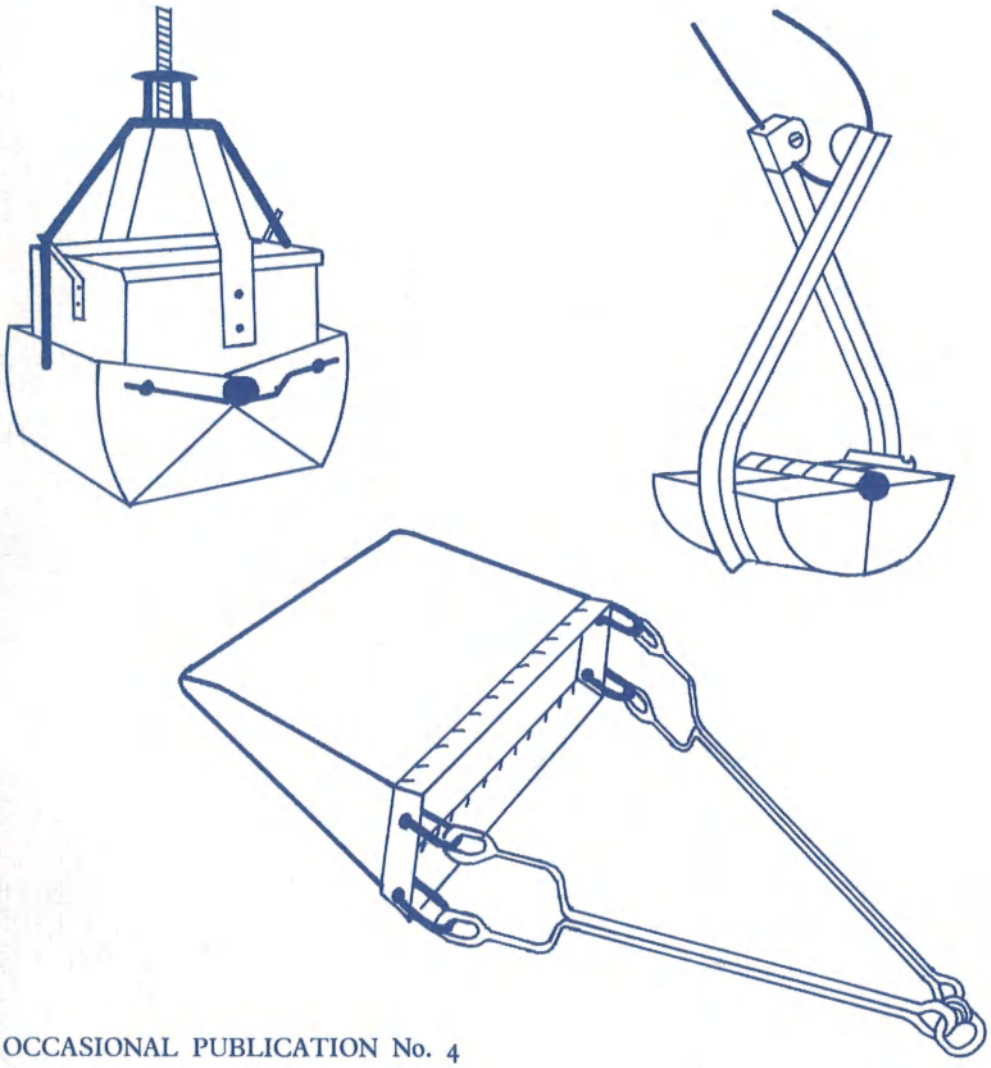
FRESHWATER BIOLOGICAL ASSOCIATION

A Bibliography of

SAMPLERS FOR BENTHIC INVERTEBRATES

J. M. Elliott & P. A. Tullett



OCCASIONAL PUBLICATION No. 4

A BIBLIOGRAPHY OF

SAMPLERS

FOR BENTHIC INVERTEBRATES

compiled by

J.M. Elliott & P.A. Tullett

Freshwater Biological Association

Occasional Publication No. 4

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Introduction

This annotated bibliography covers the literature to the end of November 1977 and includes references to samplers that could be used for the rapid removal of benthic invertebrates from the natural substrata of rivers and streams. The bibliography does not therefore include references to colonisation samplers using artificial or natural substrata, or to light traps, or to traps for catching drifting invertebrates, upstream -moving invertebrates and the emerging imagines of aquatic insects. Although sub-surface samplers that require colonisation of substrata in containers are excluded, tubes that are driven into the substratum to sample immediately the interstitial and hyporheal fauna are included in the section on small diameter corers (5.2). The bibliography also includes marine samplers that have been, or could be, used in freshwater. Although our coverage of Russian work is incomplete, we have included a selection of recent and important references. We will continue collecting references and will be pleased to receive copies or notifications of papers omitted and new publications.

We have seen nearly all the publications in this bibliography and the brief annotations include information on sampling area, mode of operation, or any other characteristics that we consider important. The review section is deliberately biased towards freshwater samplers and includes a selection of the more relevant publications on sampling marine benthos. References to samplers are divided into the following six major categories: net and quadrat samplers; scoops, shovels and dredges; grabs; corers; suction and air-lift samplers; electroshocking samplers. This classification of samplers according to type is continued within each of these sections except the last. The references to samplers have also been classified according to the mode of operation of the sampler (S = sampler limited to shallow water of wadeable depth; D = diver-operated sampler; R = sampler operated by remote control from above water surface), the type of substratum on which the sampler can be used (M = mud and soft sediments; C = coarse gravel; L = large stones; P = macrophytes), and the origin of the sampler (Mar = marine; FW = freshwater). This classification is based on the information supplied by the authors and we have assumed that the information is correct. Most of the foreign titles have been translated into English.

The number of references in each category is shown in the summary

table. There are more corers than any other kind of sampler and some of the small diameter corers may be unsuitable for benthos of rivers because of their small sampling area. Most of the remotely-controlled samplers can be used only on a muddy substratum and very few are suitable for a stony bottom (L in the table). Many of the marine samplers are very heavy and weights are included in the annotations where appropriate. These samplers would require a large boat and a power winch. Most of the diver-operated samplers are suction and air-lift samplers. Most of the references on efficiencies and comparisons are to work performed in the sea or in lakes. Section 9 lists samplers that are described only in the catalogue of the manufacturer.

We are pleased to acknowledge the help of Mr J.E.M. Horne who has checked all the references and has translated the titles of Russian publications. We also thank Mrs J. Hawksford for her care and patience in typing this bibliography, and the following for their useful comments on an earlier draft of this bibliography: J.S. Alabaster, Dr P.D. Armitage, Dr. A.D. Berrie, Dr. H. Décamps, A. Eleftheriou, M.T. Furse, T. Gledhill, T.R. Graham, H.A. Hawkes, J.C. Peters, M.S. Rolfe, Dr L.M. Skinner, F.S. Woodiwiss, Dr. J.F. Wright. Some of the cost of the research involved in the preparation of this bibliography has been met by the Department of the Environment as part of a contract to the Association (Contract No. DGR 480/329).

SUMMARY TABLE OF CLASSIFICATION OF REFERENCES ON SAMPLERS

		OPERATION		*SUBSTRATUM*				*ORIGIN*		
		S	R	M	C	L	P	Mar	FW	Total
2. Nets and quadrat samplers	2.1. Simple	34	3	3	21	21	15	2	33	35
	2.2. Diver operated			2	3	3	2	2	2	4
3. Scoops, shovels and dredges	3.1. Scoops	7	8	9	3			7	2	9
	3.2. Shovels	9			9	9			9	9
	3.3. Dredges	3	42	41	35	12	1	33	12	45
	3.4. Anchor dredges		6	6	6			6		6
4. Grabs	4.1. Ekman type		15	15	1			3	12	15
	4.2. Orange-peel type		5	5				4	1	5
	4.3. Petersen type		8	8				7	1	8
	4.4. Smith-McIntyre type		3	3	1			3		3
	4.5. Van-Veen type		5	5	2			5		5
	4.6. Other grabs	3	25	26	14		3	8	20	28
	4.7. Diver operated			1				1		1
5. Corers	5.2. Small diameter < 10 cm	25	82	107	6	3		55	52	107
	5.3. Large diameter ⩾ 10 cm	3	38	41	2			28	13	41
	5.4. Multiple		7	7				4	3	7
	5.5. Diver operated			4	1			1	3	4
6. Suction and air-lift samplers	6.1. Mud suckers		7	7				4	4	7
	6.2. Hydraulic suction samplers	1	7	8	6			7	1	8
	6.3. Air-lift samplers		4	4	4			2	2	4
	6.4. Diver operated hand suckers			3	4	4	3	4		4
	6.5. Diver operated hydraulic suction samplers			9	7	1	1	7	2	9
	6.6. Diver operated air-lift samplers			10	7	2		8	2	10
7. Electroshocking samplers		5		5	3	2			5	5
8. Efficiencies and comparisons								38	47	85

1. *REVIEWS*

[Some of these publications have only short sections dealing with bottom sampling].

1.1. FRESHWATER

Albrecht, M.L. (1959). Die quantitative Untersuchung der Bodenfauna fliessender Gewässer (Untersuchungsmethoden und Arbeitsergebnisse). (The quantitative study of the bottom fauna of flowing water) (In German). *Z. Fisch.* (N.F.) *8*, 481-550.

American Public Health Association, American Water Works Association, Water Pollution Control Federation (1976). *Standard methods for the examination of water and wastewater.* 14th edition. Washington. APHA. 1193 pp. [One short chapter describes a small number of bottom samplers]

Birge, E.A. (1921). A second report on limnological apparatus. *Trans. Wis. Acad. Sci. Arts Lett. 20*, 533-552.

Brinkhurst, R.O. (1967). Sampling the benthos. Great Lakes Inst., Univ. Toronto. PR 32.

Brinkhurst, R.O. (1974). *The benthos of lakes.* London. Macmillan, 190 pp. [One short chapter describes a small number of bottom samplers]

Cummins, K.W. (1962). An evaluation of some techniques for the collection and analysis of benthic samples with special emphasis on lotic waters. *Am. Midl. Nat. 67*, 474-504. [Contains a very brief review of bottom samplers]

Dittmar, H. (1955). Die quantitative Analyse des Fließwasser-Benthos. (The quantitative analysis of flowing water benthos) (In German). *Arch. Hydrobiol. (Suppl.) 22*, 295-300.

Edmondson, W.T. & Winberg, G.G. (1971). *A manual on methods for the assessment of secondary productivity in fresh waters.* IBP Handbook No. 17. Oxford. Blackwell. 358 pp. [Two sections describe a wide range of samplers]

Hellawell, J.M. (1977). *Biological surveillance of rivers.* Medmenham and Stevenage: Water Research Centre. [One chapter is a critical review of bottom samplers]

Hess, A.D. (1941). New limnological sampling equipment. *Spec. Publs. limnol. Soc. Am.*, 6, 1-5.

Hynes, H.B.N. (1970). *The ecology of running waters.* Liverpool, University Press. 555 pp. [Brief review of samplers in chapter on the quantitative study of benthic invertebrates]

Juday, C. (1926). A third report on limnological apparatus. *Trans. Wis. Acad. Sci. Arts Lett. 22*, 299-314.

Macan, T.T. (1958). Methods of sampling the bottom fauna in stony streams. *Mitt. int. Verein. theor. angew. Limnol. 8*, 1-21. [Limited to shallow, stony streams]

Mason, C.F. (1977). A bibliography of biological surveillance methodology for macro-invertebrates in running waters. *Tech. Memo. Wat. Data Unit* No. 14.

Schwoerbel, J. (1970). *Methods of hydrobiology.* Oxford. Pergamon. 200 pp. [Two chapters have sections describing a selection of samplers]

Slack, K.V., Averett, R.C., Greeson, P.E., & Lipscomb, R.G. (1973). Methods for collection and analysis of aquatic biological and microbiological samples. *Techniques of water-resources investigations of the United States Geological Survey*, Book 5, Chapter A4, 165 pp. [One section describes a selection of samplers]

Sly, P.G. (1969). Bottom sediment sampling. *Proc. 12th Conf. Gt Lakes Res.* 883-898. [Equipment trials and evaluation]

Southwood, T.R.E. (1966). *Ecological methods with special reference to the study of insect populations.* London. Methuen. [One chapter describes a selection of samplers]

Water Research Centre (1976). Biological monitoring and surveillance of rivers. *Notes Wat. Res.* No. 3, 4 pp.

Weber, C.I. (Ed.) (1973). Biological field and laboratory methods for measuring the quality of surface waters and effluents. *Environmental Monitoring Series, U.S. Environmental Protection Agency.* EPA 670/.4.73. 001. [One short chapter describes a small number of samplers]

Welch, P.S. (1948). *Limnological methods.* N.Y. McGraw-Hill. 381 pp. [One chapter describes a small number of samplers]

Wiederholm, T. (1972). Provtagnings- och analysmetodik vid bottenfaunaundersökingar. (Methods in sampling and analysis of bottom fauna). (In Swedish). *Meddn naturvards. limnol. Unders.* No. 50, 46 pp. *Scr. limnol. upsal. 8B*, 319.

Zhadin, V.I. (1956). Methods of study of the bottom fauna and the ecology of bottom invertebrates. (In Russian). Ch. 40 in *Zhizn presnykh Vod SSSR 4*, pt 1. (Ed. E.N. Pavlovskii & V.I. Zhadin) Moskva. AN SSSR 279-382.

Zhadin, V.I. (1960). *Methods of hydrobiological investigation.* (In Russian). Moskva, Vysshaya Shkola. 191 pp. (also in Polish as *Metody Badán Hydrobiologicznych* Warszawa 1966).

1.2. MARINE

Bouma, A.H. (1969). *Methods for the study of sedimentary structures.* N.Y. Wiley. 458 pp. [One chapter describes samplers, chiefly corers].

Deacon, G.E.R. (1962). *Oceans.* London, Hamlyn. 297 pp.

Hedgpeth, J.W. (1957). Obtaining ecological data from the sea. In *Treatise on marine ecology and paleoecology* Vol. 1. (Ed. J.W. Hedgpeth) *Mem. Geol. Soc. Am.* 67, 53-86 [This chapter is an extensive review with sections by G. Thorson on "Sampling the benthos" and G. Gunter on "Dredges and trawls"]

Holme, N.A. (1964). Methods of sampling the benthos. In *Advances in Marine Biology* Vol. 2. (Ed. F.S. Russell) London, Academic. 171-260 pp. [This chapter is a comprehensive account of sampling methods]

Holme, N.A. & McIntyre, A.D. (1971). *Methods for the study of marine benthos.* IBP Handbook No. 16. Oxford. Blackwell. 334 pp. [This is a good, recent account]

Hopkins, T.L. (1964). A survey of marine bottom samplers. In *Progress in oceanography* Vol. 2. (Ed. Mary Sears). N.Y. Pergamon. 213-256 pp.

Hough, J.L. (1939). Bottom sampling apparatus. In *Recent marine sediments* (Ed. P.D. Trask) Tulsa, U.S.A. Amer. Assoc. Pet. Geol.

Longhurst, A.R. (1959). The sampling problem in benthic ecology. *Proc. N.Z. ecol. Soc. 6*, 8-12.

Menzies, R.J. (1964). Improved techniques for benthic trawling at depths greater than 2000 meters. *Antarctic Research Series* Vol. 1. American Geophysical Union, 93-109.

1.3. FRESHWATER/MARINE

Lamotte, M. & Bourlière, F. (1971). *Problèmes d'écologie: l'échantillonnage des peuplements animaux des milieux aquatiques.* (Problems of ecology: the sampling of animal populations of aquatic environments) (In French). Paris. Masson. 294 pp. [Three chapters review sampling methods for freshwater and marine benthos]

2. *NETS AND QUADRAT SAMPLERS*

[operated by hand]

2.1. SIMPLE

2.1 a) *Invertebrates in mud and on stones.*

Calow, P. (1972). A method for determining the surface areas of stones to enable quantitative density estimates of littoral stonedwelling organisms to be made. *Hydrobiologia, 40,* 37-50.

Dunn, D.R. (1961). The bottom fauna of Llyn Tegid (Lake Bala), Merionethshire. *J. Anim. Ecol. 30,* 267-81 [Open-ended galvanized iron cylinder with sampling area of 828 cm^2] S, CL, FW

Dusoge, K. (1966). Composition and interrelations between macrofauna living on stones in the littoral of Mikolajskie Lake. *Ekol. pol. (A) 14,* 755-762. [Box sampler] S, CL, FW

Finnish IBP-PM Group (1969). Quantitative sampling equipment for the littoral benthos. *Int. Revue ges. Hydrobiol. Hydrogr. 54,* 185-93. [Square-quadrat box sampler with sampling area of 1109 cm^2] S, MCLP, Mar

Fricke, A.H. & Thum, A.B. (1976). A distance measuring wheel for estimating substrate surface area. *Trans. R. Soc. S. Afr. 42,* 185-191. [Determines area of substrata enclosed by quadrat sampler]

Frost, S., Huni, A. & Kershaw, W.E. (1971). Evaluation of a kicking technique for sampling stream bottom fauna. *Can. J. Zool. 49,* 167-73. [Square-framed conical net with aperture of 300 µm] S, CL, FW

Geijskes, D.C. (1935). Faunistisch-ökologische Untersuchungen am Röserenbach bei Liestal im Baseler Tafeljura. (Faunistic-ecological studies on the Röseren stream near Liestal in Baseler Tafeljura) (In German). *Tijdschr. Ent. 78,* 251-382. [Calculated surface area of stones sampled by cylinder of Neill, 1938] S, CL, FW

Hess, A.D. (1941). New limnological sampling equipment. *Spec. Publs. limnol. Soc. Am.,* 6, 1-5. [Cylindrical cage covered with coarse gauze (aperture 4.2 mm) and with sampling area of 929 cm^2; collecting net (9 meshes cm^{-1}) attached to downstream side] S, CL, FW

Husmann, S. (1956). Untersuchungen über die Grundwasserfauna zwischen Harz und Weser. (Studies on the groundwater fauna between the Harz mountains and the river Weser) (In German). *Arch. Hydrobiol. 52,* 1-184. [Sieve-like telescopic metal cylinder driven into hole excavated in the substratum; interstitial animals washed out of substratum and into cylinder] S, CL, FW

Jónasson, P.M. (1948). Quantitative studies of the bottom fauna. In Berg, Biological studies on the River Susaa. *Folia limnol scand. 4,* 203-84. [Box sampler with sampling area of 450 cm^2] S, CL, FW

Kangas, P. (1972). Quantitative sampling equipment for the littoral benthos. *IBP i Norden 10,* 9-16. [Square-quadrat box sampler with sampling area of 1109 cm^2] S, MCLP, Mar

Lane, E.D. (1974). An improved method of Surber sampling for bottom and drift fauna in small streams. *Progve Fish Cult. 36*, 20-22. [Surber sampler has an inner coarse net (9 meshes cm^{-1}) and an outer fine net (29 meshes cm^{-1})] S, CL, FW

Morgan, N.C. & Egglishaw, H.J. (1965). A survey of the bottom fauna of streams in the Scottish Highlands, Part I. Composition of the fauna. *Hydrobiologia 25*, 181-211. [Kicking technique with pond net] S, CL, FW

Mundie, J.H. (1971). Sampling benthos and substrate materials, down to 50 microns in size, in shallow streams. *J. Fish. Res. Bd Can. 28*, 849-60. [Box sampler with adjustable upstream inlet and downstream, two nested nets (apertures 600 μm and 50 μm); sampling area 0.18 m^2] S, CL, FW

Neill, R.M. (1938). The food and feeding of the brown trout (*Salmo trutta* L.) in relation to the organic environment. *Trans. R. Soc. Edinb. 59*, 481-520. [Cylinder sampler with sampling area of 1000 cm^2 and depth penetration of 5 cm] S, CL, FW

Prater, B.L. (1968). Sampling box for shallow water use. *Bio-Science 18*, 326. [Box sampler with sampling area of 929 cm^2] S, CL, FW

Scott, D. (1958). Ecological studies on the Trichoptera of the River Dean, Cheshire. *Arch. Hydrobiol. 54*, 340-92. [Used metal quadrat (25 x 25 cm, depth 5 cm) pushed into substratum, and pond net] S, CL, FW

Slack, K.V. (1955). A study of the factors affecting stream productivity by the comparative method. *Invest. Indiana Lakes Streams. 4*, 3-47. [Enclosed sides and front of Surber sampler with wire mesh and used paddle to stir up enclosed substrata] S, CL, FW

Surber, E.W. (1934). *A quantitative net for collecting bottom animals in streams*. Washington, Bureau of Fisheries. 1-4. [Describes in detail the construction of a Surber sampler; sampling area 929 cm^2 (1 sq. foot), mesh size 9 meshes cm^{-1}] S, CL, FW

Surber, E.W. (1937). Rainbow trout and bottom fauna production in one mile of stream. *Trans. Am. Fish. Soc. 66*, 193-202. [Brief description and drawing of Surber sampler] S, CL, FW

Surber, E.W. (1970). Procedures in taking stream bottom samples with the stream square foot bottom sampler. *Proc. a. Conf. SEast Ass. Game Fish. Commn 23* (1969), 587-591.

Waters, T.F. & Knapp, R.J. (1961). An improved stream bottom fauna sampler. *Trans. Am. Fish. Soc. 90*, 225-226. [Cylindrical cage covered with netting (aperture 471 μm) and with sampling area of 929 cm^2; collecting net attached to downstream side of cage. Sampler similar to that of Hess 1941] S, CL, FW

Whitley, L.S. (1962). New bottom sampler for use in shallow streams. *Limnol. Oceanogr. 7*, 265-6. ['Bucket' circular quadrat sampler with sampling area of 500 cm^2] S, M, FW

Wilding, J.L. (1940). A new square foot aquatic sampler. *Spec. Publs. limnol. Soc. Am.* No. 4, 1-4. [Outer cylinder with sampling area of 929 cm^2 is first driven into substratum, then large stones are washed and removed. Inner cylinder with valve bottom is inserted, then valve is closed and inner cylinder containing the sample is removed (mesh size of inner cylinder 9 meshes cm^{-1})] S, CL, FW

Withers, J.D. & Benson, A. (1962). Evaluation of a modified Surber bottom fauna sampler. *Proc. W. Va Acad. Sci. 34*, 16-20.

2.1 b) *Invertebrates on macrophytes*

Andrews, J.D. & Hasler, A.D. (1944). Fluctuations in the animal populations of the littoral zone in Lake Mendota. *Trans. Wis. Acad. Sci. Arts Lett. 35*, 175-186. [Plants enclosed by canvas bag with zip in side to allow operator to reach in and detach plants from bottom; mouth of bag can be closed so that sample is removed from water; sampling area 0.5 m^2] S, P, FW

But, V.I. (1938). Quantitative drag for the investigation of the benthos of weed-beds in water-bodies. (In Russian). *Dokl. Akad. Nauk SSSR, 14.* [Pair of movable knives are pulled towards pair of fixed knives and pull a bag of bolting cloth behind them. Sample is thus enclosed in a bag] S, P, FW

Forsberg, C. (1959). Quantitative sampling of subaquatic vegetation. *Oikos 10*, 233-240. [Cuts vegetation from 1 dm^2; may also sample invertebrates but sampler will not prevent some invertebrates from escaping] S, P, FW

Garnett, P.A. & Hunt, R.H. (1965). Two techniques for sampling freshwater habitats. *Hydrobiologia 26*, 114-20. [Cylindrical sampler with cutting blade at bottom and sampling area of 0.033 m^2; modified Ekman grab with one jaw sharpened and sampling area of 0.050 m^2; both samplers used for sampling molluscs] SR, P, FW

Gerking, S.D. (1957). A method of sampling the littoral macrofauna and its application. *Ecology 38*, 219-266. [Box sampler with closing bottom; plants have to be cut manually] S, P, FW

Gillespie, D.M. & Brown, C.J.D. (1966). A quantitative sampler for macroinvertebrates associated with aquatic macrophytes. *Limnol. Oceanogr. 11*, 404-406. [Plants enclosed in a vertical bag and the open bottom of the bag is closed with a sliding door fitted with blades; cutter is operated from above the water surface; sampling area 0.1 m^2] S, P, FW

Grøntved, J. (1957). A sampler for underwater macrovegetation in shallow waters. *J. Cons. perm. int. Explor. Mer, 22*, 293-297. [Cylindrical sampler with vertical and horizontal cutters] S, P, FW

Howard-Williams, C. & Longman, T.G. (1976). A quantitative sampler for submerged aquatic macrophytes. *J. limnol. Soc. Sth. Afr. 2*, 31-33. [Rotary cutter with lower blades and hooks to entangle plants; sampling area 625 cm^2; samples to depth of 3 m; designed for sampling macrophytes but could be used for sessile invertebrates on macrophytes] R, P, FW

Kořínková, J. (1971). Sampling and distribution of animals in submerged vegetation. *Vest. csl. Spol. zool. 35*, 209-221. [Box, 1 x 1 x 1.25 m, to enclose plants and with sliding bottom to close box, plants torn off substratum by hand] S, P, FW

Kutikova, L.A. (1974). A modified sampler for collecting the microfauna on shallows and in aquatic plants. (In Russian). *Inf. Byull. Biol. vnutr. Vod*, No. 22, 61-63. S, P, FW

McCauley, V.J.E. (1975). Two new quantitative samplers for aquatic phytomacrofauna. *Hydrobiologia 47*, 81-89. [Describes two tube samplers, each with a cutting blade at the base; one cylinder is 50 cm high with diameter of 30 cm, the other is 75 cm long with diameter of 10 cm; latter sampler used for sampling rushes and bullrushes] S, P, FW

Mackie, G.L. & Qadri, S.U. (1971). A quantitative sampler for aquatic phytomacrofauna. *J. Fish. Res. Bd Can. 28*, 1322-1324. [Plants enclosed in vertical box and open bottom of box is closed with a shutter carrying a cutter that is operated by dropping a messenger; sampler was used at depths down to 2 m] SR, P, FW

Minto, M.L. (1977). A sampling device for the invertebrate fauna of aquatic vegetation. *Freshwat. Biol. 7*, 425-430. [Pole-mounted open-ended box that is closed by bottom shutter with a cutting blade; sampling area 175 cm^2] S, P, FW

2.2. DIVER-OPERATED

Finnish IBP-PM Group (1969). Quantitative sampling equipment for the littoral benthos. *Int. Revue ges. Hydrobiol. Hydrogr. 54*, 185-93. [Similar samplers are also described in Kangas (1972), see 2.1 a)] [Describes Tvärminne cylindrical sampler with cutting plate inserted at base and sampling area of 270 cm^2; square-quadrat box sampler with sampling area of 1109 cm^2 is modified in Kangas (1972) for use in deep water]

Gale, W.F. & Thompson, J.D. (1974). Aids to benthic sampling by SCUBA divers in rivers. *Limnol. Oceanogr. 19*, 1004-1007. [Describes submersible raft and anchoring device for divers in rivers]

Gilligan, M.R. (1976). Small marine animal collector for use by divers. *Progve Fish Cult. 38*, 40-41. [Plexiglass tube with piston; animals sucked in when piston withdrawn and then pushed into collecting net when piston returned] D, CL, Mar

Gray, R.H. & Neitzel, D.A. (1976). Surber sampling in deep water for bottom organisms. *Progve Fish Cult. 38*, 142-143. [Folding Surber sampler with extra bag for large stones] D, CL, FW

Nygaard, G. (1958). On the productivity of the bottom vegetation in Lake Langsø. *Verh. int. Verein. theor. angew. Limnol. 13*, 144-155. [Cylinder sampler with closed top is pushed to depth of 20 cm into the substratum, then bottom is closed manually with iron disc; sampling area 0.05 m^2] D, MP, FW

3. *SCOOPS, SHOVELS AND DREDGES*

3.1. SCOOPS

[Samplers that scoop sediment with a rotating container]

Conrad-Stork, B.V. (not dated). Offshore sampling and prospecting equipment. *Offshore Drilling News 1*, 2 pp. [Describes Duits- "Hamon"-grab, really a scoop that rotates 120° and penetrates about 20 - 30 cm to take 36 litres of substratum; scoop mounted on large frame] R, MC, Mar

Dendy, J.S. (1944). The fate of animals in stream drift when carried into lakes. *Ecol. Monogr. 14*, 333-57. [Brass cylinder with mesh bottom is pushed about 12 cm into mud, then inverted and removed; sampling area 48 cm^2] SR, M, FW

Gilson, G. (1906). Description d'un sondeur - collecteur et remarques sur le prélèvement d'échantillons du fond de la mer. (Description of a collecting-probe and notes on the taking of samples from the bottom of the sea) (In French). *Publs Circonst. Cons. perm. int. Explor. Mer 35*, 3-12. [Hemispherical scoop, diameter 20 cm, fixed to iron rod and closed by lid; operates best in fine-grain sediments and shallow water] S, M, Mar

Holme, N.A. (1949). A new bottom sampler. *J. mar. biol. Ass. U.K. 28*, 323-332. [Semi-circular scoop rotates 180° to sample area of about 0.05 m^2 to depth of 15 cm; sampler and large frame weighs 45 kg and is usually weighted in use to about 110 kg] SR, MC, Mar

Holme, N.A. (1953). The biomass of the bottom fauna in the English Channel off Plymouth. *J. mar. biol. Ass. U.K. 32*, 1-49. [Two rotating scoops reduce movement of sampler and take two samples, each from about 0.05 m^2 to depth of about 15 cm; total weight in operation is about 115 kg] SR, MC, Mar.

Hydro Products (not dated). The Shipek sediment sampler. *Hydro Products Spec. Bull.* 3 pp. [Semi-circular scoop rotates 180° to sample area of about 0.04 m^2 to depth of about 10 cm; scoop activated by two large springs; weight about 70 kg] SR, MC, Mar

Lugn, A.L. (1927). Sedimentation on the Mississippi River. *Augustana Library Publ. 2*, 102 pp. [Weighted cup scoops a sample of mud (volume 170 cm^3) from a uniform depth; weight 5 kg] SR, M, FW

Stetson, H.C. (1938). The sediments of the continental shelf of the eastern end of the United States. *Pap. phys. Oceanogr. Met. 5*, 1-48. [Describes Stetson-Iselin scoop: a curved tube (diam. 5 cm) rotated by gears cuts into sediment and seals it; weight about 45 kg] SR, M, Mar

Thomson, C.W. (1877). *The voyage of the 'Challenger'. The Atlantic. A preliminary account of the general results of the exploring voyage of H.M.S. Challenger*. Vol. 1 London. Macmillan. [Describes Fitzgerald sediment scoop: a cup on the end of a weighted arm rotates through the sediment until it contacts a cup cover plate; takes only a small sample] R, M, Mar

3.2. SHOVELS

[Samplers that are pushed through the substratum for a fixed distance and are therefore limited to shallow water]

Allen, K.R. (1940). Studies on the biology of the early stages of the salmon (*Salmo salar*), 1. Growth in the River Eden. *J. Anim. Ecol. 9*, 1-23. [Describes shovel sampler, 30.5 cm wide and sampling an area of 0.185 m^2 to depth of 7.5 cm] S, CL, FW

Dittmar, H. (1955). Ein Sauerlandbach. (A stream in Sauerland) (In German). *Arch. Hydrobiol. 50*, 305-552. [Describes shovel sampler that looks like a dust-pan with wire mesh (aperture 0.1 mm) over top and bottom] S, CL, FW

Hynes, H.B.N. (1961). The invertebrate fauna of a Welsh mountain stream. *Arch. Hydrobiol. 57*, 344-388. [Describes draw-hoe type sampler that samples an area of 600 cm^2 to depth of 4 cm; nets consist of outer fine net (40 threads cm^{-1}) and inner string bag to retain large stones] S, CL, FW

Macan, T.T. (1958). Methods of sampling the bottom fauna in stony streams. *Mitt. int. Verein. theor. angew. Limnol. 8*, 1-21. [Describes shovel sampler that samples an area of 0.05 m^2 (width 22.5 cm); nets consist of outer fine net (68 threads cm^{-1}) and inner coarse net to retain large stones] S, CL, FW

Moon, H.P. (1935). Methods and apparatus suitable for an investigation of the littoral region of oligotrophic lakes. *Int. Revue ges. Hydrobiol. Hydrogr. 32*, 319-333. [Describes sampler that is a cross between a scoop and a shovel; used for sampling littoral benthos in lakes] S, CL, FW

Percival, E. & Whitehead. H. (1926). Observations on the biology of the mayfly *Ephemera danica* Müll. *Proc. Leeds phil. lit. Soc. 1*, 136-148. [Describes shovel sampler, similar to that of Macan (1958)] S, CL, FW

Prater, B.L., Barton, D.R. & Olive, J.H. (1977). New sampler for shallow-water benthic macroinvertebrates. *Progve Fish Cult. 39*, 57-8. [Sampler looks like a box mounted on a shovel] S, CL, FW

Scott, W., Hile, R.O. & Spieth, H.T. (1928). A quantitative study of the bottom fauna of Lake Wawasee (Turkey Lake). *Invest. Indiana Lakes Streams 1*, 5-25. [Metal frame (20 cm x 50 cm x 12 cm deep) inserted into substratum to depth of 6 cm; hoe dredge then used to remove substratum enclosed by frame] S, CL, FW

Wundsch, H.H. (1924). Die quantitative Untersuchung der Bodenfauna und -flora in ihrer Bedeutung für die theoretische und angewandte Limnologie. (The quantitative study of the bottom fauna and flora, and their significance in theoretical and applied limnology) (In German). *Verh. int. Verein. theor. angew. Limnol. 2*, 13-59. [Brief description of D-shaped and triangular shovel samples; no figures] S, CL, FW

3.3. DREDGES

[Samplers that are dragged across and dig into the bottom to obtain a sample]

Allen, D.M. & Inglis, A. (1958). A pushnet for quantitative sampling of shrimp in shallow estuaries. *Limnol. Oceanogr. 3*, 239-241. [Hand operated sledge dredge used to catch shrimps in stiff, rooted vegetation] S, MP, Mar

Baird, R.H. (1955). A preliminary report on a new type of commercial escallop dredge. *J. Cons. perm. int. Explor. Mer, 20*, 290-294. R, MC, Mar.

Beauchamp, R.S.A. (1932). A new dredge. *Int. Revue ges. Hydrobiol. Hydrogr. 27*, 467-469. [The position of a tow net, suspended between and slightly above a pair of metal runners, can be altered, depending on the type of substratum] R, MCL, FW

Bervas, J.Y., Potin, L. & Reyss, D. (1973). Realisation d'une draque epibenthique à fermeture automatique. (Construction of an epibenthic dredge with an automatic closing device) (In French). Document interne CNEXO, Brest (Unpublished report.) R, MC, Mar

Bieri, R. & Tokioka, T. (1968). Dragonet 11, an opening-closing quantitative trawl for the study of micro-vertical distribution of zooplankton and the meio-epibenthos. *Publs Seto mar. biol. Lab. 15*, 373-390. [Dredge fitted with flow-meter and pedometer] R, MC, Mar

Boillot, G. (1964). Géologie de la Manche occidentale. Fonds rocheux, dépôts quaternaires, sédiments actuels. (Geology of the western English Channel. Rocky bottom, quaternary deposits, actual sediments) (In French). *Annls Inst. océanogr. 42*, 1-219. [Describes Rallier-du-Baty dredge, a robust mushroom-shaped instrument with a strong net lined with sacking] R, MCL, Mar

Bonomi, G. (1969). The use of a new version of the Tonolli mud burrower for sampling low density benthonic populations. *Verh. int. Verein. theor. angew. Limnol. 17*, 511-515. [Improved version of Tonolli (1962)] R, M, FW

Borley, J.O. (1923). The marine deposits of the southern North Sea. *Fishery Invest., Lond.* Ser. 2, *4*, 73 pp. [Conical dredge fitted with canvas bag; length of frame 86 cm, mouth diameter 43 cm, weight 22 kg] R, MCL, Mar.

Bourcart, J. & Boillot, G. (1960). La répartition des sédiments dans la Baie du Mont-Saint-Michel. (The distribution of sediments in the bay of Mont-Saint-Michel). (In French). *Revue Geogr. phys. Geol. dyn. 3*, 189-99. [Weighted, all metal, conical dredge with rigid arms instead of chains] R, MCL, Mar

Bryant, G. (1974). A wheeled device for sampling the biota of a concrete lined canal. *Calif. Fish Game 60*, 97-99. [Specialised dredge; box on wheels operated by cable from the bank and scrapes sample from substratum, weight 18 kg] R, FW

Butler, T.H. & Sheldon, R.W. (1969). Trawl-board sediment sampler. *J. Fish. Res. Bd Can. 26*, 2751-3. [Steel pipe fixed at about 40° above an oval hole in the shoe of an otter board on a trawl] R, M, Mar

Castagna, M. (1967). A benthic sampling device for shallow water. *Limnol. Oceanogr. 12*, 357-359. [Square-framed dredge with adjustable cutter bar and water pipes in front of sampler; jets of water cut through the substratum in front of the blade and wash it into the bag] R, MC, Mar

Clarke, A.H. (1972). The arctic dredge, a benthic biological sampler for mixed boulder and mud substrates. *J. Fish. Res. Bd Can. 29*, 1503-5. [Very large, kite-shaped dredge; width 1 m, length 2 m, weight 408 kg] R, MC, Mar

Corey, S. & Craib, J.S. (1966). A new quantitative bottom sampler for microfauna. *J. Cons. perm. int. Explor. Mer. 30*, 346-353. [Improved version of dredge of Muus, 1964; new dredge closes automatically, samples a surface area of 0.05 m^2 to depth of 3 cm] R, MC, Mar

Ekman, S. (1947). Ueber die Festigkeit der marinen Sedimente als Faktor der Tierverbreitung, ein Beitrag zur Associations Analyse. (On the firmness of marine sediment as a factor in animal distribution, a contribution to association analysis) (In German). *Zool. Bidr. Upps. 25*. [Dredge with four rakes in front of rectangular mouth] R, MCL, Mar

Elster, H.J. (1933). Eine Schlittendredge. *Int. Revue ges. Hydrobiol. Hydrogr. 29*, 290-2. [Sledge dredge with rake in front of rectangular mouth (30 x 50 cm)] R, MCL, FW

Emery, K.O. & Champion, A.R. (1948). Underway bottom sampler. *J. sedim. Petrol. 18*, 30-33. [Torpedo-shaped dredge that digs into bottom; length 38 cm, weight 5 kg] R, MC, Mar

Fast, A.W. (1968). A drag dredge. *Progve Fish Cult. 30*, 57-61. [Tubular dredge that separates benthos from sediments] R, MCL, FW

Fowler, G.H. & Allen, E.J. (1928). *Science of the Sea*. (2nd edn). Oxford. Clarendon. 502 pp. [Describes Ball's simple rectangular dredge, very similar to Naturalist's dredge (Holme & McIntyre 1971)] R, MC, Mar

Franklin, A. & Pickett, G.D. (1972). Introduction of the hydraulic cockle dredge. *Commercial Fishing 3*, 18-22. [Specialised dredge for commercial fishing] R, MC, Mar

Frolander, H.F. & Pratt, I. (1962). A bottom skimmer. *Limnol. Oceanogr. 7*, 104-6. [Sledge-dredge which does not collect sediment but samples the water immediately above the mud layer, and collects animals in the upper layer of mud and in the water just above the mud] R, M, FW

Gunter, G. (1957). Dredges and trawls. In *Treatise on marine ecology and paleoecology*, Vol. 1. (ed. J.W. Hedgpeth). *Mem. geol. Soc. Am. 67*, 73-80. [Very short and selective review]

Gustafson, G. (1934). On the Thalassinidae of the Swedish west coast. *Ark. Zool. 28*, 1-19. [Describes heavy ring dredge for sampling burrowing Crustacea] R, M, Mar

Hessler, R.R. & Sanders, H.L. (1976). Faunal diversity in the deep sea. *Deep-Sea Res. 14*, 65-78 [Large sledge-dredge with closing mouth, weight 160 kg] R, MCL, Mar

Holme, N.A. & McIntyre, A.D. (1971). *Methods for the study of marine benthos*. IBP Handbook No. 16. 334 pp. Oxford. Blackwell. [Detailed description of Riley push-net and Naturalist's rectangular dredge, as supplied by the Marine Biological Lab., Plymouth] R, MC, Mar

Howard, A.E. (1976). A comparison of some new methods for surveying large areas of cockles (*Cardium edule*). *Tech. Rep. Fish. Lab. Lowestoft* No. 30. 8 pp. [Describes Burnham cockle dredge, weight 50 kg] R, MC, Mar

Kamler, E. & Riedel, W. (1960). A method of quantitative study of the bottom fauna of Tatra streams. *Polskie Archwm Hydrobiol. 21*, 95-105. [Small hand-operated dredge used in small streams] S, CL, FW

Karling, T.G. (1937). Ein Apparat zum Auffangen von Kleintieren des Meeresbodens. (An apparatus for catching the small animals at the bottom of the sea) (In German) *Acta Soc. Fauna Flora fenn. 60*, 387-391. ['Bottom-plane' dredge with adjustable scoop that digs into the sand or mud; the width of the sampling aperture can be varied between 0.5 and 3 cm] R, M, Mar.

MacGinitie, G.E. (1948). Dredges for use at marine laboratories. *Turtox News 26*, (12), 280-1. [Very brief description of several marine dredges] R, MC, Mar

Menzies, R.J. (1964). Improved techniques for benthic trawling at depths greater than 2000 meters. *Antarctic Research Series* Vol. 1. American Geophysical Union, 93-109. [Describes small dredge with mouth 100 cm wide and 10 cm high; 3 m-long bag is protected by angle-iron frame] R, MC, Mar

Mortensen, T.H. (1925). An apparatus for catching the microfauna of the sea bottom. *Vidensk. Meddr. dansk naturh. Foren. 80*, 445-451. [Sledge dredge improved later by Ockelmann (1964)] R, MC, Mar

Muus, B. (1964). A new quantitative sampler for the meiobenthos. *Ophelia 1*, 209-216. [Small dredge with sampling area of 150 cm^2 to depth of 2-3 cm, weight 25-30 kg, closing mouth] R, MC, Mar

Nalwalk, A.J., Hersey, J.B., Reitzel, J.S. & Edgerton, H.E. (1962). Improved techniques of deep-sea rock dredging. *Deep-Sea Res. 8*, 301-302. R, CL, Mar.

Ockelmann, K.W. (1964). An improved detritus-sledge for collecting meiobenthos. *Ophelia 1*, 217-222. [Sledge dredge based on that of Mortensen (1925)] R, MC, Mar

Pickett, G.D. (1973). The impact of mechanical harvesting on the Thames Estuary cockle fishery. *Lab. Leafl. Fish. Lab. Lowestoft* (New Series) No. 29. 22 pp. [Describes hydraulic dredge used for commercial fishing for cockles] R, MC, Mar.

Pullen, E.J., Mock, C.R. & Ringo, R.D. (1968). A net for sampling the intertidal zone of an estuary. *Limnol. Oceanogr. 13*, 200-202. [Sledge dredge for capturing shrimps] S, M, Mar

Richardson, R.E. (1921). The small bottom and shore fauna of the Middle and Lower Illinois River and its connecting lakes, Chillicothe to Grafton: its valuation; its sources of food supply; and its relation to the fishery. *Bull. Ill. St. nat. Hist. Surv. 13*, 363-522. [Describes dredge similar to Naturalist's dredge (Holme & McIntyre, 1971)] R, MC, FW

Riedl , R. (1955). Aufsammlung tiefer Meeresböden in abgegrenzten Schichten und Flächen. (On sampling the upper layers and surface of the sea bottom in deep water) (In German). *Arch. Hydrobiol. 51*, 189-208. [Sledge-dredge similar to, but more elaborate than, that described by Bieri & Tokioka (1968)] R, MC, Mar

Robertson, D. (1868). On marine dredging. *Proc. nat. Hist. Soc. Glasg. 1*, 179-88. [Bucket dredge, diameter 20 cm and length 38 cm, digs into mud until full and takes about 8 l of mud] R, M, Mar

Ruello, N.V. (1975). A small beam trawl for sampling surface or demersal and benthic animals. *Bull. Aust. Soc. Limnol.* No. 6, 9-16. [Mouth of net is 1.2 m wide; originally used to sample prawns in an estuary] R, MC, FW

Smith, J.E. (1932). The shell gravel deposits, and the infauna of the Eddystone grounds. *J. mar. biol. Ass. U.K. 18*, 243-278. [Conical dredge with canvas bag] R, MC, Mar

Steiner, G. (1919). Untersuchungsverfahren und Hilfsmittel zur Erforschung der Lebewelt der Gewässer. (Study methods and aids for the investigation of water life) (In German). *Handbuch der Mikroskop. Technik.* pt. 7 & 8, 1-148. [Describes the dredges of Forel and Steinmann] R, MCL, FW

Taylor, J.L. (1965). Bottom samplers for estuarine research. *Chesapeake Sci. 6*, 233-234. [Describes a bucket dredge and a bottom drag] R, MC, Mar

Thomson, C.W. (1873). *The depths of the sea.* London. Macmillan. 527 pp. [Describes O.F. Müller's dredge, first described in 1779] R, MC, Mar

Tonolli, V. (1962). Nuovi strumenti per la raccolta e la separazione dei popolamente bentonici. (A new instrument for the collection and separation of benthic populations) (In Italian). *Pubbl. Staz. zool. Napoli, 32* (Suppl.), 20-29. [Large cylinder rotates as it is pulled along the bottom and takes in sediment through a small opening; modified slightly by Bonomi (1969)] R, M, FW

Usinger, R.L. & Needham, P.R. (1956). A drag type riffle-bottom sampler. *Progve Fish Cult. 18*, 42-44. [Dredge with rectangular mouth, 46 cm wide by 13 cm high, and with rakes along mouth] R, CL, FW

3.4. ANCHOR DREDGES

[Samplers that dig in at one place and are not towed along]

Carey, A.G. & Hancock, D.R. (1965). An anchor-box dredge for deep-sea sampling. *Deep-Sea Res. 12*, 983-984. R, MC, Mar

Forster, G.R. (1953). A new dredge for collecting burrowing animals. *J. mar. biol. Ass. U.K. 32*, 193-8. [Digs to depth of about 20 cm, mouth of net 45 cm wide and 24 cm high, weight 35 kg] R, MC, Mar

Holme, N.A. (1961). The bottom fauna of the English Channel. *J. mar. biol. Ass. U.K. 41*, 397-461. [Double-sided anchor dredge that does not dig as deep as Forster's and that tends to drag through the sediment] R, MC, Mar

Sanders, H.L. (1956). Oceanography of Long Island Sound, 1952-1954. 10. The biology of marine bottom communities. *Bull. Bingham oceanogr. Coll. 15*, 345-414. [Double-sided anchor dredge penetrates to depth of 7.6 cm] R, MC, Mar

Sanders, H.L., Hessler, R.R. & Hampson, G.R. (1965). An introduction to the study of deep-sea benthic faunal assemblages along the Gay Head-Bermuda transect. *Deep-Sea Res. 12*, 845-867. [Double-sided anchor dredge with two heavy-angled digging plates, penetrates to depth of 11 cm, weight 225 kg] R, MC, Mar

Thomas, M.L.H. (1960). A modified anchor dredge for collecting burrowing animals. *J. Fish. Res. Bd Can. 17*, 591-4. [Adjustable anchor dredge with wire gauze to sift the sediment as it is towed along; really a deep-digging dredge] R, MC, Mar

4. *GRABS*

[Samplers with jaws that are forced shut by weights, lever arms, springs, or cords]

4.1. EKMAN-TYPE

[Box-shaped sampler with two scoop-like jaws]

Alsterberg, G. (1922). Om provtagning med Ekman's bott-hämtare. (On trials with Ekman's bottom grab) (In Swedish). *Skr. söd. Sver. Fisk För.* R, M, Mar.

Bacescu, M. (1957). Apucatorul-sonda pentru studiul cantitativ al organismelor de fundun aparat mixt pentru colectarea simulanta a macro- si microbentosului. (A grab-corer for the quantitative study of benthic organisms, a dual apparatus for sampling macro- and micro-benthos at the same time) (In Roumanian). *Bul. Inst. Cerc. pisc. 16*, 69-82. [Large grab enclosing a square corer; sampling area 0.1 m^2 for grab, 100 cm^2 for corer] R, M, Mar

Berg, K. (1938). Studies on the bottom animals of Esrom Lake. *K. danske vidensk. Selsk. Skr. 8*, 259 pp. [Ekman grab on pole with lower end modified to release closing mechanism] R, M, FW

Borutskii, E.V. (1935). Vertical distribution of benthos in open-water lake sediments and the significance of this factor in assessing the food-value of water-bodies. (In Russian). *Trudy limnol. Sta. Kosine 20*, 129-49. [Tall grab for very soft mud] R, M, FW

Burton, W. & Flannagan, J.F. (1973). An improved Ekman-type grab. *J. Fish. Res. Bd Can. 30*, 287-290. [Has weighted top lids, kept open during descent] R, M, FW

Deevey, E.S. & Bishop, J.D. (1942). A fishery survey of important Connecticut lakes: Limnology. *Bull. Conn. St. geol. nat. Hist. Surv. 63*, 69-121. [Grab on pole, jaws closed by rope operated levers] R, M, FW

Ekman, S. (1911). Neue Apparate zur qualitativen und quantitativen Erforschung der Bodenfauna der Seen. (New apparatus for the qualitative and quantitative investigation of the bottom fauna of lakes) (In German) *Int. Revue ges. Hydrobiol. Hydrogr. 3*, 553-561. [Original description of grab] R, M, FW

Ekman, S. (1933). Über einen neuen Bodengreifer für marinzoologische Zwecke nebst Bemerkungen über die limnologische Bodengreifermethodik. (On a new bottom grab for marine zoology with observations on the methodology of bottom grabs in limnology) (In German). *Int. Revue ges. Hydrobiol. Hydrogr. 28*, 312-329. [Heavier marine version of Ekman grab] R, M, Mar

Hrbaček, J. (ed.) (1962). *Hydrobiologicke metody.* (Hydrobiological methods) (In Czech). Praha, 130 pp. [Grab on pole, used in shallow water with harder sediments] R, MC, FW

Lenz, F. (1931). Untersuchung über die Vertikalverteilung der Bodenfauna im Tiefensediment von Seen. Ein neuer Bodengreifer mit Zerteilungsvorrichtung. (Studies on the vertical distribution of the bottom fauna of the profundal sediments of lakes. A new bottom grab with a dividing mechanism) (In German). *Verh. int. Verein. theor. angew. Limnol. 5*, 232-61 [Modified Ekman] R, M, FW

Murray, T.D. & Charles, W.N. (1975). A pneumatic grab for obtaining large, undisturbed mud samples : its construction and some applications for measuring the growth of larvae and emergence of adult Chironomidae. *Freshwat. Biol. 5*, 205-210. [Heavy grab is closed by pneumatic pistons; sampling area 0.25 m^2, depth of sample 15 cm, weight of grab 130 kg] R, M, FW

Rawson, D.S. (1947). An automatic-closing Ekman dredge and other equipment for use in extremely deep water. *Spec. Publs Limnol. Soc. Am.* No. 18, 1-8. R, M, FW

Schröder, Th. (1932). Über die Möglichkeit einer quantitativen Untersuchung der Boden-und Ufertierwelt fließender Gewässer, zugleich: Fischereibiologische Untersuchungen im Wesergebiet I. (On the possibility of a quantitative study of both the bottom and bank animals of flowing waters: fishery biology studies in the Weser district I) (In German). *Z. Fisch. 30*, 105-127. [Describes operation of Ekman grab in running water; grab should be lowered to just above bottom, boat and grab drift together, then grab and messenger dropped simultaneously so that grab is sprung at once] R, M, FW

Slack, H.D. (1972). A lever-operated Ekman grab. *Freshwat. Biol. 2*, 401-405. [Larger Ekman that is lever-operated and is therefore similar to van Veen grab] R, M, FW

Szczepański, A. (1953). Analiza dynamiki populacji Skaposzczetów dna Wisly pod Warszawa. (Variations of the population of the bottom-living oligochaetes in the Vistula) (In Polish). *Polskie Archwm Hydrobiol. I*, 227-50. [Ekman-type grab with only one jaw and small sampling area of 10-20 cm^2] R, M, FW

Zhadin, V.I. (1960). *Methods of hydrobiological investigation* (In Russian). Moskva. Vysshaya Shkola. 191 pp. [Describes modified Ekman grab of Szczepański (1953)]

4.2. ORANGE-PEEL-TYPE

[Samplers with four curved jaws closing to encircle a hemisphere of sediment]

Briba, C. & Reys, J.P. (1966). Modifications d'une benne 'orange peel' pour des prélèvements quantitatifs du benthos de substrates meubles. (Modifications of an orange-peel grab for the quantitative sampling of the benthos of loose substrata) (In French). *Recl Trav. Stn mar. Endoume 41*, 117-121. [Spring-loaded version] R, M, Mar

Hartman, O. (1955). Quantitative survey of the benthos of San Pedro Basin. Southern California. Part 1. Preliminary results. *Allan Hancock Pacif. Exped. 19*, 185 pp. [Describes orange-peel grab in use] R, M, Mar

Merna, J.W. (1962). Quantitative sampling with the orange peel dredge. *Limnol. Oceanogr. 7*, 432-33. [Estimates sampling area and volume of sediment sampled] R, M, FW

Packard, E.L. (1918). A quantitative analysis of the molluscan fauna of San Francisco Bay. *Univ. Calif. Publs Zool. 18*, 299-336. [Describes orange-peel grab] R, M, Mar

Reish, D.J. (1959). Modification of the Hayward orange peel bucket for bottom sampling. *Ecology 40*, 502-3. [Describes improved grab for quantitative sampling] R, M, Mar

4.3. PETERSEN-TYPE

[Grab with weighted jaws; small version of grab used commercially for dredging, unloading coal, etc., usually samples about 0.1 m^2 of bottom]

Flury, J. (1963). A modified Petersen grab. *J. Fish. Res. Bd Can. 20*, 1549-50. [Petersen grab with pneumatic closing mechanism] R, M, Mar

Hartman, O. (1955). Quantitative survey of the benthos of San Pedro Basin, Southern California. Part 1. Preliminary results. *Allan Hancock Pacif. Exped. 19*, 185 pp. [Used 'Campbell' grab which is a large version of a Petersen grab, weighs 410 kg] R, M, Mar

Hartman, O. & Barnard, J.L. (1958). The benthic fauna of the deep basins off Southern California. *Allan Hancock Pacif. Exped. 22*, 67 pp. [Used 'Campbell' grab] R, M, Mar

Léger, M. (1904). Sondeur à drague. (Dredger) (In French). *Bull. Mus. océanogr. Monaco 8*, 8 pp. [Modified Petersen grab called 'Monaco' grab] R, M, Mar

Lisitsyn, A.P. & Udintsev, G.B. (1955). New model dredges. (In Russian). *Trudy vses. gidrobiol. Obshch. 6*, 217-222. ['Okean' grab, weight 150 kg, similar to Freidinger modification of Petersen grab (see Naumann 1925)] R, M, Mar

Naumann, E. (1925). See und Teich. (Lake and pond) (In German). *Handb. biol. ArbMeth. 9*, 103-138. [Describes Friedinger modification of Petersen grab; jaws closed by cords that cross from one jaw to the other] R, M, FW

Petersen, C.G.J. & Boysen Jensen, P. (1911). Valuation of the Sea. I. Animal life of the sea bottom, its food and quantity. *Rep. Dan. biol. Stn 20*, 81 pp. [Early description of Petersen grab] R, M, Mar

Petersen, C.G.J. (1918). The sea bottom and its production of fish food. *Rep. Dan. biol. Stn 25*, 62 pp. [Early description of Petersen grab] R, M, Mar

Zhadin, V.I. (1960). *Methods of hydrobiological investigation* (In Russian). Moskva. Vysshaya Shkola 191 pp. [Describes 'Okean' grab (see Lisitsyn & Udintsev, 1955)]

4.4. SMITH-McINTYRE-TYPE

[Jaws forced into sediment by two springs; usually samples about 0.1 m^2 of bottom to depth of 7 cm]

Carey, A.G. & Paul, R.R. (1968). A modification of the Smith-McIntyre grab for simultaneous collection of sediment and bottom water. *Limnol. Oceanogr. 13*, 545-549. R, M, Mar

Hunter, B. & Simpson, A.E. (1976). A benthic grab designed for easy operation and durability. *J. mar. biol. Ass. U.K. 56*, 951-957. [Modified Smith-McIntyre grab called Hunter grab] R, MC, Mar

Smith, W. & McIntyre, A.D. (1954). A spring-loaded bottom sampler. *J. mar. biol. Ass. U.K. 33*, 257-264. [Original description; weight about 45 kg] R, M, Mar

4.5. VAN VEEN-TYPE

[Jaws closed by pincer-like action of two long arms; usually samples about 0.1 m^2 of bottom]

Kornicker, L.S. (1958). Ecology and taxonomy of recent marine ostracodes in the Bimini area, Great Bahama Bank. *Publs Inst. mar. Sci. Univ. Texas 5*, 194-300. [Describes Emery modification of van Veen grab] R, MC, Mar

Lassig, J. (1965). An improvement to the van Veen bottom grab. *J. Cons. perm. int. Explor. Mer 29*, 352-353. [Modified release mechanism] R, MC, Mar

Nichols, M.M. & Ellison, R.L. (1966). Light-weight bottom samplers for shallow water. *Chesapeake Sci. 7*, 215-7. [Small version of van Veen grab; sampling area 140 cm^2] R, M, Mar

Thamdrup, H.M. (1938). Der van Veen-Bodengreifer. Vergleichsversuche über die Leistungsfähigkeit des van Veen und des Petersen Bodengreifers. (The van Veen bottom grab. Comparison of the efficiency of the van Veen and Petersen bottom grabs) (In German). *J. Cons. perm. int. Explor. Mer 13*, 206-212. [Describes van Veen grab] R, M, Mar

Veen, J. van (1936). *Onderzoekingen in de Hoofden, in verband met de gesteldheid der Nederlandsche Kust.* (In Dutch). Diss. University of Leiden. [Original description] R, M, Mar

4.6. OTHER GRABS

Allan, I.R.H. (1952). A hand-operated quantitative grab for sampling river beds. *J. Anim. Ecol. 21*, 159-160. [Hand-operated but can be used to depth of 3.3 m; sampling area 348 cm^2] R, MC, FW

Auerbach, M. (1953). Ein quantitativer Bodengreifer. (A quantitative bottom grab) (In German). *Beitr. Naturk. Forsch. SudwDtl. 12*, 17-23. [Cross between a box corer and a grab, latter closes bottom of box, weight 13.25 kg] R, M, FW

Baird, R.H. (1958). A preliminary account of a new half square meter bottom sampler. *I.C.E.S. Shellfish Committee, Paper* no. 70. [Used for epifauna of oyster beds; jaws closed by springs and levers, sampler not enclosed on upper surface, sampling area 0.5 m^2] R, M, Mar

Bay, E.C. & Frommer, S.I. (1965). A littoral dredge for quantitative bottom samples. *Calif. Vector Views 12*, 56-57. [Hand-operated grab] S, MC, FW

Borutskii, E.V. (1952). On the priority of quantitative studies of the benthos. (In Russian). *Zool. Zh. 31*, 843-845. [Describes Klassen grab with semi-cylindrical jaws that are freed on contact with bottom by a release mechanism operated with a separate rope; sampling area 0.09 m^2] R, M, Mar

Dromgoole, F.I. & Brown, J.M.A. (1976). Quantitative grab sampler for dense beds of aquatic macrophytes. *N.Z. Jl mar. Freshwat. Res. 10*, 109-118. [Similar to Ponar grab (see Powers & Robertson 1967); sampling area 2 500 cm^2, weight 35 kg] R, MCP, FW

Ford, J.B. & Hall, R.E. (1958). A grab for quantitative sampling in stream muds. *Hydrobiologia 11*, 198-204. [Hand operated grab on pole, sampling area 77.5 cm^2 to depth of 5 cm] R, M, FW

Franklin, W.R. & Anderson, D.V. (1961). A bottom sediment sampler. *Limnol. Oceanogr. 6*, 233-234. [Describes grab similar to that of Auerbach (1953)] R, M, Mar

Guignard, J.P. (1965). Un nouvel instrument d'investigation limnologique: la drague à fermeture automatique. (A new instrument for limnological investigation: an automatically closing dredge) (In French). *Bull. Soc. vaud. Sci. nat. 69*, 93-96. [Describes a grab with weighted jaws that close automatically when grab digs into bottom] R, MC, FW

GÜnther, B. (1963). Ein neuer Bodengreifer. (A new bottom grab) (In German). *Z. Fisch.* N.F. *11*, 635-9. [Light grab with bag attached to one jaw, weight 1.5 kg] R, M, FW

Hargrave, B.T. (1969). Epibenthic algal production and community respiration in the sediments of Marion Lake. *J. Fish. Res. Bd Can. 26*, 2003-2026. [Wedge-shaped grab with one closing door] R, M, FW

Hough, J.L. (1939). Bottom sampling apparatus. In *Recent marine sediments* (Ed. P.D. Trask). Tulsa, U.S.A. Amer. Assoc. Pet. Geol. [Describes 'Fish-Hawk' model of Ross 'Clamshell' grab; two small cups snap together by means of strong coiled spring when sampler hits the substratum] R, M, Mar

Jackson, H.W. (1970). A controlled depth volumetric bottom sampler. *Progve Fish Cult. 32*, 113-115. [Manually-operated grab with guide plates; operated in deep water by extending arms] R, MC, FW

Kellen, W.R. (1954). A new bottom sampler. *Spec. Publs. limnol. Soc. Am.* No. 22, 4 pp. [Manually operated grab, sampling area 225 cm^2, weight 3.6 kg] S, M, FW

LaFond, E.C. & Dietz, R.S. (1948). New snapper-type sea floor sediment sampler. *J. sedim. Petrol. 18*, 34-37. [Foot-triggered grab with jaws closed by powerful spring; weight 27 kg, takes 470 cm^3 sample] R, MC, Mar

Larimore, R.W. (1970). Two shallow water bottom samplers. *Progve Fish Cult. 32*, 116-119. [Manually-operated grab similar to that of Jackson (1970), operates to depth of 3.3 m] R, MC, FW

Lee, R.E. (1944). A quantitative survey of the invertebrate fauna in Menemsha Bight. *Biol. Bull. mar. biol. Lab., Woods Hole 86*, 83-97. [Heavy (135 kg) 'clamshell'-bucket grab; sampling area 0.56 m^2] R, M, Mar

Macan, T.T. (1949). Survey of a moorland fishpond. *J. Anim. Ecol. 18*, 160-186. [Hand operated grab, suitable for cutting macrophytes; sampling area 1225 cm^2] S, P, FW

McCullough, J.D. & Williams, S. (1976). Electrically powered sampler for benthic macroinvertebrates. *Progve Fish Cult. 38*, 186-187. [Light grab (6.8 kg) with jaws closed by electric motor and geared levers, sampling area about 500 cm^2 to depth of 8 cm] R, MC, FW

Mann, K.H. (1965). Heated effluents and their effects on the invertebrate fauna of rivers. *Proc. Soc. Wat. Treat. Exam. 14*, 45-53. [Manually-operated grab on pole; sampling area about 400 cm^2; operates to depths of 4 m] R, MC, FW

Mozley, S.C. & Schapelsky, O. (1973). A Ponar grab modified to take three samples in one cast, with notes on Ponar construction. *Proc. 16th Conf. Gt Lakes Res.* 97-99. [Ponar grab (see Powers & Robertson, 1967) divided into three compartments] R, MC, FW

Økland, J. (1962). Litt om teknikk ved insamling og konservering av freshvannsdyer. (Notes on methods for collecting and preserving freshwater invertebrates) (In Norwegian). *Fauna, Oslo 15*, 69-92. [Modified vegetation grab of Macan (1949) for use in deep water (5-6 m)] R, P, FW

Powers, C.F. & Robertson, A. (1967). Design and evaluation of an all-purpose benthos sampler. *Spec. Rep. Gt Lakes Res. Div., Univ. Mich.* 30, 126-131. [Original description of Ponar grab] R, MC, FW

Rieth, A. (1960). Ein vereinfachter funktionssicherer Bodengreifer. (A simplified, positively-fuctioning bottom grab) (In German). *Mikrokosmos 49*, 252-6. [Grab kept open by very simple mechanism that is automatically released when grab touches bottom] R, MC, FW

Ruttner, F. (1913/14). Über einige bei der Untersuchung der Lunzer Seen verwendete Apparate und Gerätschaften. (Some of the apparatus and equipment used in the study of Lunz lakes) (In German). *Int. Revue ges. Hydrobiol. Hydrogr. 6*, 53-62. [Describes Ruttner scissor grab] R, M, FW

Snerzhinskii, V.A. (1951). *Practical oceanography (work in marine exploration)* (In Russian). Leningrad. Gidrometeoizdat. 600 pp. [Describes Ulsky grab, weight 25 kg, and Ross 'Clamshell' or 'Telegraph' grab] R, M, Mar

Thomson, C.W. (1873). *The depths of the sea*. London. Macmillan. 527 pp. [Describes the 'Bulldog' grab, a forerunner of the 'Clamshell' snapper; the jaws are held apart by a weight that falls off on reaching the bottom; jaws closed by heavy rubber band] R, MC, Mar

Verneaux, J. (1966). Sur une technique d'analyse benthique quantitative. Adaptation de deux modèles d'échantillonneurs de fond aux prélèvements quantitatifs de la faune benthique en rivière profonde (type Doubs). (On a technique of quantitative analysis for benthos. Adaptation of two models of bottom samplers for quantitative sampling of the benthic fauna of deep rivers) (In French). *Annls Fac. Sci. Besancon, Zool.*, 27-35. [Describes a "coupole" (= dome-shaped) grab; sampling area 0.05 m^2, weight 25 kg] R, MC, FW

4.7. DIVER-OPERATED GRAB

Rowe, G.T. & Clifford, C.H. (1973). Modifications of the Birge-Ekman box corer for use with SCUBA or deep submergence research vessels. *Limnol. Oceanogr. 18*, 172-175. D, M, Mar

5. *CORERS*

[Tubes that are driven vertically into the sediment]

5.1. REVIEWS

Bezrukov, P.L. & Petelin, B.P. (1960). Manual on collection and preliminary treatment of samples of marine deposits. (In Russian). *Trudy Inst. Okeanol. 44*, 81-111. [Reviews Russian coring gear]

Kullenberg, B. (1955). Deep-sea coring. *Rep. Swed. deep Sea Exped. 4*, 35-96.

Strøm, K.M. (1938). Recent bottom samplers securing undisturbed profiles of the upper sediment layers. *Geologie Meere Binnengewäss. 2*, 300-302. [Very brief and selective review]

Wright, H.E., Livingstone, D.A. & Cushing, E.J. (1965). Coring devices for lake sediments. In *Handbook of paleontological techniques* (Eds B. Kummel & D. Raup). San Francisco, Freeman. 494-520.

5.2. SMALL DIAMETER CORERS

[Diameter less than 10 cm]

Agassiz, A. (1888). *Three cruises of the Blake*. Boston. Houghton Mifflin. 314 pp. [Describes Belknap-Sigsbee gravity-piston corer] R, M, Mar

Baker, J.H., Pugh, L.A. & Kimball, K.T. (1977). A simple hand corer for shallow water sampling. *Chesapeake Sci. 18*, 232-236 [Diameter 5 cm] S, M, Mar

Bou, C. (1974). Les méthodes de récolte dans les eaux souterraines interstitielles (Methods of collecting in subterranean and interstitial waters) (In French). *Annls Spéléol. 29*, 611-619. [New version of tube of Bou & Rouch (1967), internal diameter 2 cm; manual impact corer with pointed, pyramid-shaped tip and a series of holes above the tip; tube driven into substratum by sledge hammer and then water + debris + animals pumped out and filtered; used for sampling interstitial fauna] S, MCL, FW

Bou, C. & Rouch, R. (1967). Un nouveau champ de recherches sur la faune aquatique souterraine. (A new field of research on subterranean aquatic fauna) (In French). *C. r. hebd. Séanc. Acad. Sci., Paris 265*, 369-370. ['Bou-Rouch' tube, internal diameter 2.6 cm; manual impact corer with pointed steel tip and a series of holes (diameter 0.5 cm) about 10 cm from the tip; tube driven into substratum by sledge hammer and then water + debris + animals pumped out and filtered; used for sampling interstitial fauna] S, MCL, FW

Bowen, V.T. & Sachs, P.L. (1964). The free corer. *Oceanus 11*, (2) 2-6. [Diameter 6.6 cm; attached to buoy] R, M, Mar

Brinkhurst, R.O., Chua, K.E. & Batoosingh, E. (1969). Modifications in sampling procedures as applied to studies on the bacteria and tubificid oligochaetes inhabiting aquatic sediments. *J. Fish. Res. Bd Can. 26*, 2581-93. [Diameter 5 cm; Kajak-Brinkhurst (K-B) gravity corer] R, M, FW

Brinkhurst, R.O. & Kennedy, C.R. (1965). Studies on the biology of the Tubificidae (Annelida, Oligocheta) in a polluted stream. *J. Anim. Ecol. 34*, 429-443. [Diameter 5.1 cm; piston corer operated manually] S, M, FW

Brown, S.R. (1956). A piston sampler for surface sediments of lake deposits. *Ecology 37*, 611-613. [Diameter 5 cm; piston corer] R, M, FW

Bussche, H.K.J. van den & Houbolt, J.J.H.C. (1964). A corer for sampling shallow marine sands. *Sedimentology 3*, 155-159. [Diameter 7 cm; piston corer forced in by weights, weight 300 kg] R, M, Mar.

Byrne, J.V. & Kulm, L.D. (1962). An inexpensive lightweight piston corer. *Limnol. Oceanogr. 7*, 106-108. [Diameter 7.6 cm; piston corer] R, M, Mar

Coler, R.A. & Haynes, R.C. (1966). A practical benthos sampler. *Progve Fish Cult. 28*, 95. [Diameter 3.8 cm; manual corer operated to depths of 3.3 m] R, M, FW.

Craib, J.S. (1965). A sampler for taking short undisturbed marine cores. *J. Cons. perm. int. Explor. Mer 30*, 34-39. [Diameter 5-7 cm; gravity corer, weight 44 kg] R, M, Mar

Cushing, E.J. & Wright, H.E. (1965). Hand-operated piston corers for lake sediments. *Ecology 46*, 380-384. [Describes modified version of piston corer of Vallentyne (1955) and Livingstone (1955), diameter 2.5 cm and 5 cm; also larger diameter (c. 10 cm) piston corer and drive frame for operating corers] R, M, FW

Daniel, T.C. & Chesters, G. (1971). Design and construction of a shallow water sediment core sampler. *Environ. Lett. 1*, 225-228. [Diameter 5 cm; weight 12 kg, manually-operated on pole] S, M, FW

Davis, R.B. & Doyle, R.W. (1969). A piston corer for upper sediment in lakes. *Limnol. Oceanogr. 14*, 643-648. [Diameter 2.9 - 10 cm; piston corer, weight 15 kg] R, M, FW

Deevey, E.S., Jr. (1965). Sampling lake sediments by use of the Livingstone sampler. In *Handbook of paleontological techniques* (Eds B. Kummel & D. Raup) San Francisco. Freeman. 521-529 pp. [See also Livingstone (1955)] R, M, FW

Delamare-Deboutteville, C. (1960). *Biologie des eaux souterraines littorales et continentales.* (The biology of underground water) (In French). Paris, Hermann. 740 pp. [Diameter 1 cm; manual impact corer with solid screw at lower end and a series of small holes about 40 cm from the tip; tube driven into stony substratum and then water + animals entering the tube are pumped out; used for sampling interstitial fauna] S, MCL, FW

Efford, I.E. (1960). A method of studying the vertical distribution of the bottom fauna in shallow waters. *Hydrobiologia 16*, 288-92. [Diameter 6 cm; freezing corer using liquid oxygen, manually operated] S, M, FW

Ekman, V.W. (1905). An apparatus for the collection of bottom samples. *Publs Circonst. Cons. perm. int. Explor. Mer* No. 27, 6 pp. [Describes original gravity corer, later modified by other workers] R, M, Mar

Elgmork, K. (1962). A bottom sampler for soft mud. *Hydrobiologia 20*, 167-172. [Diameter 7 cm; piston corer based on Friedinger water sampler] R, M, FW

Emery, G.R. & Broussard, D.E. (1954). A modified Kullenberg piston corer. *J. sedim. Petrol. 24*, 207-211. [Diameter 4.8 cm] R, M, Mar

Emery, K.O. & Dietz, R.S. (1941). Gravity coring instrument and mechanics of sediment coring. *Bull. geol. Soc. Am. 52*, 1658-1714. [Diameter 5 or 6.3 cm; gravity corer, weight 2.70 kg] R, M, Mar

Fenchel, T. (1967) The ecology of marine microbenthos. 1. The quantitative importance of ciliates as compared with metazoans in various types of sediments. *Ophelia 4*, 121-137. [Diameter 2.1 cm; manual corer closed at lower end by rubber ball] S, M, Mar

Ferencz, M. (1968). Vorstudium über die vertikale Verteilung des Zoobenthos der Theiss. (Studies on the vertical distribution of the zoobenthos of the Theiss). *Tiscia (Szeged) 4* 53-58. [Diameter 8.4 cm; manually operated corer] R, M, FW

Fortier, S. & Blaney, H.F. (1928). Silt in the Colorado River and its relation to irrigation. *Tech. Bull. U.S. Dep. Agric. 67*, 95 pp. [Diamter 2.7 cm; manually operated 'Canal' corer] S, M, FW

Giani, N. (1974). Description d'un nouveau type de carottier pour les sédiments très fluides. (Description of a new type of corer for very fluid sediments) (In French). *Annls Limnol. 10*, 99-108. [Diameter 8 cm; gravity corer] R, M, FW

Ginsburg, R.N. & Lloyd, R.M. (1956). A manual piston coring device for use in shallow water. *J. sedim. Petrol. 26*, 64-66. [Diameter 5 cm; manually operated piston corer] S, M, Mar

Gleason, G.R. & Ohlmacher, F.J. (1965). A core sampler for *in situ* freezing of benthic sediments. *Ocean Sci. Ocean Eng. 2*, 737-741. [Diameter 3.9 cm; gravity corer with CO_2 as freezing agent; weight 3.8 kg] R, M, FW

Hanna, M.A. (1954). A simple coring tube for soft sediments. *J. sedim. Petrol. 24*, 263-269. [Diameter 7.6 cm; manual corer] S, M, Mar

Hendrix, P.F., Parker, N.C. & Miller, N.A. (1975). An inexpensive core sampler for lake deposits. *Am. Midl. Nat. 94*, 223-6. [Diameter 2 cm; impact corer] R, M, FW

Holme, N.A. & McIntyre, A.D. (1971). *Methods for the study of marine benthos*. IBP Handbook No. 16. Oxford. Blackwell. 334 pp. [Diameter 2.5 cm; 'Butler' gravity corer, weight 7 kg] R, M, Mar

Holz, D.D., Mayer, F.L. Jr. & Tindle, R.C. (1972). A core-type sampler for pesticide studies. *Progve Fish Cult. 34*, 117-118. [Diameter 5 cm; operated on pole] R, M, FW

Hongve, D. (1972). En bunnhenter som er lett a lage. (A bottom sampler which is easy to make). *Fauna, Oslo 25*, 281-3. [Diameter 2.5 cm; gravity corer] R, M, FW

Hough, J.L. (1939). Bottom sampling apparatus. In *Recent marine sediments* (Ed. P.D. Trask.) Tulsa, U.S.A. Amer. Assoc. Pet. Geol. [Describes Rittenhouse manual corer (diameter 3.8 cm), Banks manual corer (diameter 3.8 cm), Kindle's 'Seedtester' manual corer, Woods Hole gravity corer (diameter 2.5 cm)] R, M, Mar

Husmann, S. (1971). Eine Rammpumpe zur Untersuchung des subaquatischen Stygorheals. (A pump-borer for studying the subaquatic stygorheal). (In German). *Gewäss. Abwäss. 50/51*, 115-119. [Diameter 3.5 cm; manual impact corer with solid, pointed tip and holes (diameter 1.2 cm) above tip; tube driven into substratum and then pump at upper end used to pump out water and interstitial animals that have entered tube] S, MCL, FW

Hvorslev, M.J. & Stetson, H.C. (1946). Free-fall coring tube; a new gravity bottom sampler. *Bull. geol. Soc. Am. 57*, 935-950. [Diameter 5 cm; gravity corer] R, M, Mar

Iselin, C.O. (1932). Deep sea bottom samplers. *Bull. natn. Res. Coun., Wash.* No. 85, 451-454. [Iselin gravity corer; square cross section with removable side] R, M, Mar

Jenkin, B.M. & Mortimer, C.H. (1938). Sampling lake deposits. *Nature, Lond. 142*, 834-5. [Diameter 6 cm; gravity corer samples one third of total cross-sectional-area] R, M, FW

Jenkin, B.M., Mortimer, C.H. & Pennington, W. (1941). The study of lake deposits. *Nature, Lond. 147*, 496-500. [Describes core cutter that is an improved version of that described by Jenkin & Mortimer (1938)] R, M, FW

Joly, J. (1914). On the investigation of the deep-sea deposits. *Scient. Proc. R. Dubl. Soc. 14*, 256-67. [Diameter 2.6 cm; hydrostatic pressure used to rotate corer] R, M, Mar.

Kaczmarek, M. (1963). Jahreszeitliche Quantitätsschwankungen der Collembolen verschiedener Waldbiotope der Puszcza Kampinoska. (Seasonal quantitative fluctuations of Collembola in the forest biotope of Puszcza Kampinoska) (In German). *Ekol. pol. (A) 11*, 127-139. [Diameter 3.6 cm; soil corer, sometimes used in freshwater] R, M, FW

Kajak, Z. (1965). Remarks on the causes of the scarcity of benthos in Lake Lisunie. *Ekol. pol. (A) 13*, 23-32. [Diameters 3.6 cm, 8 cm; gravity corer] R, M, FW

Kajak, Z., Kacprzak, K. & Polkowski, R. (1965). Chwytacz rurowy do pobierania prób dna. (Tubular bottom sampler) (In Polish). *Ekol. pol. (B) 11*, 159-165. [Diameter 3.6 cm; gravity corer] R, M, FW

Kölmel, R. (1974). A new meiofauna sampler for quantitative sampling in soft bottoms. *Mar. Biol. 25*, 163-68. [Small square, manual corer; sampling area 8 cm x 2 cm] S, M, Mar

Kubinov, E.I. (1957). Vibratory piston core-sampler. (In Russian). *Trudy Inst. Okeanol. 25*, 143-52. [Diameter 5.35 cm; vibrator is a 2-3 kW motor] R, M, Mar

Kullenberg, B. (1947). The piston core sampler. *Svenska hydrogr. -biol. Kommn. Skr., Tred. Ser.: Hydrografi 1*, 46 pp. [Diameter 4.6 cm, describes original double counter-weight piston corer with core catcher] R, M, Mar

Livingstone, D.A. (1955). A lightweight piston sampler for lake deposits. *Ecology 36*, 137-139. [Diameter 3.5 cm; piston corer] R, M, FW

Lundqvist, G. (1923). Nagra nya rörlodtyper. (Some new apparatus for collecting bottom samples.) (In Swedish with German summary). *Skr. söd. Svar. FiskFör.* A23, 34-46. [Describes several corers, diameters 1.5 - 5 cm, based on impact corer of Naumann (1916)] R, M, FW

Mackereth, F.J.H. (1958). A portable core sampler for lake deposits. *Limnol. Oceanogr. 3*, 181-191. [Diameter 3.5 cm; pneumatically operated corer] R, M, FW

Mackereth, F.J.H. (1969). A short core sampler for subaqueous deposits. *Limnol. Oceanogr. 14*, 145-151. [Diameter 5 cm; shorter version of the corer of Mackereth (1958)] R, M, FW

Mackin, J.G. (1962). Canal dredging and silting in Louisiana bays. *Publs Inst. mar. Sci. Univ. Tex. 7*, 262-314. [Diameter 5 cm; manually operated corer fastened to wooden pole] S, M, Mar

Maitland, P.S. (1969). A simple corer for sampling sand and finer sediments in shallow water. *Limnol. Oceanogr. 14*, 151-156. [Diameter 7 cm; manually operated] S, M, FW

McIntyre, A.D. (1968). The meiofauna and microfauna of some tropical beaches. *J. Zool. 156*, 377-392. [Diameter 2.5 cm; manually operated soil corer that splits longitudinally into two halves] S, M, Mar

Milbrink, G. (1971). A simplified tube bottom sampler. *Oikos 22*, 260-263. [Diameter 9.5 cm; gravity corer with end closed automatically or by messenger; also modified version with detachable lower tube] R, M, FW

Mills, A.A. (1961). An external core retainer. *Deep-Sea Res. 7*, 294-295. [Corer has simple check valve on top and external core-retaining mechanism at lower end] R, M, Mar

Moore, D.G. (1961). The free corer, sediment sampling without wire and winch. *J. sedim. Petrol. 31*, 627-630. [Diameter 3.5 cm; gravity corer] R, M, Mar

Moore, G.M. (1939). A limnological investigation of the microscopic benthic fauna of Douglas Lake, Michigan. *Ecol. Monogr. 9*, 537-582. [Diameter 2.2 cm; gravity corer] R, M, Mar

Moore, H.B. & Neill, R.G. (1930). An instrument for sampling marine muds. *J. mar. biol. Ass. U.K. 16*, 589-594. [Diameter 2.4 cm, 3.8 cm, 5 cm; gravity corer] R, M, Mar

Mordukhai-Boltovskoi, F.D. (1958). Improved arrangement of a tubular bottom-sampler. (In Russian). *Byull. Inst. Biol. Vodokhran. 1*, 47-49. [Diameter 7.1 cm; manual corer operated on pole] R, M, FW

Mortimer, C.H. (1942). The exchange of dissolved substances between mud and water in lakes. III and IV. *J. Ecol. 30*, 147-201. [Diameter 7.6 cm; describes Jenkin sampler; gravity corer only suitable for soft mud; samples surface mud and water above it; core tube closed by lids] R, M, FW

Murray, J. (1885). *Report on the scientific results of the voyage of H.M.S. Challenger, 1*, 509 pp. London. [Describes Valve Lead gravity corer, 'Hydra' gravity corer, Baillie rod gravity corer (diameter 6.3 cm)] R, M, Mar

Naumann, E. (1916). Om profillodning i gyttje och dyavlagringar. (In Swedish with summary in German). *Årsb. Sver. geol. Unders.* 31 pp. [Diameter 2 cm; original description of impact corer] R, M, FW

Nichols, M.M. & Ellison, R.L. (1966). Light-weight bottom samplers for shallow water. *Chesapeake Sci. 7*, 215-7. [Diameter 5.8 cm; gravity corer on pole or rope] R, M, Mar

Paterson, C.G. & Fernando, C.H. (1971). A comparison of a simple corer and an Ekman grab for sampling shallow-water benthos. *J. Fish. Res. Bd Can. 28*, 365-368. [Diameter 5.7 cm; manually operated corer] S, M, FW

Perfiliew, B. (1931). Die mikrozonale Methode als Grundlage limnologischer Untersuchungen in der Typologie und Geochronologie der Seen, und ein neuer Apparat für Schlammbohrungen vom Boote auf grosse Tiefen (Kolbenbohrer). (The microzonal method for basic limnological studies on the typology and geochronology of lakes, and a new apparatus for mud coring from a boat in deep water) (In German). *Int. Hydrol. Kongr.* Sevilla 1929, II, 265-269. R, M, FW

Pettersson, H. & Kullenberg, B. (1940). A vacuum core sampler for deep-sea sediments. *Nature, Lond. 145*, 3669, 306. [Diameter 5 cm; piston corer] R, M, Mar

Phleger, F.B. (1951). Ecology of the Foraminifera, northwestern Gulf of Mexico: Part 1. *Mem. geol. Soc. Am. 46*, 88 pp. [Diameter 3.5 cm; gravity corer] R, M, Mar

Pierce, J.W. & Howard, J.D. (1969). An inexpensive portable vibrocorer for sampling unconsolidated sands. *J. sedim. Petrol. 39*, 385-390. [Diameter 7.6 cm] R, M, Mar

Piggot, C.S. (1936). Apparatus to secure core samples from the ocean bottom. *Bull. geol. Soc. Am. 47*, 675-684. [Diameter 5 cm; impact corer fired into bottom by explosive charge] R, M, Mar

Pratje, O. (1938). Gewinnung und Untersuchung der Meeresgrundproben. (Obtaining and examining samples from the sea bottom) (In German). *Handb. biol. ArbMeth. 9*, 377-542. [Sjostedt impact corer, driven into bottom by weight of 30 kg] R, M, Mar

Rees, C.B. (1940). A preliminary study of the ecology of a mud-flat. *J. mar. biol. Ass. U.K. 24*, 185-199. [Diameter 1.8 cm; manual corer] S, M, Mar

Reish, D.J. & Green, K.E. (1958). Description of a portable piston corer for use in shallow water. *J. sedim. Petrol. 28*, 227-229. [Diameter 2.5 cm; manually operated piston corer, worked by rods in water depth down to 10 m] R, M, Mar

Reissinger, A. (1930). Methoden zur Untersuchung von Seeschlammschichten, ihrer Mächtigkeit und ihrer Zusammensetzung. (Methods for examining the mud layer of lakes, their thickness and their composition) (In German). *Ber. naturw. Ges. Bayreuth 3*, 5-27.

Renaud-Debyser, J. (1957). Description d'un carrotier adapté aux prélèvements des sables de plage. (Description of a corer adapted for sampling sandy beaches) (In French). *Revue Inst. fr. Pétrole 12*, 501-502. [Square corer 5 x 5 cm; manually operated; each side inserted separately by hand] S, M, Mar

Richards, A.F. & Keller, G.H. (1961). A plastic-barrel sediment corer. *Deep-Sea Res. 8*, 306-312. [Diameter 8 cm; gravity corer] R, M, Mar

Riedl, R.J. & Ott, J. (1970). A suction-corer to yield electric potentials in sediment layers. *Senckenberg. marit. 2*, 67-84. [Diameter 3.5 - 3.6 cm] R, M, Mar

Roots, W. (1973). A stored energy seabed corer for sediments and bedrock. *Underwat. J. 5*, 6-8. [Diameter 5 cm; piston corer driven into sediment in < 1 sec by strong rubber bands; has core catcher] R, M, Mar

Rowley, J.R. & Dahl, A.O. (1956). Modifications in design and use of the Livingstone piston sampler. *Ecology 37*, 849-851. [Diameter 3.8 cm; simplified corer of Livingstone (1955)] R, M, FW

Ruppert, E.E. (1972). An efficient, quantitative method for sampling the meiobenthos. *Limnol. Oceanogr. 17*, 629-31. [Diameter 5.5 cm; Riedl & Ott (1970) suction corer modified so that sub-samples can be taken] S, M, Mar

Sachs, P.L. & Raymond, S.O. (1965). A new unattached sediment sampler. *J. mar. Res. 23*, 44-53. [Diameter 6.5 cm; 'free' gravity corer. Weight 82 kg] R, M, Mar

Schneider, F. (1969). A coring device for unconsolidated lake sediments. *Water Resources Research 5*, 524-526. [Diameter 7 cm; modified version of Livingstone (1955) corer] R, M, FW

Shapiro, J. (1958). The core freezer - a new sampler for lake sediments. *Ecology 39*, 758. [Diameter 3.2 cm; gravity corer with CO_2 as freezing agent] R, M, FW

Shier, J.E. & Oaks, R.Q. (1966). Plastic tube coring technique for unconsolidated wet sand. *J. sedim. Petrol. 36*, 241-244. [Diameter 5 cm; vibrocorer] S, M, Mar

Silverman, M. & Whaley, R.S. (1952). Adaptation of the piston coring device to shallow water sampling. *J. sedim. Petrol. 22*, 11-16. [Diameter 5 cm; modified Kullenberg piston corer] R, M, Mar

Sjostedt, F.G. (1923). En orientiering over bottonforhallandena i Ooresund och sodra Ostersjon. Undersokningar over Ooresund. (In Swedish) IX *Acta Univ. lund.* N.F., Avd. 2, *18*, 1-30. [Gravity corer] R, M, Mar

Slack, H.D. (1954). The bottom deposits of Loch Lomond. *Proc. R. Soc. Edinb. B, 65*, 213-38. [Diameter 2.5 cm; impact corer] R, M, FW

Smidt, E. (1951). Animal production in the Danish Wadden Sea. *Meddr Kommn Danm. Fisk.- og Havunders. Ser. Fisk. 10*, (6), 1-151. [Manual corer] R, M, Mar

Smith, A.J. (1959). Description of the Mackereth portable core sampler. *J. sedim. Petrol. 29*, 246-250. [Diameter 3.5 cm; a description of the corer of Mackereth (1958)] R, M, FW

Snerzhinskii, V.A, (1951). *Practical oceanography (work in marine exploration)* (In Russian). Leningrad. Gidrometeoizdat. 600 pp. [Describes Cable-type gravity corer, Zbekochernaz tube gravity corer, similar to Ekman (1905) corer] R, M, Mar

Soule, F.M. (1932). Oceanographic instruments and methods. *Bull. natn. Res. Coun., Wash.* No. 85, 411-441. [Streamlined version of Belknap-Sigsbee gravity corer, see Agassiz (1888)]

Staaten, L.M.J.U. van (1954). Composition and structure of recent marine sediments in the Netherlands. *Leid. geol. Meded. 19*, 1-110. [Diameter 6 cm; manually operated on pole] S, M, Mar

Stocker, Z.S.J. & Williams, D.D. (1972). A freezing core method for describing the vertical distribution of sediments in a streambed. *Limnol. Oceanogr. 17*, 136-138. [Diameter 2.5 cm; manual corer with liquid nitrogen as freezing agent] S, MC, FW

Strøm, K.M. (1934). A new sampler lead. *Norsk geol. Tidsskr. 14*, 162-166. [Describes gravity corer (diameter c. 2 cm) and 'Rammer Lead' impact corer similar to Sjostedt corer, see Pratje (1938)] R, M, Mar

Strøm, K.M. (1939). A handy sediment sampler. *Norsk geol. Tidsskr. 17*, 50-52. [Diameter 1.8 cm; light gravity corer, weight 2 kg] R, M, FW

Sumner, F.B., Luderback, G.D., Schmitt, W.L. & Johnston, E.C. (1914). A report on the physical conditions in San Francisco Bay, based on the operations of the U.S. Fisheries Steamer 'Albatross' during the years 1912 and 1913. *Univ. Calif. Publs Zool. 14*, 1-198. ['Albatross' gravity corer] R, M, Mar

Taylor, J.L. (1965). Bottom samplers for estuarine research. *Chesapeake Sci. 6*, 233-234. [Diameter 6.4 cm; manual corer] S, M, Mar

Thoulet, J. (1890). *Oceanographie statique*. Paris, Baudoin. 74-76. [Describes Prince of Monaco's gravity corer] R, M, Mar

Trask, P.D. (1927). Oceanography and oil deposits. *Bull. natn. Res. Coun., Wash.* No. 61, 235-240. [Diameter 3.8 cm, gravity corer] R, M, Mar.

Twenhofel, W.H. (1933). The physical and chemical characteristics of the sediments of Lake Mendota, a freshwater lake of Wisconsin. *J. sedim. Petrol. 3*, 68-76. [Diameter 7.6 cm; impact corer] R, M, FW

Ulomskii, S.N. (1952). Experiments on the quantitative calculation of the benthos on compact river bottoms. (In Russian). *Trudy vses. gidrobiol. Obshch. 4*, 297-304. [Diameter 5 - 5.6 cm, Lastochkin-Ulomskii piston corer] R, M, FW

Vallentyne, J.R. (1955). A modification of the Livingstone piston sampler for lake deposits. *Ecology 36*, 139-141. [Slightly modified corer of Livingstone (1955)] R, M, FW

Varney, F.M. (1935). A marine coring instrument - its construction and use. *Trans. Am. geophys. Un.* 16th.Ann. Meeting *1*, 264-266. ['Pile-Driver' impact corer] R, M, Mar

Varney, F.M. & Redwine, L.E. (1937). A hydraulic coring instrument for submarine geological investigations. *Rep. Comm. Sedim., Wash.* 107-114. [Hydrostatic piston corer] R, M, Mar

Walker, C.R. (1955). A core sampler for obtaining samples of bottom muds. *Progve Fish Cult. 17*, 140. [Diameter 3 cm (?); manually operated piston corer made from automobile tyre pump] S, M, FW

Wieckowski, K. (1970). New type of lightweight piston core sampler. *Bull. Acad. pol. Sci. Sér. Sci. géol. géogr. 18*, 57-62. [Diameter 6 cm; manually operated piston corer, operated on a rod in deep water] R, M, FW

Williams, D.D. & Hynes, H.B.N. (1974). The occurrence of benthos deep in the substratum of a stream. *Freshwat. Biol. 4*, 233-56. ['Standpipe' corer, diameter 2.5 cm; manual impact corer driven into stony substratum of gravel beds in rivers, lower end of corer opens above solid conical tip, samples 25 cm^3 of substratum] S, MC, FW

Wilson, I.T. (1941). A new device for sampling lake sediments. *J. Sedim. Petrol. 11*, 73-79. [Diameters 1.9 cm and 3.2 cm; manually operated, but very long, corer] R, M, FW

Züllig, H. (1953). Ein neues Lot zur Untersuchung der obersten Schlammschichten, zur Messung des Sedimentabsatzes und zur Erfassung bodennaher Wässerschichten. *Schweiz. Z. Hydrol. 15*, 275-84. [Diameter 4 cm; gravity corer for sampling water-sediment interface] R, M, FW

Zumberge, J.H. (1962). A new shipboard coring technique. *J. geophys. Res. 67*, 2529-2536. [Diameter 5 cm; piston corer] R, M, Mar

5.3. LARGE DIAMETER CORERS

[Diameter greater than 10 cm]

Andresen, A., Sollie, S. & Richards, A.F. (1965). N.G.I. gas-operated sea-floor sampler. *Proc. 6th int. Conf. Soil Mech.* 3 pp. [Diameter 22 cm; torpedo-shaped, gas-operated piston corer, weight 510 kg] R, M, Mar

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. [Diameter 12.5 cm; 'counterflush' corer, water pumped into corer washes sediment up into collecting sieve] R, MC, Mar

Auerbach, M. (1953). Ein quantitativer Bodengreifer. (A quantitative bottom grab) (In German). *Beitre. naturk. Forsch. SüdwDtl. 12*, 17-23. [Cross between a box corer (10 cm x 10 cm) and a grab, latter closes bottom of box, weight 13.25 kg] R, M, FW

Barnett, P.R.O. (1969). A stabilizing framework for the Knudsen bottom sampler. *Limnol. Oceanogr. 14*, 648-49. [Modification of corer of Knudsen (1927) to prevent it falling over]

Bay, E.C. & Caton, J.R. (1969). A benthos core sampler for wading depths. *Calif. Vector Views, 16*, 88-89. [Diameter 10.2 cm; manual corer] S, M, FW

Berggren, H. (1972). Sedimentprovtagning med rörhämtare. (Sediment sampling with a core sampler) (In Swedish) *Vatten, 4*, 374-377. [Diameter 11 cm; manually operated from pole or rope] R, M, FW

Bouma, A.H. & Marshall, N.F. (1964). A method for obtaining and analysing undisturbed oceanic sediment samples. *Mar. Geol. 2*, 81-99. [Describes sampler similar to box corer of Reineck (1963); sampling area 600 cm^2] R, M, Mar

Burke, J.C. (1968). A sediment coring device of 21 cm diameter with sphincter core retainer. *Limnol. Oceanogr. 13*, 714-718. [Diameter 21 cm; gravity corer with iris closing mechanism at lower end] R, M, FW

Burnett, B.R. (1977). Quantitative sampling of microbiota of the deep-sea benthos- 1. Sampling techniques and some data from the abyssal central North Pacific. *Deep-Sea Res. 24*, 781-789. [Further modification of vegematic USNEL spade (box) corer so that subsamples of microbenthos can be taken with microcorer with diameter of 0.95 cm] R, M, Mar

Digerfeldt, G. & Letteväll, U. (1969). A new type of sediment sampler. *Geol. För. Stockh. Förh. 91*, 399-406. [Describes two square corers; one with width of 10.4 cm (sampling area 110 cm^2) and piston, one with width of 15.8 cm (250 cm^2) and no piston; both closed by plates at lower end] R, M, FW

Drzycimski, I. (1967). Czerpacz rurowy do pobierania prob dennych. (A tube sampler for collecting bottom samples) (In Polish). *Ekol. pol. B, 13*, 273-275. [Diameter 10 cm; gravity corer closed automatically at lower end by a knife] R, M, FW

Enequist, P. (1941). Ein neuer Zerteiler-Bodenstecher für Sedimentanalysen zu ökologischen Zwecken. (A new dividing bottom probe for sedimentanalysis for ecological purposes) (In German). *Zool. Bidr. Upps. 20*, 461-464. [Square corer, sampling area 100 cm^2; gravity corer with bottom closed by plates, weight 35 kg] R, M, Mar

Farris, R.A. & Crezee, M. (1976). An improved Reineck Box for sampling coarse sand. *Int. Revue ges. Hydrobiol. Hydrogr. 61*, 703-705. [Sampling area 3400 cm^2; modified box corer of Reineck (1963)] R, M, Mar

Gale, W.F. (1971). Shallow water core sampler. *Progve Fish Cult. 33*, 238-239. [Diameter 10 cm; manual corer] R. M. FW

Hessler, R.R. & Jumars, P.A. (1974). Abyssal community analysis from replicate box cores in the central North Pacific. *Deep-Sea Res. 21*, 185-209. [Describes USNEL spade corer, a modified and enlarged version of box-corer of Reineck (1963); sampling area 2500 cm^2] R, M, Mar

Hjort, J. & Ruud, J.T. (1938). A bottom sampler for the mud-line. *Hvalråd. Skr. 17*, 145-151. [Diameter 15.5 cm; combined water sampler and bottom corer, weight 40 - 50 kg] R, M, Mar

Holme, N.A. (1953). The biomass of the bottom fauna in the English Channel off Plymouth. *J. mar. biol. Ass. U.K. 32*, 1-49. [Diameter 16.25 cm; sediment sucked in by the pressure differential between air within the sampler and the surrounding water] R, M, Mar

Isaacs, J.D. & Brown, D.M. (1968). 'Bootstrap' corer. *J. sedim. Petrol. 38*, 159-162. [Diameter 13 cm; piston corer with closing device at lower end, weight 140 kg] R, M, Mar

Johansen, A.C. (1927). Preliminary experiments with Knudsen's bottom sampler for hard bottom. *Meddr. Kommn Havunders. Ser. Fisk. 8*, (4), 6 pp. [Describes performance of corer of Knudsen (1927)] R, M, Mar

Jonasson, A. & Olausson, E. (1966). New device for sediment sampling. *Mar. Geol. 4*, 365-372. [Sampling area 30 x 30 cm; box corer closed by lever arm] R, M, Mar.

Jumars, P.A. (1975). Methods for measurement of community structure in deep-sea macrobenthos. *Mar. Biol. 30*, 245-252. [Modified USNEL spade corer of Hessler & Jumars (1974); called "vegematic box corer" because the corer is divided up into 25 contiguous sub-corers, each with sampling area of 100 cm^2] R, M, Mar

Kanneworff, E. & Nicolaisen, W. (1973). The 'Haps' a frame-supported bottom corer. *Ophelia 10*, 119-129. [Diameter 13.6 cm; gravity corer supported by frame and with closing plate to act as a core catcher; similar to box corer of Reineck (1963) but probably lighter (no weight given)] R, MC, Mar

Kaplan, E.H., Welker, J.R. & Krause, M.G. (1974). A shallow water system for sampling macrobenthic infauna. *Limnol. Oceanogr. 19*, 346-350. [Diameter 36 cm; similar to corer of Knudsen (1927); corer reverses manually or automatically to retain sample] R, MC, Mar

Keegan, B.F. & Könnecker, G. (1973). *In situ* quantitative sampling of benthic organisms. *Helgoländer wiss. Meeresunters. 24*, 256-263. [Diameter 15 cm; pneumatically operated corer] R, M, Mar

Kermabon, A., Blavier, P. & Cortis, V. (1965). The Saclantcen sphincter corer assembly. *NATO Unclassified Tech. Rep.* No. 34. [Description of corer of Kermabon *et al.* (1966)] R, M, Mar

Kermabon, A., Blavier, P., Cortis, V. & DeLauze, H. (1966). The 'sphincter' corer: a wide diameter corer with water-tight core catcher. *Mar. Geol. 4*, 149-162. [Diameter 12 cm; piston corer similar to that of Kullenberg (1947) but with 'sphincter' to close lower end] R, M, Mar

Kirpichenko, M.J. (1964). An instrument for collecting samples of bottom sediments. (In Russian). *Sb. Rab. Koms. gidromet. Obs. 3*, 174-77. [Sampling area 20 cm^2 ~ 2000 cm^2; automatically closed with top lid and bottom curtains operated by springs] R, M, FW

Knudsen, M. (1927). A bottom sampler for hard bottom. *Meddr Kommn Havunders, Ser. Fisk. 8* (3) 4 pp. [Diameter 36 cm; sampling depth 30 cm; pump used to suck sampler down into sediment then coring tube inverted to retain sediment] R, M, Mar

Kögler, F.C. (1963). Das Kastenlot. (The box-corer) (In German). *Meyniana 13*, 1-7. [Box corer that is longer and has a smaller cross-section than corer of Reineck (1963)] R, M, Mar

Lang, K. (1930). Ein neuer Typus des quantitativen Bodenschöpfers. (A new type of quantitative bottom scoop) (In German). *Arch. Hydrobiol. 21*, 147-150. [Diameter 18 cm; gravity corer with five valves in the lid, no core retainer at lower end] R, M, FW

McManus, D.A. (1965). A large diameter coring device. *Deep-Sea Res. 12*, 227-232. [Diameter 15 cm; piston corer with spring-leaf core catcher in lower end] R, M, Mar

Menzies, R.J. & Rowe, G.T. (1968). The LUBS, a large undisturbed bottom sampler. *Limnol. Oceanogr. 13*, 708-714. [Sampling area 617 cm^2 or 2490 cm^2; gravity corer with canvas or nylon bag to close lower end and retain sample] R, M, Mar

Milbrink, G. (1968). A microstratification sampler for mud and water. *Oikos, 19*, 105-110. [Sampling area 12.3 cm by 13.5 cm; square plexiglass gravity corer, automatically closes and cuts sample into strata by means of slides] R, M, FW

Pettersson, O. (1928). A new apparatus for the taking of bottom-samples. *Svenska hydrogr.-biol. Kommn. Skr., N.S. Hydrogr. 6*, (6), 6-8. [Sampling area 400 cm^2; square impact corer forced into sediment by sliding weight of 20 - 40 kg; horizontal shield pulled across lower end to retain sample] R, M, Mar

Prokopovich, N.P. (1966). Ecological sampler for soft sediments. *Ecology 47*, 856-858. [Sampling area 232 cm^2; manual or gravity square corer closed automatically at lower end by plastic bottom with cutting edge] R, M, FW

Reineck, H.E. (1963). Der Kastengreifer. (The corer-grab) (In German). *Natur Mus., Frankf. 93*, 102-108. [Sampling area 20 cm by 30 cm; frame-supported square box corer with hinged cutting area that closes bottom; weight 750 kg] R, M, Mar

Reineck, H.E. (1967). Ein Kolbenlot mit Plastik-Rohren.. (A piston-corer with a plastic tube) (In German). *Senckenberg. leth. 48*, 285-289. [Diameter 10.2 cm; plastic-barrel piston corer] R, M, Mar

Rosfelder, A.M. & Marshall, N.F. (1967). Obtaining large, undisturbed and oriented samples in deep water. In *Marine geotechniques* (ed. A.F. Richards) 243-263. Urbana, Univ. Illinois Press. [Larger version of box corer of Reineck (1963); sampling area 600 cm^2] R, M, Mar

Rzoska, J. (1931). Bemerkungen über die quantitative Erfassung der Litoralfauna. (Observations on the quantitative sampling of the littoral fauna) (In German). *Verh. int. Verein. theor. angew. Limnol. 5*, 261-269. [Diameter 11.7 cm; manual corer] S, M, FW

Sanders, J.E. (1966). Summary of research on the Atlantic shelf and adjoining coastal areas carried out at Hudson Laboratories in 1965-1966. Hudson Laboratories of Columbia University, Informal Documentation No. 123, 26 pp. [Describes 'Klovan-Imbrie' wedge-shaped box corer, closed by sliding side] S, M, Mar

Thayer, G.W., Williams, R.B., Price, T.J. & Colby, D.R. (1975). A large corer for quantitatively sampling benthos in shallow water. *Limnol. Oceanogr. 20*, 474-80. [Diameter 30.5 cm; hydraulically operated corer similar to that of Knudsen (1927)] R, M, Mar.

5.4. MULTIPLE TUBE CORERS

[Weighted frames holding more than one core barrel]

Fowler, G.A. & Kulm, L.D. (1966). A multiple corer. *Limnol. Oceanogr. 11*, 630-633. [Five corers, each of diameter 3.5 cm; gravity corer, weight 110 kg but can be increased to 550 kg] R, M, Mar

Hakala, I. (1971). A new model of the Kajak bottom sampler, and other improvements in the zoobenthos sampling technique. *Annls zool. fenn. 8*, 422-426. [Three or six corers, each based on corer of Kajak (1965); upper ends of core tubes close automatically on contact with substratum; weight with six corers is 12.5 kg] R, M, FW

Hamilton, A.L., Burton, W. & Flannagan, J.F. (1970). A multiple corer for sampling profundal benthos. *J. Fish. Res. Bd Can. 27*, 1867-1869. [Four corers, each of diameter 4.7 cm, gravity corer with upper ends of core tubes closing automatically or by messenger; weight 7.9 kg] R, M, FW

Holme, N.A. (1964). Methods of sampling the benthos. In *Advances in marine biology* Vol. 2. (Ed. F.S. Russell). London, Academic. 171-260. [Five corers, each based on corer of Moore & Neill (1930)] R, M, Mar

Kemp, A.L.W., Savile, H.A., Gray, C.B. & Mudrochova, A. (1971). A simple corer and a method for sampling the mud-water interface. *Limnol. Oceanogr. 16*, 689-694. [Three corers, each of diameter 6.7 cm, based on commercially produced 'Benthos' gravity corer, valves at upper end of each core tube; weight 28 kg] R, M, FW

Krogh, A. & Spärck, R. (1936). On a new bottom sampler for investigation of the microfauna of the sea bottom. *K. danske Vidensk. Selsk. Skr. 13*, 1-12. [Six corers, each of diameter 2.8 cm; gravity corer, rubber check valves at upper end of each core tube] R, M, Mar

Milbrink, G. (1971). A simplified tube bottom sampler. *Oikos, 22*, 260-263. [Four corers, each of diameter 7 cm; gravity corer, upper ends of core tubes closed by rubber bung when activated by messenger] R, M, FW

Snerzhinskii, V.A. (1951). *Practical oceanography (work in marine exploration)* (In Russian). Leningrad. Gidrometeoizdat. 600 pp. [Multiple tube cable corer, each corer being a cable-type gravity corer; samples held in tubes by the suction of an overhead washer valve] R, M, Mar

5.5. DIVER-OPERATED CORERS

Fager, E.W., Flechsig, A.O., Ford, R.F., Clutter, R.I. & Ghelardi, R.J. (1966). Equipment for use in ecological studies using SCUBA. *Limnol. Oceanogr. 11*, 503-509. [Manual corers; diameter 6.6 cm, closed by plate at lower end; also square corer with sampling area of 45 cm^2] D, M, Mar

Kangas, P. (1972). Quantitative sampling equipment for the littoral benthos. *IBP i Norden 10*, 9-16. [Diameter 18.5 cm; Tvärminne manual corer with cutting plate inserted manually at lower end, see also Finnish IBP-PM group (1969)] D, MC, FW

Kirchner, W.B. (1974). A SCUBA diver operated corer for determining vertical distribution in the benthos. *Progve Fish Cult. 36*, 27-8. [Diameter 9 cm; manual corer with plates that are inserted to divide core into sections] D, M, FW

Walker, B. (1967). A diver operated pneumatic core sampler. *Limnol. Oceanogr. 12*, 144-146. [Light, portable corer, based on pneumatic corer of Mackereth (1958)] D, M, FW

6. *SUCTION AND AIR-LIFT SAMPLERS*

6.1. MUD SUCKERS

[Samplers that suck in sediment by vacuum or by pressure difference between air within the sampler and the surrounding water; all these samplers take a very small sample]

Holme, N.A. (1955). An improved 'vacuum' grab for sampling the sea-floor. *J. mar. biol. Ass. U.K. 34*, 545-51. [Mud sample sucked into tube; size of sample varies with depth from 10 ml at 2.7 m to 500 ml at 50-70 m; weight 13.6 kg] R, M, Mar

Hough, J.L. (1939). Bottom sampling apparatus. In *Recent marine sediments* (Ed. P.D. Trask). Tulsa, U.S.A. Amer. Assoc. Pet. Geol. [Describes Renn suction sampler that uses an evacuated glass bottle; end of glass tube broken on contact with bottom and sample sucked in; originally used for sampling bacteria] R, M, Mar

Hunt, D.O. (1926). A new method for quantitative sampling of the sea-bottom. *J. mar. biol. Ass. U.K. 14*, 529-534. [Similar to sampler of Holme (1955), except that sample tube is hermetically sealed with glass plate that is automatically broken on contact with bottom, sample is then sucked in] R, M, Mar

Moore, G.M. (1939). A limnological investigation of the microscopic fauna of Douglas Lake, Michigan. *Ecol. Monogr. 9*, 537-582. [Ooze sampler, based on that of Rawson (1930), with compressed rubber bulb attached to funnel; messenger used to free plates holding bulb and as bulb expands, sediment is sucked in through brass screen at mouth of funnel] R, M, FW

Purasjoki, K.J. (1953). Zwei verbesserte Apparate zum Auffangen von Kleintieren des See-und-Meeresbodens. (Two improved samplers for catching small animals from the bottom of lakes and the sea) (In German). *Archvm Soc. zool.-bot. fenn. 'Vanamo' 8*, 110-114. [Compressed bellows attached to funnel; messenger releases catch and expanding bellows suck in mud through screen at mouth of funnel] R, M, Mar FW

Rawson, D.S. (1930). The bottom fauna of Lake Simcoe and its role in the ecology of the lake. *Publs Ont. Fish. Res. Lab. 40*, 1-183. [Original ooze sucker, later modified slightly by Moore (1939)] R, M, FW

Roszczak, R. (1964). Zmodyfikowany czerpak denny. (A modified bottom dredger) (In Polish). *Ekol. pol. (B) 10*, 239-242. [Mud sucker for microinvertebrates; samples water - mud interface, samples taken at water depths of 32 m] R, M, FW

6.2. HYDRAULIC SUCTION SAMPLERS

[Samplers that use pumped water, often through a venturi tube, to suck sample up a tube]

Allen, D.M. & Hudson, J.H. (1970). A sled-mounted suction sampler for benthic organisms. *Spec. scient. Rep. U.S. Fish Wildl. Serv. - Fish.* No. 614, 1-5. [Suction pipe mounted on sledge which is drawn over the substratum; pump, venturi tube and collecting bag are all on a boat; when sledge moves 12.5 m, 1 m^2 of substratum is sampled] R, MC, Mar

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. ['Counterflush' corer, diameter 12.5 cm, pushed into bottom and water pumped into corer washes sediment up into collecting sieve] R, MC, Mar

Emig, C.C. & Lienhart, R. (1971). Principe de l'aspirateur sous-marin automatique pour sédiments meubles. (Principle of an automatic submarine suction sampler for loose sediments) (In French). *Vie Milieu (Suppl.) 22*, 573-578. [Self-contained suction sampler with the suction provided by a propeller operated by an electric motor; sediment sucked into 3 tubes arranged as a tripod and with a total surface sampling area of 0.1 m^2; weight 40 kg] R, M, Mar

Heurteaux, P. & Marazanof, F. (1965). Une méthode de prélèvement quantitatif en écologie aquatique. (A method of quantitative sampling in aquatic ecology) (In French). *Annls Limnol. 1*, 191-196. [Deep sided quadrat pushed into substratum to enclose an area of bottom; only suitable for very shallow water; contents then sucked out with manually-operated suction pump; used for sampling shallow swamps and ponds] S, M, FW

Larsen, P.F. (1974). A remotely operated shallow water benthic suction sampler. *Chesapeake Sci. 15*, 176-78. [Sampler is a cross between diver-operated sampler of Brett (1964) and boat-operated sampler of True et al. (1968); diameter of suction pipe is 12.7 cm] R, MC, Mar

Pickett, G.D. (1973). The impact of mechanical harvesting on the Thames Estuary cockle fishery. *Lab. Leafl. Fish. Lab. Lowestoft* (NS) No 29, 22 pp. [Describes hydraulic suction dredge with intake pipe mounted on sledge] R, MC, Mar

Reys, J.P. & True, R. (1966). Un nouvel appareil de prélèvement quantitatif de substrats meubles. (New apparatus for the quantitative sampling of loose substrata) (In French). *2nd Int. oceanogr. Congr.*, Moscow, *2*, 298-299. [Abstract only: see True et al. (1968)] R, MC, Mar

True, M.A., Reys, J.P. & Delauze, H. (1968). Progress in sampling the benthos: the benthic suction sampler. *Deep-Sea Res. 15*, (2), 239-242. [Coring tube of 0.1 m^2 area is sucked into bottom when a pump circulates water through a venturi tube in the corer; sample sucked up into basket in upper end of corer; sampler lowered on wire and water pump either on the boat or powered by submerged electric motor with cable to the boat] R, MC, Mar

6.3. AIR-LIFT SAMPLERS

[Samplers that use air under pressure to lift substratum and animals from the bottom and into a collecting net]

Della Croce, N. & Chiarabini, A. (1971). A suction pipe for sampling midwater and bottom organisms in the sea. *Deep-Sea Res. 18*, 851-854. [Suction pipe connected to funnel that samples an area of 1.7 m^2; air injected into pipe lifts sample into collecting net; lower tube from air inlet to funnel is 2 m and upper tube from air inlet to net must be at least 6.5 m; weight 160 kg] R, MC, Mar

Emig, C.C. (1977). Un nouvel aspirateur sous-marins, à air comprimé. (A new submarine suction-sampler, using compressed air) (In French). *Mar. Biol. 43*, 379-380. [Compressed air fed into short cylinder (diameter 25 cm) placed on bottom and connected to suction pipe (diameter 9 cm) leading to a boat; water inlets in the form of 5 small tubes are used to counterbalance the suction effect; weighted to about 15 kg] R, MC, Mar

Mackey, A.P. (1972). An air-lift for sampling freshwater benthos. *Oikos, 23*, 413-415. [Compressed air fed into lower end of 3 m long plastic tube with diameter of 8 cm; tube pushed into sediment and material removed by air-lift into net bag above the water] R, MC, FW

Pearson, R.G., Litterick, M.R. & Jones, J.V. (1973). An air-lift for quantitative sampling of the benthos. *Freshwat. Biol. 3*, 309-15. [A series of air jets open into a square aluminium box, sampling area 400 cm^2; sample sucked up tube of 5 cm diameter and tube ends in U-shape to deliver sample into collecting net; used in water depths of 0.2 m to 4 m] R, MC, FW

6.4. DIVER OPERATED HAND SUCKERS

[Suction samplers with a small mouth; they can be used to remove animals from a defined area of bottom, but latter must be disturbed by hand if invertebrates are not on the surface of the substratum]

Bleakney, J.S. (1969). A simplified vacuum apparatus for collecting small nudibranchs. *Veliger 12*, 142-143. ["Acadian SOCK", small hand-operated sucking device for collecting animals directly from the substratum] D, MCLP, Mar

Clark, K.B.(1971). The construction of a collecting device for small aquatic organisms and a method for rapid weighing of small invertebrates. *Veliger 13*, 364-367. [Small hand-operated sucker] D, MCLP, Mar

Gilligan, M.R. (1976). Small marine animal collector for use by divers. *Progve Fish Cult. 38*, 40-41. [Plexiglass tube with piston; animals sucked in when piston withdrawn and then they are pushed into collecting net when piston returned] D, CL, Mar

Tanner, C., Hawkes, M.W., Lebednik, P.A. & Duffield, E. (1977). A hand-operated suction sampler for the collection of subtidal organisms. *J. Fish. Res. Bd Can. 34*, 1031-1034. [Simple hand operated pump that sucks animals into first compartment, and then pushes water and animals into sample bottle] D, MCLP, Mar

6.5. DIVER OPERATED HYDRAULIC SUCTION SAMPLERS

[Samplers that use pumped water, often through a venturi tube, to suck sample up a tube]

Brett, C.E. (1964). A portable hydraulic diver-operated dredge-sieve for sampling subtidal macrofauna. *J. mar. Res. 22*, 205-209. [Sampling frame, 0.33 m^2, forced into bottom and then contents sucked out by hydraulic suction sampler, using aspirator principle with jet of water injected through hose from power pump on boat, outflow passed through sieve, used to water depths of 46 m] D, MC, Mar

Ekdale, A.A. & Warme, J.E. (1973). A diver-operated dredge for collecting quantitative samples in soft sediments. *J. Paleont. 47*, 1119-21. [Hydraulic suction dredge, similar to that of Brett (1964); sampling cylinder (surface area 0.10 - 0.25 m^2) inserted in bottom and then contents sucked out into underwater rigid basket] D, M, Mar

Emig, C.C. & Lienhart, R. (1967). Un nouveau moyen de récolte pour les substrates meuble infralittoraux: l'aspirateur sous-marin. (A new method of collecting from loose substrates of the infralittoral region: the submarine sucker) (In French). *Recl Trav. Stn mar. Endoume 58*, 115-120. [Self-contained hydraulic sucker powered by 12 v battery in watertight compartment, sample filtered through rigid cone of metal gauze] D, MC, Mar

Gale, W.F. & Thompson, J.D. (1975). A suction sampler for quantitatively sampling benthos on rocky substrates in rivers. *Trans. Am. Fish. Soc. 104*, 398-405. [Describes dome-shaped sampler (diameter 45 cm, sampling area 0.18 m^2) with arm-holes and pump to suck organisms out of sampler into bag] D, MC, FW

Gulliksen, B, & Deras, K.M. (1975). A diver-operated suction sampler for fauna on rocky bottoms. *Oikos, 26*, 246-249. [A sampling bottle with 0.5 mm sieve is connected to a manual suction pump used to suck up contents of area contained by a sampling frame] D, M, Mar

Massé, H. (1967). Emploi d'une suceuse hydraulique transformée pour les prélèvements dans les substrats meubles infralittoraux. (Use of a transformed hydraulic dredge for quantitative sampling in the loose infralittoral substratum) (In French). *Helgoländer wiss. Meeresunters. 15*, 500-505. [Slightly modified version of suction sampler of Brett (1964)] D, MC, Mar

Massé, H. (1970). La suceuse hydraulique, bilan de quatre années de émploi sa manipulation, ses avantages et inconvénients. Peupleuments benthique. (The hydraulic dredge, a balance sheet of its advantages and disadvantages after four years of use. Benthic populations) (In French). *Tethys 2*, 547-556. [Discusses advantages and disadvantages of dredge of Massé (1967)] D, MC, Mar

Smith, W.L. (1973). Submersible device for collecting small crustaceans. *Crustaceana 25*, 104-105. [Small hydraulic suction sampler with bilge pump powered by 6 v battery] D, MCLP, Mar

Zimmermann, V. & Amblühl, H. (1970). Zur Methodik der quantitativen biologischen Probenahmen in stark strömenden Flüssen. (On a method of quantitative biological sampling in strong-flowing rivers) (In German). *Schweiz. Z. Hydrol. 32*, 340-344. [Cylinder with sampling area of 750 cm^2 pushed into bottom and then contents sucked out with pipe connected to water pump on land or in boat] D, MC, FW

6.6. DIVER OPERATED AIR-LIFT SAMPLERS

[Samplers that use air under pressure to lift substratum and animals from the bottom and into a collecting net]

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*, 701-5. [Sampling area 0.02 m^2, samples to water depth of 8 m] D, MC, FW

Barnett, P.R.O. & Hardy, B.L.S. (1967). A diver-operated quantitative sampler for sand macrofaunas. *Helgoländer wiss. Meeresunters, 15*, 390-398. [Sampler in two parts - 1) sample cylinder (I.D. 35.7 cm; sampling area 0.1 m^2) pushed into sand at first by hand, then by pressure difference as air replaces water in cylinder, 2) air-lift pump used to remove contents of cylinder after lid removed] D, MC, Mar

Christie, N.D. & Allen, J.C. (1972). A self-contained diver-operated quantitative sampler for investigating the macrofauna of soft substrates. *Trans. R. Soc. S. Afr. 40*, 299-307. [Sampling cylinder (I.D. 35.7 cm, sampling area 0.1 m^2) sinks into bottom by pressure difference created when air replaces water in cylinder, then air-lift used to remove sediment containing animals. See also Zoutendyk (1971)] D, M, Mar

Finnish IBP-PM Group (1969). Quantitative sampling equipment for the littoral benthos. *Int. Revue ges. Hydrobiol. Hydrogr. 54*, 185-93. [Sampling area 0.11 m^2, used at water depths of 2-15 m] D, MC, Mar

Hiscock, K. & Hoare, R. (1973). A portable suction sampler for rock epibiota. *Helgoländer wiss. Meersunters. 25*, 35-38. [Small suction sampler based on that of Barnett & Hardy (1967), weighs 25 kg; used to suck out contents of quadrat; scraper on end of suction tube used to remove organisms; cannot be used in shallow water < 2 m] D, MCL, Mar

Kangas, P. (1972). Quantitative sampling equipment for the littoral benthos. *IBP i Norden 10*, 9-16. [Modified version of suction sampler described in Finnish IBP-PM Group (1969), raft removed and sampler completely submerged, describes two models for smooth rock and stony bottoms] D, MCL, Mar

Keegan, B.F. & Könnecker, G. (1973). *In situ* quantitative sampling of benthic organisms. *Helgoländer wiss. Meeresunters. 24*, 256-263. [Suction sampler based on that of Barnett & Hardy (1967), but with several modifications, including a self-contained air supply] D, MC, Mar

Kritzler, H., Hiskey, R.M. & Thomas, P.J. (1974). A system for the quantitative sampling of shallow water benthos. *Int. Revue ges. Hydrobiol. Hydrogr. 59*, 621-27. [Sampling area 0.063 m^2, 'Gismo' sampler with sampling area completely enclosed before contents sucked out and sieved on a boat, requires diver and boatman] D, MC, Mar

Vogele, L., Boyer, R. & Heard, W. (1971). A portable underwater suction device. *Progve Fish Cult. 33*, 62-63. [Small air-lift sampler, diameter of suction pipe 2.5 cm, pipe bends about 1 m from mouth to deliver air-water-mud suspension into small collecting bag; used for collecting fish eggs and larvae] D, M, FW

Zoutendyk, P. (1971). A self-contained diver-operated air-lift pump for quantitative sampling of infratidal rock communities. *Baralogia Proc. 1st 2nd S. Afr. Symp. Underwat. Sci.* 108-112. [Air-lift sampler, later modified by Christie & Allen (1972)] D, M, Mar

7. *ELECTROSHOCKING SAMPLERS*

Bayless, J.D. (1961). The use of electrical stimuli in live-picking organisms from bottom samples. *Proc. 15th a. Conf. SEast Ass. Game Fish Commn*, 286-288.

Dittmar, H. (1951). Anwendungsmöglichkeiten des zerhackten Gleichstromes für ökologische Arbeiten. (Possible applications of direct current for ecological work) (In German). *Arch. Hydrobiol. 45*, 217-223. [Used 120 v D.C. shocker to separate animals from mud samples] S, M, FW

Ervin, J.L. & Ball, R.C. (1974). Electronic devices for the capture of aquatic invertebrates. *Tech. Rep. Inst. Wat. Res. Mich. State Univ.* No. 40. 71 pp. [Used 110 v A.C. shocker to remove burrowing invertebrates from fine silt; sampling area enclosed by wooden box] S, M, FW

Fahy, E. (1972). An automatic separator for the removal of aquatic insects from detritus. *J. appl. Ecol. 9*, 655-58. [Used pulsed D.C. shocker, 400 v, 30-60 cycles/s, for three periods of 2 min to drive invertebrates out of the substratum, into the current and finally onto collecting sieves] S, MC, FW

Hughes, B.D. (1975). A comparison of four samplers for benthic macroinvertebrates inhabiting coarse river deposits. *Wat. Res. 9*, 61-9. [Used fish shocker to remove invertebrates from area enclosed by modified sampler of Neill (1938)] S, MCL, FW

Lehmann, U. (1967). Drift und Populationsdynamik von *Gammarus pulex fossarum* Koch. (Drift and population dynamics of *Gammarus pulex fossarum* Koch) (In German). *Z. Morph. Ökol. Tiere 60*, 227-274. [Electroshocker (0.6 kW) used to remove gammarids within sampling frame of 1 m^2; net used to catch shocked animals] S, MCL, FW

8. *EFFICIENCIES AND COMPARISONS*

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*, 701-5. [Compares air-lift sampler and Ekman grab; air-lift more efficient] FW

Albrecht, M.L. (1961). Ein Vergleich quantitativer Methoden zur Untersuchung der Makrofauna fließender Gewässer. (A comparison of quantitative methods for investigating the macrofauna of flowing water) (In German). *Verh. int. Verein. theor. angew. Limnol. 14*, 486-490. [Compares hand-net collecting of 10 stones, Surber-sampler, and Macan shovel sampler in shallow stony streams] FW

Alm, G. (1922). Über die Prinzipien der quantitativen Bodenfaunistik und ihre Bedeutung für die Fischerei. (On the principles of quantitative studies of the bottom fauna and its significance for fisheries) (In German). *Verh. int. Verein. theor. angew. Limnol. 1*, 168-180. [Discusses the defects of a Birge-Ekman grab] FW

Armitage, P.D., MacHale, A.M. & Crisp, D.C. (1974). A survey of stream invertebrates in the Cow Green basin (Upper Teesdale) before inundation. *Freshwat. Biol. 4*, 369-398. [Compares kick-sample catches in pond net with samples taken with shovel sampler of Macan (1958)] FW

Baird, R.H. (1959). Factors affecting the efficiency of dredges, pp. 222-4. In *Modern fishing gear of the world* (Ed. H. Kristjonsson). London. Fishing News (Books) Ltd. 607 pp. [Briefly discusses the various factors that determine the efficiency of a dredge] Mar

Baker, J.H., Kimball, K.T. & Bedinger, C.A. Jr. (1977). Comparison of benthic sampling procedures: Petersen grab vs. Mackin corer. *Wat. Res. 11*, 597-601. [Mackin corer found to be more efficient] FW

Baker, J.H., Pugh, L.A. & Kimball, K.T. (1977). A simple hand corer for shallow water sampling. *Chesapeake Sci. 18*, 232-236. [Compares their hand corer with Mackin corer] FW

Beeton, A.M., Carr, J.F. & Hiltunen, J.K. (1965). Sampling efficiencies of three kinds of dredges in Southern Lake Michigan. *Proc. 8th Conf. Gt Lakes Res.*, 209. [Compares efficiencies of the Petersen, orange-peel and Smith-McIntyre grabs; Smith-McIntyre took more species and more animals] FW

Beukema, J.J. (1974). The efficiency of the van Veen grab compared with the Reineck box sampler. *J. Cons. perm. int. Explor. Mer 35*, 319-327. [Compares van Veen grab and Reineck box corer in marine sands] Mar.

Birkett, L. (1958). A basis for comparing grabs. *J. Cons. perm. int. Explor. Mer 23*, 202-7. [Compares Petersen and van Veen grabs and develops index of digging efficiency] Mar

Brinkhurst, R.O., Chua, K.E. & Batoosingh, E. (1969). Modifications in sampling procedures as applied to studies on the bacteria and tubificid oligochaetes inhabiting aquatic sediments. *J. Fish. Res. Bd Can. 26*, 2581-93. [Compares Kajak-Brinkhurst corer with Ekman grab, and Freshwater Biological Association corer with Ekman grab; concludes that K-B corer is the best] FW

Burns, R.E. (1963). A note on some possible misinformation from cores obtained by piston-type coring devices. *J. sedim. Petrol. 33*, 950-952. [Discusses factors that affect the efficiency of piston corers] Mar

Burton, W. & Flannagan, J.F. (1973). An improved Ekman-type grab. *J. Fish. Res. Bd Can. 30*, 287-290. [Compares improved version with old version of Ekman grab and concludes that new grab is better than old] FW

Christie, N.D. (1975). Relationship between sediment texture, species richness and volume of sediment sampled by a grab. *Mar. Biol. 30*, 89-96. [Discusses factors that affect efficiency of a grab] Mar

Chutter, F.M. (1972). A reappraisal of Needham and Usinger's data on the variability of a stream fauna when sampled with a Surber sampler. *Limnol. Oceanogr. 17*, 139-141. [Examines efficiency of Surber sampler, using data of Needham & Usinger (1956)] FW

Chutter, F.M. & Noble, R.G. (1966). The reliability of a method of sampling stream invertebrates. *Arch. Hydrobiol. 62*, 1, 59-103. [Examines efficiency of Surber sampler in a shallow, stony river] FW

Davis, F.M. (1925). Quantitative studies on the fauna of the sea bottom. No. 2. Results of the investigations in the southern North Sea, 1921-1924. *Fishery Invest., Lond.* Ser. 2, *8*, (4), 50 pp. [Discusses disadvantages of Petersen grab] Mar

Dickinson, J.J. & Carey, A.G. (1975). A comparison of two benthic infaunal samplers. *Limnol. Oceanogr. 20*, 900-2. [Compares Smith-McIntyre grab with anchor-box dredge; grab better] Mar

Emig, C.C. & Lienhart, R. (1971). Principe de l'aspirateur sous-marin automatique pour sédiments meubles. (Principle of an automatic submarine suction sampler for loose sediments) (In French). *Vie Milieu (Suppl.) 22*, 573-578. [Compares own suction sampler with that of Brett (1964)] Mar

Fast, A.W. (1968). A drag dredge. *Progve Fish Cult. 30*, 57-61. [Compares drag dredge with Petersen grab] FW

Flannagan, J.F. (1970). Efficiencies of various grabs and corers in sampling freshwater benthos. *J. Fish Res. Bd Can. 27*, 1691-1700. [Compares Ponar grab, Shipek scoop, Franklin-Anderson grab, Ekman grab, multiple corer (Hamilton et al. 1970), Dietz-La Fond grab, Benthos 2170 gravity corer, Alpine 211 gravity corer] FW

Frost, S., Huni, A. & Kershaw, W.E. (1971). Evaluation of a kicking technique for sampling stream bottom fauna. *Can. J. Zool. 49*, 167-73. [Examines efficiency of simple net method of sampling in shallow steams] FW

Gage, J.D. (1975). A comparison of the deep-sea epibenthic sledge and anchor box dredge samplers with the van Veen grab and hand coring by diver. *Deep-Sea Res. 22*, 693-702. [Compares epibenthic sledge (Hessler & Sanders 1967), Forster anchor dredge, van Veen grab and hand cores taken by diver; latter method most efficient] Mar

Gale, W.F. & Thompson, J.D. (1975). A suction sampler for quantitatively sampling benthos on rocky substrates in rivers. *Trans. Am. Fish. Soc. 104*, 398-405. [Compares diver-operated suction sampler with Petersen, Ekman and Ponar grabs, a corer, and a Surber sampler; only the suction sampler worked efficiently] FW

Gallardo, V.A. (1965). Observations on the biting profiles of three bottom samplers. *Ophelia 2*, 319-322. [Compares biting efficiency of Petersen, van Veen and Smith-McIntyre grabs] Mar

Gaufin, A.R., Harris, E.K. & Walter, H.J. (1956). A statistical evaluation of stream bottom sampling data obtained from three standard samplers. *Ecology 37*, 643-648. [Compares efficiency of pond net, Ekman grab and Surber sampler in a stream] FW

Giani, N. (1974). Description d'un nouveau type de carottier pour les sédiments très fluides. (Description of a new type of corer for very fluid sediments) (In French). *Annls Limnol. 10*, 99-108. [Compares gravity corer with Ekman grab; corer more efficient] FW

Gilat, E. (1963). Methods of study in marine benthonic ecology. *Colloque Com. Benthos, Commn int. Explor. scient. Mer Méditerr.* 7-13. Marseille. [Compares Petersen grab, beam trawl and bottom dredge] Mar.

Gillespie, D.M. & Brown, C.J.D. (1966). A quantitative sampler for macroinvertebrates associated with aquatic macrophytes. *Limnol. Oceanogr. 11*, 404-406. [Compare their sampler with hand net] FW

Holme, N.A. (1949). A new bottom sampler. *J. mar. biol. Ass. U.K. 28*, 323-332. [Compares 0.05 m^2 single scoop sampler with 0.01 m^2 Petersen grab] Mar

Holme, N.A. (1953). The biomass of the bottom fauna in the English Channel off Plymouth. *J. mar. biol. Ass. U.K. 32*, 1-49. [Compares Petersen grab, new double-scoop sampler, and new suction corer] Mar

Holme, N.A. & McIntyre, A.D. (1971). *Methods for the study of marine benthos*. IBP Handbook No. 16. Oxford, Blackwell. 334 pp. [Chapter 8 is a good review of the efficiency of benthos sampling gear] Mar

Holopainen, I.J. & Sarvala, J. (1975). Efficiencies of two corers in sampling soft-bottom invertebrates. *Annls zool. fenn. 12*, 280-284. [Compares efficiencies of two single Kajak-type corers (sampling areas 15.2 cm^2, 54.6 cm^2) with diver-operated manual corer (sampling area 54.6 cm^2)] FW

Howard, A.E. (1976). A comparison of some new methods for surveying large areas for cockles (*Cardium edule*). *Fish. Res. tech. Rep. Lowestoft.* No. 30. 8 pp. [Compares efficiencies of following samplers for catching cockles: Burnham cockle dredge, shrimp beam trawl, oyster hand dredge, modified Baird oyster dredge, Day grab and Smith-McIntyre grab] Mar

Howmiller, R.P. (1971). A comparison of the effectiveness of Ekman and Ponar grabs. *Trans. Am. Fish. Soc. 100*, 560-564. [Compares efficiencies of Ponar and Ekman grabs in hard and soft substrata of Lake Michigan] FW

Hudson, P.L. (1970). Quantitative sampling with three benthic dredges. *Trans. Am. Fish. Soc. 99*, 603-7. [Compares Ponar, Ekman and orange-peel grabs] FW

Hughes, B.D. (1975). A comparison of four samplers for benthic macro-invertebrates inhabiting coarse river deposits. *Wat. Res. 9*, 61-9. [Compares the following samplers in shallow stony sections of river: Surber, modified Neill cylinder, electroshocker and tray with artificial substratum] FW

Hunter, B. & Simpson, A.E. (1976). A benthic grab designed for easy operation and durability. *J. mar. biol. Ass. U.K. 56*, 951-957. [Compares new Hunter grab with Smith-McIntyre grab] Mar

Ivanov, A.I. (1965). Underwater observations of the functioning of sampling equipment for benthos collections (In Russian). *Okeanologiya 5*, 917-924. [Compares Petersen grab and Okean 50 grab with samples taken by a diver] Mar

Johansen, A.C. (1927). Preliminary experiments with Knudsen's bottom sampler for hard bottom. *Meddr Kommn Havunders., Ser. Fisk. 8*, (4), 6 pp. [Compares Knudsen (1927) large diameter corer with 0.1 and 0.2 m^2 Petersen grabs] Mar

Jónasson, P.M. (1955). The efficiency of sieving techniques for sampling freshwater bottom fauna. *Oikos 6*, 183-207. [Compares extraction efficiencies of sieves used to remove invertebrates from samples obtained with the Lenz (1931) version of the Ekman grab] FW

Jónasson, P.M. (1958). The mesh factor in sieving techniques. *Verh. int. Verein. theor angew. Limnol. 13*, 860-866. [Examines the effect of mesh size of sieves used to separate invertebrates from mud sample obtained with an Ekman grab] FW

Kajak, Z. (1963). Analysis of quantitative benthic methods. *Ekol. pol. (A), 11*, 1-57. [Compares efficiencies of two Kajak corers (sampling areas 10 cm^2, 5 cm^2) with Ekman grab in lakes] FW

Karlsson, M., Bohlin, T. & Stetson, J. (1976). Core sampling and flotation: two methods to reduce costs of a chironomid population study. *Oikos, 27*, 336-338. [Compares Ekman grab and core sampler of Milbrink (1971)] FW

Kroger, R.L. (1972). Underestimation of standing crop by the Surber sampler. *Limnol. Oceanogr. 17*, 475-78. [Examines efficiency of Surber sampler] FW

Kutty, M.K. & Desai, B.N. (1968). A comparison of the efficiency of the bottom samplers used in benthic studies off Cochin. *Mar. Biol. 1*, 168-171. [Compares van Veen and Petersen grabs, van Veen better] Mar

Lamotte, M. & Bourlière, F. (1971). *Problèmes d'écologie: l'échantillonnage des peuplements animaux des milieux aquatiques.* (Problems of ecology: the sampling of animal populations of aquatic environments) (In French). Paris. Masson. 294 pp. [Chapter 5 includes a comparison between grab of Briba & Reys (1966) and suction sampler of True et al. (1968)] Mar

Lavery, M.A. & Costa, R.R. (1972). Reliability of the Surber sampler in estimating *Parargyractis fulicalis* (Clemens) (Lepidoptera: Pyralidae) populations. *Can. J. Zool. 50*, 1335-6. [Found that Surber sampler was inadequate for sampling this aquatic moth] FW

Leonard, J.W. (1939). Comments on the adequacy of accepted stream bottom sampling techniques. *Trans. 4th N. Am. Wildl. Conf.*, 288-295. [Examines efficiency of Surber sampler in shallow streams] FW

Lie, U. & Pamatmat, M.M. (1965). Digging characteristics and sampling efficiency of the 0.1 m^2 van Veen grab. *Limnol. Oceanogr. 10*, 379-384. [Examines efficiency of van Veen grab] Mar

Mackey, A.P. (1972). An air-lift for sampling freshwater benthos. *Oikos 23*, 413-415. [Compares his air-lift sampler with corer of Maitland (1969)] FW

Mackie, G.L. & Qadri, S.U. (1971). A quantitative sampler for aquatic phytomacrofauna. *J. Fish. Res. Bd Can. 28*, 1322-1324. [Compares their new sampler with Ekman grab] FW

Massé, H. (1967). Emploi d'une suceuse hydraulique transformée pour les prélèvements dans les substrats meubles infralittoraux. (Use of a transformed hydraulic dredge for quantitative sampling in the loose infralittoral substratum) (In French). *Helgoländer wiss. Meeresunters. 15*, 500-505. [Compares suction dredge with orange-peel grab] Mar

McIntyre, A.D. (1956). The use of trawl, grab and camera in estimating marine benthos. *J. mar. biol. Ass. U.K. 35*, 419-429. [Compares catches of Agassiz trawl and van Veen grab with estimates of animal abundance from underwater photographs] Mar

McIntyre, A.D. (1971). Deficiency of gravity corers for sampling meiobenthos and sediments. *Nature, Lond, 231*, 260. [Compares gravity corer with diver-operated manual corer] Mar

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Ursin, E. (1954). Efficiency of marine bottom samplers of the van Veen and Petersen types. *Meddr Danm. Fisk.-og Havunders.* N.S. *1*, (7), 8 pp. [Compares van Veen and Petersen grabs, van Veen generally better] Mar

Ursin, E. (1956). Efficiency of marine bottom samplers with special reference to the Knudsen sampler. *Meddr Danm. Fisk.-og Havunders.* N.S. *1*, (14), 6 pp. [Compares Knudsen large-diameter corer with van Veen grab; caught similar numbers of invertebrates but Knudsen caught more species] Mar

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Wigley, R.L. (1967). Comparative efficiencies of van Veen and Smith-McIntyre grab samplers as revealed by motion pictures. *Ecology, 48*, 168-169. [Large shock wave created by van Veen grab whilst it descended to the bottom, but only a weak oscillatory shock wave was caused by Smith-McIntyre grab] Mar

Zelt, K.A. & Clifford, H.F. (1972). Assessment of two mesh sizes for interpreting life-cycles, standing crop, and percentage composition of stream insects. *Freshwat. Biol. 2*, 259-269. [Compares Surber sampler with pond net and also compares catches with different mesh sizes] FW

9. *SAMPLERS FROM CATALOGUES*

[These samplers were originally described only in the catalogue of the manufacturer]

Grabs

Foerst-Petersen grab (Limnological Apparatus Company, 2406 N. Bernard Street, Chicago, Illinois 60647, U.S.A.) [Has weighted jaws of Petersen grab and lever arms of van Veen grab]

Marukawa's snapper grab (Rigosha & Co., Ltd., 2 Kajicho 1 - Chome, Kanda, Chiyoda-ku, Tokyo 101, Japan) [Heavy weight pushes grab into sediments and jaws closed by springs; sampling capacity 300 cm^3; weight 9 kg]

Mud-snapper grab (Rigosha & Co.) [Rod-operated grab samples to water depth of 2 m; sampling capacity 100 cm^3; weight 6 kg]

Seki grab (Rigosha & Co.) [Sampling capacity 500 cm^3; weight 5.2 kg]

Tamura's grab (Rigosha & Co.) [Jaws closed automatically by spring when trigger plate touches bottom; weight 10 kg]

Corers

Alpine gravity corer (Alpine Geophysical Assoc. Inc., Norwood, N.J., U.S.A.) [Diameter 4.1 cm, weight 45 kg; self-sealing valve at upper end of tube]

Benthos' gravity corer (Benthos Inc., North Falmouth, Mass., U.S.A.) [Diameter 6.6 cm, weighted up to 80 kg]

Gilson corer/F.B.A. automatic mud sampler (Freshwater Biological Association, Ambleside, Cumbria, England) [Diameter 5.3 cm; can be used on pole or weighted on a line as a gravity corer]

G.M. manual impact corer (G.M. Mfg. Co., 12 East 12th Street, New York 3, N.Y., U.S.A.) [Diameter 4.4 cm, weight 8 kg; heavy weight used to drive corer into sediment, diver-operated in deep water]

Kitahara's gravity corer (Rigosha & Co.)

Niino's impact corer (Rigosha & Co.) [Diameter 3.5 cm; driven in by 50 kg weight]

Okamoto's gravity corer (Rigosha & Co.) [Uses rocks held in net bag instead of weights, rocks discarded after corer driven into substratum]

INDEX TO SAMPLERS WITH COMMON NAMES

The original reference for each sampler is given in parenthesis after the common name.

Name	Author	Section
'Acadian SOCK'	(Bleakney 1969)	6.4
'Albatross' corer	(Sumner et al. 1914)	5.2
Allan grab	(Allan 1952)	4.6
'Alpine 211' corer		9
Auerbach box corer/grab	(Auerbach 1953)	4.6, 5.3
Baillie rod corer	(Murray 1885)	5.2
Baird grab	(Baird 1958)	4.6
Ball's dredge	(Fowler & Allen 1928)	3.3
Banks corer	(Hough 1939)	5.2
Barnett & Hardy air-lift sampler	(Barnett & Hardy 1967)	6.6
Belknap-Sigsbee corer	(Agassiz 1888)	5.2
'Benthos' corer		9
Birge-Ekman grab	see Ekman grab	4.1
'Bootstrap' corer	(Isaacs & Brown 1968)	5.3
Bou-Rouch tube	(Bou & Rouch 1967)	5.2
Bouma box sampler	(Bouma & Marshall 1964)	5.3
Brett suction sampler	(Brett 1964)	6.5
'Bulldog' grab	(Thomson 1873)	4.6
Butler corer	(Holme & McIntyre 1971)	5.2
Cable-type corer	(Snerzhinskii 1951)	5.2
Campbell grab	(Hartman 1955)	4.3
'Canal' corer	(Fortier & Blaney 1928)	5.2
'Clamshell' grab	(Snerzhinskii 1951)	4.6
'Coupole' grab	(Verneaux 1966)	4.6
Craib corer	(Craib 1965)	5.2
Dietz-La Fond grab	(La Fond & Dietz 1948)	4.6
'Dragonet 11' dredge	(Bieri & Tokioka 1968)	3.3
Duits 'Hamon' grab	(Conrad-Stork not dated)	3.1
Ekman corer	(Ekman, V.W. 1905)	5.2
Ekman dredge	(Ekman, S. 1947)	3.3
Ekman grab	(Ekman, S. 1911)	4.1
F.B.A. corer		9
'Fish-Hawk' grab	(Hough 1939)	4.6
Foerst-Peterson grab		9
Forster anchor dredge	(Forster 1953)	3.4
Franklin-Anderson grab	(Franklin & Anderson 1961)	4.6
Freidinger grab	(Naumann 1925)	4.3
Gilson, corer		9
'Gismo' sampler	(Kritzler et al. 1974)	6.6
G.M. manual impact corer		9
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'Haps' corer	(Kanneworff & Nicolaisen 1973)	5.3
Haywood orange peel grab	(Reish 1959)	4.2
Holme anchor dredge	(Holme 1961)	3.4
Holme double mud scoop	(Holme 1953)	3.1
Holme vacuum grab	(Holme 1955)	6.1
Hunt suction sampler	(Hunt 1926)	6.1
Hunter grab	(Hunter & Simpson 1976)	4.4
Hvorslev-Stetson corer	(Hvorslev & Stetson 1946)	5.2
'Hydra' corer	(Murray 1885)	5.2
Iselin corer	(Iselin 1932)	5.2
Jenkin corer	(Jenkin & Mortimer 1938)	5.2
Jenkin mud/water sampler	(Mortimer 1942)	5.2
Kajak corer	(Kajak et al. 1965)	5.2
Kajak-Brinkhurst (K-B) corer	(Brinkhurst et al. 1969)	5.2
Kindle's 'Seedtester' corer	(Hough 1939)	5.2
Kitahara's gravity corer		9
Klassen grab	(Borutskii 1952)	4.6
Klovan-Imbrie box corer	(Sanders 1966)	5.3
Knudsen corer	(Knudsen 1927)	5.3
Kullenberg corer	(Kullenberg 1947)	5.2
La Fond-Dietz grab	(La Fond & Dietz 1948)	4.6
Lastochkin-Ulomskii corer	(Ulomskii 1952)	5.2
Lenz grab	(Lenz 1931)	4.1
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Moore corer	(Moore 1939)	5.2
Moore ooze sucker	(Moore 1939)	6.1
Mud-snapper grab		9
Müller's dredge	(Thomson 1873)	3.3
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Naumann corer	(Naumann 1916)	5.2
Neill cylinder	(Neill 1938)	2.1a
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Okamoto's gravity corer		9
Okean or Okean '50' grab	(Lisitsyn & Udintsev 1955)	4.3
Petersen grab	(Petersen & Boysen-Jensen 1911)	4.3
Phleger corer	(Phleger 1951)	5.2
Piggot 'gun' corer	(Piggot 1936)	5.2
'Pile driver' corer	(Varney 1935)	5.2
Ponar grab	(Powers & Robertson 1967)	4.6
Prince of Monaco corer	(Thoulet 1890)	5.2

'Rammer lead' corer	(Strøm 1934)	5.2
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Reineck box corer	(Reineck 1963)	5.3
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Riedl dredge	(Riedl 1955)	3.3
Riley push net	(Holme & McIntyre 1971)	3.3
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Ruttner scissor grab	(Ruttner 1913/14)	4.6
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'Telegraph' grab	(Snerzhinskii 1951)	4.6
Tonolli mud burrower	(Tonolli 1962)	3.3
Tvärminne corer	(Kangas 1972)	5.5
Ulsky grab	(Snerzhinskii 1951)	4.6
USNEL spade (box) corer	(Hesler & Jumars 1974)	5.3
Valve lead corer	(Murray 1885)	5.2
Van Veen grab	(van Veen 1936)	4.5
'Vegematic' box corer	(Jumars 1975)	5.3
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Hopkins, T.L. 1964	1.2
Hough, J.L. 1939	1.2, 4.6, 5.2
Howard, A.E. 1976	3.3, 8
Howard-Williams, C. & Longman 1976	2.1 b
Howmiller, R.P. 1971	8
Hrbaček, J. 1962	4.1
Hudson, P.L. 1970	8
Hughes, B.D. 1975	8
Hunt, D.O. 1926	6.1
Hunter, B. & Simpson	4.4
Husmann, S. 1956	2.1a
Husmann, S. 1971	5.2
Hvorslev, M.J. & Stetson 1946	5.2
Hydro Products (not dated)	3.1
Hynes, H.B.N. 1961	3.2
Hynes, H.B.N. 1970	1.1
Isaacs, J.D. & Brown 1968	5.3
Iselin, C.O. 1932	5.2
Ivanov, A.I. 1965	8
Jackson, H.W. 1970	4.6
Jenkin, B.M. & Mortimer 1938	5.2
Jenkin, B.M., Mortimer & Pennington 1941	5.2
Johansen, A.C. 1927	5.3, 8
Joly, J. 1914	5.2
Jónasson, A. & Olausson 1966	5.3
Jónasson, P.M. 1948	2.1a
Jónasson, P.M. 1955	8
Jónasson, P.M. 1958	8
Juday, C. 1926	1.1
Jumars, P.A. 1975	5.3
Kaczmarek, M. 1963	5.2
Kajak, Z. 1963	8
Kajak, Z. 1965	5.2
Kajak, Z., Kacprzak & Polkowski 1965	5.2
Kamler, E. & Riedel 1960	3.3
Kangas, P. 1972	2.1a, 5.5,6.6
Kanneworff, E. & Nicolaisen 1973	5.3
Kaplan, E.H., Welker & Krause 1974	5.3
Karling, T.G. 1937	3.3
Karlsson, M., Bohlin & Stetson 1976	8
Keegan, B.F. & Könnecker 1973	5.3, 6.6
Kellon, W.R. 1954	4.6
Kemp, A.L.W., Savile, Gray & Mudrochova 1971	5.4
Kermabon, A., Blavier & Cortis 1965	5.3
Kermabon, A., Blavier, Cortis & DeLauze 1966	5.3
Kirchner, W.B. 1974	5.5
Kirpičenko, M.J. 1964	5.3
Knudsen, M. 1927	5.3
Kögler, F.C. 1963	5.3
Külmel, R. 1974	5.2
Kořínková, J. 1971	2.1b
Kornicker, L.S. 1958	4.5
Kritzler, H., Hiskey & Thomas 1974	6.6
Kroger, R.L. 1972	8
Krogh, A & Sparck 1936	5.4
Kudinov, E.I. 1957	5.2
Kullenberg, B. 1947	5.2
Kullenberg, B. 1955	5.1
Kutikova, L.A. 1974	2.1b
Kutty, M.K. & Desai 1968	8
La Fond, E.C. & Dietz 1948	4.6
Lamotte, M. & Bourlière 1971	1.3, 8
Lane, E.D. 1974	2.1a
Lang, K. 1930	5.3
Larimore, R.W. 1970	4.6
Larsen, P.F. 1974	6.2
Lassig, J. 1965	4.5
Lavery, M.A. & Costa 1972	8
Lee, R.E. 1944	4.6
Léger, M. 1904	4.3
Lehmann, U. 1967	7
Lenz, F. 1931	4.1
Leonard, J.W. 1939	8
Lie, U. & Pamatmat 1965	8
Lisitsyn, A.P. & Udintsev 1955	4.3
Livingstone, D.A. 1955	5.2
Longhurst, A.R. 1959	1.2
Lundqvist, G. 1923	5.2
Lugn, A.L. 1927	3.1

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Macan, T.T. 1949	4.6
Macan, T.T. 1958	1.1, 3.2,
MacGinitie, G.E. 1948	3.3
Mackereth, F.J.H. 1958	5.2
Mackereth, F.J.H. 1969	5.2
Mackey, A.P. 1972	6.3, 8
Mackie, G.L. & Qadri 1971	2.1b, 8
Mackin, J.G. 1962	5.2
Maitland, P.S. 1969	5.2
Mann, K.H. 1965	4.6
Mason, C.F. 1977	1.1
Massé, H. 1967	6.5, 8
Massé, H. 1970	6.5
McCauley, V.J.E. 1975	2.1b
McCullough, J.D. & Williams 1976	4.6
McIntyre, A.D. 1956	8
McIntyre, A.D. 1968	5.2
McIntyre, A.D. 1971	8
McManus, D.A. 1965	5.3
Meehan, W.R. & Elliot 1974	8
Menzies, R.J. 1964	1.2, 3.3
Menzies, R.J. & Rowe 1968	5.3, 8
Merna, J.W. 1962	4.2
Milbrink, G. 1968	5.3
Milbrink, G. 1971	5.4, 8
Milbrink, G. & Wiederholm 1973	8
Mills, A.A. 1961	5.2
Minto, M.L. 1977	2.1b
Moon, H.P. 1935	3.2
Moore, D.G. 1961	5.2
Moore, G.M. 1939	5.2, 6.1,
Moore, H.B. & Neill 1930	5.2
Mordukhai-Boltovskoi, F.D. 1958	5.2
Morgan, N.C. & Egglishaw 1965	2.1a
Mortensen, T.H. 1925	3.3
Mortimer, C.H. 1942	5.2
Mozley, S.C. & Schapelsky 1973	4.6
Mundie, J.H. 1971	2.1a, 8
Murray, J. 1885	5.2
Murray, T.D. & Charles 1975	4.1
Muus, B. 1964	3.3
Nalwalk, A.J., Hersey, Reitzel & Edgerton 1962	3.3
Naumann, E. 1916	5.2
Naumann, E. 1925	4.3
Needham, P.R. & Usinger 1956	8
Neill, R.M. 1938	2.1a
Neiman, A.A. 1965	8
Nichols, M.M. & Ellison 1966	4.5
Nygaard, G. 1958	2.2
Ockelmann, K.W. 1964	3.3
Okland, J. 1962	4.6
Orton, J.H. 1925	8
Packard, E.L. 1918	4.2
Paterson, C.G. & Fernando 1971	5.2, 8
Pearson, R.G., Litterick & Jones 1973	6.3, 8
Percival, E. & Whitehead 1926	3.2
Perfiliew, B. 1931	5.2
Petersen, C.G.J. 1913	8
Petersen, C.G.J. 1918	4.3
Petersen, C.G.J. & Boysen Jensen 1911	4.3
Pettersson, H. & Kullenberg 1940	5.2
Pettersson, O. 1928	5.3
Phleger, F.B. 1951	5.2
Pickett, G.D. 1973	3.3
Pierce, J.W. & Howard 1969	5.2
Piggot, C.S. 1936	5.2
Powers, C.F. & Robertson 1967	4.6
Prater, B.L. 1968	2.1a
Prater, B.L., Barton & Olive 1977	3.2
Pratje, O. 1938	5.2
Prejs, A. 1969	8
Prokopovich, N.P. 1966	5.3
Pullen, E.J., Mock & Ringo 1968	3.3
Purasjoki, K.J. 1953	6.1
Rawson, D.S. 1930	6.1
Rawson, D.S. 1947	4.1
Rees, C.B. 1940	5.2
Reineck, H.E. 1963	5.3
Reineck, H.E. 1967	5.3
Reish, D.J. 1959	4.2
Reish, D.J. & Green 1958	5.2
Reissinger, A. 1930	5.2
Renaud-Debyser, J. 1957	5.2
Reys, J.P. 1964	8
Reys, J.P. & True 1966	6.2, 8
Richards, A.F. & Keller 1961	5.2
Richardson, R.E. 1921	3.3
Riedl, R. 1955	3.3
Riedl, R. 1958	8
Riedl, R.J. & Ott 1970	5.2
Rieth, A. 1960	4.6

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Robertson, D. 1868	3.3
Roots, W. 1973	5.2
Rosfelder, A.M. & Marshall 1967	5.3
Roszczak, R. 1964	6.1
Rowe, G.T. & Clifford 1973	4.7
Rowley, J.R. & Dahl 1956	5.2
Ruello, N.V. 1975	3.3
Ruppert, E.E. 1972	5.2
Ruttner, F. 1913/14	4.6
Rzoska, J. 1931	5.3
Sachs, P.L. & Raymond 1965	5.2
Sander, G. 1957	8
Sanders, H.L. 1956	3.4
Sanders, H.L., Hessler & Hampson 1965	3.4
Schneider, F. 1969	5.2
Schrader, Th. 1932	4.1
Schwoerbel, J. 1970	1.1
Scott, D. 1958	2.1a
Scott, W., Hile & Spieth 1928	3.2
Seyb, S.M., Hammond & Gilliard 1977	8
Shapiro, J. 1958	5.2
Shier, J.E. & Oaks 1966	5.2
Silverman, M. & Whaley 1952	5.2
Sjostedt, F.G. 1923	5.2
Slack, H.D. 1954	5.2
Slack, H.D. 1972	4.1
Slack, K.V. 1955	2.1a
Slack, K.V., Averett, Greeson & Lipscomb 1973	1.1
Sly, P.G. 1969	1.1
Smidt, E. 1951	5.2
Smith, A.J. 1959	5.2
Smith, J.E. 1932	3.3
Smith, K.L. & Howard 1972	8
Smith, W. & McIntyre 1954	4.5, 8
Smith, W.L. 1973	6.5
Snerzhinskii, V.A. 1951	4.6, 5.2, 5.4
Soule, F.M. 1932	5.2
Southwood, T.R.E. 1966	1.1
Staaten, L.M.J.U. van 1954	5.2
Stanczykowska, A. 1966	8
Steiner, G. 1919	3.3
Stetson, H.C. 1938	3.1
Stocker, Z.S. J. & Williams 1972	5.2
Strøm, K.M. 1934	5.2
Strøm, K.M. 1938	5.1
Strøm, K.M. 1939	5.2
Sumner, F.B., Louderback, Schmitt & Johnston 1914	5.2
Surber, E.W. 1934	2.1a
Surber, E.W. 1937	2.1a
Surber, E.W. 1970	2.1a
Szczepanski, A. 1953	4.1
Tanaka, H. 1967	8
Tanner, C., Hawkes, Lebednik & Duffield 1977	6.4
Taylor, J.L. 1965	3.3, 5.2
Thamdrup, H.M. 1938	4.5, 8
Thayer, G.W., Williams, Price & Colby 1975	5.3, 8
Thomas, M.L.H. 1960	3.4
Thomson, C.W. 1873	3.3, 4.6
Thomson, C.W. 1877	3.1
Thoulet, J. 1890	5.2
Tonolli, V. 1962	3.3
Trask, P.D. 1927	5.2
True, M., Reys & Delauze 1968	6.2
Twenhofel, W.H. 1933	5.2
Ulomski, S.N. 1952	5.2
Ursin, E. 1954	8
Ursin, E. 1956	8
Usinger, R.L. & Needham 1956	3.3
Vallentyne, J.R. 1955	5.2
Varney, F.M. 1935	5.2
Varney, F.M. & Redwine 1937	5.2
Veen, J. van 1936	4.5
Verneaux, J. 1966	4.6
Vogele, L., Boyer & Heard 1971	6.6
Walker, B. 1967	5.5
Walker, C.R. 1955	5.2
Wasmund, E. 1932	8
Water Research Centre 1976	1.1
Waters, T.F. & Knapp 1961	2.1a
Weber, C.I. 1973	1.1, 8
Welch, P.S. 1948	1.1
Whitley, L.S. 1962	2.1a
Wieckowski, K. 1970	5.2
Wiederholm, T. 1972	1.1
Wigley, R.L. 1967	8
Wilding, J.L. 1940	2.1a
Williams, D.D. & Hynes 1974	5.2
Wilson, I.T. 1941	5.2
Withers, J.D. & Benson 1962	2.1a
Wright, H.E., Cushing & Livingstone 1965	5.1
Wundsch, H.H. 1924	3.2

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Zelt, K.A. & Clifford 1972	8
Zhadin, V.I. 1956	1.1
Zhadin, V.I. 1960	1.1, 4.1
Zhadin, V.I. 1966	4.3
Zimmermann, V. & Ambühl 1970	6.5
Zoutendyk, P. 1971	6.6
Züllig, H. 1953	5.2
Zumberge, J.H. 1962	5.2