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PRELIMINARY EXPERIMENTS WITH KNUDSEN'S BOTTOM SAMPLER FOR HARD BOTTOM

BY

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I. Introduction.

In comparative quantitative investigations of the invertebrates of the sea floor, a point to aim at is that the bottom sampler used for taking samples of the bottom should penetrate as far down as the animals themselves or at least as the great majority of the animals taken by weight. The experiments made have shown that the PETERSEN Grab does not fulfil these conditions when used on fine sandy bottom, but the investigations which have been undertaken with this type of bottom sampler have nevertheless proved of essential importance as a means to valuation of the sea bottom; that is to say, for ascertaining which areas afford abundant food for certain species of fish, and which are but scantily furnished in this respect. On the other hand, it cannot be denied that in such valuations the Petersen Grab will, owing to its construction, greatly favour a soft bottom at the expense of the hard.

How far invertebrates penetrate down into the sea bottom in Danish and adjacent waters is but little known. From a series of diggings which I have made in the shallows of Randers Fjord, Ringkjøbing Fjord and Graadeep, it appears that certain of the larger invertebrates, such as *Mya arenaria* and *Arenicola marina*, may go until about 30 cms. down. When therefore Professor KNUDSEN asked my opinion as to the depth to which his new bottom sampler ought to penetrate into the sea bottom, I suggested 30 cms. as being probably a suitable depth.

The experience since gained with the KNUDSEN bottom sampler shows that as a rule, invertebrates are not taken beyond abt. 12—25 cms. down in the sea floor. In a single instance however, the annelid Aricia was found abt. 28—30 cms. down, and this suggests the advisability of employing, by way of experiment, a bottom sampler penetrating more than 30 cms. into the sea floor.

Professor KNUDSEN was of opinion that his bottom sampler would normally go right down into the sea floor without drawing up bottom material into the cylinder from the area outside that covered by the mouth of the cylinder itself; the experiments made have confirmed the correctness of this view, at any rate as regards sandy bottom. In the course of three experiments made in the Køge Bay on the 2nd September 1926, on sandy bottom at 3 metres' depth, in calm, clear sunny weather, it was observed that no funnel-shaped depression was formed outside the cylinder, but that the latter sank slowly down into the sea floor. This is entirely in accord with the fact that we find, in most of the samples brought up, a natural sedimentation, often with considerable difference between the strata, and that the bottom organisms which bore their way deep down into the sea floor are as a rule discovered in their natural position.

In one single case we have found a considerable disturbance in the natural sedimentation in a sample which was put down in a zink-cover, but it could not be settled whether this disturbance had occurred while the bottom sampler took the material from the sea bottom, or while the sample was put down in the zink-cover. When the cylinder hits a stone or other hard material it may be hindered in penetrating vertically into the sea bottom.

II. On the bottom material and bottom fauna brought up by the different bottom samplers from identical localities.

Experiments for comparison between the effect of the Knudsen bottom sampler and the large and small Petersen grabs were made at the following places and times:

1) 26. April 1926. The Sound — from the "Dana".
2) 1.—3. Sept. 1926. Køge Bay — From the "Japetus Steenstrup".
3) 16. Decbr. 1926. The North Sea, outside Fanø — from the "Dana".
4) 17. Decbr. 1926. Graadeep — from the "Dana".

During the period from April to September, various improvements in the Knudsen bottom sampler were introduced, the implement being hardly strong enough in construction in its original form. From September to December also, certain further improvements in construction were made.

Most of the experiments were carried out from vessels at anchor; occasionally, however, without anchoring.

The number of litres of bottom material brought up with the different bottom samplers per 0.1 square m. on firm bottom show, in the case of the Petersen grabs, approximately how many centimetres they have penetrated, on an average, into the sea floor. (This does not however, by any means indicate uniform penetration over the entire surface, which is undoubtedly not the case). We have to reckon with a certain loss of material from the Petersen grabs, as some is washed away while hauling up, so that the grabs have really penetrated a little deeper down than would appear from the bulk of bottom material actually brought on deck.

In the case of the Knudsen bottom sampler, we find that, given favourable weather and current conditions, it will bring up material from the full depth to which it penetrates, i. e. abt. 30 cms. Should the vessel, owing to wind or current, shift from the spot where the sample is being taken while it is being brought up, some of the bottom material may be washed out of the cylinder together with the animals it contains; this will however, only or mainly affect that portion which is taken deepest down.

Most of the experiments hitherto carried out for purposes of comparison between the working power of the Knudsen bottom sampler and the Petersen grabs were made on sandy bottom without vegetation; the results of these experiments — as far as the quantity of material and bottom fauna brought

Table 1. Showing the working power of Knudsen's Bottom Sampler and Petersen's Grabs on sandy bottom.

Date	Locality	Central Position	Depth m	Bottom material in litres per 0.1 m²			Weight in grammes of bottom invertebrates per 0.1 m²			No. of samples		
				Pet. 0.1 m²	Pet. 0.2 m²	Knudsen 0.1 m²	Pet. 0.1 m²	Pet. 0.2 m²	Knudsen 0.1 m²	Pet. 0.1 m²	Pet. 0.2 m²	Knudsen 0.1 m²
1926 April 26	The Sound	55°48′ 12°54′	11	0.1	4.5	ca. 30[1]	0.3	5.1	18.1	1	1	1
— Sept. 1	Køge Bugt	55°27′.5 12°32′	14	1.3		- 30	2.8		8.0	2	0	2
— — 2	—	55°22′.7 12°15′	3	2.5	3.4	- 30	1.9	3.5	5.0	2	2	2
— — 2	—	55°30′ 12°18′	11	0.6	1.4	- 30[2]	2.8	4.0	16.2	2	2	2
— — 3	—	55°27′.3 12°25′	14	1.8	1.8	- 30	13.2	8.4	24.7	2	2	2
— Dec. 16	North Sea off Fanø...	55°25′.3 8°15′.2	9	0.5	0.8	- 17	1.1	1.6	33.0	1	1	3
— — 16	— — - — ...	55°25′ 8°13′.4	11	0.5	1.0	- 7.5	1.4	3.4	2.3	1	1	2
— — 17	Graadeep	55°28′.1 8°25′.1	9	2.5	5.5	- 30	0.0	0.2	5.7	1	1	1
		Average per 0.1 m²...		1.2	2.6	25.6	2.9	3.7	14.1			

[1] The samples contained besides sand some finer material.
[2] The undermost part of the samples (ca. 3 cms.) consisted of clay with fresh-water molluscs.

Table 2. Rough weight of Invertebrates in gr. per sq. m. in the Køge Bay, Sept. 1.—3. 1926.[1]

(Worked out by ANTON FR. BRUUN).

Species	Petersen's 0.1 sq. m.	Petersen's 0.2 sq. m.	Knudsen's 0.1 sq. m.
Diastylis sp.	0.78	0.79	0.50
Gammaridae	0.03	0.01	0.13
Macoma baltica	5.04	3.75	22.13
Cardium edule > 1 cm.	32.13	28.92	53.13
Cardium edule < 1 cm.	8.94	10.17	16.88
Mya arenaria > 2 cm.	—	0.67	3.38
Mya arenaria < 2 cm.	1.25	2.75	6.75
Mytilus edulis	0.28	2.92	8.94
Utriculus obtusus	0.10	0.02	0.06
Hydrobia sp.	1.13	1.56	0.63
Littorina littorea		0.25	—
Arenicola marina	—	—	16.88
Aricia sp.	0.81	0.67	1.75
Travisia forbesi	0.09	0.29	0.63
Nephtys sp.	—	—	0.25
Lepidonotus sp.	—	—	0.75
Halicryptus spinolosus	—	0.33	2.00
Total...	50.58	53.10	134.79

Table 3. Alcohol weight of Invertebrates in gr. per sq. m. Off Fanø, depth 9 m. Decbr. 16. 1926.[1]

(Worked out by ANTON FR. BRUUN).

Species	Petersen's 0.1. sq. m.	Petersen's 0.2 sq. m.	Knudsen's 0.1 sq. m.
Abra alba	—	—	7.3
Macoma baltica	—	—	26.0
Mac. baltica juv.	—	—	0.7
Tellina fabula	—	1.0	3.3
Tellina fabula juv.	—	0.1	0.03
Nucula nitida	—	0.5	3.3
Cardium edule	—	—	55.3
Cardium edule juv.	—	—	1.0
Montacuta ferruginosa	—	0.1	0.8
Mactra subtruncata	—	10.0	38.7
Hydrobia sp.	—	1.5	14.3
Aricia sp.	—	—	1.0
Onuphis sp.	—	—	1.7
Ophelia limacina	—	—	0.3
Pectinaria koreni	—	1.0	150.7
Nephtys sp.	—	—	17.0
Nephtys sp. juv.	1.0	1.5	3.7
Annelide sp.	—	—	1.7
Ophiura texturata	10.0	—	1.0
Echinocardium cordatum	—	—	2.0
Total...	11.0	15.7	329.83

[1] About the area actually worked, see Table 1.

up is concerned — will be found in Table 1. From this it appears that the Knudsen bottom sampler does not only bring up a far greater bulk of bottom material than the Petersen grabs, but also a far greater quantity of bottom organims per unit of surface. It will be noticed, for instance, that the Knudsen bottom sampler brought up on an average about five times as many grammes of bottom organisms per unit of surface as the small Petersen grab, and about four times as many as the large Petersen grab.

It must be borne in mind, however, that this statement applies to fine sandy bottom only.[1]

It will be seen from Table 1 that at one of the North Sea stations we have 17 litres of bottom material as the average for three samples brought up by the Knudsen bottom sampler, while at the other station, we have an average of 7.5 litres for two samples. The individual samples here amounted, at the first station, to 20, 10 and 20 litres, at the second, 10 and 5 litres. At the former station, the vessel was not anchored, at the latter, it was anchored, and the current carried the vessel athwart of wind and waves. There is reason to suppose that the bottom sampler penetrated, in all the experiments, down to about 30 cms. depth, but that some of the material was washed away while hauling in, the implement being dragged some distance along the bottom.

From the Tables 2 and 3 it appears that the difference in the quantity of bottom fauna brought up was due to the fact that the Knudsen bottom sampler, penetrating deeper down into the sea floor than the Petersen grabs, took several species which the Petersen grabs either failed to reach at all, or took only as small specimens from the upper levels, e. g. *Arenicola marina, Pectinaria koreni, Mya arenaria, Macoma baltica* etc.

The small Petersen grab did not in our experiments go more than about 0.5—3.0 cms. down into a firm sandy bottom, and the large Petersen grab did not penetrate more than 1—6 cms. into this type of bottom. The Petersen grabs thus bring up only a fraction of the bottom fauna found in the area worked, and the fraction so taken is of greatly varying magnitude in the different cases.

As already noted, the Petersen grabs will at times penetrate only 1—2 cms. or even less into firm sandy bottom. There is reason to believe that certain bottom fishes, including the plaice and the dab, often seek their food deeper down in a sandy floor of this kind. Many of the organisms which are capable of making their way deep down into the sea floor are of importance as fish-food as long as they keep to the upper levels, but not when they move farther down.

[1] The pumping system naturally will be restricted to such sediments, into which the less complicated and much handier instruments would not sink deep enough.

750. 23/III 1927.

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