POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	36	1	123–132	1989

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DIFFERENTIATION OF THE HABITATS OF HYDROPSICHIDAE LARVAE (INSECTA: TRICHOPTERA) IN THE PASŁĘKA RIVER AS A RESULT OF AVOIDANCE OF TROPHIC COMPETITION

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ABSTRACT

Retardation of growth of *Hydropsyche siltalai* larvae in the life cycle was found. It is probably due to avoidance of trophic competition with *Hydropsyche pellucidula* larvae. *Cheumatopsyche lepida* avoids trophic competition by colonizing bottoms of another nature, and *Hydropsyche angustipennis* — by occurrence in running waters of another type.

1. INTRODUCTION

Larvae of caddisflies of the family Hydropsychidae are rheophilic omnivores feeding on seston which they catch in a silken case. Very often several species occur in the same microhabitats. On account of the same manner of feeding and of a closely similar tolerance to pollution (Stroot 1986), differences can be expected between these species in the spatial and temporal trophic penetration of the environment. In these caddisflies, the avoidance of trophic competition is put into realization in different ways. It consists of forming a case differing in pore diameter, this resulting in feeding on seston of dissimilar size (Wallace 1980). Moreover, a phenological shift of the life cycle may take place (Andersen, Klubnes 1983).

The goal of the present studies was to analyse the habitat-related and phenological differentiation of four caddisflies species of the family Hydropsychidae, occurring in the Pasłęka River (North-East Poland).

2. TERRAIN OF STUDIES, MATERIAL AND METHODS

The Pasłęka River is one of the purest rivers of the Masurian Lake District. It is situated on the western border of this region characterized by the coldest winters and the shortest vegetation period among all Polish lowland terrains. It rises from a dried lake at an altitude of 153 m a.s.l., and flows as two arms into the Vistula Bay in the locality Ujście (2.2 m a.s.l.). The total length of the river is 120 km, the catchment area amounts to 2330 km^2, and the slope fluctuates between 5 — 0.4‰. At the estuary which is 45 m wide and up to 3 m deep, water flow is 12.75 m/s. The vegetation period last 200 days.

The Pasłęka River flows through an open and woodland terrain. The river valley is usually

broad and flat; in its middle course it is narrow and sharply indented. Along nearly the whole river length, the borders are of a natural character. The whole river is a protected terrain with two reserves of beavers.

The material was collected at sampling stations situated more or less uniformly along the whole river. Samples were taken from April 1984 until November 1986 at 1-month intervals, with the exception of the winter months, when the river was covered with ice. The qualitative samples were taken with a hydrobiological triangle hoop (19-cm side). The qualitative samples were collected in 1985 at four selected sampling stations, using a biocenometer with an about 0.2 m^2 surface.

3. RESULTS

The Pasłęka River was found to exhibit a rich caddiesflies fauna (73 species). Larvae of the family Hydropsychidae belonged among the dominants (55.6% of the total material). *Hydropsyche pellucidula* proved to be the most numerous species in the river (3167 individuals). Larvae of *Hydropsyche siltalai* (811 indiv.) and *Cheumatopsyche lepida* (831 indiv.) occurred in lower numbers. *Hydropsyche angustipennis* was represented by only 7 larvae.

Changes in the number of larvae in the longitudinal profile of the Pasłęka River were investigated (Fig. 1). Hydropsychidae exhibited a tendency for an

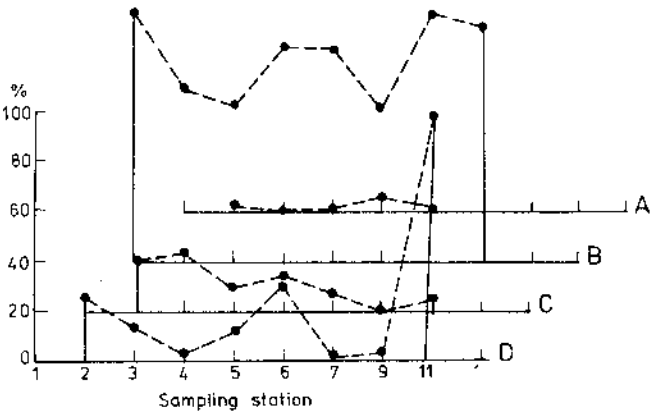

Fig. 1. The percentages of *Hydropsyche angustipennis* (A), *H. pellucidula* (B), *H. siltalai* (C) and *Cheumatopsyche lepida* (D) in the longitudinal profile of the Pasłęka River (100% — all Hydropsychidae individuals caught at a given sampling station)

increase in the percentage (dominance) of *Cheumatopsyche lepida* and for a drop in the percentage of *Hydropsyche siltalai* along the river course. The remaining two species displayed no directional changes in dominance.

Changes in the frequency of hydropsychids in the longitudinal profile of the river were studied (Fig. 2). Three species were characterized by a decrease in the frequency along the river course (*Hydropsyche pellucidula*, *H. siltalai* and

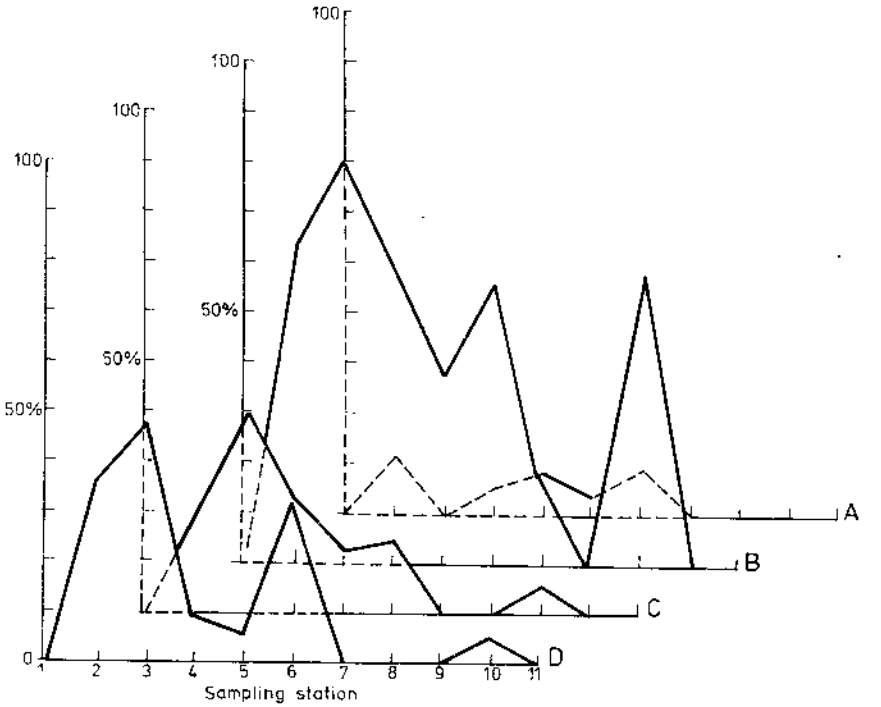

Fig. 2. Frequency of the Hydropsychidae species in the longitudinal profile of the Pasłęka River; A-D as in Fig. 1 (100% – all samples containing Trichoptera)

Cheumatopsyche lepida, whereas no such a regularity was found for *Hydropsyche angustipennis*.

Correlation coefficients characterizing the simultaneous occurrence of larvae of the investigated species in the sample were calculated. These coefficients were negative, and failed to be significant. For *H. angustipennis* and *H. pellucidula* r amounted to -0.078 for $n = 177$, whereas for *H. siltalai* and *H. pellucidula* r was -0.059 for $n = 173$. They only informed about the tendency of these caddiesflies for mutual ruling out from the sample.

The distribution of the three most numerous species as a function of the nature of the substrate was studied (Fig. 3). In all types of habitats *Hydropsyche pellucidula* was dominant. Moreover, there were great differences between the hydropsychid larvae in the preference of bottom for colonization. *Hydropsyche pellucidula* occurred in greatest numbers on a gravel bottom, and there it most evidently predominated over the remaining species. *Hydropsyche pellucidula* was less numerous among stones and vegetation. *Hydropsyche siltalai* was most frequently found among stones (the same numbers as those of *Cheumatopsyche lepida*), and in further order among vegetation (more frequently than *Ch. lepida*) and on a gravel bottom (less frequently than *Ch. lepida*). In pools no *Cheumatopsyche lepida* was found.

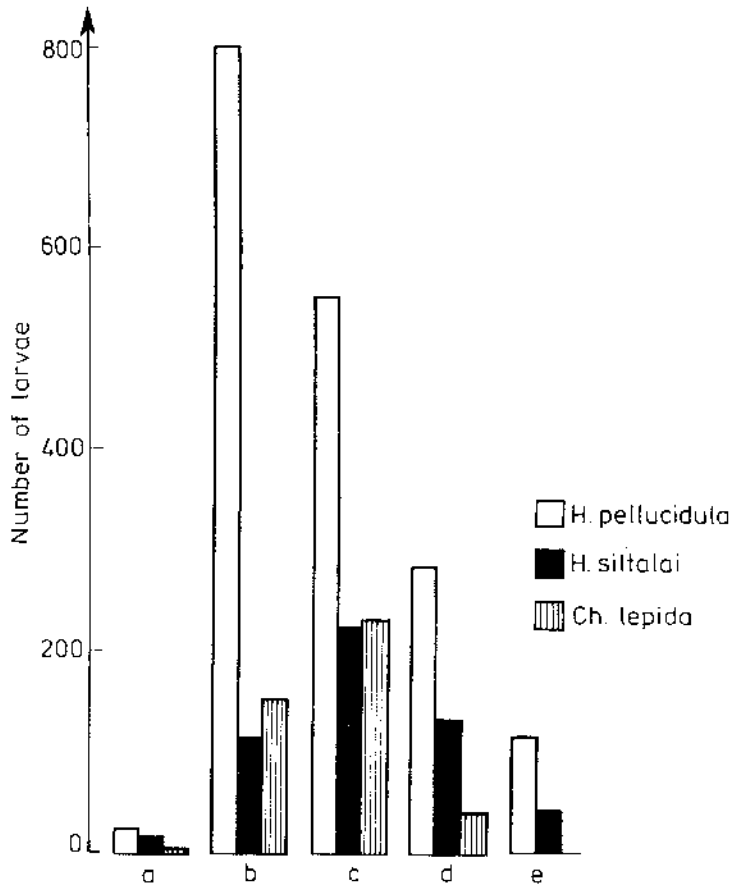

Fig. 3. Number of larvae of three dominant Hydropsychidae species in dependence on microhabitat; a — sand, b — gravel, c — stones, d — aquatic vegetation, e — pools

Changes in the numbers of these three species in dependence on the season and nature of the substrate (type of habitat) were investigated. Only sampling stations with great numbers of larvae were taken into account (Figs. 4 and 5). There were phenological differences in the structure of substrate colonization within one species and between species. Great numbers of *Hydropsyche pellucidula* larvae were observed in October and November (sampling stations 2 and 3) as well as in April and May (station 2) — (Fig. 4A). It was found that the structure of bottom colonization by this species changed in spring. From a gravel bottom (autumn) the larvae moved to pools and vegetation (April) and to stones (May). *Hydropsyche siltalai* was found in the greatest numbers in May and June (Figs. 4B and 5B). At sampling station 2 where *H. pellucidula*

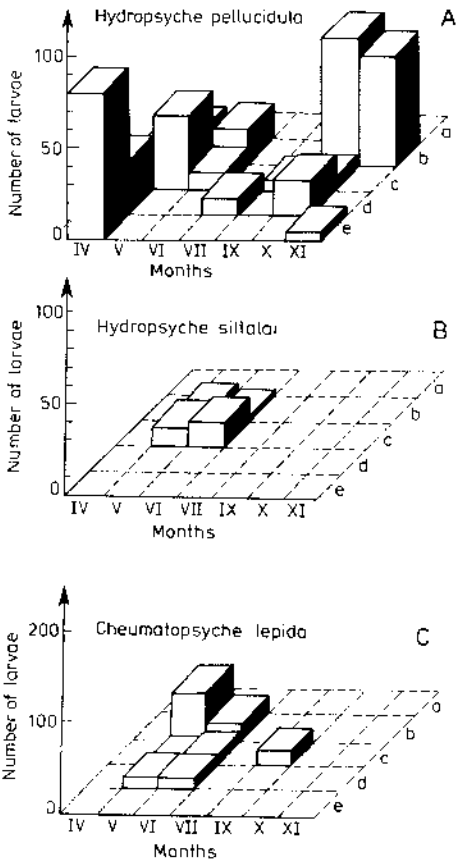

Fig. 4. Number of Hydropsychidae larvae at sampling stations 2 and 6 in dependence on season and microhabitat; a – e as in Fig. 3. A – *Hydropsyche pellucidula* at sampling station 2, B – *H. siltalai* at station 2, C – *Cheumatopsyche lepida* at station 6

was numerous in spring, *H. siltalai* was unfrequent (Fig. 4B). On the other hand, it was represented in great numbers at sampling station 6 where *H. pellucidula* occurred in spring in small numbers (Fig. 5). Also *Cheumatopsyche lepida* exhibited the greatest numbers in May and June (Fig. 4C and 5C). Only at sampling station 2 this species was unfrequent in May and June.

Furthermore, comparison was made of changes in the density of *Hydropsyche pellucidula* and *H. siltalai* larvae at three sampling stations, using quantitative samples collected in July and October (Fig. 6). In October there was a definite dominance of *H. pellucidula* and in July – of *H. siltalai.*

Fig. 5. Number of Hydropsychidae larvae at sampling station 3, in dependence on season ar microhabitat; a — e as in Fig. 3. A — *Hydropsyche pellucidula*, B — *H. siltalai*, C — *Cheumatopsyche lepida*

4. DISCUSSION

In the Pasłęka River the numbers of *Hydropsyche angustipennis* were very small, whereas in small streams of this terrain (Czachorowski, in prep.) this species evidently dominated over other larvae of the family Hydropsychidae. This may testify to washing down of the *H. angustipennis* larvae to the Pasłęka River from its small tributaries. This seemed to be confirmed by the data for the Widawka River where *Hydropsyche angustipennis* was dominant in the upper river fragment, and *H. pellucidula* — in the lower one (Kopytek,

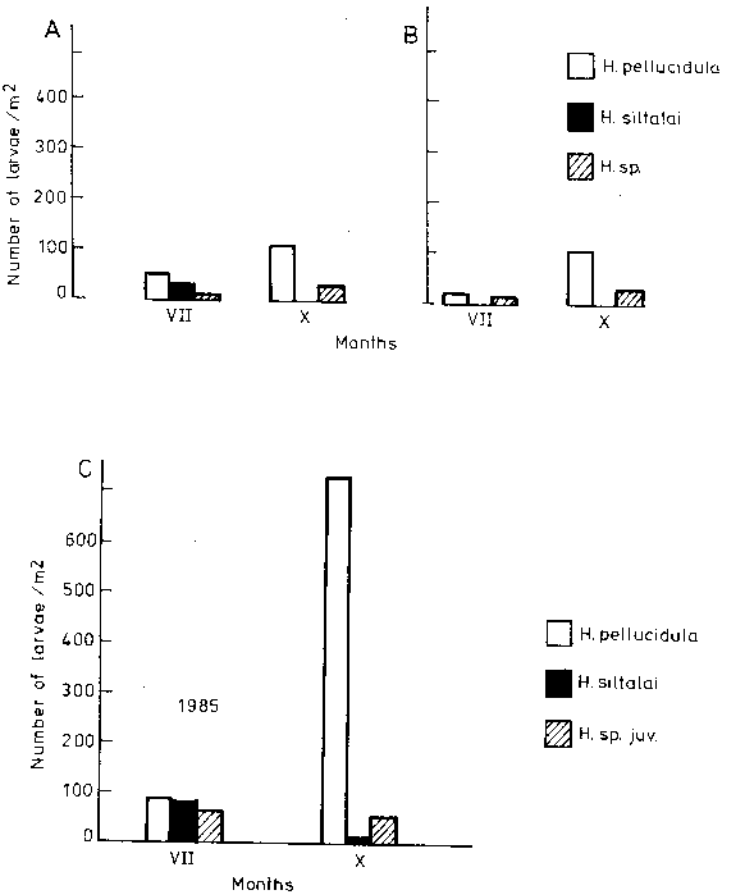

Fig. 6. Density of larvae (individuals/m^2) of the genus *Hydropsyche* in July and October at three sampling stations

Tajecki 1986). Therefore, the greatest numbers of *H. angustipennis* could be expected in the upper fragment of the Pasłęka River. Only an analysis of the frequency (Fig. 2) points to this regularity. Perhaps this is due to the fact that the Pasłęka River becomes a big river along a relatively short distance. Too small the number of sampling stations in the upper river fragment could contribute to the failure of detection of the rapid, though continuous faunistic changes. In Europe, *Hydropsyche angustipennis* has been found also in the lower river fragments (Bagge, Anttila 1986). This fact suggests that the small numbers of this caddiesfly in the big Pasłęka River and its dominance in the small streams of this terrain may result from avoidance of competition.

According to the literature, *Hydropsyche pellucidula* and *H. siltalai* have emergences at nearly the same time, i.e. in July and August (Andersen, Klubnes 1983). Therefore, it is possible that also egg laying takes place at the same time. The method for collection of the material, applied in the present

studies, permitted taking mainly the older larval stages, i.e. from the 3rd to the 5th one, whereas the younger larval stages were collected in only small numbers. Therefore, it is possible to treat the increase in the numbers of larvae as a rise of the numbers of the older larval stages, and in this manner to analyse the increase in larval size during the life cycle. *Hydropsyche pellucidula* develops intensely already in autumn and winters in the form of older larval stages (Figs. 4 and 5). On the other hand, an increase in the numbers of *H. siltalai* is observed only in spring, this suggesting that this species winters in the form of the younger larval stages. An intense rise of larval size occurs only in spring when the *H. pellucidula* larvae leave the ecosystem; with the beginning of pupation they stop feeding and thus they no more compete for food. The presence of great numbers of *H. pellucidula* larvae in early spring is related to the small numbers of *H. siltalai* larvae. The small numbers of *H. siltalai* can be explained by the presence of actively feeding *H. pellucidula* larvae.

The much later occurrence of the older larval stages of *Hydroxypsyc siltalai*, as compared with *H. pellucidula*, cannot result only from later egg laying. Comparison of the life cycle of *H. siltalai* from other European regions (Recasens 1985) with the present data points to a phenological shift of this life cycle in the Pasłęka River. This may be due to competition with *H. pellucidula* for food. A similar situation has been observed in Norwegian waters (Andersen, Klubnes 1983). Doubtless the shift of the developmental cycle remains within the range of the ecological tolerance of *Hydropsyche siltalai* larvae. This shift may indicate that *H. pellucidula* and *H. siltalai* have developed in different regions, and only relatively recently have met in one terrain (in this case – in the Masurian Lake District). In Poland *H. siltalai* has been reported only in recent years (Szczęsny 1986, Czachorowski, in prep.). Owing to the late description of *H. siltalai* (1963), it cannot be univocally stated whether this species has occurred earlier in the Masurian Lake District.

Cheumatopsyche lepida behaves in the life cycle similarly as *Hydropsyche siltalai*, because its larvae grow intensely in spring. Larvae of the older stages are also observed in autumn (Fig. 5). It seems that the avoidance of trophic competition proceeds via colonization of separate microhabitats (Fig. 3). Other ecological adaptations are also testified to by an analysis of the dominance relationships in the longitudinal profile of the river (Fig. 1). If it is assumed th the environmental conditions (current, water oxygenation, turbidity) change along the longitudinal profile, then the alterations in the dominance and the differences in the structure of dominance of the investigated species are a reflection of these environmental changes.

5. SUMMARY

Studies were performed in years 1984-1986 at 11 sampling stations situated more or less uniformly along the Pasłęka River (North-East Poland). Samples were collected at 1-month intervals, with the exception of winter when the river was covered with ice. More than 5000 larvae of four caddisflies species of the family Hydropsychidae were collected. Changes in the numbers and frequency in the longitudinal profile of the river, as well as the distribution in dependence of

the nature of the bottom and as a function of the character of the bottom and of the season were analysed.

The species *Hydropsyche pellucidula* proved to be dominant both in the river and in all the microhabitats of the bottom. Retardation of the development of larvae in the life cycle of *Hydropsyche siltalai* was found. Presumably this retardation results from avoidance of trophic competition with *H. pellucidula* larvae. The life cycle of *Cheumatopsyche lepida* proved to resemble that of *Hydropsyche siltalai*: however, the increase in larval size began already in autumn. The above-mentioned three species differ in the selection – for colonization – of bottoms characterized by dissimilar environmental conditions. It seems that the occurrence of *Hydropsyche angustipennis* larvae in the Pasłęka River is accidental; the larvae of this species either drift to the river from its small tributaries, or the Pasłęka River is an only marginal environment of their occurrence.

6. STRESZCZENIE

Badania prowadzone w latach 1984-1986 na jedenastu stanowiskach rozmieszczonych mniej więcej równomiernie na rzece Pasłęce (Północno-Wschodnia Polska). Próby pobierano w odstępach miesięcznych – za wyjątkiem zimy, kiedy to rzeka skuta była lodem. Zebrano ponad 5000 larw należących do czterech gatunków chruścików z rodziny Hydropsychidae. Analizowano zmiany liczebności i frekwencji w profilu podłużnym rzeki, rozmieszczenie w zależności od charakteru dna oraz w zależności od charakteru dna i pory roku.

Gatunek *Hydropsyche pellucidula* okazał się dominujący zarówno w rzece, jak i we wszystkich mikrosiedliskach dna. Stwierdzono opóźnienie rozwoju larw w cyklu życiowym *Hydropsyche siltalai*. Przypuszcza się, że jest to skutek unikania konkurencji pokarmowej z larwami *H. pellucidula*. Cykl życiowy *Cheumatopsyche lepida* okazał się podobny do *Hydropsyche siltalai*, jednakże wzrost wielkości larw rozpoczynał się już jesienią. U wymienionych trzech gatunków zauważa się różnice w wyborze zasiedlenia dna o różnych warunkach środowiskowych. Występowanie larw *Hydropsyche angustipennis* w rzece Pasłęce wydaje się być przypadkowe i albo larwy tego gatunku są spłukiwane do rzeki z jej drobnych dopływów, albo rzeka Pasłęka stanowi marginalne środowisko ich występowania.

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Received 22 January 1988
Accepted 7 March 1988