The Number and Size of Drifting Nymphs of Ephemeroptera, Chironomidae, and Simuliidae by Day and Night in the River Stranda, Western Norway

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Steine, I. 1972. The Number and Size of Drifting Nymphs of Ephemeroptera, Chironomidae, and Simuliidae by Day and Night in the River Stranda, Western Norway. *Norsk ent. Tidsskr. 19,* 127–131.

Observations on the drift fauna in River Stranda (Voss, western Norway) were carried out in August 1969. Quantitative samples were taken at hourly intervals throughout a 24-hour period at two different localities in the river Stranda. The nymphs of Ephemeroptera, Chironomidae, and Simuliidae were most abundant. The body size of drifting nymphs of the Ephemeroptera varied according to the time of day, with small individuals making up the population during day-time and larger animals at night. No such diurnal change was observed in the case of the Chironomidae and Simuliidae.

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The downstream transport of benthic organisms in the rivers has for some time been recognized as an important feature of lotic life. The drift fauna has been especially studied with respect to its circadian rhythm, but a number of investigations have dealt with drift as a component of population ecology (summarized by Müller (1966) and Ulfstrand (1968)). The possibility that different instars in a population may predominate in the drift at different times of day and night does not seem to have attracted much attention. It is with this latter problem we are concerned.

STUDY AREA

The study area is located in Strandavassdraget, Voss, western Norway. The drainage area is 368 km² at the outlet of lake Lundarvatn (Fig. 1). Two water courses were investigated. Locality A, Vinje (Fig. 2) on the first, is situated 2 km from the centre of the village of Vinje, about 190 m a.s.l. Locality B, Lönavatn (Fig. 3), on the second, is at the eastern inlet to lake Lönavatn about 80 m a.s.l. The distance between the stations is approximately 9 km. Both stations comprise flat river areas which provide suitable conditions for sampling. The substrate is quite homogeneous and consists of sand and various sizes of bare stones. Above Loc. A and for some distance between the stations, the bottom is covered by moss. The water has a high oxygen content and low conductivity. The streams above Lönavatn are little affected by human activity.

METHODS AND MATERIAL

Samples were taken with a Larsen sampler (Mossestad 1972) (Fig. 4). The sampler was 80 cm long excluding the net and 12.5 cm wide. The net-bag was 100 cm long and had a mesh size of 0.25 mm. Sampling was carried out at a constant distance above the bottom. At Loc. A the sampler was placed so that its centre was 34 cm from the bottom, at Loc. B 31 cm. Due to reduced water-flow during the investigation periods (Fig. 5), the total depth of the stream was reduced from 57 to 48 cm at Loc. A, and from 43 to 40 cm at Loc. B.

All samples were thus taken in the upper water layers (Ulfstrand 1968). One series was

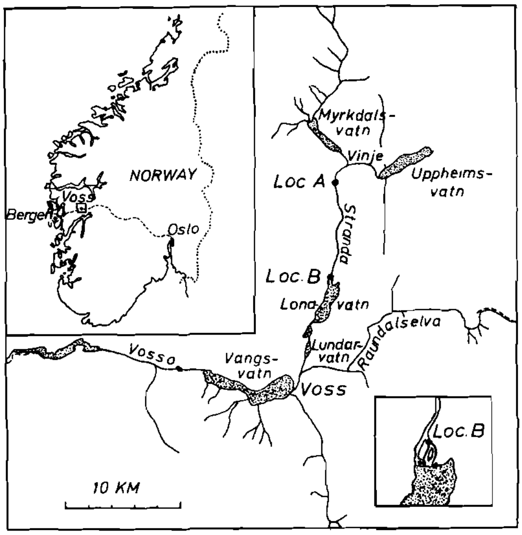

Fig. 1. Map of the water system and its situation in western Norway.

taken over 24 hrs at each station. Samples were taken during the first 30 min of each hour at Loc. A and during the first 55 min of each hour at Loc. B. The water temperature, light conditions, and water flow were recorded at the same time.

Sampling at Loc. A was carried out on 1 and 2 Aug. 1969 and at Loc. B on 4 and 5 Aug. It should be noted that sampling at Loc. A was carried out after a period of rain. Further rain later increased the water flow but this was decreasing again by the time sampling took place at Loc. B.

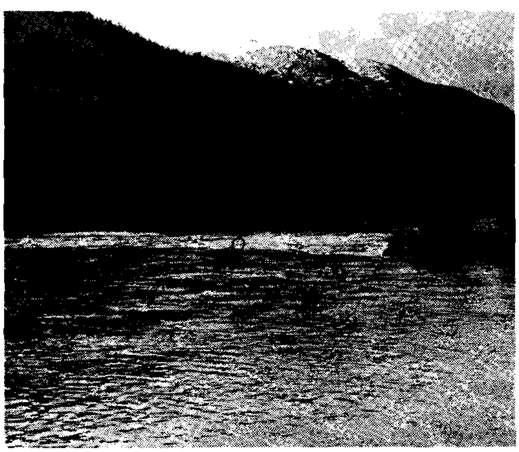

Fig. 2. Loc. A (Vinje) Strandaelva. The sampling site is indicated by a circle. The water-flow was about 30 m³/sec when the photograph was taken. Photo I. Steine, May 1972.

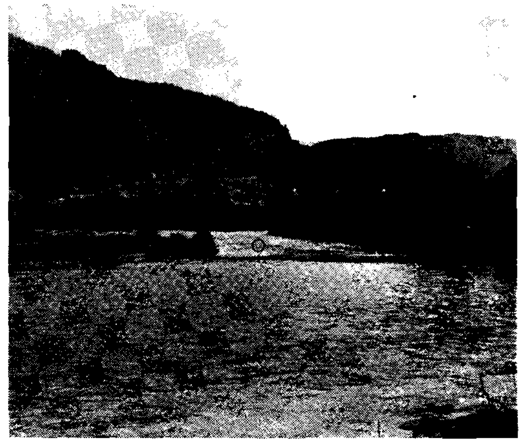

Fig. 3. Loc. B (Lönavatn) Strandaelva. The sampling site is indicated by a circle. The water-flow was about 30 m³/sec when the photograph was taken. Photo I. Steine, May 1972.

DIURNAL RHYTHM AND ANIMAL SIZE

The diurnal rhythm in the drift of nymphs of Ephemeroptera, Chironomidae, and Simuliidae is illustrated in Fig. 5. For all these groups an increase in the drift occurred during the periods of dark. In the case of the Ephemeroptera and Chironomidae, this is most noticeable at Loc. B, and in the case of the Simuliidae at Loc. A. The wet weight of the nymphs of Ephemeroptera varied during the period of observation (Fig. 6); during the light periods small nymphs made up the greatest part of the drift, while

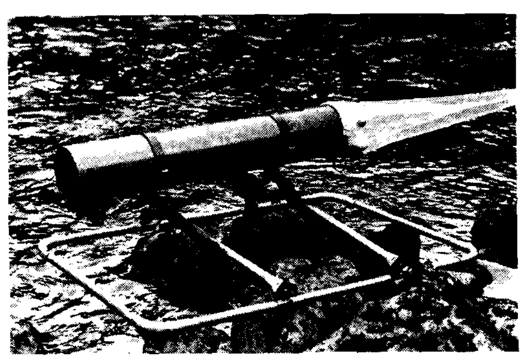

Fig. 4. The Larsen sampler. Photo I. Steine.

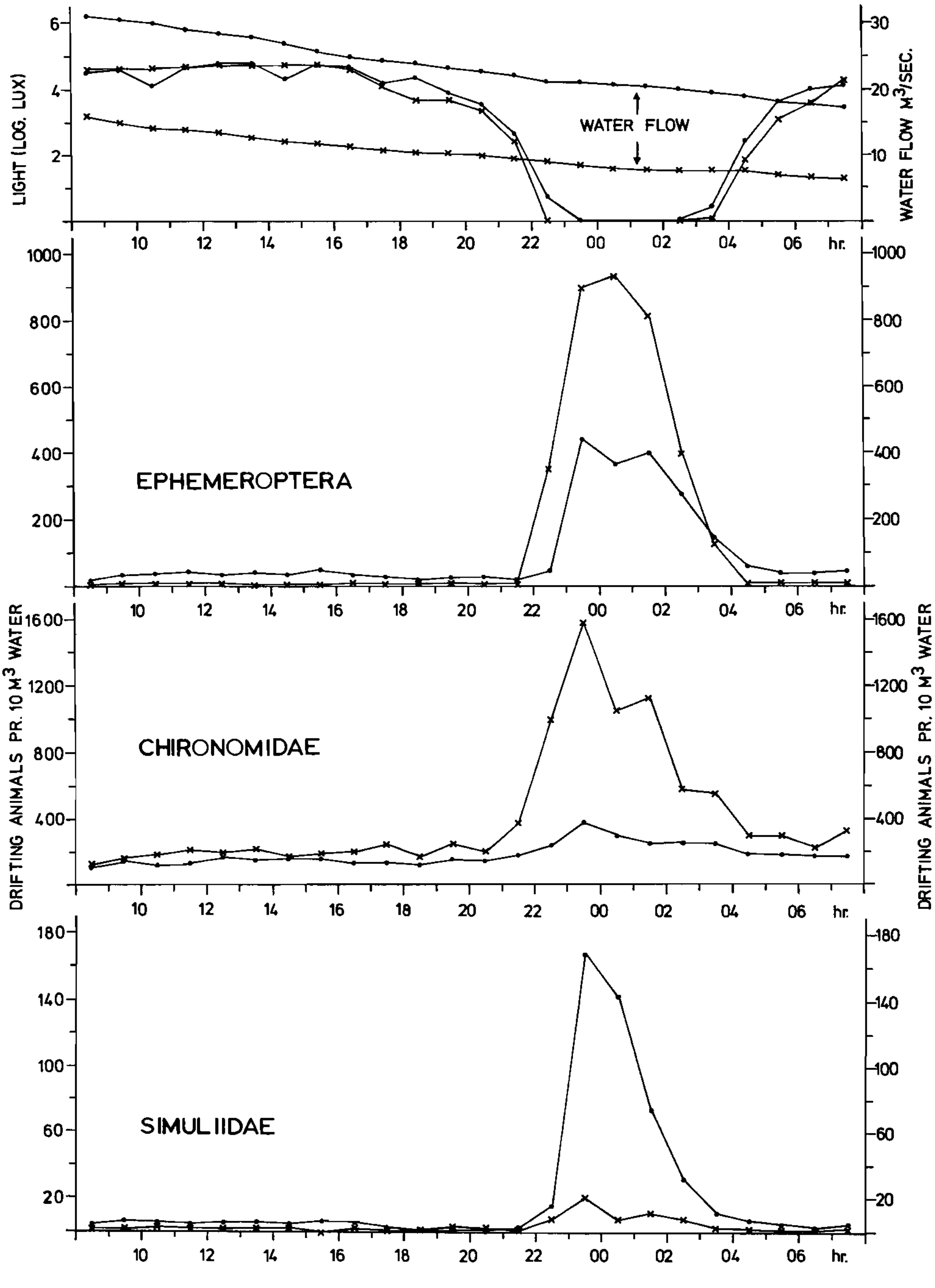

Fig. 5. Drifting animals obtained during the first 30 min of each hour at Loc. A (1–2 Aug. 1969) and during the first 55 min of each hour at Loc. B (4–5 Aug. 1969). The light conditions and water flow during the observation periods are also given.

larger animals dominated in the dark periods. The pattern is the same at both localities. A corresponding pattern was not observed in the case of the Chironomidae and Simuliidae, although some observations indicate a slight increase in individual size of the Simuliidae during the dark periods.

DISCUSSION

Several investigations on drift have been carried out in recent years and hace been summarized by Waters (1972). The possibility that different instars in a population might predominate in the drift at different times of day and night does not seem to have attracted much attention. Anderson & Lehmkuhl (1968), however, have discussed the problem in connection with investigations of 'catastrophic drift' due to freshets. They found that specimens of some genera of Ephemeroptera and of Chironomidae collected at night were heavier than those collected during the day-time. Müller (1966) confirmed that the maximum drift of baetid mayflies occurs immediately before metamorphosis and shortly before pupation in the case of the Simuliidae. Anderson (1967) reported that the activity of caddis-fly larvae depended upon their size, the large larvae being active at night, while the early larvae were active during the day-time.

During the present study the chironomid population only consisted of very small individuals. Newly hatched individuals were the most abundant in the populations of Ephemeroptera and Simuliidae too, but there were also some larger individuals. The increasing activity of the Ephemeroptera during the dark at Loc. A and Loc. B, however, does not seem to be associated with impending metamorphosis (Müller 1966).

The flow of water during the period of observation has been calculated to vary between 17 and 31 m^3/sec at Loc. A, and 7 and 16 m^3/sec at Loc. B (Fig. 5). As the water-flow diminished during the observation periods, the results are not thought to be affected by freshets, although the flow at Vinje on 30th July 1969 was estimated to be about 75 m^3/sec. In May 1971, when snow was melting and there had been heavy rainfall, a water-flow of 145 m^3/sec was recorded at Vinje.

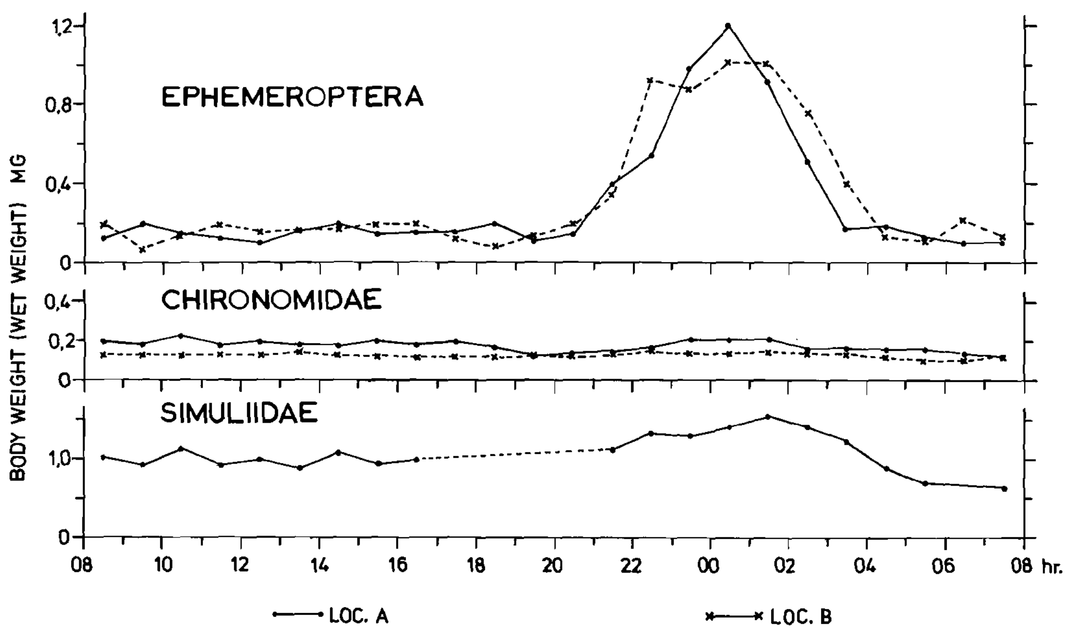

Fig. 6. Comparison of mean weights per individual at Loc. A and Loc. B during the observation periods.

Elliott (1967b) and Ulfstrand (1968) have established that the drift of insects increases with flow volume. Anderson & Lehmkuhl (1968), however, suggest that the number of drifting insects per unit volume of water is similar before and during freshets. Several investigators have indicated a diurnal rhythm in drift which is dependent not only on external factors, but also on intrinsic ones. The controlling factor, however, is usually the light intensity.

The question as to the cause of the greater size of the animals drifting during darkness does not seem to have been discussed directly in the literature. I think there may be a very simple explanation. When animal populations consist of various stages of development, it may be expected that the older and larger individuals are stronger than the small ones and are better able to occupy the best retreats. Thus the smaller, weaker animals are restricted to less favourable hiding places, i.e. the more exposed parts of the substrate. This would result in the small animals being easily swept away sown the river. According to Waters (1965) this represents 'constant drift', which occurs throughout the whole 24-hr period. In the case of Ephemeroptera, their typical greater activity at night will result in the larger specimens emerging from their hiding places then and appearing in the drift. This can be regarded as 'behavioral drift' (Waters 1965). The evidence for increased drifting during the later stages in the life cycle has been reviewed by Waters (1972) and he also discussed the varios theories relating to this phenomenon. It has often been suggested that increased drift may be a result of increased activity before pupation or emergence, when mature larvae move to more suitable areas.

The present observations indicate that the Ephemeroptera, Chironomidae, and Simuliidae were affected by the light intensity. The population of Ephemeroptera consisted of relatively young individuals of which the largest predominated at night. It has already been pointed out that this is not a consequence of greater activity before emergence. The pattern of change of mean body size of the drifting Ephemeroptera should be regarded as a reflection of 'behavioral' drift of nocturnal animals at night and of a casual drift of smaller animals during the day-time.

ACKNOWLEDGEMENT

Bergenshalvöens kommunale kraftverk (The municipal power company of the city of Bergen and surrounding districts) supported the project in Strandavassdraget between 1969 and 1971, of which this work forms a part. Professor Hans Kauri supervised the investigations and provided valuable advice. I also wish to express my gratitude to Dr. J. Matthews for checking the English.

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Received 7 August 1972