydroptila angustata Mosely, 1939	0.02	5.88	6	*NS*	0	0	0	*NS*
Hydroptila sparsa Curtis, 1834	0.03	5.88	6	*NS*	0	0	0	*NS*
Lepidostoma hirtum (Fabricius, 1775)	0	0	0	*NS*	0.02	8.33	8	*NS*
Leptocerus tineiformis Curtis, 1834	1.78	35.29	30	*NS*	0.28	33.33	5	*NS*
Limnephilus affinis Curtis, 1834	2.61	76.47	56	*NS*	0.83	50.00	14	*NS*
Limnephilus auricula Curtis, 1834	0.26	23.53	10	*NS*	0.32	33.33	20	*NS*
Limnephilus bipunctatus Curtis, 1834	0.03	11.76	12	*NS*	0	0	0	*NS*
Limnephilus decipiens (Kolenati, 1848)	0.21	11.76	9	*NS*	0.06	25.00	6	*NS*
Limnephilus flavicornis (Fabricius, 1787)	0.46	11.76	9	*NS*	0.10	25.00	5	*NS*
Limnephilus griseus (Linnaeus, 1758)	0.12	17.65	18	*NS*	0	0	0	*NS*
Limnephilus ignavus McLachlan, 1865	0.02	5.88	6	*NS*	0	0	0	*NS*
Limnephilus incisus Curtis, 1834	0.28	35.29	30	*NS*	0.04	16.67	2	*NS*
Limnephilus lunatus Curtis, 1834	0.96	29.41	26	*NS*	0.10	25.00	3	*NS*
Limnephilus rhombicus (Linnaeus, 1758)	0.15	23.53	11	*NS*	0.14	25.00	13	*NS*
Limnephilus vittatus (Fabricius, 1798)	0.18	11.76	8	*NS*	0.06	25.00	7	*NS*
Lithax obscurus (Hagen, 1859)	0	0	0	*NS*	0.04	8.33	8	*NS*
Mystacides longicornis (Linnaeus, 1758)	0.03	11.76	12	*NS*	0	0	0	*NS*
Mystacides nigra (Linnaeus, 1758)	0.02	5.88	2	*NS*	0.02	8.33	5	*NS*
Neureclipsis bimaculata (Linnaeus, 1758)	18.54	88.24	84	*	0.73	41.67	2	*NS*
Oecetis furva (Rambur, 1842)	0	0	0	*NS*	0.02	8.33	8	*NS*
Oecetis lacustris (Pictet, 1834)	0.51	47.06	38	*NS*	0.10	16.67	3	*NS*
Oecetis notata (Rambur, 1842)	0.12	23.53	15	*NS*	0.06	16.67	6	*NS*
Oecetis ochracea (Curtis, 1825)	1.30	52.94	31	*NS*	0.81	16.67	7	*NS*
Phryganea bipunctata Retzius, 1783	0.02	5.88	6	*NS*	0	0	0	*NS*
Phryganea grandis Linnaeus, 1758	0.08	11.76	12	*NS*	0	0	0	*NS*
Plectrocnemia conspersa (Curtis, 1834)	0	0	0	*NS*	0.02	8.33	8	*NS*
Psychomyia pusilla (Fabricius, 1786)	0	0	0	*NS*	0.02	8.33	8	*NS*
Rhyacophila nubila (Zetterstedt, 1840)	0	0	0	*NS*	0.04	16.67	17	*NS*
Setodes punctatus (Fabricius, 1793)	0.05	11.76	0	*NS*	3.17	33.33	33	*NS*
Stenophylax permistus McLachlan, 1895	0.15	29.41	3	*NS*	1.20	75.00	68	**

Discussion

Catching Trichoptera with light traps is useful in faunistics (e.g., Kiss et al. 1999, Nógrádi and Uherkovich 2002), life history (Crichton 1976, Svensson 1972, Waringer 1989), water quality control (Malicky 1981) or behavioural studies (Usseglio-Polatera and Auda 1987). Interpretation of results can be difficult, as a result of the different dispersal ability of caddisflies. Since the composition of adult caddisfly assemblages depends on the distance from the larval habitat, and adult assemblages close to the larval habitat accurately reflect larval caddisfly assemblages, light trap-collected caddisflies can be used as environmental indicators.

Non-metric multidimensional scaling shows little overlap among caddisfly assemblages collected in lowland and highland locations. Although the observed species richness and number of individuals of the assemblages collected in lowland and highland habitats were very similar, non-metric multidimensional scaling reveals great variability within assemblages collected in highland areas. The number of the collected species (53) is 25.2% of the total number of caddisfly species in Hungary (Nógrádi and Uherkovich 2002). Only three species were found to be statistically significant indicators. The acceptance of a species as an indicator depends not only on its occurrence in one type of habitat (in this case lowland or highland), but on the species being very common in the given habitat as well. For instance, *Rhyacophila nubila* is a typical mountainous stream dweller in Hungary (Schmera 2000), but could not be regarded as indicator species because of its rarity. In this study, *Neureclipsis bimaculata* and *Ecnomus tenellus* were the indicators of lowland habitats and *Stenophylax permistus* was an indicator of in highland habitats. The first two are very common (Nógrádi and Uherkovich 1995, 2002) and distributed in different regions (Uherkovich and Nógrádi 1991) in Hungary, but the frequency of both species is different in lowland and highland habitats. *Neureclipsis bimaculata* is common in the Tisza and its tributaries in the Great Hungarian Plain. On the other hand, *Stenophylax permistus* is widespread in Hungary but not abundant (Nógrádi and Uherkovich 1995, 2002). This species was found much more frequently in highland habitats than in lowland ones.

It is well known that some caddisfly species show preference for specific altitude based on larval studies (Pitsch 1993). Here, an attempt was made to determine whether or not caddisflies collected by light traps reflected the differences between highland and lowland habitats. The results demonstrate that caddisflies collected by light trapping properly indicate lowland and highland habitats. Because there are no specific mountain areas in Hungary (in comparison with other parts of Europe), this hypothesis may receive stronger support in other countries, in which both lowland and highland areas are present.

Acknowledgements: I thank dr. Árpád Szentesi, Prof. Dr. Péter Bíró and an anonymous referee for their comments on the manuscript and dr. Ferenc Szentkirályi for the light trap material.

References

Basaguren, A. and Orive, E. 1990. The relationship between water quality and caddisfly assemblage structure in fast-running rivers. The River Gadaguna Basin. *Environmental Monitoring and Assessment* 15: 35-48.

Crichton, M.I. 1976. The interpretation of light trap catches of Trichoptera from the Rothamsted Insect Survey. Proc. of the 1st Int. Symposium on Trichoptera, 1974. Junk, The Hague, pp. 147-158.

McCune, B. and M.J. Mefford. 1997. *PC-ORD for Windows. Multivariate Analysis of Ecological Data.* MjM software, Gleneden Beach, Oregon, USA

Dufrene, M. and P. Legendre. 1997. Species assemblages and indicator species: The need for a flexible asymmetrical approach. *Ecol. Monog.* 67: 345-366.

Kiss, O., S. Andrikovics, G. Szigetvári and I. Fisli. 1999. Trichoptera from a light trap near the Eger brook at Szarvaskő (Bükk Mountains, North Hungary). Proc. 9th Int. Symposium on Trichoptera, Chiang Mai, p. 165-170.

Malicky, H. 1981. Der Indikatorvert von Köcherfliegen (Trichoptera) in grossen Flüssen. (The importance of caddisflies as ecological indicators in large rivers) *Mitt. dtsch. Ges. allg. Ent.* 3: 135-137.

Malicky, H. 1983. *Atlas of European Tricoptera.* Junk, The Hague.

Malicky, H. 1987. Anflugdistanz und Fallenfangbarkeit von Köcherfliegen (Trichoptera) bei Lichtfallen (Flight distance and catchability of caddisflies (Trichoptera) in light-traps). *Jber. Biol. Stn Lunz* 10: 140-157.

Nógrádi, S. 1997. How to distinguish the females of the three European *Mystacides* species. *Braueria* 24: 18.

Nógrádi, S. and Á. Uherkovich. 1995. A magyarországi tegzesek (Trichoptera) elterjedése és gyakorisága az utóbbi évtizedben, számítógápes feldolgozás adatai alapján. (Distribution and abundance of caddisflies (Trichoptera) in Hungary during the last decades based on computer data processing.) *A Janus Pannonius Múzeum Évkönyve* 39: 49-67.

Nógrádi, S. and Á. Uherkovich. 2002. Magyarország tegzesei (Trichoptera). (The caddisflies of Hungary (Trichoptera)). *Dunántúli Dolgozatok (A) Természettudományi Sorozat* 11: 1-386.

Petersen, I., J.H. Winterbottom, S. Orton, N. Friberg, A.G. Hildew, D.C. Spiers and W.S.C. Gurney. 1999. Emergence and lateral dispersal of adult Plecoptera and Trichoptera from Broadstone Stream, U.K. *Freshwater Biology* 42: 401-416.

Pitsch, T. 1993. Zur Larvaltaxonomie, Faunistik und Ökologie mitteleuropaischer Fliesswasser-Köcherfliegen (Insecta: Trichoptera). Landschaftsentw. Unweltforsch, UT Berlin; Sonderheft S 8.

Podani, J. 1993. SYN-TAX. Computer programs for multivariate data analysis in ecology and systematics. *Abstr. Bot.* 17: 289-302.

Podani, J. 2000. *Introduction to the Exploration of Multivariate Biological Data.* Backhuys, Leiden, The Netherlands

Schmera, D. 2000. Occurence of a remarkable Trichoptera species in the collections of the countrywide light trap network. *Növényvédelem* 36: 357-358. (In Hungarian)

Sode, A. and P. Wiberg-Larsen. 1993. Dispersal of adult Trichoptera at a Danish forest brook. *Freshwater Biology* 30: 439-446.

Svensson, B.W. 1972. Flight periods, ovarian maturation, and mating in Trichoptera at South Swedish stream. *Oikos* 23: 370-383.

Svensson, B.W. 1974. Population movements of adult Trichoptera at a South Swedish stream. *Oikos* 25: 157-175.

Szentkirályi, F. 2002. Fifty-year-long insect survey in Hungary: T. Jermy's contributions to light-trapping. *Acta Zoologica Academiae Scientiarum Hungaricae* 48: 85-105.

Uherkovich, Á. and S. Nógrádi. 1992. Provisional check-list of the Hungarian Trichoptera. Proc. of the 6th Int. Symposium on Trichoptera. pp. 247-253.

Usseglio-Polatera, P. and Y. Auda 1987. Influence des factors météorologiques sur les résultats de piégeage lumineux. *Annl. Limnol.* 23: 65-79.

Waringer, J.A. 1989. The abundance and temporal distribution of caddisflies (Insecta: Trichoptera) caught by light traps on the Austrian Danube from 1986 to 1987. *Freshwater Biology* 21: 387-399.