

A comparison of a large diameter corer and a new hydraulic suction sampler in sampling eggs of *Coregonus albula*

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The capture efficiency of a 1500 cm² hydraulic suction sampler was evaluated in comparison with a 157 cm² corer in sampling eggs of *Coregonus albula* (L.). Samples were taken from soft and hard bottoms in three different types of lake in eastern Finland. The overall mean per m² was higher with the corer (38.4), but the difference was not significant (4.2 eggs per m²).

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1. Introduction

A large number of bottom samplers have been constructed for different purposes (see Hopkins 1964, Edmonson & Winberg 1971, Holme & McIntyre 1971, Elliott & Tullet 1978). Some have been widely used in practice and empirically shown to give accurate quantitative estimates of the fauna. However, there is still relatively little data on the capture efficiency of the various sampling instruments and the poor performance of most of the samplers which have been tested suggests that all devices used in quantitative work should be tested for their sampling efficiency in local conditions (Kajak 1963, Flannagan 1970, Holopainen & Sarvala 1975, Sarvala & Ranta 1977).

Various core samplers and air-lift suction devices are widely used for sampling bottom fauna (Elliott & Tullet 1978). Hydraulic suction samplers have been used to sample benthos by Brett (1964), True et al. (1968), Allen & Hudson (1970), Zimmermann & Ambühl (1970), Ekdale & Warne (1973), Smith (1973), Larsen (1974), Arkel & Mulder (1975), Gale & Thompson (1975), Gulliksen & Deras (1975).

The following samplers have been used to collect fish eggs or hatching larvae: a suction device (Rawson & Elsey 1950, Eschmeyer 1954, Manz 1964, Nelson 1968, Novak & Sheets 1969, Vogeles et al. 1971, Arvola 1978), a salt water sampler (Nissinen 1972), a scraper (Shumilov 1970), a grab (Zawisza & Backiel 1970), and a

large diameter corer (Viljanen 1978). Samples have also been obtained by scuba diving (Viljanen & Holopainen 1981).

The aim of the present study is to describe a new hydraulic suction sampler and to test it against the results given by a large diameter corer in sampling fish eggs. The work is part of a project concerning vendace egg and larvae survival and production in three different types of lake in eastern Finland.

The vendace, *Coregonus albula* (L.), spawns in Finland during late autumn or winter. The eggs are demersal and their egg membranes remain slightly adhesive for only a short time (Balon 1975). According to Balon (1975) *C. albula* belongs ecologically to the lithopelagophilic group of fish. The need to develop a new sampler was based on the fact that the mouth area of most conventional samplers designed for invertebrate sampling is too small to give adequate samples in areas of low egg frequency.

2. Material and methods

2.1. Construction and operation of samplers

Hydraulic suction sampler

The apparatus is designed for collecting demersal fish eggs from hard and soft bottoms down to a depth of about 20 metres.

The equipment (Fig. 1) consists of five parts: a collecting funnel (a) which lies on the bottom, a hydraulic pump (c) at the surface, a suction pipe (b) connecting a and c,

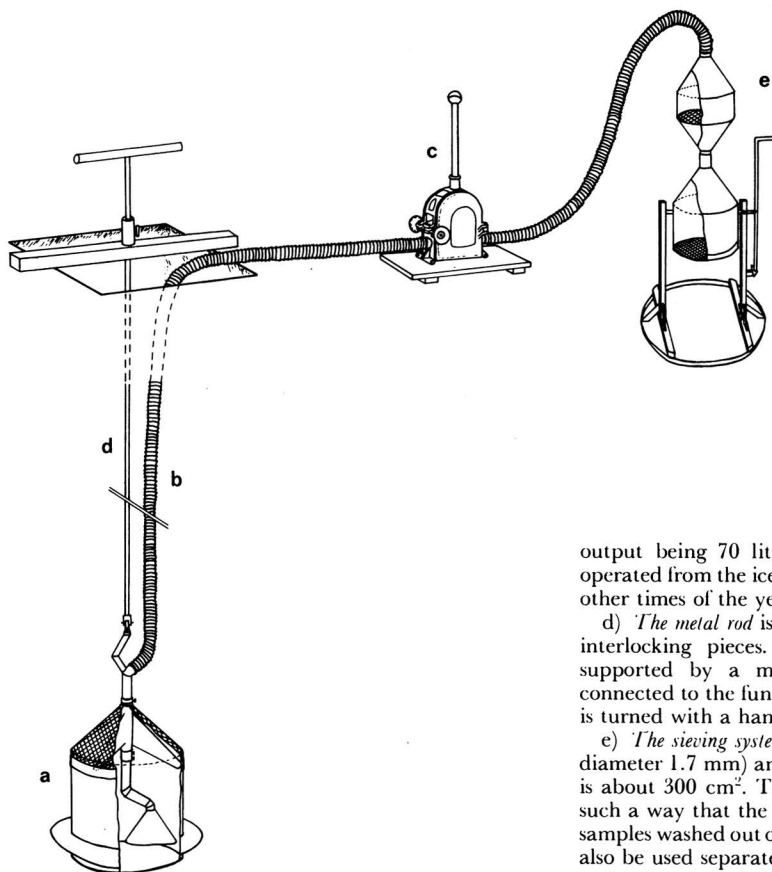


Fig. 1. The hydraulic suction sampler. a = collecting funnel, b = suction pipe, c = hydraulic pump, d = metal rod, e = sieving system. Further explanations in the text.

a rod (d) from the collecting funnel to the surface and a sieving system (e).

a) *The collecting funnel* consists of a metal cylinder with an outside collar to prevent it from being pressed too deep into soft sediment. The cylinder is 400 mm high and 437 mm in diameter and covers a sampling area of 1500 cm². Inside the cylinder there is a nozzle with a mouth-piece 218 mm long and 25 mm wide. The nozzle is connected to the suction pipe by a metal tube and the upper part of this tube is connected to the rod by a double-jointed coupling so that the nozzle can be turned horizontally though 360°. Inside the cylinder there is a stopper which prevents the nozzle from making more than one rotation. The distance of the nozzle from the bottom can be adjusted from 35 mm to 135 mm. The top of the cylinder is covered with a net of 1 mm mesh. The whole funnel system weighs about 15 kg.

b) *The suction pipe* consists of 10–20 metres of 2 mm spiral strengthened polyvinyl tubing with an inside diameter of 38 mm. The joints are secured by ordinary universal clips.

c) *The hydraulic pump* is a manually operated Whale Gusher 25 bilge pump. The pump has twin diaphragms affording two pumping units in one housing. The valves and diaphragms are made of synthetic rubber. The maximum output is 110 litres per minute, the normal

output being 70 litres per minute. The pump can be operated from the ice during the winter and from a boat at other times of the year.

d) *The metal rod* is constructed of one and a half-metre interlocking pieces. The upper section of the rod is supported by a metal frame. The lower section is connected to the funnel part as described above. The rod is turned with a handle at its top.

e) *The sieving system* consists of a 1 mm mesh sieve (egg diameter 1.7 mm) and a 5 mm mesh sieve. The sieve area is about 300 cm². The system is connected to a stand in such a way that the sieve funnel can be inverted and the samples washed out of it straight into a box. Both sieves can also be used separately.

At the start of the operation the sampler is lowered slowly to the bottom by the rod which is then locked to the frame. The metal cylinder usually sinks two or three centimetres into a hard bottom and down to the support collar in a soft bottom. After that the pumping up of sediment into the sieving system can be started. The pumping time used was 3 minutes (about 250 litres per sample). During pumping the nozzle is turned round five times. Finally the pipe is cleared by pumping water through it, the funnel being held about 1.5–2 metres above the bottom.

Corer

The sampler is a single, large diameter, modified Kajak-type corer with an acrylic plastic tube and a stainless steel mouth piece (inner diameter 141.4 mm, area 157.0 cm²). The lower end of the tube is closed automatically by plates when the sampler is pulled out of the sediment. The weight of the sampler is about 6 kg.

Soft sediment usually filled the tube to about half or two-thirds of its total length (about 70 cm). When the corer had been brought to the surface, the sediment core was allowed to slide slowly down the tube and the lower part was cut off, so that only the topmost 20 cm were retained. Sieving was carried out as described above. On very hard bottoms a metal rod was connected to the corer to help the tube to penetrate and get a good sample.

The sieving residues were preserved in the field in 2–3 % formaldehyde, stained with Rose Bengal, and

examined in the laboratory on a disc under a magnification lens ($\times 2.2$) equipped with light. The eggs were identified and measured under a dissecting microscope.

2.2. The sampling test

The comparison was carried out in Karjalan Pyhäjärvi (an oligotrophic lake), Suomunjärvi (a dysoligotrophic lake) and Onkamonsjärvi (a eutrophic lake).

As the performance of the samplers depends on the type of bottom the samples were taken from a soft bottom at a depth of 9–10 m (Karjalan Pyhäjärvi, sampling stations 1–7) and from a hard sand bottom (organic sediment layer about 2–8 cm) at a depth of 3–6 m (Suomunjärvi, sampling stations 8–10 and Onkamonsjärvi, sampling stations 11–12). At each sampling station a sample of 12 to 20 cores was taken with the core sampler and usually a sample of five suction cores with the suction sampler. Two cores taken with the core sampler were united in calculations into one unit. The samples were taken in April and November (1979) and January (1980).

The distance between the sampling areas of the two samplers was about 3 metres and that between different hauls in each sample about 0.5 metres. Altogether, 168 cores were taken with the corer and 59 suction cores with the suction sampler from a total area of 2.6 m² and 8.9 m², respectively.

For every station, the ratio of variance to mean was tested for agreement with the Poisson distribution (see Elliott 1977), and the significance of the difference in numbers per m² obtained by the two methods was compared by both the ordinary *t* test ($\sqrt{x + 0.5}$ or $\log(x + 1)$ transformation) and the nonparametric Mann-Whitney *U* test.

3. Results

The frequency distribution of the sample counts did not differ significantly from the Poisson distribution (χ^2 -test). Only one sample count was

dispersed significantly ($P < 0.05$) more than expected. The ratio of variance to mean did not differ from the Poisson distribution.

There was only one case of statistically significant difference ($P < 0.05$) in the number of eggs per m² between the methods. The corer gave a higher frequency of eggs at seven stations and the suction sampler at five stations. The overall mean per m² was higher with the corer (38.4), but the difference was not significant (4.2 eggs per m²) (Table 1).

4. Discussion

The sources of variation in the results given by these two methods are as follows: a) non-random distribution of the eggs and heterogeneity in the study area, b) errors in sieving and counting and c) the efficiency of samplers.

Statistical analysis is difficult in the comparison of the two sampling methods, because the frequency distribution of the counts varies with the size of the sampling unit. A bigger sampling area usually gives more symmetrical distributions and fewer blanks. When the sampling units have different areas, numerous blanks invalidate the use of transformations and distort the results of tests based on the ranking of counts. To overcome and minimize these difficulties two corers were united into one unit. However, there were still quite a lot of blanks. Different tests and transformations always gave practically the same results. To avoid the effects of low egg density, the possible non-random distribution of eggs and the heterogeneity of the study area, the number of sampling units per sample would have to be increased.

Table 1. Numbers of eggs per sampling unit and per m² at different sampling stations. C = cores, S = suction cores.

Sampling station	N		Numbers per sampling unit		Numbers per m ² (Mean \pm SE)	
	C	S	C	S	C	S
1	12	4	4.2	24.5	138.9 \pm 22.3	163.4 \pm 11.4
2	12	5	3.7	8.8	117.8 \pm 12.7	58.7 \pm 3.3
3	12	5	0.3	1.4	10.6 \pm 6.4	9.3 \pm 3.3
4	12	5	0.3	1.6	10.6 \pm 6.4	10.7 \pm 4.7
5	12	5	0.2	0.2	5.4 \pm 5.4	1.3 \pm 1.3
6	12	5	0.2	0.6	5.4 \pm 5.4	4.0 \pm 1.6
7	12	5	0	0.2	0	1.3 \pm 1.3
8	20	5	0.3	2.4	9.6 \pm 6.4	16.0 \pm 1.6
9	20	5	0.1	0.4	3.2 \pm 3.2	2.7 \pm 1.7
10	20	5	0.5	1.6	15.9 \pm 7.0	10.7 \pm 1.6
11	12	5	2.8	10.6	90.1 \pm 19.1	70.7 \pm 16.1
12	12	5	1.8	9.2	58.3 \pm 9.9	61.4 \pm 16.3
	168	59	1.2	5.1	38.4 \pm 14.1	34.2 \pm 13.9

As the sieving and counting procedures were identical for both methods, the likelihood of any systematic errors is very small. Perhaps the main factors which could lower the effectiveness of the suction sampler are a) the sampler produces a shock wave while descending through the water column and entering the sediment (Kajak 1963, Edmondson & Winberg 1971) and b) not all the eggs are pumped up from the funnel. The shock wave is caused mainly by the net on the top of the sampler and the outside collar. A dense net on the top of an Ekman sampler has given disastrous results (Prejs 1969). In the sampler under discussion, however, the net is coarse and from 40 to 60 cm above the lower edge of the sampler and is thought to ensure that no eggs disappear during the pumping. The shock wave can be greatly reduced if the sampler is permitted to enter the sediment gently or if pumping is started while the apparatus is being lowered (True et al. 1968, Mackey 1972). The pumping is thought to be effective because the eggs are demersal and the capacity of the pump is large enough to take even small stones; underwater observations have also confirmed that all the surface sediment under the funnel is pumped up.

According to McIntyre (1971), Charles et al. (1974) and Holopainen & Sarvala (1975) a large diameter corer is supposed to give true estimates of the frequency of zoobenthos when used carefully.

In previous comparisons suction devices have given higher densities of bottom fauna than corers or grabs, although the differences have usually not been very large (Mackey 1972, Årefjord 1972, Pearson et al. 1973, Gale & Thompson 1975).

All in all, the suction sampler seems to be as effective as the corer. It also has the advantage that it is easy and cheap to make and use. Large bottom areas can be sampled, representative samples can be taken from very hard bottoms although not from bottoms with big stones, and the samples are sieved during sampling so that the greater part of the sieving operation is eliminated.

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References

- Allen, D. M. & Hudson, J. H. 1970: A sled-mounted suction sampler for benthic organisms. — *Spec. Scient. Rep. U.S. Fish. Wildl. Serv.-Fish.* 614: 1—5.
- Arkel, M. A. van & Mulder, M. 1975: A device for quantitative sampling of benthic organisms in shallow water by means of a flushing technique. — *Neth. J. Sea Res.* 9: 365—370.
- Arvola, I. 1978: Kutualueiden ja -syvyyden arvioimisesta pumppunoutimen avulla. — *Suomen Kalastuslehti* 85: 148—150.
- Balon, E. K. 1975: Reproductive guilds of fishes: A proposal and definition. — *J. Fish. Res. Board Canada* 32: 821—864.
- Brett, C. E. 1964: A portable hydraulic diver-operated dredge-sieve for sampling subtidal macrofauna. — *J. Mar. Res.* 22: 205—209.
- Charles, W. N., East, K., Brown, D., Gray, M. C. & Murray, T. D. 1974: The production of larval Chironomidae in the mud at Loch Leven, Kinross. — *Proc. Roy. Soc. Edinburgh (B)* 74: 241—258.
- Edmondson, N. T. & Winberg, G. G. 1971: A manual on methods for the assessment of secondary productivity in fresh waters. — *IBP Handbook* 17. 358 pp. Oxford and Edinburgh.
- Ekdale, A. A. & Warne, J. E. 1973: A diver-operated dredge for collecting quantitative samples in soft sediments. — *J. Paleontol.* 47: 1119—1121.
- Elliott, J. M. 1977: Some methods for the statistical analysis of samples of benthic invertebrates. — *Freshwater Biol. Assoc., Sci. Publ.* 25: 1—156.
- Elliott, J. M. & Tullet, P. A. 1978: A bibliography of samplers for benthic invertebrates. — *Freshwater Biol. Assoc., Occ. Publ.* 4: 1—61.
- Eschmeyer, P. H. 1954: The reproduction of lake trout in Southern Lake Superior. — *Trans. Amer. Fish. Soc.* 84: 47—74.
- Flannagan, J. F. 1970: Efficiencies of various grabs and corers in sampling freshwater benthos. — *J. Fish. Res. Board Canada* 27: 1691—1700.
- Gale, W. F. & Thompson, J. D. 1975: A suction sampler for quantitatively sampling benthos on rocky substrates in rivers. — *Trans. Amer. Fish. Soc.* 104: 398—405.
- Gulliksen, B. & Deras, K. M. 1975: A diver-operated suction sampler for fauna on rocky bottoms. — *Oikos* 26: 246—249.
- Holme, N. A. & McIntyre, A. D. (eds.) 1971: *Methods for the study of marine benthos.* — *IBP Handbook* 16. 334 pp. Oxford and Edinburgh.
- Holopainen, I. J. & Sarvala, J. 1975: Efficiencies of two corers in sampling soft-bottom invertebrates. — *Ann. Zool. Fennici* 12: 280—284.
- Hopkins, T. L. 1964: A survey of marine bottom samplers. — *Progress in Oceanography* 2: 213—256.

- Kajak, Z. 1963: Analysis of quantitative benthic methods. — *Ekol. Polska* (A) 11: 1—56.
- Larsen, P. F. 1974: A remotely operated shallow water benthic suction sampler. — *Chesapeake Sci.* 15: 176—178.
- Mackey, A. P. 1972: An air-lift for sampling freshwater benthos. — *Oikos* 23: 413—415.
- Manz, J. 1964: A pumping device used to collect walleye eggs from offshore spawning areas in Western Lake Erie. — *Trans. Amer. Fish. Soc.* 93: 204—206.
- McIntyre, A. D. 1971: Deficiency of gravity corers for sampling meiobenthos and sediments. — *Nature*, Lond. 231: 260.
- Nelson, W. R. 1968: Reproduction and early life history of sauger, *Stizostedion canadense*, in Lewis and Clark Lake. — *Trans. Amer. Fish. Soc.* 97: 159—166.
- Nissinen, T. 1972: Mätitiheys ja mädin eloonjääminen muikun (*Coregonus albula* L.) kutupaikoilla Puravedessä ja Oulujärvessä (English summary: The egg density and survival of eggs on the spawning grounds of the vendace (*Coregonus albula* L.) in lakes Puruvesi and Oulujärvi). — Riista- ja kalatalouden tutkimuslaitoksen kalantutkimusosaston tiedonantoja 1: 1—114.
- Novak, P. S. & Sheets, W. 1969: Pumping device used to collect smallmouth bass fry. — *Progr. Fish. Cult.* 31 (4): 240.
- Pearson, R. G., Litterick, M. R. & Jones, N. V. 1973: An air-lift for quantitative sampling of the benthos. — *Freshwater Biol.* 3: 309—315.
- Prejs, A. 1969: Differences in abundance of benthos and reliability of its assessment in several lake habitats. — *Ekol. Polska* (A) 17: 133—147.
- Rawson, D. S. & Elsey, C. A. 1950: Reduction in the longnose sucker population of Pyramid Lake, Alberta, in an attempt to improve angling. — *Trans. Amer. Fish. Soc.* 78: 13—31.
- Sarvala, J. & Ranta, E. 1977: Performance of the Muus sampler in surveys of the brackish-water macrofauna. — *Ann. Zool. Fennici* 14: 191—197.
- Shumilov, I. P. 1970: Survival of eggs of the Baikal Omul (*Coregonus autumnalis migratorius* (Georgi)) in spawning grounds of the Kichera River and the effect of river flow and strength of year-classes. — *J. Ichthyol.* 11(2): 223—230.
- Smith, W. L. 1973: Submersible device for collecting small crustaceans. — *Crustaceana* 25: 104—105.
- True, M. A., Reys, J.-P. & Delauze, H. 1968: Progress in sampling the benthos: the benthic suction sampler. — *Deep-Sea Res.* 15: 239—242.
- Viljanen, M. 1978: Muikun populaatiodynamiikasta Suomenselällä. — In: Meriläinen, J. (ed.), Kalatuotantoon vaikuttavat tekijät luonnonvaraisessa dys-oligotrofisessa järvessä (Suomunjärvi, Lieksa). Loppuraportti 31.12.1978: 328—338. Joensuu.
- Viljanen, M. & Holopainen, I. 1981: Estimation of absolute population density of perch (*Perca fluviatilis* L.) at egg, larval and adult stages in a dysoligotrophic lake. — *Ann. Zool. Fennici* (in press).
- Vogele, L. E., Boyer, R. L. & Heard, W. R. 1971: A portable underwater suction device. — *Progr. Fish. Cult.* 33: 62—63.
- Zawisza, J. & Backiel, T. 1970: Gonad development, fecundity and egg survival in *Coregonus albula* L. — In: Lindsey, C. C. & Woods, C. S. (eds.), *Biology of coregonid fishes*: 363—397. University of Manitoba Press, Winnipeg, Canada.
- Zimmermann, U. von & Ambühl, H. 1970: Zur Methodik der quantitativen biologischen Probenahmen in stark strömenden Flüssen. — *Schweiz. Zeitschr. Hydrol.* 32: 340—344.
- Åarefjord, F. 1972: The use of an air-lift in freshwater bottom sampling. A comparison with the Ekman bottom sampler. — *Verh. Int. Verein. Theor. Angew. Limnol.* 18: 701—705.

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