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# The Growth of Some Ephemeropteran Nymphs during Winter in a North Swedish River

by

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ABSTRACT

The growth of the Ephemeroptera species *Heptagenia fuscogrisea* Retzius, *Leptophlebia marginata* L. and *Ephemerella mucronata* Bengtsson was studied from the middle of September 1967 to the middle of May 1968 in the River Rickleån in northern Sweden. Sampling was performed also during periods with ice cover. Growth was estimated from four different body measures and proceeded fairly steady through all the winter for the three species. There were no indications of changed body proportions during the investigation period.

## INTRODUCTION

In 1967, a minor study was started on the growth of some ephemeropteran nymphs in the River Rickleån in the county of Västerbotten, northern Sweden. The River Rickleån has been documented as a rich salmon river for almost 500 years. In the years of 1960 to 1967, the Swedish Salmon Institute controlled the salmon migration by a fish trap and much biological information on the invertebrate fauna was also collected.

In agreement with earlier investigations on salmon parr (Alm, 1919, Maitland 1965) the stomach content of salmon smolt caught in the fish trap indicated that ephemeropteran nymphs were important and often dominating as food organisms (Södergren & Österdahl 1965). These findings made it desirable to collect more knowledge about the Ephemeroptera living in the River Rickleån.

The low temperatures and the comprehensive ice periods on this latitude severily limit the possibility to collect material for field studies on aquatic organisms in winter. This study was an attempt to brave these problems and to record the growth during the winter of three common ephemeropteran nymphs in the River Rickleån, namely *Heptagenia fuscogrisea* Retzius, *Leptophlebia marginata* L. and *Ephemerella mucronata* Bengtsson.

## THE RIVER RICKLEÅN; STUDY AREA

The River Rickleån is a comparatively small woodland river in northern Sweden. The watershed, 1673 km², lies entirely within the coniferous belt. The river originates in Lake Bygdeträsket, 47.7 km from the mouth, and discharges into the Gulf of Bothnia at 64° 05′ (Södergren 1976). Rapids alternate with fast and slow reaches and pools. Three minor water-power plants, about 15 km from the mouth have a slight influence on the natural waterflow. The mean water discharge is 16 m³/sec., but varies from about 3 m³/sec. during low water conditions to 160-180 m³/sec. during maximum spring flood (Göthberg & Karlström 1975). The vegetation of the area is dominated by coniferous forest, but there are also many farms along the river. In the rapids, the water mosses, *Fontinalis dalecarlica* and *F. antipyretica*, are dominating. Where the river slows down, *Ranunculus peltatus* is found on soft bottoms. Soft bottoms are, however, rather scarce and higher vegetation is consequently scarce, too. In some places, where the water-flow slows down considerably, a dense littoral vegetation may be found, dominated by *Nuphar luteum, Potamogeton natans* and *Equisetum fluviatile*. The mean pH of the river water is 6.5. and it is rich in iron and humic compounds, giving the water a brownish colour. The river is covered with ice from Oct./Nov. to Apr./May, and in the slow reaches, it may be as thick as 1.5 m. In the rapids however, some midstream areas are always open. Anchor ice exists in large amounts, especially in November (Södergren 1976).

Three stations, about 1 km from the mouth of the river, were sampled 9 times from September 12, 1967 to May 19, 1968 and constituted two disparate habitats. Stn 1 and 3 were rapids with stony bottoms, rich in tufts of *Fontinalis* spp. Stn 2 was in a slow-flowing part of the river with sand bottom and ranging to a dense belt of *Equisetum fluviatile*. The water depth varied with the season and sampling was performed at a depth of about 0.2 to 1.5 m.

## MATERIAL AND METHODS

On each sampling occasion, water temperature was measured at a depth of approximately 0.1 m. Data on the first occurrence of ice and its break-up were obtained from Robertsfors Bruk AB.

At Stn 1 and 3, stones with *Fontinalis spp.* were picked up by hand and rinsed under water in a bucket. As the stones were picked up, a hand net was held downstream to catch disturbed and drifting nymphs. In deeper parts of the rapids, stones were rolled about with a rake up-stream the hand net and the disturbed nymphs were caught in the net.

At Stn 2, where littoral vegetation was abundant, the net was swept through the vegetation and in the free water. The hand net used at all three localities had a mesh-size of 1.8 mm.

During the period with ice, the sampling was complemented with cage traps. The traps were open cylinders (length 40 cm, inner Ø 10 cm) formed of mosquitonetting (mesh size 1.6 mm), with removable plastic funnels constituting the inlets on each

side to entrap the nymphs (Bengtsson 1968). They could be sunk down or hauled up through holes made in the ice.

A comparison of catches taken with traps and net was performed in the middle of May. No significant difference in size distribution and composition of species of Ephemeroptera was observed (Bengtsson 1968). Therefore, it was concluded that the methods were equally useful for the purpose of this investigation.

The nymphs were immediately preserved in 70% ethanol and stored for at least 24 hours before measured under a low-power microscope with an eye-piece micrometer. The body length was measured from the front of the head to the base of the terminal filament. Furthermore, the width of the head and pronotum and the length of the tibia of the right foreleg were measured. All measures were made with an accuracy of 0.1 mm.

## RESULTS

The water temperature was 15°C on the first sampling occasion (12 Sept.) and decreased rapidly to 3°C at the end of October. The drop in temperature slowed down in October-November, which was a comparatively mild period with much rainfall. At Stn 2 adjacent meadows and young willow vegetation were partly submerged periodically during this period.

Ice covered the river from the beginning of December, which is late for this river. At Stn 2, the ice reached its maximum thickness, 1.2 m, in the beginning of March. At Stn 1 and 3 and in other rapids, the ice-cover was irregular and piled up due to the strong currents and fluctuating water flow. These parts of the river were partly open during almost all the winter. After ice had broken up in spring, the water temperature increased to 3°C, in the beginning of May, and had reached 7°C at the end of the investigation period (19 May).

In total, 1327 ephemeropteran nymphs were collected and are presented in Table 1.

Table 1. Total catch of Ephemeroptera nymphs in the River Rickleån on nine sampling occasions from September 12, 1967 to May 19, 1968.

| Date | 12.9 | 30.9 | 21.10 | 25.11 | 19.2 | 9.3 | 4.4 | 1.5 | 19.5 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ephemera vulgata* L. | 2 | 1 | | | | | | | | 3 |
| *Heptagenia fuscogrisea* Retz. | 90 | 132 | 104 | 67 | 14 | 32 | 80 | 80 | 86 | 685 |
| *H. dalecarlica* Bengtsson | | 21 | 17 | 25 | 10 | | 1 | | 5 | 79 |
| *Baetis* spp. | | 11 | 13 | 9 | 7 | 9 | 3 | 6 | 4 | 62 |
| *Cloeon dipterum* L. | 3 | 6 | | 1 | | | | | 1 | 11 |
| *Leptophlebia marginata* L. | 8 | 6 | 9 | 4 | 25 | 43 | 50 | 76 | 30 | 251 |
| *L. vespertina* L. | | | | | | | 11 | 7 | 3 | 21 |
| *Ephemerella ignita* Poda | | 1 | | | | | | | | 1 |
| *E. aurivilli* Bengtsson | | 6 | 4 | 8 | 2 | 1 | 2 | 2 | 7 | 32 |
| *E. mucronata* Bengtsson | | 18 | 7 | 14 | 11 | 59 | 26 | 29 | 18 | 182 |
| Total: | 103 | 202 | 154 | 128 | 69 | 144 | 173 | 200 | 154 | 1327 |

Table 2. Body lengths of *H. fuscogrisea*, *L. marginata* and *E. mucronata* from September 12, 1967 to May 19, 1968 in the River Ricklean.

| Date | *Heptagenia fuscogrisea* n | mean | range | s.d | *Leptophlebia marginata* n | mean | range | s.d | *Ephemerella mucronata* n | mean | range | s.d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.9 | 90 | 4.5 | 3.0- 6.4 | 0.81 | 8 | 3.5 | 2.9- 4.0 | 0.35 | — | — | — | — |
| 30.9 | 132 | 4.9 | 3.2- 7.4 | 0.80 | 6 | 4.0 | 3.2- 4.4 | 0.42 | 18 | 2.8 | 2.3-3.9 | 0.40 |
| 21.10 | 104 | 5.2 | 3.6- 8.3 | 0.97 | 9 | 4.2 | 3.4- 5.0 | 0.48 | 7 | 3.7 | 3.3-4.1 | 0.38 |
| 25.11 | 67 | 6.5 | 4.2- 8.8 | 0.98 | 4 | 4.6 | 3.7- 5.2 | 0.63 | 14 | 4.0 | 3.3-5.1 | 0.49 |
| 19.2 | 14 | 7.0 | 5.2- 8.5 | 1.00 | 25 | 5.8 | 4.5- 7.7 | 0.84 | 11 | 4.3 | 3.5-5.0 | 0.43 |
| 9.3 | 32 | 7.3 | 4.8-10.0 | 1.25 | 43 | 5.9 | 3.8- 7.0 | 0.70 | 59 | 4.9 | 3.5-6.5 | 0.57 |
| 4.4 | 80 | 8.0 | 3.9-11.0 | 1.26 | 50 | 6.2 | 4.5- 8.3 | 0.77 | 26 | 5.2 | 3.8-6.6 | 0.58 |
| 1.5 | 80 | 8.4 | 6.0-11.3 | 1.21 | 76 | 7.3 | 5.2-10.0 | 1.00 | 29 | 5.5 | 4.2-7.1 | 0.76 |
| 19.5 | 86 | 9.0 | 4.5-11.7 | 1.38 | 30 | 7.0 | 5.3- 8.6 | 0.95 | 18 | 5.7 | 4.5-6.6 | 0.54 |

## Heptagenia fuscogrisea

In total, 685 nymphs of *H. fuscogrisea* were caught. The mean body length increased from 4.5 to 9.0 mm during the period (Table 2). As seen in Fig. 1 there is a wide range in body length, but the material had a normal distribution throughout the whole investigation period. From Stn 1 and 3 in particular, some nymphs of *H. dalecarlica* were also obtained (Fig. 1).

## Leptophlebia marginata

During the investigation period, 251 nymphs belonging to this species were caught. Nymphs were rare during the first four sampling occasions, but became more numerous in early spring, especially in April and May. The mean body length increased from 3.5 to 7.3 mm (Table 2) and the growth seemed to be comparatively steady throughout the whole investigation (but with maxima in September and April). On the last four sampling occasions 21 small nymphs of *L. vespertina* were also caught (Fig. 2). These nymphs were smaller than the nymphs of *L. marginata*, so there was no case of overlapping in size distribution between the two species.

## Ephemerella mucronata

This species was unexpectedly hard to obtain in satisfying numbers for this investigation. Only 182 specimens were found in spite of the fact that it had been recorded as a very common winter species in the rapids of the river (Södergren 1976). No nymphs at all were found on September 12, but the first ones were found on September 30. Some nymphs of *E. aurivilli* Bengtsson, in all 30 specimens, were also obtained. On September 12, one single specimen of *E. ignita* Poda with a body length of about 10 mm was recorded.

In Fig. 3 *E. mucronata* and *E. aurivilli* are presented together in length classes. Nymphs of *E. mucronata* were seen to grow considerably in October and Feb./March.

The measures of head, pronotum, tibia and body length gave no indication of changed body proportion for any species during the investigated period (Table 3).

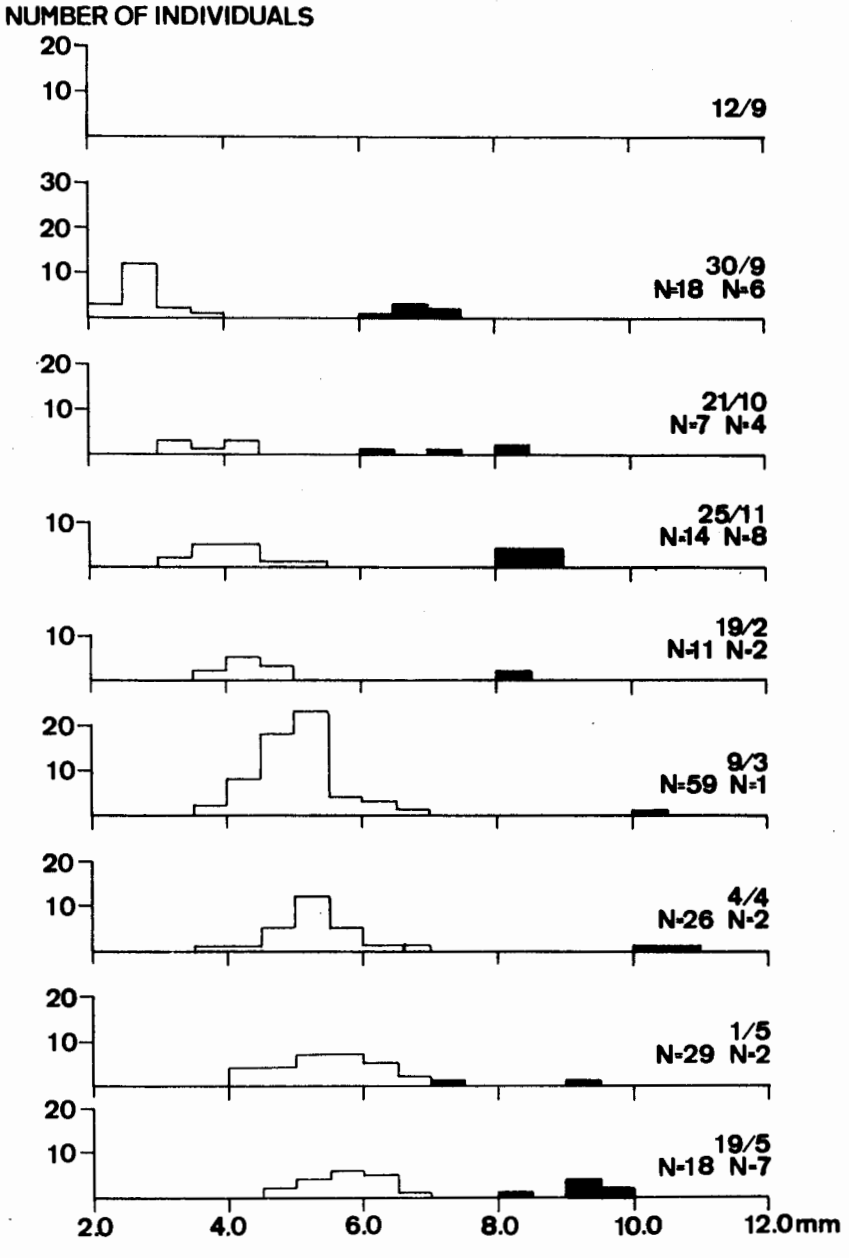


Fig. 1. Size distribution of *H. fuscogrisea* and *H. dalecarlica* (black) in 0.5 mm bodylength-classes on each sampling occasion in the River Rickleån.

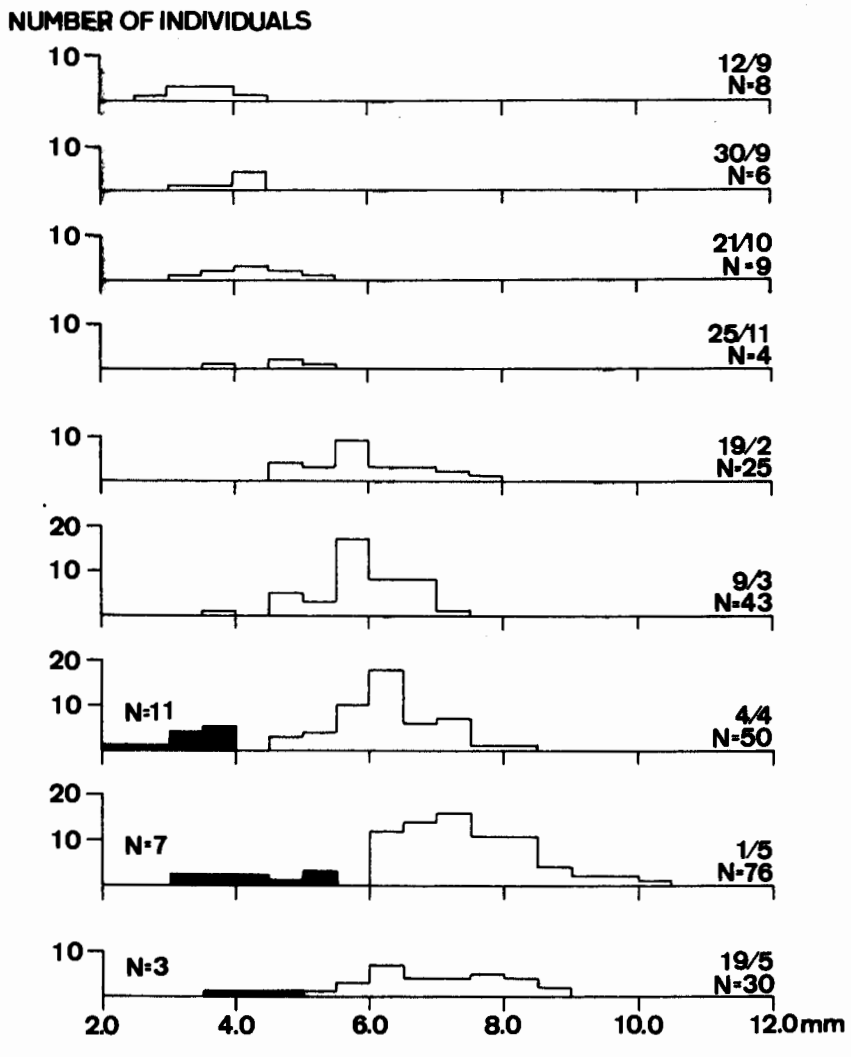


Fig. 2. Size distribution of *L. marginata* and *L. vespertina* (black) in 0.5 mm bodylength-classes on each sampling occasion in the River Rickleån.

## DISCUSSION

As demonstrated in Tables 2 and 3 and in Figs. I-3, there is a continuous growth during the winter for all three investigated species. A comparatively fast growth is noted for *H. fuscogrisea* during Oct.-Nov., which seemed to coincide with high water level in the river with subsequent submersion of banks, meadows, etc.

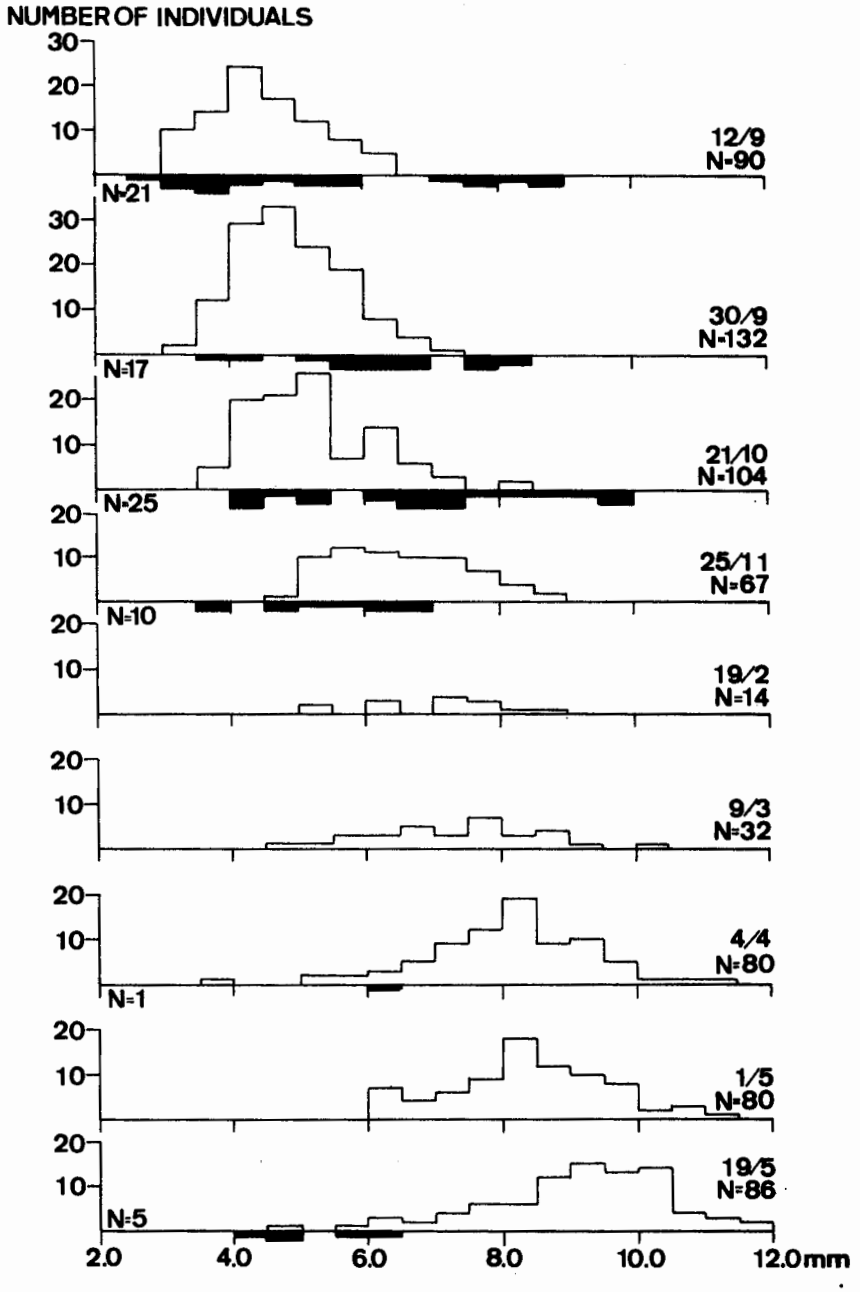


Fig. 3. Size distribution of *E. mucronata* and *E. aurivilli* (black) in 0.5 mm bodylength-classes on each sampling occasion in the River Rickleån.

Table 3. Body length (B), width of head (H), width of pronotum (P) and tibia length (T) of *H. fuscogrisea*, *L. marginata* and *E. mucronata* in the River Rickleån, September, 12, 1967, to May 19, 1968.

| | 12.9 | 30.9 | 21.10 | 25.11 | 19.2 | 9.3 | 4.4 | 1.5 | 19.5 |
|---|---|---|---|---|---|---|---|---|---|
| n | 90 | 132 | 104 | 67 | 14 | 32 | 80 | 80 | 86 |
| B | 4.5 | 4.9 | 5.2 | 6.5 | 7.0 | 7.3 | 8.0 | 8.4 | 9.0 |
| H | 1.3 | 1.4 | 1.4 | 1.8 | 2.0 | 2.0 | 2.2 | 2.2 | — |
| P | 1.2 | 1.3 | 1.4 | 1.7 | 1.9 | 1.9 | 2.1 | 2.2 | — |
| T | 0.9 | 1.1 | 1.1 | 1.4 | 1.5 | 1.5 | 1.7 | 1.8 | — |
| | | | | *Heptagenia fuscogrisea* | | | | | |
| n | 8 | 6 | 9 | 4 | 25 | 43 | 50 | 76 | 30 |
| B | 3.5 | 4.0 | 4.2 | 4.6 | 5.8 | 5.9 | 6.2 | 7.3 | 7.0 |
| H | 0.8 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.6 | — |
| P | 0.8 | 0.9 | 0.9 | 1.0 | 1.3 | 1.4 | 1.5 | 1.6 | — |
| T | 0.6 | 0.7 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.3 | — |
| | | | | *Leptophlebia marginata* | | | | | |
| n | — | 18 | 7 | 14 | 11 | 59 | 26 | 29 | 18 |
| B | — | 2.8 | 3.7 | 4.0 | 4.3 | 4.9 | 5.2 | 5.5 | 5.7 |
| H | — | 0.7 | 0.8 | 0.8 | 1.0 | 1.1 | 1.2 | 1.2 | — |
| P | — | 0.9 | 1.1 | 1.1 | 1.3 | 1.4 | 1.4 | 1.5 | — |
| T | — | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | — |
| | | | | *Ephemerella mucronata* | | | | | |

Nymphs of this species were then observed far from their original habitat, especially among dead leaves in dense stands of willow (*Salix* sp.) and alder (*Alnus* sp.). It seems plausible that the water temperature temporarily might have reached higher values in the submerged terrestrial vegetation with still water than in the more fast-running parts of the river. The temperature curve in Fig. 4, which is based on too few measurements, might therefore be misleading, especially in Oct.-Nov. For the other two species, however, and for *E. mucronata* in particular, living in the rapids, the temperature curve is perhaps more relevant through the whole investigation.

*L. marginata* demonstrates a comparatively steady growth through the winter, even during the period with ice cover (Fig. 4). The results are in good agreement with growth figures for this species in Øvre Heimdalsvatn in Norway (Brittain 1978).

The occurrence of small nymphs of *L. vespertina* in the beginning of April was expected, as both *Leptophlebia* species are known to be abundant in the river (Södergren 1971). According to Brittain (1978), the occurrence of *L. marginata* seems to be at the expense of *L. vespertina* and this is probably valid for the present material, too. There is no overlapping in size distribution between the two species, and their emergence periods are well separated, in time (S. Södergren, unpublished observations). This seems to be general when the two species are present at the same localities (Brittain 1974), and it is probably a good example of temporal distribution due to competition between systematically related (congeneric) species (Grant & Mackay 1969). Compared to data from Great Britain (Moon 1939, Macan 1961) and from central Sweden (Kjellberg 1972, 1973), *L. vespertina* has a quite different life cycle in the River Rickleån.

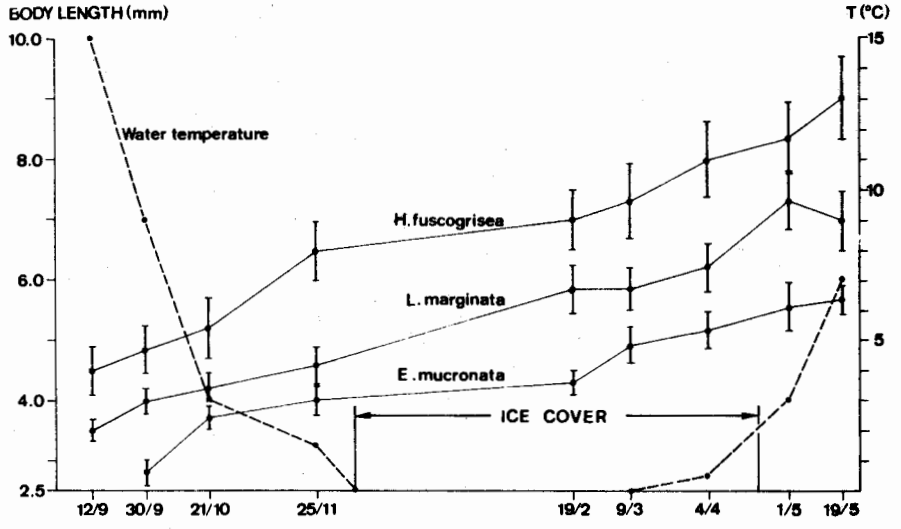


Fig. 4. Development of mean body length for *H. fuscogrisea, L. marginata* and *E. mucronata* in the River Rickleån from September 12 to May 19, 1968.

Of the three *Ephemerella* species occurring in the River Rickleån, *E. mucronata* is a typical winter species (Södergren, 1976). Most of its growth is seen to take place during the investigated period (Sept.-May). The other two *Ephemerella* species occurring in the river have life cycles that are well separated from each other and *E. mucronata*. Södergren (1976) suggested that in the River Rickleån *E. ignita* is overwintering as diapausing eggs or as very small nymphs, and that *E. aurivilli* is larger than *E. mucronata* through the whole winter (see Fig. 3). Compared to data from the River Vindelälven, Lapland, Sweden (Ulfstrand 1968), where *E. ignita* is missing, the life cycles of the other two *Ephemerella* species are different. The life cycle of *E. mucronata* is there very similar to the life cycle of *E. ignita* in the River Rickleån as described by Södergren (1976), while *E. aurivilli* in the River Vindelälven represents a sort of compromise between the life cycles of *E. aurivilli* and *E. mucronata* as demonstrated in the River Rickleån.

The occurrence of one species at a locality depends on a series of abiotic and biotic factors, many of which vary between years, with subsequent variability in abundance, emergence etc. This contributes to that workers in the same area seem quite often not to agree on life cycles (Hynes 1970) and there clearly remains much further work to be done to reveal the mechanisms that govern the variability.

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