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Life histories of four species of Ephemeroptera

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With 1 figure in the text

Introduction

Between an alluvial plain and the estuary, the River Lune runs in a loop, known as Crook o' Lune, through a low ridge of Millstone Grit. The strata of this formation run horizontally, and the river-bed is floored by flat sheets of rock with few holes and protuberances. Near the middle of this region, which is wide, there is a weir, and this ensures that the channel upstream is always full of water. The permanently submerged rock is covered by moss [*Cinclidotus fontinaloides* (HEDW.) BEDUR.]. Here the four species discussed below were taken from April or May to September or October. Winter collections will be described separately, and a general account of the communities of the R. Lune is given by MACAN (1976).

Methods

Collections were made with a fine net (24 mesh/cm). We endeavoured to collect a certain number of nymphs on each visit and it must be stressed that the figures quoted are not comparable; low numbers represent a smaller population than indicated because we collected for a longer time and vice versa. The summers were fine and dry most of the time, but, when the river was in flood, nymphs could be found in submerged terrestrial vegetation. An emergence trap is not feasible in an area frequented by the general public, and is at risk in times of flood in a river large enough to transport whole trees.

Predators were not counted but they were obviously abundant, and that they took a considerable toll of the nymphs under discussion is a reasonable deduction. During the summer there were large shoals of small fish near the moss. *Phoxinus phoxinus* (LINNAEUS) was identified, and there may have been young of large species. *Cottus gobio* LINNAEUS and *Noemacheilus barbatulus* LINNAEUS were taken in the moss. Beetles of the genera *Deronectes* and *Oreodytes*, and what were probably their larvae, were very numerous at times during the summer.

Centroptilum pennulatum EATON

Most nymphs about to emerge were in the 7 mm group, some were in the group above and a few in the group below.

No specimens were taken on 7 May, 1975, but nymphs of the smallest size group were numerous on 21 May (Fig. 1); the generation, presumably originating from diapause eggs, started suddenly, probably a few days before 21 May. Thereafter numbers remained satisfactorily large (47, 82, 80, 124, 84 respectively in the first five weeks), and increase in length was rapid. A few nymphs were large enough to emerge on 4 June and many were at this stage on 11 June; development had taken about one month.

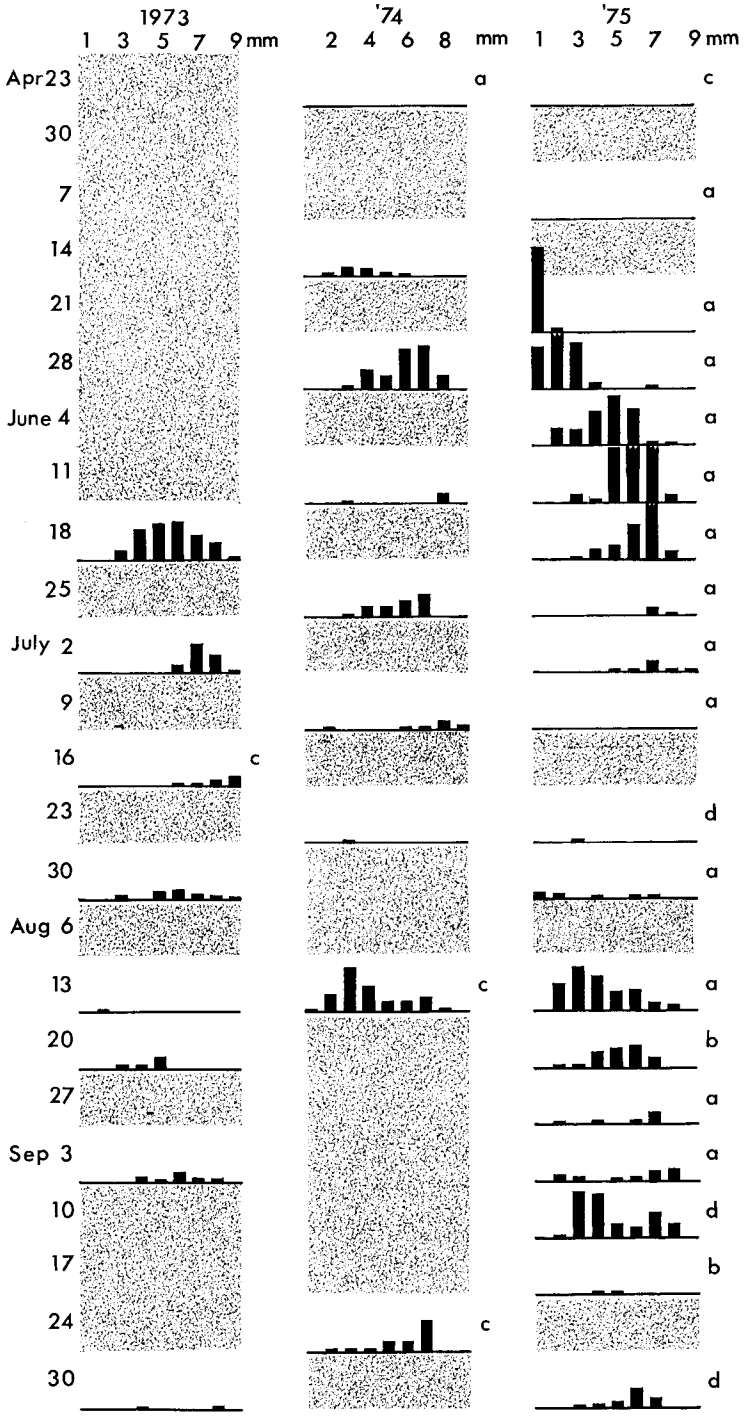

Fig. 1. Numbers of *Centroptilum pennulatum* in millimetre size-groups. The shading covers weeks in which no collections were made. Scale: the distance between weeks is equivalent to 30 specimens. a, river low and clear; b, river level up slightly and water turbid; c, collecting possible from bank only; d, high flood, collecting in terrestrial vegetation. When there is no indication, conditions were good.

By the third week, sizes range from 2 to 8 mm, and nymphs large enough to emerge were found from early June to early July. This spread means that the eggs of the next generation will be hatching over a longer period than those of the first and that the identity of the generations is likely, therefore, to become less clear with each succeeding one.

Specimens were scarce throughout July, but a reasonably clear generation developed throughout August and was followed by a large number of small nymphs on 10 Sept. (Fig. 1). Eggs had therefore taken about one week to hatch. If this deduction is correct, a generation takes about five weeks. The first eggs hatched in the middle of May, and nymphs, most of them large, were present at the end of September. None were found on 13 October. They were, therefore, present during 21 weeks and there should have been four generations. If these deductions are correct, there was a generation in July, whose numbers were low, either because predation was intense or weather was unfavourable for oviposition during that month.

Some specimens of the first generation reached full size in three weeks. If their eggs also took seven days to develop, these quick growers could have achieved five generations in the period. The slow growers might have achieved only three.

There are other possibilities. PLESKOT (1958), studying *Baetis fuscatus (bioculatus)* has suggested that apparent generations are not generations at all but cohorts springing from eggs laid the year before; in other words, *C. pennulatum* has one generation a year, a long emergence period, and a development time of exactly twelve months. Periods of bad weather when the adults are on the wing, or excessive predation when the nymphs are developing, will lead to few eggs in certain periods. Abundant oviposition between them will produce in the following year cohorts which the observer tries to interpret as generations.

It is possible that some of each batch of eggs hatch soon and the rest enter diapause. This would explain why the first generation, whose eggs have been at risk from predators for seven months, is larger than those which follow although their development takes place in a much shorter time.

A definite conclusion must await careful laboratory work of the kind that BOHLE (1972) has applied with such success. In the meantime it is believed that the presentation and discussion of field data is worthwhile, in that it discloses the problems facing those who carry the study further.

The appearance of *C. pennulatum* in 1974 was about two weeks earlier than in 1975, and in the former year *Procloeon* emerged in April. The early months of 1974 were colder than those of 1975 most of the time, but distinctly warmer after 26 March. MACAN & MAUDSLEY (1966) describe a similar relationship between temperature in a tarn and time of emergence of certain insects, 10 or 11 °C being critical, but, as in the present instance, it is uncertain whether rate of change or absolute value is effective.

Procloeon bifidum (BENGTSSON)

(SOWA (1975), followed by DAHLBY (1973), regards *P. pseudorufulum* KIMMINS as a synonym of *P. bifidum*). Ripe nymphs were in the 5, 6 and occasionally

7 mm size-groups. The first generation of 1975 is very similar to that of *C. pennulatum*, and nothing in the rest of the data goes against the conclusion that the two species have identical life histories.

Centroptilum luteolum (MÜLLER)

Specimens about to emerge were generally in the 6 mm size-group, sometimes in the 5 mm, and rarely in the 4 or 7 mm size-group. A few nymphs, most about 2 mm long, were found throughout the winter. In the spring their numbers are suddenly augmented by smaller nymphs, which supports BRETSCHKO's (1965) suggestion that some of the progeny of the last generation of a season overwinter as eggs and some as nymphs. He remarks that this leads to a complicated picture (komplizierten Kurvenbild), which is an apt description of the data from the R. Lune. BRETSCHKO (1965) recorded two generations separated by a gap in late summer attributed to unfavourably high temperature, though the temperature reached only 17 or 18 °C. MACAN & MAUDSLEY (1968) believe that their collections in Windermere indicate a slow winter-generation and possibly two quick summer-generations, but their numbers were small and obtained by means of a coarse net which would not have retained the smallest nymphs. There are probably four or five generations during the summer in the R. Lune.

Baetis scambus EATON

Most nymphs about to emerge are in the 5 mm size-group, but some are in the 4 mm size-group. Numbers larger than those of the other species tend to be separated by very small numbers. This could be caused by movement of swarms into and out of the small area in which collections were made, but, as one large catch was always followed by another when collections were a week apart, it was probably due to development more rapid and more synchronized than that of the other species. The low catches suggest a longer period in the egg. A generation appeared to take about a month and the season was longer than that of the other species, particularly at the end.

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