5.5 MACROINVERTEBRATES OF THE SANDY AND SILTY BOTTOM

(by A. Herzig)

5.5.1 Introduction

Several kilometres of the backwater area are covered by silt and sand (Fig. 5.5.1), and hence a method is needed which allows quantitative sampling in these sediments. According to Brinkhurst (1974), the following requirements should be met by such a sampling device:

a) The sampler must penetrate sufficiently deep into the sediment; all the animals inhabiting the sediment column underneath the surface area sampled should be trapped.

b) The sampler should enclose the same surface area with each trial and hence the entire depth should be sampled equally.

c) During descent, the sampler should not disturb the sediment or the fauna; no animals should be lost before the sampler is closed.

d) The closure of the sampler should be such that no sediment is lost during retrieval.

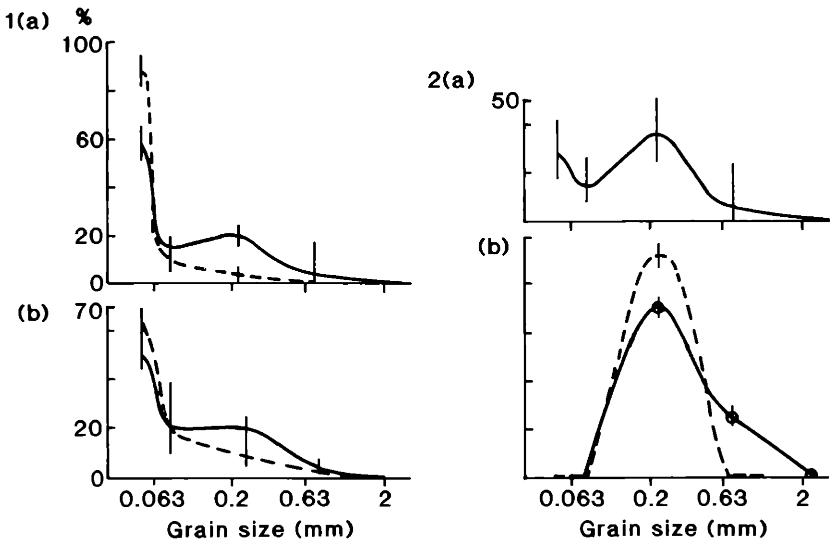

Fig. 5.5.1. Grain size distribution of bed material [diameter of the grain size (mm) in percent]. 1. Silty bottom: (a) Near the dam; (b) Four kilometres upstream from the dam (depth ≤ 12 m). 2. Sandy bottom: (a) Four kilometres upstream from the dam (depth > 12 m); (b) Fourteen kilometres upstream from the dam (depth > 5 m). Broken line indicates the grain size distribution after a low discharge of 900 $m^3 sec^{-1}$ for one month.

5.5.2 Equipment and general performance

The sampler used for the present investigation: the multicorer „RINI-MUCO" (Danielopol & Niederreiter, 1990; Plate 5.5.1), does fulfil the requirements mentioned above. Due to its weight (empty corer 60 kg), it penetrates deep enough into the silty and sandy sediments (Table 5.5.1) so that all animals of the prevailing zoobenthic groups are sampled [depth distribution of the major groups: Oligochaeta, Polychaeta, Chironomidae; see Herzig (1987)].

Table 5.5.1. Mean core length and standard deviation (S.D.) within one multicorer (= six cores). SI = silt dominated substratum; SA = sand dominated substratum. 0 (near the dam) = area in front of the sluice-gate; km 4 = river kilometre 1984; km 14 = river kilometre 1994. (Grain size distribution see Fig. 5.5.1).

Distance from the dam (in km)	Water depth (in m)	Type of substratum	Mean core length (in cm)	S.D. within six cores of one multicorer (in cm)		
				mean	max	min
0	15–18	(SI)	17.6	1.5	2.8	0.6
4	<12	(SI)	11.6	2.4	5.4	0.8
14	<5	(SI)	11.2	2.1	3.8	1.1
4	<12	(SA)	8.1	1.7	3.7	0.6
14	<5	(SA)	12.4	2.1	4.0	1.3

All six sampling units enclose the same surface area of 27.3 cm^2. The multicorer covers a total area of 0.28 m^2 and reveals a relatively high precision which is reflected by the small variation of the core lengths within one trial (Table 5.5.1). The construction of the sampler allows the water to pass through the tubes during descent and therefore minimises turbulence at the tube openings and resulting disturbances at the sediment surface when the tubes are penetrating. Therefore a sample of the sediment, complete with the overlying water, is removed with little disturbance of the sediment water interface and no loss of the enclosed sediment because of the closing mechanism (Plate 5.5.1)

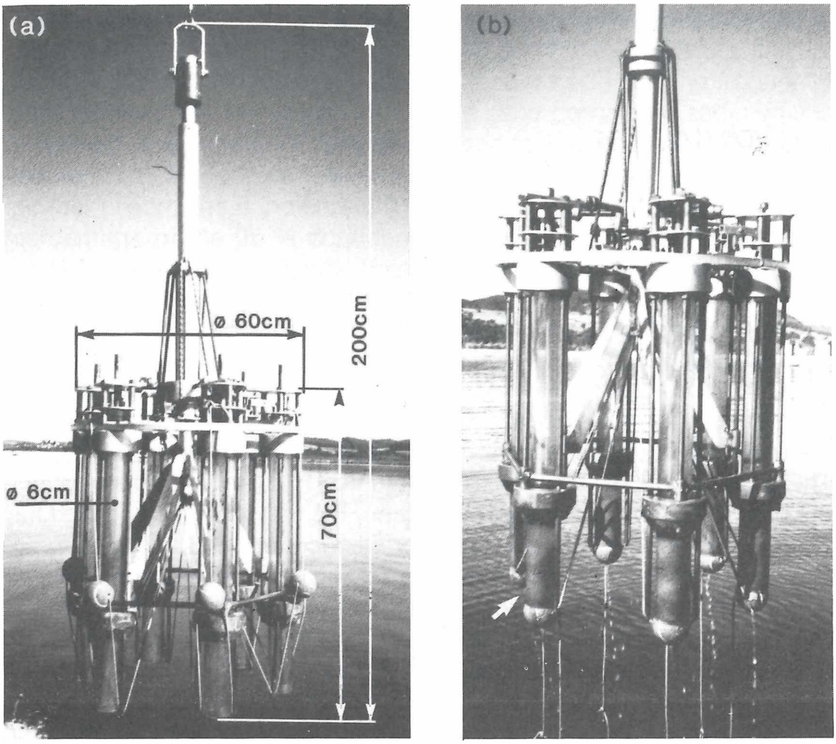

Plate 5.5.1. The multicorer „RINIMUCO“ [described by Danielopol & Niederreiter (1990)].
(a) Before lowering. (b) After lifting. → = sediment in the corer.

5.5.3 Precision

Besides the choice of a suitable tool, the number and size of the samples requires careful determination. On the basis of a pilot study (July, August 1985) it became obvious that the populations of the dominant animals (in silt and sand) are highly aggregated. In this case a large number of small samples is preferable to a small number of large samples (Elliott, 1977; Southwood, 1978). Many small units reveal more degrees of freedom, a reduced statistical error and may cover a wider range of the habitat; hence the catch is more representative.
As the negative binomial turned out to be a suitable model for the samples, D (index of precision) is given by

$$D = (t^2/\overline{x})\sqrt{\overline{x}/n + \overline{x}^2/(nk)}$$

and

$$n = (t^2/D^2)\,(1/\overline{x} + 1/k)$$

and

$$k = \overline{x}^2/(s^2-\overline{x})$$

where n = number of sampling units; D = index of precision expressed as percentage of the 95 % confidence limits of the mean; s^2 = variance; $\overline{x}$ = arithmetic mean; 1/k = measure of clumping (or index of dispersion); k = a parameter of the negative binomial distribution, and the values of t are found in Student's t-distribution (Elliott, 1977).
The values of these statistics were assumed from samples taken during the pilot study and in addition throughout the first year of sampling (July 1985 – August 1986). The results for Oligochaeta and Polychaeta are shown in Figures 5.5.2-4. Obivously no relationship exists between $\overline{x}$ and 1/k (Fig. 5.5.1). However, a considerable variation in the index of dispersion (1/k) does occur for the same number of sampling units (n) and surface area in each sample. The highest 1/k-values could be calculated for samples taken in sand dominated sediments and, irrespective of the sediment type, after periods when current changed rapidly from low to high levels and vice versa, e.g. spates.

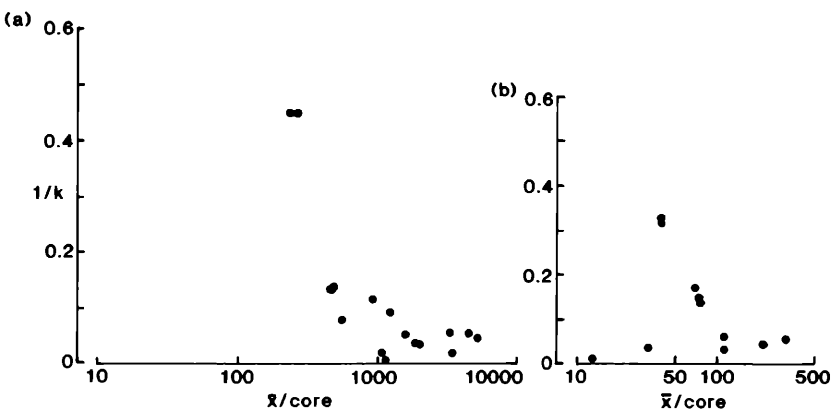

Fig. 5.5.2. Relationship between arithmetic mean ($\overline{x}$) and the parameter of the negative binominal distribution (1/k). (a) Oligochaeta. (b) Polychaeta.

From Figures 5.5.2 and 5.5.3 the number of sampling units needed to reach a precision of ± 20 % and ± 40 % confidence limits can be deduced from the degree of clumping (1/k). In addition the frequency distribution of the 1/k-values for silt and sand dominated sediments is presented. The number of samples needed to reach a distinct degree of precision for Oligochaeta is given in Table 5.5.2. In addition the workable number of samples is indicated. It is obvious that a precision of ± 40 % (percentage of the 95 % confidence limits) is attainable, but a higher level of precision is very likely. The same is valid for Polychaeta and Chironomidae.

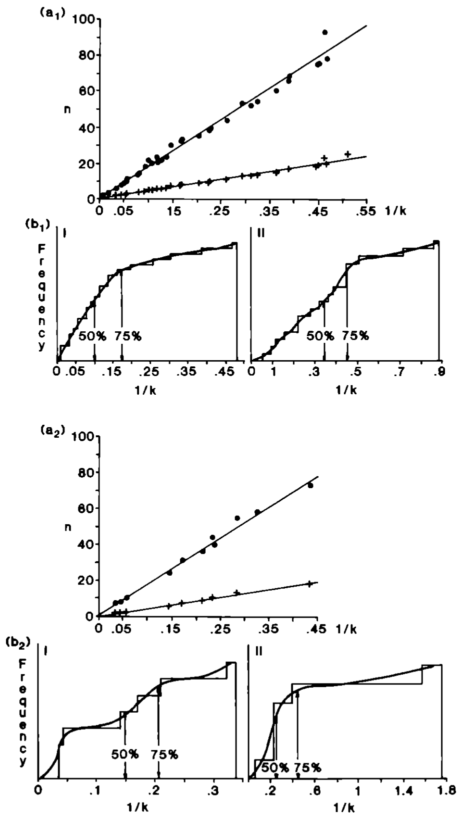

Fig. 5.5.3. (a) Relationship between index of dispersion (1/k) for (1) Oligochaeta, (2) Polychaeta and number of sampling units (n) for 20 % () and 40 % (+) of precision expressed as percentage of 95 % confidence limits of the mean. (b) Frequency distribution of the index of dispersion (1/k), and grain size analysis for (I) silt dominated and (II) sand dominated sediments: 1. Oligochaeta; 2. Polychaeta.

Table 5.5.2. Number of sampling units in each sample. D = 20 % and 40 % of precision expressed as percentage of 95% confidence limits of the mean. Example: Oligochaeta; 1/k value = median for the period July 1985 – July 1986. SI = silt dominated sediments 1/k = 0.1; SA = sand dominated sediments 1/k = 0.35.

Type of sediment	SI	SI	SA	SI	SA	Total
Distance from the dam (in km)	0	4	4	14	14	
Water depth (in m)	15-18	<12	>12	<5	>5	
D ± 20 % C.L.	18	18	62	18	62	178
D ± 40 % C.L.	5	5	15	5	15	45
Number of samples taken	5–10	6–20	4–21	4–12	5–12	35–54

In conclusion one may assert that the number of sampling units taken routinely from the different sediment types enables one to obtain fairly good estimates of population densities.

References

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