Freshwat. Biol. 1971, Volume 1, pages 405–409

The Ephemeroptera of the River Bela, Westmorland

J. M. COLLINS *Taunton School*

Manuscript accepted 15 June 1971

Summary
Though larger and more calcareous than a Lake District Beck, the River Bela now harbours a similar community of Ephemeroptera. Three species characteristic of small rivers were not recorded after the sides had been straightened and cleared of emergent vegetation and the bottom had been levelled.

Introduction

Minshall & Kuehne (1969) give an account of the River Duddon, which rises high in the Lake District mountains and runs swiftly to the sea through a steep-sided narrow valley. Macan, Mackereth and Gledhill (see Macan, 1963) investigated Ford Wood Beck, a small stream at lower altitude flowing through agricultural land for most of its length. Gledhill compared the catches in an emergence trap in this beck with those in another at an altitude of 624 m. The River Bela resembles the Duddon in size and length and in flowing over a stony bottom, but it rises at a lower altitude and flows through much flatter, and in its lower reaches, more calcareous, country. It resembles Ford Wood Beck in that it drains agricultural land for most of its course. It was thought that comparison might be interesting. Another point of interest is that the River Bela is periodically dredged to prevent flooding.

Description of River Bela

The Lake District lies on hard rocks, Ordovician to the north, Silurian to the south, and these afford a convenient boundary except in the south east where the Silurian rocks extend towards the Pennines. The River Bela rises on this extension at an altitude of about 300 m and flows south by west between the valleys of the Rivers Kent and Lune. The lower reaches run through limestone, covered with boulder clay. Finally it swings round to the north to discharge into the Kent estuary.

The system (Fig. 1) consists of two main tributaries and the nomenclature varies from map to map. Commonly the River Bela is regarded as originating at the junction of the two tributaries, Peasey Beck to the east, and the slightly smaller Stainton Beck to the west, but it is inconvenient not to retain one name to cover the whole system. In its upper parts Stainton Beck is labelled St Sunday Beck on some maps.

At Beetham Bridge (station 1) the river is some 20 m wide and about 30 cm deep

Correspondence: Mr J. M. Collins, 'Brendon', North Street, Milverton, Somerset.

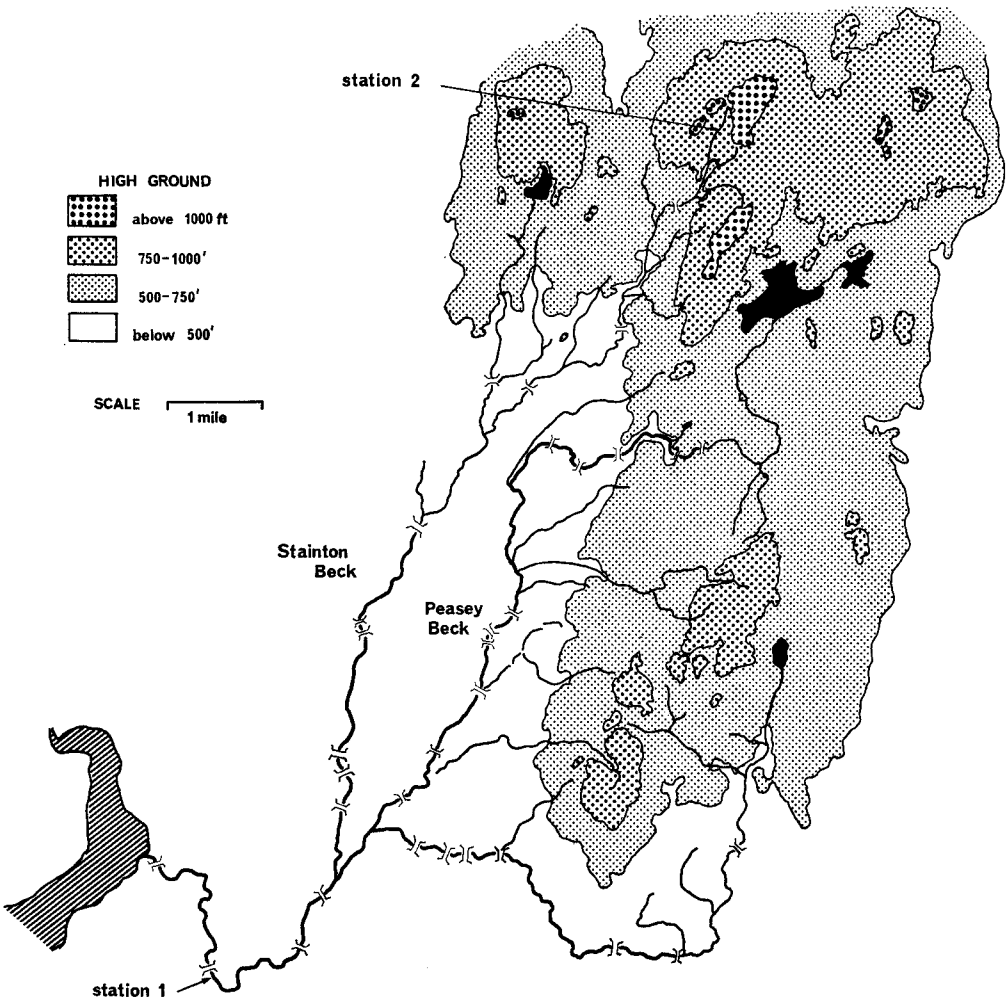

Fig. 1. Map of the Bela river system.

at low water. At station 2 in the headwaters the width is about 2 m and the depth about 10 cm.

Table 1 presents some measurements. The highest concentration of calcium in the lower reaches of the River Duddon was 3·74 mg/l. The figure for Ford Wood Beck

Table 1. Some features of the River Bela

	Station 1	Station 2	Stainton Beck above effluent from milk factory	Mouth of Peasey Beck
Max surface speed recorded (cm/s)	60	30	—	—
Min surface speed recorded (cm/s)	40	14	—	—
Max temperature (°C)	21	23·0	—	—
Min temperature (°C)	4·5	6·0	—	—
Calcium (mg/l)	59	—	60	40·5

Plate 1. River Bela from Beetham Bridge, 1971. (*Photograph by* Dr T. T. Macan.)

(*Facing p.* 406)

was 11·5 mg Ca/l, which is high for the Lake District and attributable to an overloaded septic tank. In comparison, the value in the River Bela is high.

History of observations

In May and June 1953 Dr T. T. Macan made some collections of which the chief interest is that they are the only ones before extensive work on the river. Dr Macan has described to the author how at Beetham the river widened into a bay to which carters could bring their horses to drink. There were patches of mud on the bottom and extensive growths of various emergent plants. Later the river banks were straightened and revetted (Plate 1).

The present survey started in February 1964 and continued until September, collections being made every three weeks. Dr Macan paid further visits in June 1965 and 1966 and in March 1971.

The species collected and comparison with other streams

Collections were made with a hand net, with either ten or twenty meshes per centimetre. Stones were lifted off the bottom by hand and the net used to secure any organism that was carried down by the current. Animals clinging to the stone were dislodged in the mouth of the net. A collection lasted for 10 minutes. This is the time and technique used by Macan (1957) in his study of Ford Wood Beck and his results are comparable when an adjustment has been made for number of stations worked (Table 2).

Table 2. Species list and total numbers caught in net, and some other records

	Fine net		Coarse net	
	Station 2	Station 1	Station 1	Ford Wood B
Heptagenia lateralis	55	26	18	36
Ecdyonurus torrentis	88	18	58	18
Baetis rhodani	412	93	747	450
Baetis pumilus	243	122	2	90
Rhithrogena semicolorata	142	350	707	450
Ephemerella ignita	41	177	566	18
Caenis rivulorum	23	93	247	++
Baetis scambus	1	112	127	1
Ecdyonurus venosus	1	1	—	4
Ephemera danica	—	—	1	—
Habrophlebia fusca	—	1	—	4
Paraleptophlebia submarginata	1	—	—	19
Centroptilum luteolum	—	—	—	—
Procloeon rufulum	—	—	—	—
Centroptilum pennulatum	—	—	—	—

(i) *Species more abundant at the upper station* (2)

Heptagenia lateralis is a species of the headwaters, restricted to them by inability to tolerate the temperatures reached lower down (Macan, 1963). *Ecdyonurus torrentis* is another species generally found only in small stony streams, possibly because it cannot compete with *E. dispar* and *E. venosus* lower down. *Baetis pumilus* belongs

to this category but whether *B. rhodani* does is not clear in view of the enormous discrepancy between collections with the two different nets.

(ii) *Species more abundant at the lower station*
The remaining four of the eight common species fall into this category. *Baetis scambus* is rarely found on a stony bottom and occurs where there is sand and gravel. Its scarcity at station 2 accords with what is known of it elsewhere.

(iii) *Rare species*
Ephemera danica might be expected to be more abundant in sand and gravelly reaches. Only a proportion of the total would be captured by means of the method used.

(iv) *Species not recorded in the regular survey*
In June 1965 Dr Macan collected at Beetham Bridge, and at Hang Bridge, the next one up. Here there was a thicker growth of *Ranunculus* and at the edges emergent vegetation in which the reed grass, *Phalaris arundinacea* was prominent. In this marginal vegetation *Centroptilum luteolum* was taken. It was here that collecting in 1953 yielded this species, a few specimens of *C. pennulatum* and a single *Procloeon rufulum*. *C. pennulatum* was more numerous in the bay at Beetham Bridge, and has not been recorded since this was filled in.

Apart from *Ephemera danica*, which burrows in sand, the species lists from the river and the beck (Table 1) are identical. The numbers of *Baetis scambus* in the beck would have been larger if there had been a collecting station in a slow stretch with emergent *Sparganium*. *Caenis rivulorum* is not listed by Macan (1957) but I learn from him in a personal communication that it was present. There is, therefore, close correspondence not merely between the species present but also between their relative numbers. The more productive water and the larger size of the River Bela alike appear to have no influence on the ephemeropteran fauna. It is indeed similar in tributaries of the lower basin of the River Duddon, except that the rare species and *Caenis rivulorum* are not recorded, and *Ecdyonurus venosus* takes the place of *E. torrentis*. In the upper Duddon and its tributaries, however, where the concentration of calcium is lower, no Ephemeroptera, apart from an occasional *B. rhodani*, occurred.

Macan (1957) lists six species, *Baetis fuscatus* and *B. scambus* (which are inseparable in the nymphal stage) both being included, which, together with those found also in becks, inhabit Lake District rivers. All have been found in the Bela, with the unexpected exception of *Heptagenia sulphurea*. Three (the last three on Table 2) were taken by Macan in 1953 but not by the author ten years later. Their range has evidently been curtailed, some may even have been exterminated, by the operations of the drainage engineers. It may be said that the straight margins and regular depth that they have given to the Bela have reduced it faunistically from a river to a beck.

Hynes (1961) records that, as one passes down the River Dee, *Heptagenia lateralis* is replaced by *H. sulphurea* and *Ephemerella ignita* by *E. notata*. *Rhithrogena semicolorata* is joined by *R. haarupi*. Macan's (1957) records suggest that *Ecdyonurus torrentis*, *E. venosus* and *E. dispar*, possibly also *E. insignis* replace each other down the length of the river. None of these 'big-river' species was recorded in the River Bela and it will evidently be necessary to go to a larger river to elucidate the relation of these species to the rest and to look for the ecological characteristics of a 'big' river.

Life histories

Caenis rivulorum. Numbers dropped in July, apparently owing to emergence and no larvae small enough to be the progeny of this generation had been found when collections ceased in September. At the start of operations in the previous April there had been a few small nymphs. Clearly there is one generation per year; probably eggs lie dormant over the winter.

Baetis scambus. Small nymphs appeared in April. Total numbers of nymphs were highest in June and August and lower in July. The size of the smallest nymph increases steadily throughout the period when nymphs are present, which suggests but one generation. The winter is evidently spent in the egg stage.

Ephemerella ignita. In Ford Wood Beck tiny nymphs were once taken at the end of May but in most years nymphs were recorded only in the months June, July, August and September. This was true also of the River Bela except that small nymphs appeared at the beginning of May.

The life histories of no other species in the River Bela and in Ford Wood Beck differ significantly to call for comment.

Acknowledgments

I wish to thank Dr T. T. Macan who has put his records at my disposal and helped in other ways, Mr J. Heron who analysed the water samples, and Miss Annette Kitching who drew Fig. 1.

References

Hynes H.B.N. (1961) The invertebrate fauna of a Welsh mountain stream. *Arch. Hydrobiol.* **57**, 344–388.

Macan T.T. (1957) The Ephemeroptera of a stony stream. *J. Anim. Ecol.* **26**, 317–342.

Macan T.T. (1963) *Freshwater Ecology.* Longmans, London.

Minshall G.W. & Kuehne R.A. (1969) An ecological study of invertebrates of the Duddon, an English mountain stream. *Arch. Hydrobiol.* **66**, 169–191.