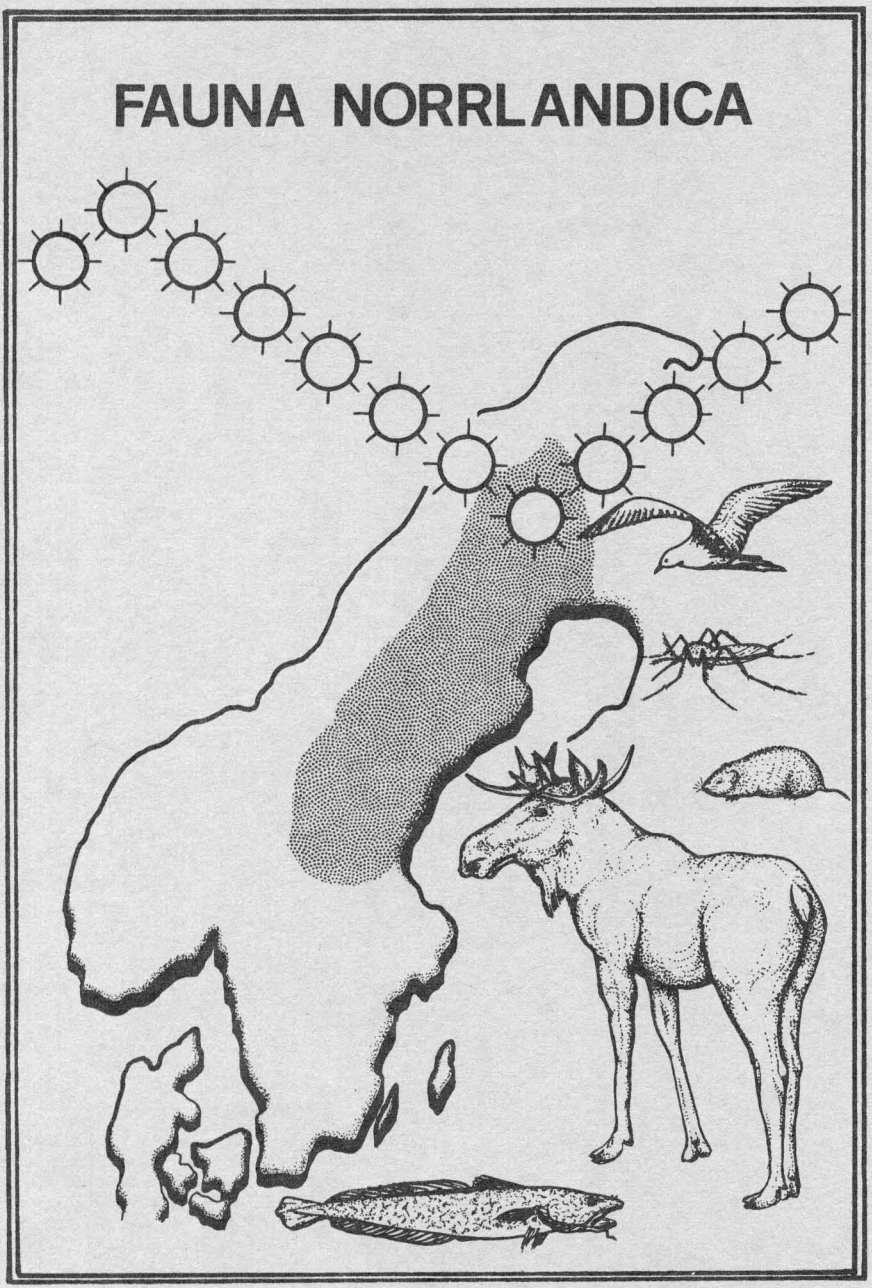
Michael Hubbard

FAUNA NORRLANDICA



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THE INFLUENCE OF REACTOR COOLING WATER ON THE LIFE CYCLE OF CAENIS HORARIA L. (Ins.: Ephemeroptera).

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THE INFLUENCE OF REACTOR COOLING WATER ON THE LIFE CYCLE OF CAENIS HORARIA (Ins. Ephemeroptera)

P.E. Lingdell & K. Müller

1. INTRODUCTION

Investigations which we have carried out at several localities in coastal areas of the Gulf of Bothnia (Lingdell & Müller 1979a, 1979b, 1981) show that *Caenis horaria* L. is widespread in brackish waters of the Gulf of Bothnia. Fig. 1 shows the localities where the species has been found.

Observations at the Kalö island in the northern Bothnian Bay were reported by Kuusela (pers. comm.) and the findings in the Archipelago Sea were published by Saaristo (1966). From other observations carried out by the authors it was found that *Caenis horaria* occurs in salinities between 2-5.5‰.

In the summer of 1979 we observed *C. horaria* in the so-called Biotest lake in salinities between 5 and 5.5‰. The Biotest lake is a [illegible] ha part of the coast near Forsmark, some 120 km north of Stockholm, which was dammed in. The reactor cooling water is led into this test-lake in order to control the effect of the heated water on the plant and animal life. The reactor had not yet been started in 1979 but the first inflow of reactor cooling water occurred at the beginning of July 1980 before the hatching and flight periods of most insects living in the Biotest lake.

The following study compares the effect of the drastic increase of water temperature which occurred in the summer of 1980 on the mayfly *C. horaria*.

2. INVESTIGATION AREA AND METHODS

The Biotest lake is situated in the southern part of the Bothnian Sea ($60^{o}32'N$, $18^{o}23'E$). Fig. 2 shows a map of the Biotest lake, the inflow of cooling water from the reactor and the outflow in to the Bothnian Sea. The investigations in 1979 and 1980 were carried out by means of a light-trap. The light-trap was placed in the middle of the lake (See Fig. 2). In 1979 the trap was emptied at weekly intervals, in 1980 at more irregular intervals (weekly or two-weekly intervals, See Tab. 2). The light-trap was of the type described by Olsson (1971) (Fig. 2), it was modified with a fan added to the top of the trap. The trap had two collecting vessels containing ethylene-glycol. The captured insect material was transferred to 70% alcohol and is deposited in the collection Lingdell (1979) and for the year 1980 in the collections of the Dept. of Ecological Zoology, the University of Umeå. Fig. 3 shows the development of the water temperature for 1979 and 1980, which demonstrates clearly the influence of the cooling water from the Forsmark reactor I, which started around July 10th with an input of about 90 m^3 sec^{-1} of $30^{o}C$ warm water.

3. RESULTS

3.1 THE OCCURRENCE OF *Caenis horaria* AT SEVERAL LOCALITIES IN COASTAL AREAS OF THE GULF OF BOTHNIA

The values for the occurrence of *C. horaria* in 1979 and 1980 are given in Fig. 4.

The quantity of captured *C. horaria* at several investigation bothnian sites is very similar. One value is absolutely differ-

ent, the *C. horaria* caught in the Biotest lake in 1980, which rises up to more than 7000 individuals compared to the average of 56 in the year 1979.

3.2 THE SEASONAL FLIGHT PERIODS OF CAENIS HORARIA IN 1979 AND 1980 IN THE BIOTEST LAKE

Tabs. 1 and 2 show the mayflies caught in 1979 and 1980. In 1979 the mayflies hatched and flew between July 9 - July 30. The flight period shows a typical univoltine developmental cycle. This is even the case for all investigation sites in other studies in coastal localities in the Gulf of Bothnia (Holmö island, Vallgrund, Norrby archipelago, Ulvön). The most interesting difference in 1980 in the Biotest lake is that we could observe another generation - at the end of September - beginning of October. This phenomenon has only been observed for this species by Landa (1968) in Czechoslovakia.

4. DISCUSSION

Our investigations on the distribution of the mayfly species *Caenis horaria* show that this ephemeropteran is typical for the low degrees of salinity occurring in the Gulf of Bothnia. The observations in the years 1979 and 1980 show that this species had an univoltine annual cycle with a hatching and flying period in July and, in northern localities, into the middle of August.

In 1980, in the Biotest lake, the catches of *C. horaria* rise up to more than 7000 individuals. This could be caused by the optimal weather conditions which occurred in coastal areas of the Gulf of Bothnia in the summer of 1980. However, the drastic

Tab. 1 Flight periods of *Caenis horaria* in the Biotest lake, summer 1979. Intervals emptyed

	9/7	16/7	23/7	30/7	6/8	13/8	20/8	27/8	3/9	10/9	17/9	24/9	1/10
No. of C. horaria	4	6	27	19	-	-	-	-	-	-	-	-	-

Tab. 2 Flight periods of *Caenis horaria* in the Biotest lake, summer 1980, Intervals emptyed

	1/7	14/7	28/7	5/8	12/8	25/8	1/9	10/9	15/9	22/9	28/9	5/10	15/10
No. of C. horaria	-	40	4314	3200	6	3	-	-	4	20	43	6	-

increase of water temperature caused by the input of cooling water must be considered as an important factor for this adult swarming. The warm water input had not altered the hatching and flying period of the summer generation.

The most important difference is between the two years, as in fact another generation occurs in autumn. We can postulate that the warm water input results in the occurrence of a multivoltine life cycle. It is known for the mayfly genera *Baetis* that warmer water gives rise to two or more generations in the course of the summer (Müller-Liebenau 1969, Lingdell & Müller 1980). Landa (1968) describes for *Caenis horaria* two generations from Czechoslovakian waters, and it is suggested that the cooling water input into the Biotest lake for the first time in Scandinavia induced the development of two generations of this mayfly.

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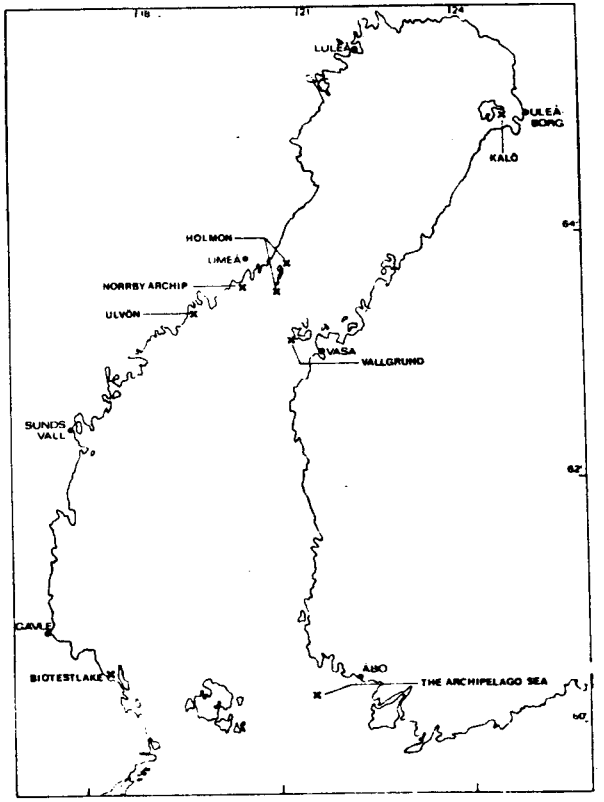

Fig. 1. Localities in the Gulf of Bothnia at which the mayfly Caenis horaria were observed.

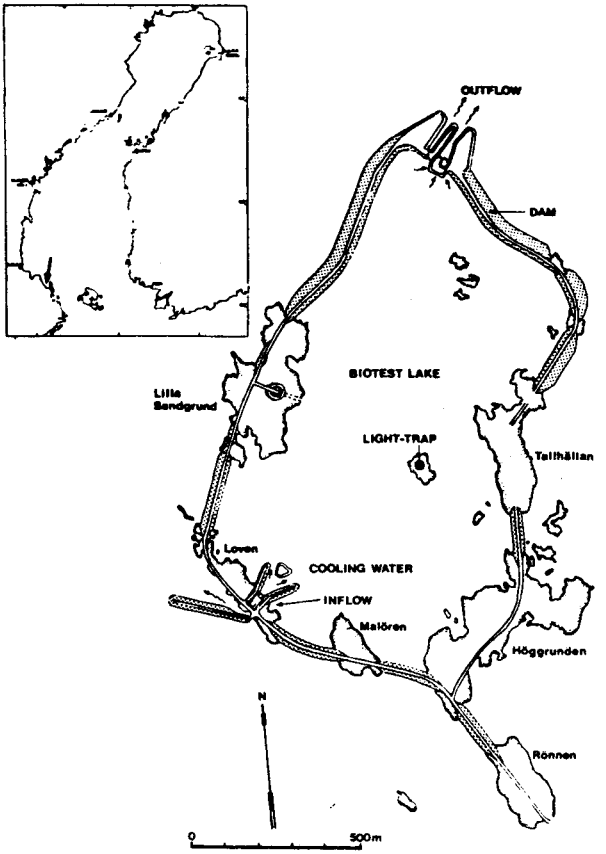

Fig. 2. Map of the Biotest lake.

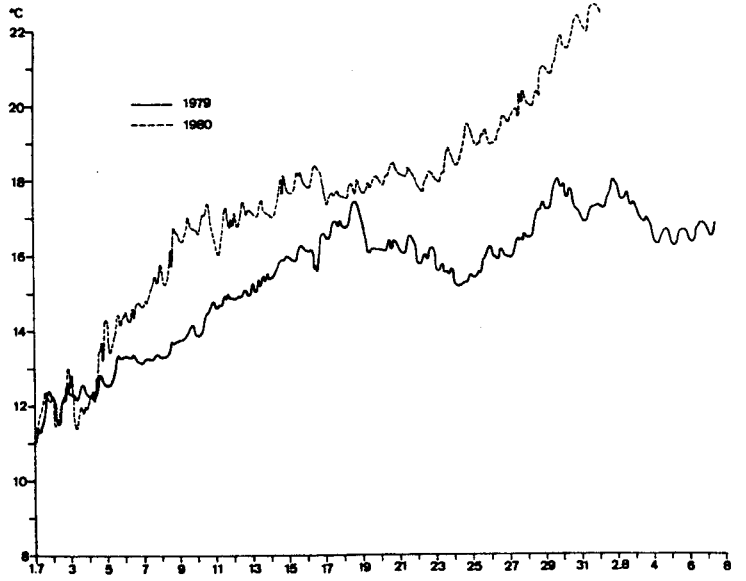

Fig. 3. The development of water temperature in the Biotest lake in 1979 and 1980 (after measurements made by the Swedish Hydrographical and Meteorological Institute).

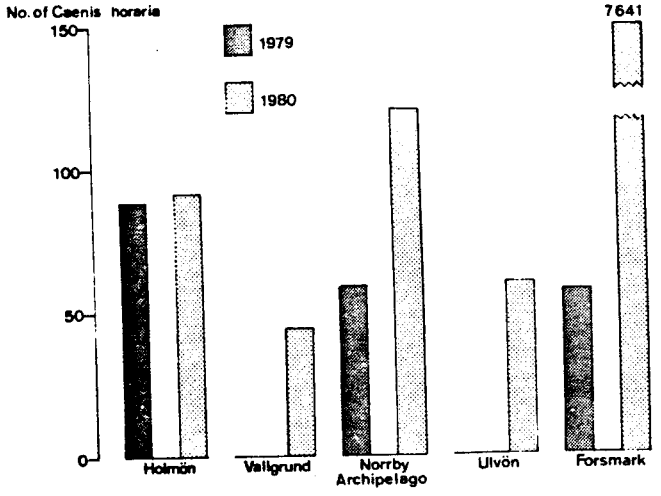

Fig. 4. The abundance of *Caenis horaria* in light-traps at several coastal localities in the Gulf of Bothnia in 1979 and 1980.