

FLYING BEHAVIOUR OF SOME MAYFLIES (EPHEMEROPTERA) AND
STONEFLIES (PLECOPTERA) IN TWO RAPIDS OF THE RIVER DAL-
ÄLVEN

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1. INTRODUCTION

The river Dalälven has been since 1898 subjected to an increasing degree of water regulation. Today most of the rapids are regulated by hydroelectric power stations and resevoirs in the upper stretches of the river (Fig. 1).

In the lower reaches of the river at Gysinge and at Söderfors two rapids have been investigated. At Gysinge, apart from a varying seasonal water run-off, the rapid is typical of a large northern Swedish river. In contrast to this, in the Söderfors area on the northern side of the Söderfors hydroelectric power station, the river is partly diverted into a rapid with continuous water flow the so called Bredforsen rapids. Fig. 2 shows the changes in the water flow prior to water regulation, the water flow in the Gysinge rapids for the year 1980, and in the Bredforsen (Söderfors) with a continuous flow has been made to protect the salmonids which occur in the rapids.

The question we have attempted to answer is: Has the changed water flow or the continuous run-off influenced the basic behaviour pattern of running water insects - the colonization cycle (Müller 1954, 1974, Roos 1957).

2. INVESTIGATION AREA AND METHODS

The investigation area is showed in Fig. 1. The distance between both rapids is about 30 km at the coordinates $60^{\circ}15'N$, $16^{\circ} 40'E$.

The investigations to analyze the flight movements and flight directions have been carried out by means of Malaise-traps. These traps, of the bilateral type (Malaise, 1937), have been placed out across the lower reaches of both rapids. At Gysinge from May, 5th to June, 30th. Unfortunately, the trap has been destroyed by an extremely large water flow in the first week of July. We have therefore only the results from this period available. At Söderfors (Bredforsen) the investigations were made from May, 5th to October, 15th, 1980. The traps have been emptied at 10 - 14 day-intervals.

The material is deposited in the collection of H. Mendl, Kempten, FRG (Plecoptera) and in collection P.E. Lingdell, Enskede, Sweden.

3. RESULTS

The dominating insect groups in both rapids are caddisflies, non-biting midges and blackflies. These are mainly supported by the rich food resources which derive from the lake-like parts of the river Dalälven situated upstream the rapids. These conditions support the abundance of net-spinning caddisflies and other passive feeders. In the Bredforsen rapids, with a continuous water flow, this resulted in an almost complete absence of stoneflies, which cannot compete with the monoculture of caddisflies in this rapid. On the other hand

we can observe in the Bredforsen a relative rich occurrence of the mayfly *Baetis rhodani*. It is clear that the total number of both insect groups such as mayflies and stoneflies have been reduced in their number of taxa after the river regulation. Only the species which have the possibility to adapt to the changed conditions occur in high numbers. They are, in the Gysinge rapids, the mayflies *Leptophlebia marginata* and *L. vespertina* and the stonefly *Nemoura cinerea*, and in the Bredfors rapids *Baetis rhodani*.

3.1 THE FLIGHT MOVEMENTS OF MAYFLIES AND STONEFLIES IN THE GYSINGE RAPIDS

90% of all observed mayflies in the Gysinge rapids were represented by the *Leptophlebia* species *L. marginata* L. and *L. vespertina* L.. A clear upstream directed flight behaviour can be seen for both species from Fig. 3. This is even the case for the dominating stonefly *Nemoura cinerea* (Fig. 4).

3.2 THE FLIGHT MOVEMENTS OF MAYFLIES IN THE SÖDERFORS (BREDFORSSEN) RAPIDS.

In contrast to the dominating mayflies of the genus *Leptophlebia* only 15 individuals were captured in the Bredforsen. Even here the mayflies are represented to 90% by only one species: *Baetis rhodani*. Even this species showed flight movements directed against the current direction (Fig. 5).

4. DISCUSSION

Müller (1954) advanced the hypothesis of a "Colonization cycle". The hypothesis states that arial adults of aquatic insects

compensate for gradual downstream movements of the larvae by active upstream flight. From many investigators work we can draw the conclusion that the colonization cycle is a basic strategy used by running water insects to survive in streams and rivers (Roos 1957, Russev 1972, Madsen et al. 1973, 1976).

In the introduction we have pondered the question of the function of the colonization cycle in a regulated water. In spite that the total number of mayflies and stoneflies in a regulated river have been reduced when compared with an unregulated river, or are nearly absent as in the case of stoneflies for the Bredforsen with continuous water discharge, the species which have survived follow clearly the phenomenon of the colonization cycle.

The influences of water regulations are mainly analyzed by means of faunistic or floristic investigations. We will emphasize that even studies on the ecological behaviour of animals can be a method to investigate changes in the environment and therefore can be seen as a more objective basis for forming a judgement for the ecological consequences of river regulations.

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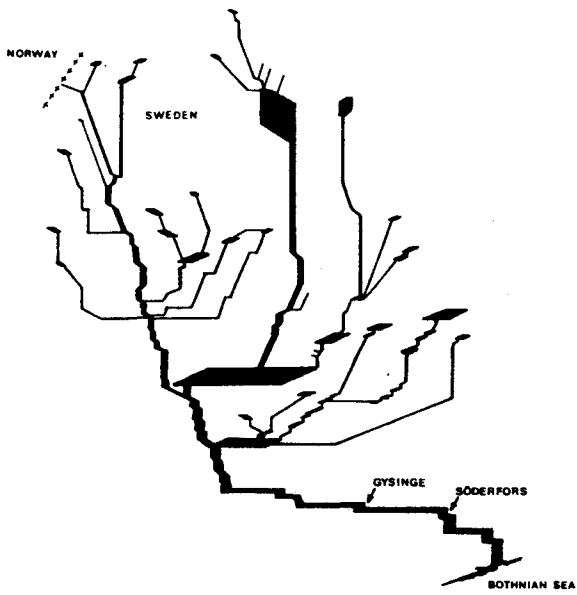


Fig. 1. Survey of the water regulation in the river Dalälven
(after Rydberg 1966).

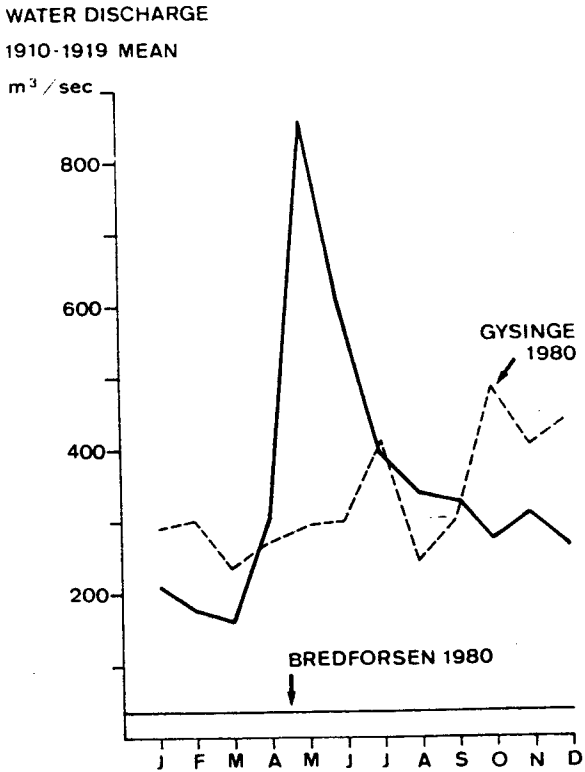


Fig. 2. The water discharge in the river Dalälven 1910-1919, and in the Gysinge and Bredforsen rapids 1980.

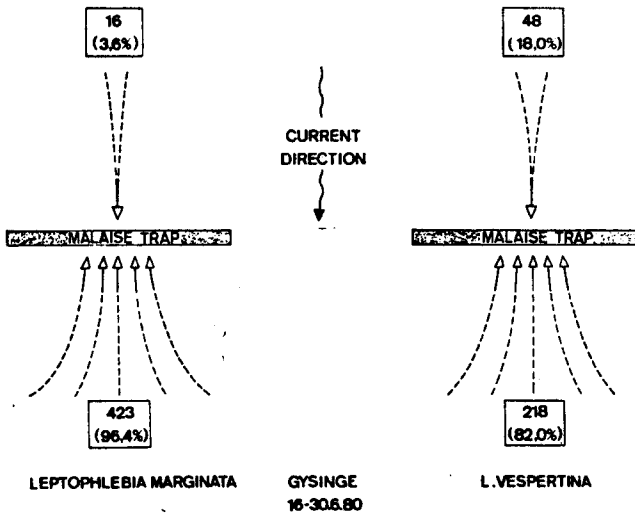


Fig. 3. Upstream and downstream flight movements of *Leptophlebia marginata* and *L. vespertina* in the Gysinge rapids.

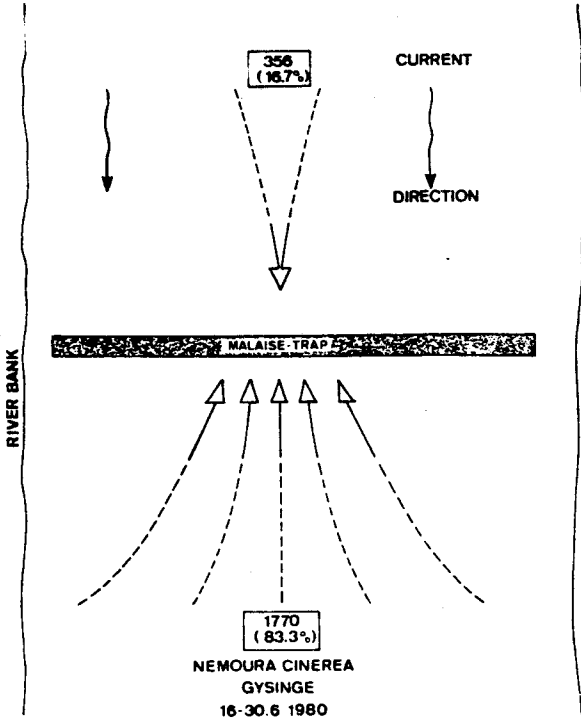


Fig. 4. Upstream and downstream flight movements of *Nemoura cinerea* in the Gysinge rapids.

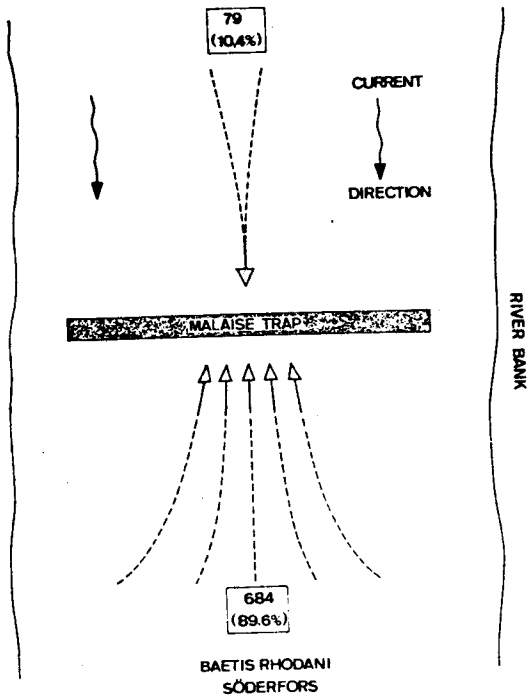


Fig. 5. Upstream and downstream flight movements of *Baetis rhodani* in the Bredforsen rapids.