

Migrations of *Leptophlebia vespertina* L. and *L. marginata* L. (Ins.: Ephemeroptera) in the Estuary of a Coastal Stream

by

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ABSTRACT

Investigations carried out in a coastal stream flowing to the Northern Bothnian Sea (Ångerån, 63°35'N, 19°50'E) have shown a high drift rate of mayfly nymphs towards the coastal areas. The nymphal development takes place in the estuaries with low salinity (conductivity between 47 and 9800 μ S; salinity between 0 and 4-5‰). After the emergence (May/June) the adults fly from the coastal areas to lay their eggs in the stream biotope in the Ångerån. There thus appears to be a colonization cycle between the coastal stream and adjacent coastal areas. The migration movements of downstream drift and the compensatory upstream directed flight are interpreted as a survival strategy of the species concerned.

INTRODUCTION

The mayflies *Leptophlebia vespertina* and *L. marginata* are two of the most widespread and abundant species in European fresh waters. The nymphs occur in lakes, lotic and lenitic parts of streams and rivers, and as is shown in the present paper also in brackish estuaries.

In the present investigation we have followed the seasonal migrations of the nymphs and adults between two extremely different biotopes.

INVESTIGATION AREA AND METHODS

The investigation has been concentrated to the mouth of the small coastal stream Ångerån which flows into the Bothnian Sea about 30 km south of the city Umeå (63°35'N, 19°50'E).

The chemical and physical conditions of the stream are described by Müller and Müller-Haeckel (1978). Among the most interesting features of the river from an ecological point of view are the drastic changes of the hydrogen-ion

content and conductivity between the stream and the coastal areas (Fig. 1). In the stream the annual mean for pH is 5.4 while in the sea the corresponding figure is 7.4. The annual means for conductivity vary from 50 μS in the lower reaches of the stream, to 7124 μS at a site about 1000 m beyond the estuary. Between relatively stable conditions as well in the stream as in the sea there occurs a zone of high variability, caused by fluctuations in the seawater level and the seasonally varying discharge of the stream.

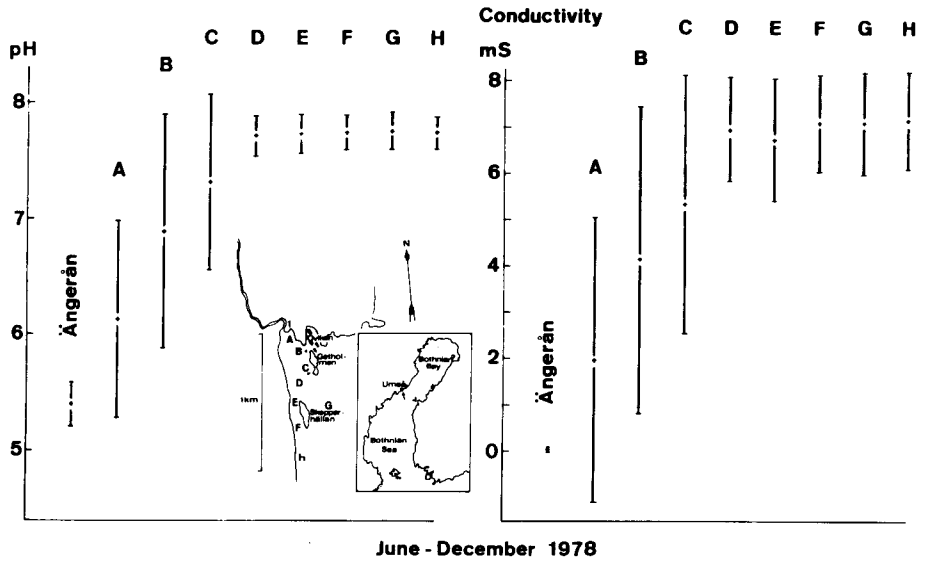


Fig. 1 Map of the investigation area in the northern Bothnian Sea, the estuaries of the river Ångerån and the changes of the hydrogen-ion concentration and conductivity from the Ångerån to adjacent coastal areas, after investigation June-December 1978.

RESULTS

1. Drift of *L. vespertina* and *L. marginata* in the mouth part of the Ångerån

Table 1 shows the number of samples per month, the mean water discharge, the number of drifting mayflies in the drift samples and the calculated number of mayflies related to water discharge.

The total estimated number of Ephemeroptera drifting past the sampling point in the entire water body from 19 May until 20 November amounts to 706104 individuals. Of this number *Leptophlebia vespertina* and *L. marginata* constitute 351908 and 341949 individuals respectively. The remainder, some 12247

Table 1. The drift of mayfly nymphs in the mouth of the River Ångerån

Number of samples	Month	Mean water discharge m ³ /sec	Number of <i>Leptophlebia vespertina</i>	Number of <i>Leptophlebia marginata</i>	Total number of Ephemeroptera	Calculated number of Ephemeroptera drifting past the sampling point/month	Calculated number of Ephemeroptera drifting past the sampling point/24 h
12	May	3.60	93	38	131	101866	8489
30	June	0.60	21	—	25	3240	108
31	July	0.30	—	—	13	842	27
31	Aug.	0.45	—	40	60	5832	188
30	Sept.	0.70	505	895	1419	214553	7152
31	Oct.	0.60	1218	1028	2257	292507	9436
20	Nov.	0.50	395	406	808	87264	4363
			2232	2402	4713	706104	

individuals, consists of *Heptagenia fuscogrisea* Retz., *Siphonurus linneanus* Etn., *Cloeon dipterum* Linné, *Baetis rhodani* Pict. and *B. subalpinus* Bgts.

The number of drifting mayfly nymphs reflects the life cycle of both *Leptophlebia* spp. The emergence and flight period for *L. marginata* occur in May and last until the end of June and for *L. vespertina* occurs at the beginning of June and lasts until mid-July. After oviposition and egg-development the first drifting nymphs of *L. marginata* were observed at the end of August, and *L. vespertina* two weeks later. High drifting rates were found during September and October after which there was a gradual decrease throughout November.

The nymphal growth and development was very rapid in late summer and autumn and showed the same pattern of seasonal development as that which Brinck (1949) for stoneflies termed a "hiemal growth type". The mean length of *Leptophlebia vespertina* and *L. marginata* in November was 3.1 mm and 5.0 mm respectively which amounts to 43% and 54% respectively of the mean length just prior to emergence in the ensuing spring.

2. Colonization of *Leptophlebia vespertina* and *L. marginata* in coastal areas.

Fortnightly controls were made at localities A to H (Fig. 1) by means of colonization boxes (Fig. 2). Considerable numbers of both *Leptophlebia* species occurred at the sites A, B and C in May/June at times of low conductivity of about 100 μ S, but even later on in September/November when salinity was higher

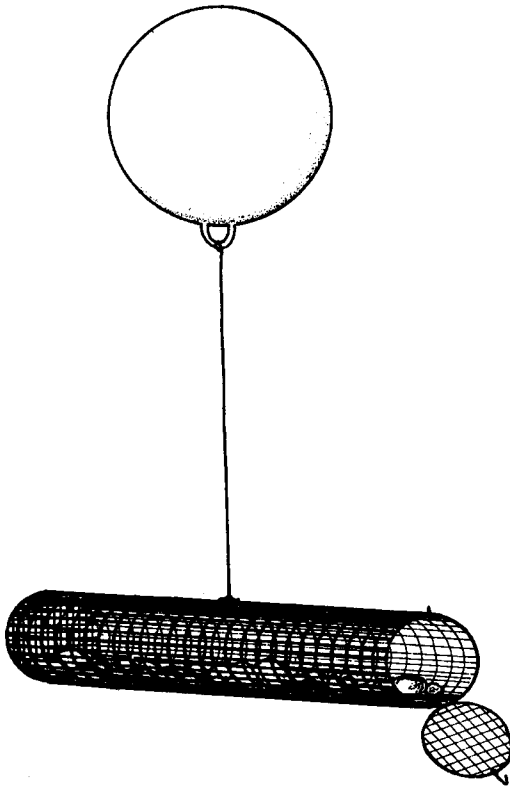


Fig. 2 The colonization box.

(variations between 48 and 9800 μS means 1938 and 4217 and sites A and B) both species occurred in the boxes at sites A and B.

3. Flight behaviour of *L. vespertina* and *L. marginata*

Eleven window-traps were placed in the vicinity of the river mouth. A survey on mayflies captured in the window-traps is made in Table 2.

Table 2. Mayfly imagines in the lower and upper parts of the window-traps (25 June-5 July 1978).

Species	Lower part	Upper part	% lower part
<i>L. vespertina</i>	39	19	67.2
<i>L. marginata</i>	5	3	62.5
	44	22	66.7

There was an evident accumulation of mayfly adults in the afternoons (maximum 14°-18°).

DISCUSSION

In our investigation we counted a total number of 4634 nymphs of *L. vespertina* and *L. marginata* drifting downstream in the lower reaches of the Ängerån. Related to the total water discharge of the stream the estimated number of *L. vespertina* and *L. marginata* was 693857. Some 706104 mayfly nymphs of all species were found leaving the stream and entering the sea.

The colonization boxes at sites A, B and C (in spring) and A and B in autumn were found to contain living larvae.

The examination of the catches in the window-traps showed that upstream directed flights of adult mayflies predominated to an extent of 66.7%.

The high drift rate indicates that an appreciable part of the population leaves the Ängerån and enters offshore parts of the northern Bothnian Sea. This does not exclude the possibility that a part of the population remains in the Ängerån, which undertake drift in May before emergence.

What is the reason of this behaviour? The movements of larvae and imagines can be seen in relation to the extreme variations in the water discharge in the Ängerån. During the winter the water discharge in the stream is very low (0.2 m³/sec) from January to March. The low water flow is combined with a reduction of suitable biotopes for the larvae. The existence of ice dams indicates very instable hydrographical conditions in the river bed.

After ice formation November-December the offshore areas offer more stable conditions. The fact that both *Leptophlebia* species tolerate low concentrations of salt makes it possible for them to occupy larger areas for larval development in the winter and in springtime.

The cycle is completed by upstream flight of the adults and oviposition in the stream.

These results indicate the existence of a "Colonization cycle" (Müller 1954, 1973, 1974, Roos 1957, Lehmann 1971, Göthberg 1972, Mendl and Müller 1978) between extremely different biotopes.

The alternate exploitations of the stream as a site for reproduction and of brackish water as a habitat suitable for nymphal development can be considered as a survival strategy for these two species of mayflies.

ACKNOWLEDGEMENTS

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