YALE
PEABODY
MUSEUM

P.O. BOX 208118 | NEW HAVEN CT 06520-8118 USA | PEABODY.YALE. EDU

JOURNAL OF MARINE RESEARCH

The *Journal of Marine Research,* one of the oldest journals in American marine science, published important peer-reviewed original research on a broad array of topics in physical, biological, and chemical oceanography vital to the academic oceanographic community in the long and rich tradition of the Sears Foundation for Marine Research at Yale University.

An archive of all issues from 1937 to 2021 (Volume 1–79) are available through EliScholar, a digital platform for scholarly publishing provided by Yale University Library at https://elischolar.library.yale.edu/.

Requests for permission to clear rights for use of this content should be directed to the authors, their estates, or other representatives. The *Journal of Marine Research* has no contact information beyond the affiliations listed in the published articles. We ask that you provide attribution to the *Journal of Marine Research*.

Yale University provides access to these materials for educational and research purposes only. Copyright or other proprietary rights to content contained in this document may be held by individuals or entities other than, or in addition to, Yale University. You are solely responsible for determining the ownership of the copyright, and for obtaining permission for your intended use. Yale University makes no warranty that your distribution, reproduction, or other use of these materials will not infringe the rights of third parties.

This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.
https://creativecommons.org/licenses/by-nc-sa/4.0/

A Sea-bottom Sampler that Collects Both Water and Sediment Simultaneously[1]

David R. Schink, Kent A. Fanning, John Piety[2]
Narragansett Marine Laboratory
Kingston, Rhode Island

ABSTRACT

A simple sampler, assembled mainly from commercially available equipment, is described. It simultaneously collects water samples at 1, 2, 3, 4, 5, and 6 m above the sea floor and takes a short core at the same location.

Introduction. Data from the Swedish Deep-sea Expedition 1947–1948 (Bruneau et al. 1953, Koczy 1953) show that in many parts of the world the bottom 25 m of the ocean possess perceptibly different chemical and thermal properties than the overlying water. These anomalies must be caused by the flux of chemicals and heat between the sea floor and the water, although the chemical flux—in contrast to the heat flux—has not been directly observed. The existence of this gradient is somewhat surprising. Without doubt, vast amounts of material are being removed from the ocean, but the removal need not occur by diffusion at the sea bottom, and there is no *a priori* reason to assume that mixing at the interface is so slow that chemical gradients in this zone are preserved. Hence this unusual zone deserves investigation.

If a flux does occur from the sediments to the water, then the chemical gradients of the interstitial water in the core are also of interest. To make valid correlations, it is therefore desirable to sample both sediment and interstitial water directly beneath the water samples. Commonly, cores taken from a drifting ship are obtained several miles from where the water is collected, even though such cores are taken immediately following the hydrographic cast.

A device employed to obtain such data consists of a water sampler and a gravity corer. The water sampler has six Frautschy bottles that close simultaneously when a foot strikes the sea floor; the gravity corer drops from a piston-corer release at the same time. A pinger (Edgerton and Cousteau 1959)

---

[1] This work was supported by Office of Naval Research contract NONR 396(08).
Accepted for publication and submitted to press 9 May 1966.

[2] Present Address: Alpine Geophysical Associates, Norwood, N. J.

attached just above the device helps to control the approach to the sea floor, then is switched off at bottom contact.

Description. Fig. 1 shows diagrammatically the components of the water sampler. It includes six inverted Frautschy bottles (Hytech. San Diego, California, model 211) mounted along a frame of 2-inch schedule-80 PVC pipe (polyvinyl chloride, standard length 6.1 m, I.D. 3.7 cm, O.D. 5.9 cm). The bottles are spaced one meter apart, and the frame hangs from a collar and bail threaded onto the upper end. A 60-pound lead weight is threaded onto the lower end. A retrieval line, secured to the weight, extends the length of the frame to the bail and is secured to the frame at intervals with tape.

The inner pipe (standard length 6.1 m, O.D. 3.3 cm) rises from the foot and rides freely inside the frame. Just below each bottle, a nylon rod (1.3 cm diameter) is threaded at a right angle through the inner pipe, and this rod protrudes to the outside through a slot in the frame.

The foot, 41 cm in diameter, consists of a metal ring (1.3-cm steel rod) and four bent spokes joined to a pair of centrally located steel plates (0.3 cm thick). The plates are fitted over the inner pipe and are held in place with a pair of standard PVC pipe flanges threaded onto the inner pipe. The foot and inner pipe extend 30 cm below the end of the frame.

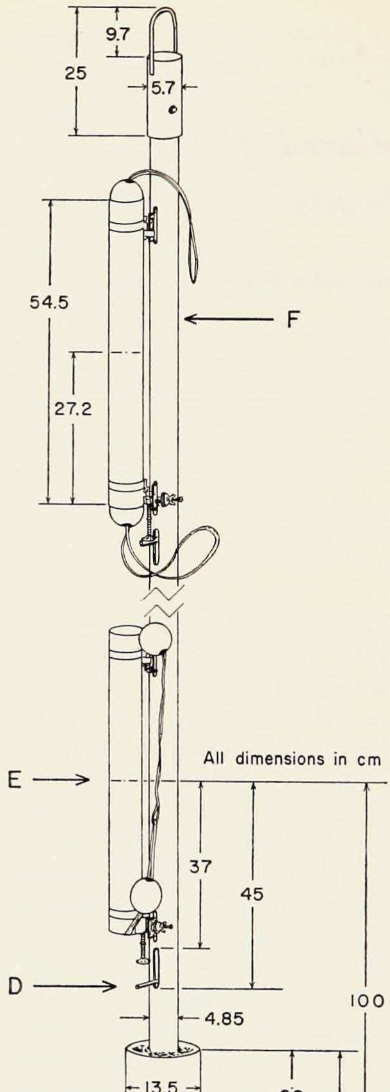


Figure 1. The top and bottom of the water sampler. A, foot; B, inner pipe; C, weight; D, nylon tripping rod; E, open Frautschy bottle; F, closed Frautschy bottle. The bottom part of the sampler is shown as it appears before the foot strikes the sea floor; the top part shows the sampler after it has struck the sea floor. The retrieval line and the shear-pin safety are not shown.

In an early model the drag effects sometimes pushed the foot up and caused pretripping of some bottles when the sampler entered turbulent surface water. To prevent this pretripping, a pressure-powered pin release (Benthos, model 900) was added to hold the inner pipe until hydrostatic pressure released it at an intermediate depth. At greater depths the spring in the wire prevents the sudden changes in direction that would cause pretripping. Since this device was added there has been no evidence of pretripping.

All metal parts of the sampler except the lead weight are 316 stainless steel.

The Frautschy water-sampling bottle, a modification of the Van Dorn (1956) sampler, is an open length of PVC pipe. Each bottle is accompanied by a pair of soft, hollow rubber balls (O.D. 5.7 cm, I.D. 3.7 cm) joined by a stretched piece of surgical tubing that passes inside. When the sample bottle is open, the balls are held clear of the pipe and flushing is unrestricted.

Since a Frautschy bottle is designed for attachment to a hydrocast wire, it was necessary to make the following changes in order to attach the bottle to the frame instead of to a wire. Loops were made of 316 stainless-steel rod (0.5 cm diameter). These loops, placed in small grooves cut into the frame, are held by standard worm-screw hose clamps (Fig. 2A). To prevent the loop from swinging on the frame, tabs were welded across one side of each loop, and to prevent the bottle from swinging around the loops, the portion of the loop that is clamped to the bottle was made from flat stock. (Although we used a rectangular piece of steel [0.32 × 0.64 cm], a square piece [0.64 × 0.64 cm] would have been better). The threaded knob usually employed to secure the bottle to the wire is flat on the outside and tapered on the inside; this knob was merely turned over so that it would hold the square steel bar between the ridged plate on the bottle and the flat side of the knob (Fig. 2B). The tripping rod furnished with the bottle was replaced with a longer one.

The sediment sampler is a conventional gravity corer (G.M. Manufacturing Co., model 65 M 1440), which consists of a hollow 68-kg lead coring weight with a bail attached and a 183-cm brass or stainless-steel coring tube with a plastic core liner. The coring tube screws onto the lower end of the lead coring weight, and the upper end of the weight is fitted with a one-way valve; this valve allows water passing upward inside the weight to escape and prevents loss of the core during retrieval of the corer. The corer, which is secured to the end of the wire with a Benthos weak-link assembly (Benthos, model 400), is held by a corer release (G.M. Manufacturing Co., model 15 M 1443) that is fastened about 7 m up the wire (Fig. 3). Another pressure-powered pin is attached to the corer release to prevent it from operating in the upper portion of the water column (Sachs 1964).

A magnetic switch (Benthos, model 2224) is fastened to the corer release or to the frame of the water sampler. This pressure-protected switch is opened or closed by the motion of a nearby magnet. The pinger is connected through the switch so that it is turned off when the corer-release arm moves the magnet from the switch. Normally this occurs on contact with the bottom, but premature closing of the sampler might also be signaled in this way.

Operation. Prior to launching, the corer (without the barrel) is attached to the end of the regular hydrographic wire, and the corer release is fastened on the wire above it. Intervening wire is coiled and taped to the corer release; the shear-pin (pressure-powered) safeties are set; and the water sampler, which serves as the tripping weight for the corer release, is then attached. After this assembly is passed over the side of the ship, the foot of the water sampler is lowered into position with a detachable line. Then the core barrel is connected to the corer, the pinger is fastened to the wire above the corer release, and the switch wires are connected.

The lead weight insures that the sampler descends in a vertical attitude. In early applications of the sampler, a conservative descent velocity of 25 m/min. was used. However, divers observing a 30-m free fall of the sampler reported a perfectly vertical descent at a sinking velocity of more than 200 m/min. Thereafter the rig was successfully lowered at 150 m/min. When the pinger indicates that the sampler is approaching bottom, the sampler is lowered one meter at a time until bottom contact is indicated.

When the foot strikes the sea floor, the inner pipe stops, but the frame (with the weight and bottles attached) continues to descend. The weight insures the downward thrust of the frame and successful tripping of the bottles. As each bottle strikes its respective protruding nylon rod (secured to the inner pipe), the rubber balls are pulled onto the ends of each bottle by the stretched piece of surgical rubber tubing. Since these bottles do not reverse, the depth of sampling is more accurate than with reversing bottles. Concurrently, the water sampler trips the corer release to obtain the sediment sample.

After the samples have been taken and the device is retrieved, the pinger is taken off the wire. By means of the retrieval line, the water sampler is pulled to a horizontal attitude and taken aboard. The corer release is then detached from the wire, and finally the corer—hitherto just below the ship—is raised to deck level; the corer barrel is removed and the corer weight brought aboard.

Discussion. The PVC pipes of the sampler are inexpensive and are considered expendable. In the first 15 lowerings, two breaks occurred. The first was a fracture of the inner pipe just below the weight; in this case the foot was retained by a safety line that was attached between the foot and the weight. The second failure was a fracture of the frame where a hose clamp probably was fastened too tightly; nothing was lost. These breaks were due to the brittleness of PVC pipe in the cold. Better design might dictate the use of a fiberglass pole such as that used in pole vaulting. Unfortunately, for the next several years such poles will not be long enough, and the cost of custom fabrica-

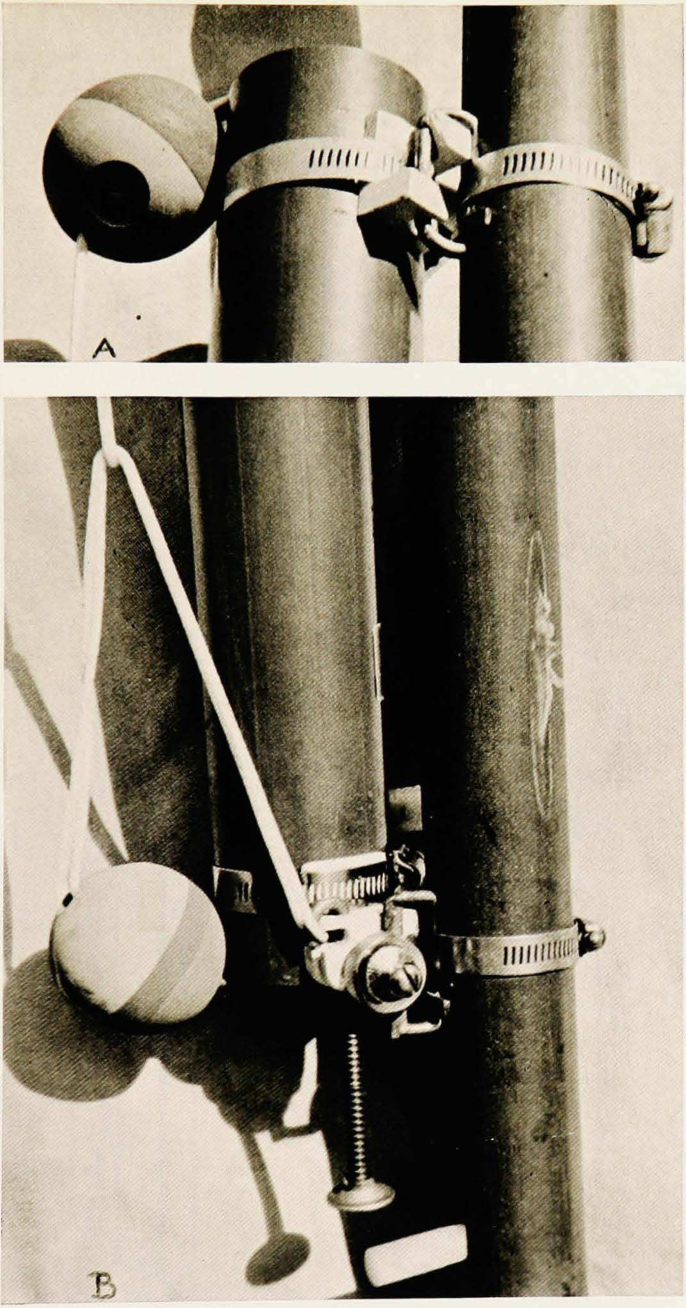


Figure 2. A, Frautschy bottle hooked to steel loop on pipe. B, Frautschy bottle clamped to steel bar on frame.

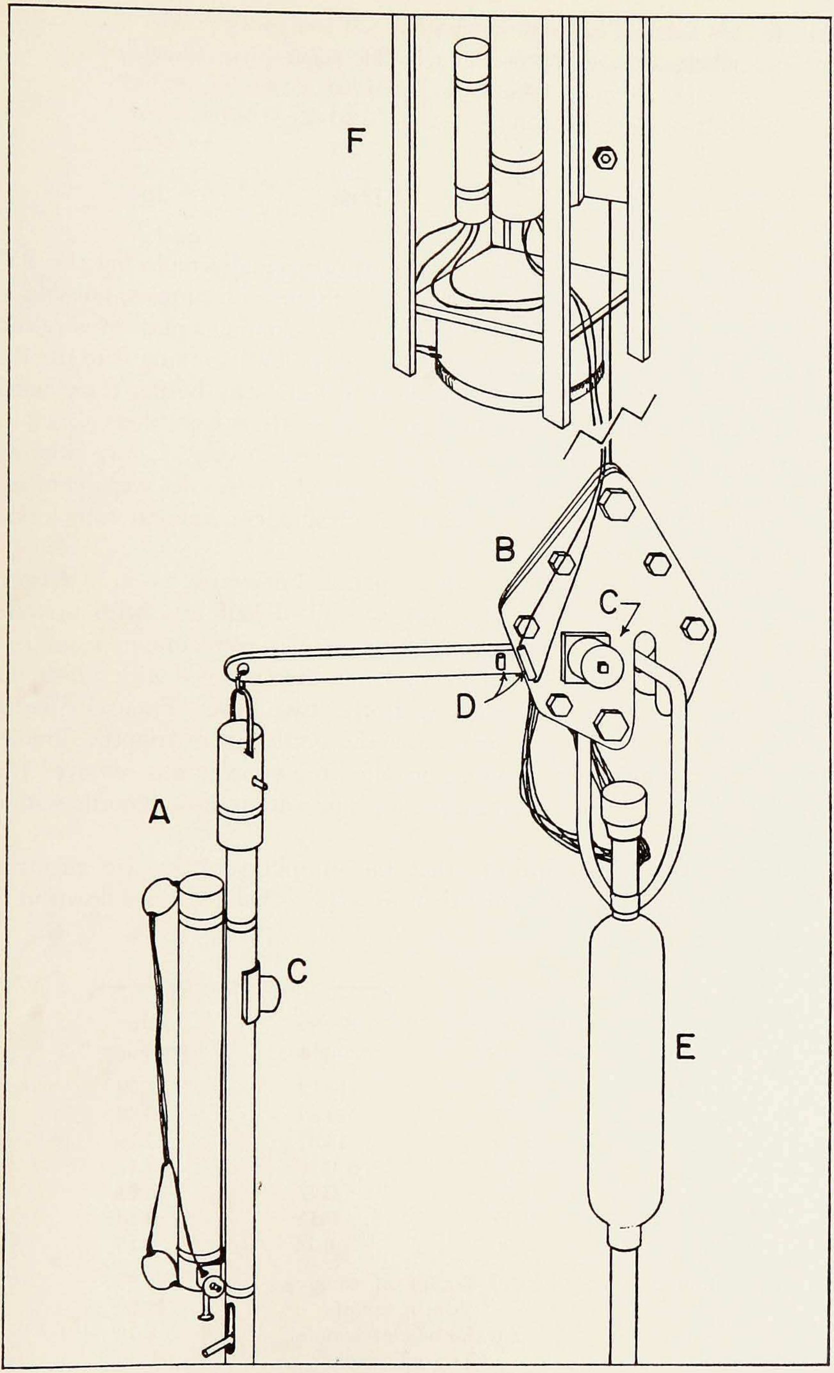


Figure 3. The corer-release arrangement. A, the water sampler, which serves as the tripping weight for the corer release; B, the corer release; C, the shear-pin safety devices; D, the mag-

Table I.

Bottle	Time (hrs)	Chlorinity (°/oo)	Seawater (leakage)
1	0	.23	0
2	4	.26	0.2
3	12	.29	0.4
Seawater	–	14.86	100

tion does not compare well with the cost of occasionally replacing the PVC pipe. Although breaks do not generally cause the loss of samples, possible loss due to more serious fractures might be avoided by fastening a piece of wire cable to the bail, running the cable inside the inner pipe, and fastening it to the foot.

To demonstrate the extent of leakage in a Frautschy bottle, three bottles were tripped in a drum of fresh water, and two of these were then placed in a drum af seawater for four and twelve hours, respectively. Later, chlorinity inside the bottles was measured by titration, and the results were compared with the chlorinity of seawater. As Table I indicates, contamination by leakage is clearly not a serious problem.

The flushing efficiency of the bottles was tested in a tank 0.8 m in diameter and approximately 3 m deep. The tank was filled half way with seawater, then topped off with fresh water. Salinity samples were drawn from holes that had been drilled in the side of the tank and then plugged with self-tapping metal screws. The water sampler, with the two lower Frautschy bottles attached, was lowered into the tank, and the bottles were tripped. Gradient samples from the tank were taken again, then the sampler was removed from the tank, and water was drawn from the top and bottom of each bottle without mixing.

It appears from the chlorinity that the sampling bottles are effectively flushed (Table II). The data show that no water is being carried down in the

Table II.

		Chlorinity (°/oo)	
Sample	Ht. above bottom (m)	Before sampling	After sampling
Tank	.25	14.02	13.99
	.75	13.87	13.88
	1.25	13.87	13.16
	1.50	0.76	13.12
	1.75	0.22	0.61
	2.00	0.15	0.38
	2.50	0.14	0.15
Bottle	1.0	Bottom of sample	13.93
		Top of sample	13.29
	2.0	Bottom of sample	0.18
		Top of sample	0.19

bottles more than 25 cm, and the chlorinities seem to indicate that the sample is exactly from the sampling depth after the bottle has passed through. However, the sampler apparently perturbed the gradient slightly. Also, the apparatus raised the entire water level in the narrow tank, pushing the halocline above the 1.5 m mark.

Although the dimensions of the foot are clearly important in determining tripping efficiency in soft bottom, we have not investigated the efficiency of this particular design. However, this foot has always seemed to work on contact with the sea floor, and no mud has been found on the upper part of the sampler.

REFERENCES

BRUNEAU, L., J. G. JERLOV, and F. F. KOCZY
1953. Physical and chemical methods. Rep. Swed. Deep-sea Exped., *3*: 99–112, I–XLI.

EDGERTON, H. E., and J. T. COUSTEAU
1959. Underwater camera positioning by sonar. Rev. Sci. Instr., *30*: 1125–1126.

KOCZY, F. F.
1953. Chemistry and hydrography of the water layers next to the ocean floor. Statens (Sweden) Naturvet. Forskn. Aarsb. (1951–1952), 7: 97–102.

SACHS, P. L.
1964. A hydraulically actuated safety device. J. Mar. Res., *22*: 105–109.

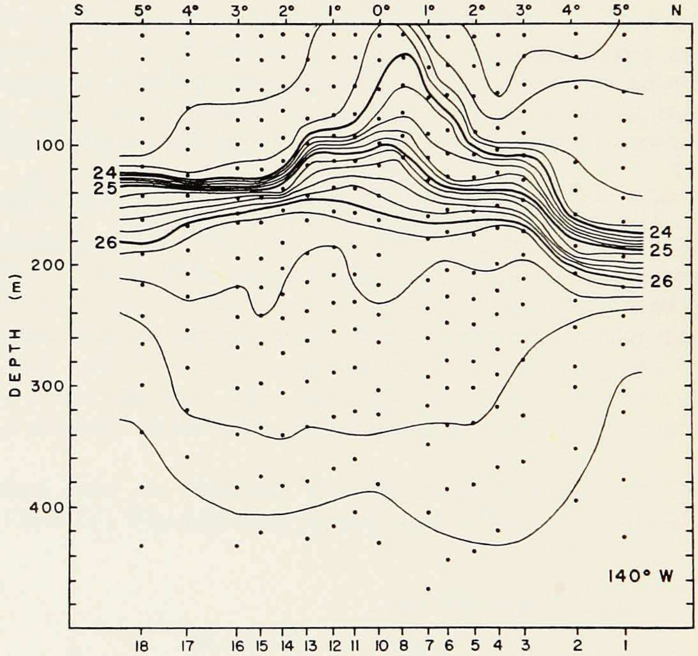
VAN DORN, W. G.
1956. Large volume water samplers. Trans. Amer. geophys. Un., *37*: 682–684.

ERRATUM

in

Further measurements and observations on the Cromwell Current, by John A. Knauss, J. Mar. Res., *24* (2): 205–240

On page 231 in Fig. 14, the incorrect upper half of this figure should be as follows:



Pages 231 and 232 have been printed correctly and are being distributed in the front af this issue (Vol. 24, no. 3) so that the incorrect pages can be replaced with the correct ones. Additional copies of the corrected pages are available from either the author or the Journal of Marine Research.