Mesh-size and efficiency of sampling of larval Chironomidae

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Abstract

Living and preserved chironomid larvae in samples of the aquatic macrophyte, *Ranunculus calcareus,* were washed through a tier of sieves and plankton netting of decreasing mesh-size, ranging from 1000 μm to 50 μm. Almost all living first instar larvae passed through a 125 μm mesh, as did a large proportion of second instars and some third instar larvae. The proportion of living larvae passing through the 125 μm sieve was clearly correlated with head capsule width. Relatively few preserved larvae passed through the 125 μm sieve.

The relevance of these data is stressed in relation to studies of the autecology, population dynamics and production of Chironomidae.

Introduction

The importance of using a fine-mesh sieve in order to sample chironomid larvae effectively has long been recognized (e.g. Jonasson, 1955). Jonasson (1958) found that up to that time a mesh of 600 μm was generally regarded as satisfactory for retaining most benthic invertebrates but went on to demonstrate that a reduction in mesh-size to 200 μm resulted in a six-fold increase in the number of animals captured. More recently Mason (1981) recommended a mesh of 500 μm as being adequate for routine sampling of invertebrates in relation to water quality surveillance.

In previous studies of chironomid populations in southern English chalk-streams, in which a mesh of 250 μm or 125 μm was used (Pinder, 1983; Pinder & Clare, 1980; Williams, 1981), second instar larvae were grossly under-represented and first instar larvae were rarely found. In consequence, and as a preliminary to detailed studies of the autecology of 3 species, namely *Eukiefferiella claripennis* (Lundbeck), *E. ilkleyensis* Edw. and *Tvetenia calvescens* (Edw.) it was necessary to reappraise the influence of mesh-size on sampling efficiency. In the chalk streams from which samples were taken, all 3 species primarily inhabit submerged macrophytes, although in other situations they may also occur on stone or gravel substrata.

As part of a more extensive sampling programme, samples were taken from 2 southern English chalk-streams, the Tadnoll Brook, described by Pinder (1974) and the Bere Stream (Westlake *et al.*, 1972). In both streams the dominant submerged macrophyte was *Ranunculus penicillatus* var. *calcareus* (R. W. Butcher) C. D. K. Cook.

Methods

Samples were taken from Tadnoll Brook on 18 April, 1983 and from Bere Stream on 16 May, 1983. Each sampling unit consisted of 3, 20 cm lengths of *R. calcareus* stem and attached leaves, taken respectively from the surface, middle and underside of the same clump of vegetation. Each segment of plant was taken by hand and enclosed

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immediately in a polythene bag. Thirty such units were taken from the Tadnoll Brook, and 10 from the Bere stream.

The Tadnoll Brook sample was washed and sieved immediately on return to the laboratory, whilst the animals were still alive. The Bere Stream sample, however, was as preserved in 70% industrial alcohol and animals were removed by washing into sieves sometime later. Otheise treatment of the 2 samples was identical.

Each sample unit was thoroughly washed with a jet of water over a series of sieves and plankton netting of 1000 μm, 125 μm, 70μm and 50 μm aperture, arranged in descending order of size. No chironomid larvae were retained by the 1000 μm sieve which served only to retain the bulk of plant material. Larvae retained by each size of mesh were transferred to separate petri-dishes, picked out under ×20 magnification and preserved in 70% industrial alcohol, prior to being mounted on slides for microscopic examination.

Only the 3 species mentioned above were identified and measured, but the total number of larvae retained by each size of mesh was also recorded. Instar determination was performed using measurements of head-capsule length (McCauley, 1974).

Results

Table 1 shows the number of larvae retained by each size of mesh, and the proportion of the total which passed through a mesh of 125 μm and 70 μm.

Almost 40% of living larvae passed through the 125 μm sieve, whereas less than 6% of preserved larvae did so. Only a very small proportion (ca 0.5%) of living larvae and ca 0.1% of preserved larvae passed through the 70 μm mesh.

Table. 1 Mean number of chironomid larvae per sample unit retained by a mesh size of 125 μm, 70 μm and 50 μm, together with 95% confidence intervals (log. transformed). The percentage passing through the 125 μm and 70 μm mesh is shown in parentheses.

Mesh size	125 μm	70 μm	50 μm
Fresh sample (n = 30) (Tadnoll Brook)	112.2 ⁄ 1.27 (38.7%)	69.93 ⁄ 1.31 (0.5%)	0.90 ⁄ 1.36
Preserved sample (n = 10) (Bere Stream)	334.9 ⁄ 1.52 (5.7%)	19.9 ⁄ 1.59 (0.1%)	0.30 ⁄ 1.59

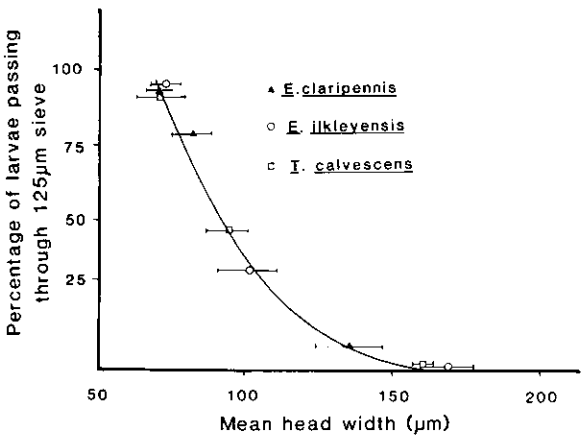

Fig. 1. Relationship between mean head capsule width of larvae of 3 species of chironomid (instars 1 to 3) and the proportion of larvae passing through a 125 μm sieve during washing.

Table 2 shows similar data for 3 species in greater detail. The majority of living, first instar larvae of all 3 species passed through the 125 μm sieve (96% of *E. ilkleyensis*, 93% of *E. claripennis* and 92% of *T. calvescens*). No *T. calvescens* larvae were found to have passed through the 70 μm mesh, but a small proportion (2.1% and 2.5% respectively) of first instar *E. claripennis* and *E. ilkleyensis* did so. Almost 80% of living, second instar *E. claripennis*, together with 32.5% of second instar *E. ilkleyensis* and 46.7% of *T. calvescens* passed through the 125 μm sieve. No second instar larvae of any of these species was found to have passed the 70 μm mesh. A small proportion (ca 1.4%) of living third

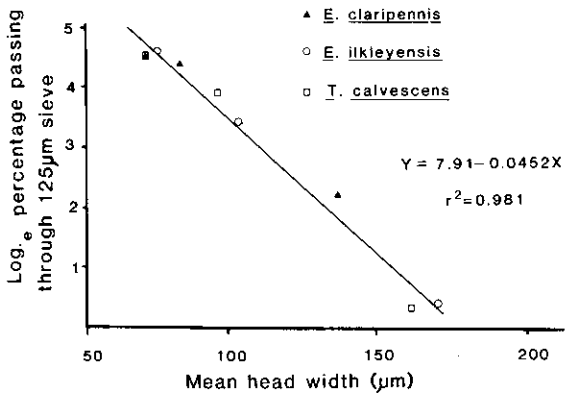

Fig. 2. Regression of mean head capsule width of 3 species of chironomid (instars 1 to 3) and logarithm of the proportion passing through a 125 μm sieve during washing.

Table 2. Mean number of larvae per sample unit of each instar of *E. claripennis, E. ilkleyensis* and *T. calvescens* retained by a mesh of 125 μm, 70 μm and 50 μm, together with 95% confidence intervals (log. transformed). The percentage passing through the 125 μm and 70 μm mesh is shown in parentheses.

	E. claripennis			*E. ilkleyensis*			*T. calvescens*		
	125 μm	70 μm	60 μm	125 μm	70 μm	50 μm	125 μm	70 μm	50 μm
(a) Living larvae (n = 30)									
Instar 1	0.1 ÷ 1.16 (93.2%)	1.33 ÷ 1.45 (2.1%)	0.03 ÷ 1.07	0.23 ÷ 1.21 (95.7%)	4.93 ÷ 1.35 (2.5%)	0.13 ÷ 1.19	0.03 ÷ 1.07 (91.7%)	0.33 ÷ 1.27 (0%)	0
Instar 2	0.47 ÷ 1.35 (79.0%)	1.77 ÷ 1.38 (0%)	0	1.93 ÷ 1.44 (32.5%)	0.93 ÷ 1.41 (0%)	0	0.53 ÷ 1.33 (46.7%)	0.47 ÷ 1.34 (0%)	0
Instar 3	7.13 ÷ 1.54 (8.6%)	0.67 ÷ 1.37 (0%)	0	4.83 ÷ 1.47 (1.4%)	0.07 ÷ 1.14 (0%)	0	2.57 ÷ 1.53 (1.2%)	0.03 ÷ 1.07 (0%	0
Instar 4	3.03 ÷ 1.43 (0%)	0	0	3.30 ÷ 1.39 (0%)	0	0	1.47 ÷ 1.47 (0%)	0	0
(b) Preserved larvae (n = 10)									
Instar 1	7.00 ÷ 2.21 (2.8%)	0.20 ÷ 1.54 (0%)	0	83.50 ÷ 1.69 (15.7%)	15.40 ÷ 1.56 (0.2%)	0.20 ÷ 1.54	5.10 ÷ 2.50 (3.8%)	0.20 ÷ 1.54 (0%)	0
Instar 2	18.30 ÷ 1.40 (0%)	0	0	94.10 ÷ 1.46 (0.2%)	0.20 ÷ 1.54 (0%)	0	3.50 ÷ 2.85 (0%)	0	0
Instar 3	10.00 ÷ 1.52 (0%)	0	0	43.10 ÷ 1.35 (0%)	0	0	5.40 ÷ 1.91 (0%)	0	0
Instar 4	5.50 ÷ 2.08 (0%)	0	0	3.30 ÷ 1.34 (0%)	0	0	1.10 ÷ 2.08 (0%)	0	0

instar larvae of *E. ilkleyensis* went through the 125 μm sieve, as did more than 8% of third instar *E. claripennis*.

A considerably smaller proportion of preserved larvae passed through the 125 μm sieve. The exceptions were mainly first instar larvae, mostly of *E. ilkleyensis*, of which a few (0.2%) also passed through the 70 μm mesh. A very small number of second instar *E. ilkleyensis* also went through the 125 μm sieve.

Fig. 1 shows the mean head width of each instar of these 3 species plotted against the proportion of living larvae passing through the 125 μm sieve. Transferring these proportions to a logarithmic scale (Fig. 2) produced a straight line relationship ($r^2 = 0.98$) of the form:

$$\log_e Y = 7.91 - 0.0452\ X$$

where Y is the proportion passing through the 125 μm sieve and X is the mean head capsule width of the instar.

Discussion

Various authors have remarked upon the importance of mesh-size in relation to sieving of samples of invertebrates (e.g. Jonasson, 1958; Mason, 1977; Maitland *et al.*, 1972). None of these authors, however, took the argument to its logical conclusion by considering the size of mesh required to retain the smallest larvae, possibly because of the inherent difficulty of using fine sieves with muddy substrata. In certain types of study this may not be an important consideration. If the objective is merely to describe the fauna in a qualitative sense it is not necessary to sample all stages and species with equal efficiency and the time required to process samples will be considerably reduced by the use of a relatively coarse mesh. This type of study, often with some attempt at quantification is relatively common in literature, whilst detailed information on autecology, production and life-cycles remains scarce. With the continuing interest in the use of chironomid communities as indicators of water quality (e.g. Wilson & Bright, 1973; Wilson & McGill, 1977; Armitage & Blackburn, 1985) it is increasingly important to understand the ecological requirements of individual species.

Generally authors have assumed that production of early instars is of relatively minor importance (e.g. Kajak, 1967). Maitland *et al.* (1972), working with *Stictochironomus* sp. in Loch Leven found that the error in estimates of production resulting from using a 500 μm sieve, as opposed to one of 125 μm was only 2.7% per annum. However, on the evidence of the present study they could well have been losing virtually all first instar larvae, and probably a significant proportion of second instars through the 125 μm sieve. In contrast, Pinder & Clare (1981) estimated that production by first and second instar larvae of *Rheotanytarsus curtistylus* Goetghebuer amounted to 43% of the total annual production of that species.

The present data indicate clearly that very few preserved larvae pass through a 125 μm sieve. The difference between living and preserved larvae may be the result of living larvae actively 'burrowing' down through the sieve, or it may be attributable to the greater rigidity of preserved larvae. It is usually necessary, however, to sieve samples prior to their preservation, in order to reduce the volume of material to be transported or to reduce the volume of preservative required. It is also often advantageous to sort samples whilst animals are alive. This enables smaller larvae to be more readily seen and also permits a degree of identification to be achieved using characters which are not available in preserved larvae, such as colouration and behaviour.

In such cases it is helpful to have a means of estimating losses resulting from the sieving process. The data indicate that such estimates may be achieved, with a high level of accuracy through a close correlation ($r^2 = 0.98$) with the logarithm of head capsule width. This would permit much more rigorous studies of autecology, population dynamics and production biology to be achieved without the amount of additional effort becoming excessive.

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References

Armitage, P. D. , J. H. Blackburn, 1985. Chironomidae in a Pennine stream system receiving mine drainage and organic enrichment. Hydrobiologia 121: 165–172.

Jonasson, P. M., 1955. The efficiency of sieving techniques for sampling freshwaer bottom fauna. Oikos 6: 183–207.

Jonasson, P. M., 1958. The mesh factor in sieving techniques. Verh. int. Ver. Limnol. 13: 860–866.

Kajak, Z., 1967. Remarks on methods of investigating benthos production. Ekol. Pol. B 13: 173–195.

Maitland, P. S., W. N. Charles, N. C. Morgan, K. East & M. C. Gray, 1972. Preliminary research on the production of Chironomidae in Loch Leven, Scotland. Proc. IBP-UNESCO Symp. Productivity Problems of Freshwaters, Kazimierz Dolny, 1970: 795–812.

Mason, C. F., 1977. Populations and production of benthic animals in two contrasting shallow lakes in Norfolk. J. anim. Ecol. 46: 147–172.

Mason, C. F., 1981. Biology of freshwater pollution. Longman, London: 250 pp.

McCauley, V. J. E., 1974. Instar differentiation in larval Chironomidae (Diptera), Can. Ent. 106: 179–200.

Pinder, L. C. V., 1974. The Chironomidae of a Small Chalk-Stream in Southern England. Ent. Tidskr. suppl. 95: 195–202.

Pinder, L. C. V., 1983. Observations on the Life-cycles of some Chironomidae in Southern England. Mem. Am. ent. Soc. 34: 249–265.

Pinder, L. C. V. & P. C. Clare, 1980. The life history and production of *Rheotanytarsus curtistylus* in a small stream in southern England. Acta. Univ. Carolinae-Biologica 1978: 163–170.

Westlake, D. F., H. Casey, F. H. Dawson, M. Ladle, R. H. K. Mann & A. F. H. Marker, 1972. The chalk stream ecosystem. Proc. IBP-UNESCO Symp. Productivity Problems of Freshwaters, Kazimierz Dolny, 1970: 795–812.

Williams, K. A., 1981. Population dynamics of epiphytic chironomid larvae in a chalk stream. Ph.D. Thesis, University of Reading: 317 pp.

Wilson, R. S. & P. L. Bright, 1973. The use of chironomid pupal exuviae for characterising streams. Freshwat. Biol. 3: 283–302.

Wilson, R. S. & J. D. McGill, 1977. A new method of monitoring water quality in a stream receiving sewage effluent, using chironomid pupal exuviae. Wat. Res. 11: 959–962.

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