

## A comparison of the efficiency of the bottom samplers used in benthic studies off Cochin

M. KRISHNAN KUTTY and B. N. DESAI

Biological Oceanography Division, National Institute of Oceanography; Ernakulam-1, India

### Abstract

The efficiency of the van Veen and Foerst 'Petersen' grabs used in sampling the bottom fauna near the Cochin Harbour area has been compared in two selected stations having different hydrographic and substratic conditions. The results indicate that the heavier grab is generally more efficient than a lighter one, especially when the substratum is sandy. An examination of the quantity of the sediment and the total number of species brought by the two grabs showed that the design of the van Veen is superior to the 'Petersen' type grab used in the present study. However, due to the highly patchy distribution of the organisms the superiority of the van Veen was less evident when a comparison was made of the total number of animals sampled by the two grabs. When the distribution is 'bunched' it is suggested that samples are drawn, as far as possible, from the same sampling position. The grabs should also be of the same weight and biting area.

### Introduction

The main problem in sampling the bottom fauna for quantitative studies is that of adequate representation of all organisms, especially those which burrow into the soil. Although a number of grabs are in use they are not uniform in their digging powers. THAMDRUP (1938), HOLME (1953), SMITH and MCINTYRE (1954), URSIN (1954, 1956), BIRKETT (1958) and others have compared the efficiency of some of the most commonly used samplers such as the van Veen and Petersen type grabs and found that the former is more efficient since it brings more material from the bottom. BIRKETT (1958) and GALLARDO (1965) also arrived at similar conclusions by studying the biting profiles of these grabs. Since both types of grabs were used in quantitative studies of the benthos around Cochin Harbour it was considered desirable to compare the efficiency of the two, especially since the hydrographic and substratic conditions in this area vary considerably.

### Material and Methods

Two stations with different environmental conditions were selected for this study. One was located in the shallow brackish water area near the shipping channel and is influenced by tidal currents. This area is rich in bottom fauna and is characterized by a silty-sand substratum. The second station was located about 7 miles off Cochin at a depth of about 10 fathoms. The fauna here is relatively poor and the substratum is largely muddy. The location and the general hydrographic features of this area are discussed by DESAI and KRISHNAN KUTTY (1966, 1967).

The Foerst 'Petersen' type bottom sampler employed in the present study was similar to the one illustrated in WELCH (1948) weighing 21.5 kg and

sampling an area of 0.044 m<sup>2</sup>. This sampler (Fig. 1) combines features of the original van Veen and Petersen grabs (HOPKINS, 1964). The second grab resembled the van Veen type with slight modifications and had a biting area of 0.048 m<sup>2</sup>. This was much lighter and weighed only 4.5 kg. Besides the significant difference in their weights, the two grabs also differed in the construction of the jaws which in the heavier grab

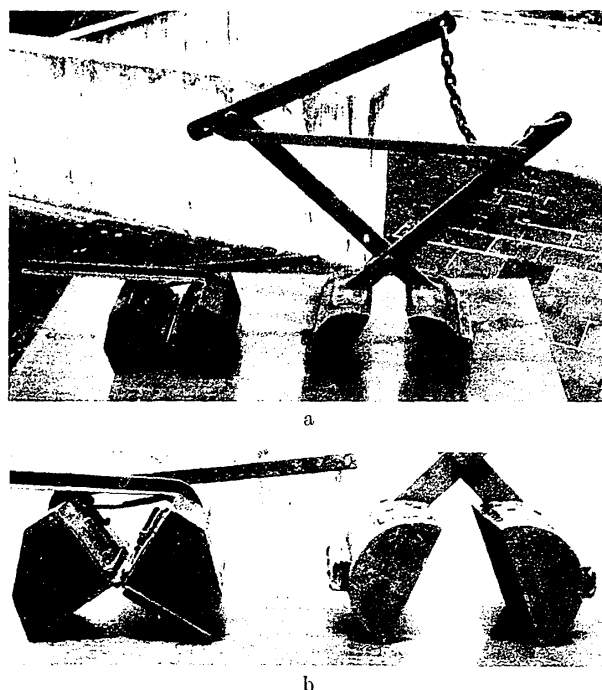


Fig. 1. The van Veen and 'Petersen' type grabs used in the present study. a: Entire grabs; b: enlargement of the jaws of the two grabs showing the difference in their construction

remained separate when set for operation, whereas in the van Veen type they opened around a hinge. At each station samples were taken from five positions and at each position the two grabs were hauled simultaneously so that they sampled the same community. The material brought by each grab was weighed before washing. All organisms retained in a 0.5 mm mesh sieve were identified and counted. In the case of foraminiferans the total count was taken assuming that all were alive.

Since the biting area of the two grabs was almost identical it was assumed that the two grabs sampled the same area.

### Results and discussion

Initial comparison of the two grabs with the same biting area should be based on the quantity of the deposit hauled by them. Other things being equal one would expect that the heavier grab brings more material since it digs deeper particularly in a sandy substratum. This is illustrated in Fig. 2 which shows that at Station 1 with a predominantly sandy substratum the heavier grab always brought more material than the lighter one although the biting area of the two grabs was the same. In a soft muddy substratum the weight of the grab is not so important since the samplers are filled completely. It is however, seen from Fig. 2 that the van Veen grab brought more material than the heavier grab in three hauls taken at Station 2 which had a muddy substratum. This may be partly due to differences in sampling condi-

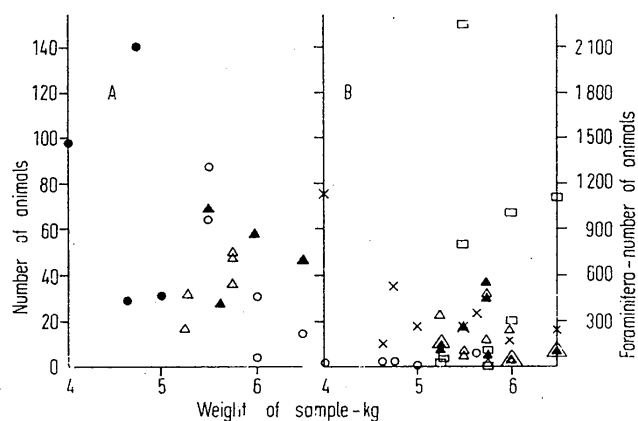


Fig. 2. Number of animals per haul plotted against the weight of the sample. (A) Station 1: • van Veen grab, ▲ 'Petersen' grab; Station 2: ○ van Veen grab, △ 'Petersen' grab. (B) Station 1: × *Diopatra neopolitana*, ○ *Meretrix ovum*; Station 2: □ Foraminifera, △ *Meretrix ovum*, ▲ *Canculus clanguloides*

tions at the time of hauling the two grabs. Another important feature to be considered is the volume of the sampler in relation to the maximum material it could sample. Some space was always left in the lighter grab even when it contained more material than the maximum quantity which the heavier grab could bring. In the muddy substratum therefore it appears that the heavier grab becomes filled before the jaws fully close. Hence the design of the lighter van Veen grab seems superior to the heavier one.

The efficiency of the two grabs was also examined by comparing the total number of the species caught with increase in the number of samples as suggested by URSIN (1956) and ELLIS (1960). This has been shown in Fig. 3. In this analysis the foraminiferans and the amphipods were each counted as one species since they were identified only up to the generic level, and since they do not seem to contain more than two species. From Fig. 3, it can be seen that at Station 2 the difference in the number of species brought by the

two grabs was very distinct, whereas at Station 1 the van Veen was found only slightly superior to the heavier 'Petersen' type grab. As mentioned before if the weight of the grab is important in a sandy substratum this might explain why at Station 1 the heavier grab brought almost the same number of species as the van Veen with increase in the number of samples. The large difference observed between the two grabs in the muddy substratum at Station 2 can easily be explained if the heavier grab gets filled before it closes completely. This analysis therefore supports the previous argument that the design of the van Veen is superior to that of the 'Petersen' type grab used in the present study. But this method of comparing the grabs is less efficient because it does not fully account for the burrowing capacity of different animals. For instance a species showing differential depth distribution with increase in size or age will be sampled by

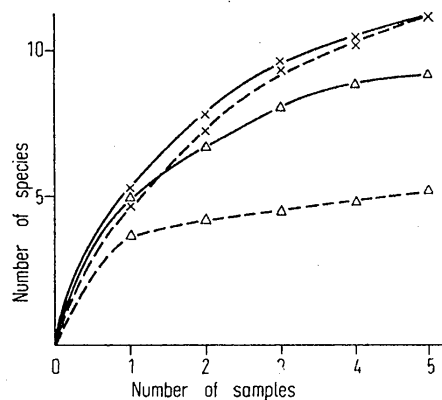


Fig. 3. Number of species plotted against the number of samples collected by the two grabs. Station 1: -x- van Veen grab; -x- 'Petersen' grab. Station 2: -△- van Veen grab, -△- 'Petersen' grab

both the grabs, although the grab digging deeper may contain more of the species with the various size groups better represented. Further if the burrowing forms are scarce in the sampling area, both the grabs may bring the same number of species.

Hence, the efficiency of the grabs was further studied, as done by BIRKETT (1958) and URSIN (1954, 1956), by analysing the relationship between the number of animals sampled and the volume of the material brought by the gears since the grab digging deeper will contain more organisms living below the surface. In Fig. 2 the total number of animals is plotted against the weight of the material sampled. No definite relationship is found between the two. In Fig. 2 (A) all the organisms sampled were treated together except foraminiferans and amphipods which were too numerous and seem to occur in small patches. In Fig. 2 (B) the main species were considered separately. Since the nature of distribution of different species and their burrowing capacity vary considerably a species-wise plot of the number of animals against the weight of the

Table 1. Comparison of the means of the main groups of animals sampled by the van Veen and 'Petersen' type grabs at the two sampling stations near Cochin Harbour, India

Sampling details	Station 1				Station 2					
	Polychaete <i>Diopatra neopolitana</i>		Settling stages of gastropods		Foraminifera <i>Rotalia</i> spp.		Bivalve <i>Meretrix ovum</i>		Gastropod <i>Canculus clanguloides</i>	
Sample size	5		5		5		5		5	
Type of grab	van Veen	'Petersen'	van Veen	'Petersen'	van Veen	'Petersen'	van Veen	'Petersen'	van Veen	'Petersen'
Raw data										
Mean	37.8	14.0	35.4	29.6	1074.4	42.4	5.6	15.0	6.2	17.6
Variance	546.7	50.0	1607.3	1263.3	492488.3	1726.8	33.3	142.0	43.2	204.3
Transformed data										
Mean	1.499	1.082	1.132	0.988	2.950	1.458	0.661	1.053	0.685	1.158
Variance	0.099	0.085	0.721	0.847	0.098	0.188	0.203	0.220	0.222	0.123
't'	7.987		-0.907		-11.124		6.770		-3.356	
	(P < 0.001)		(P > 0.1)		(P < 0.001)		(P < 0.001)		(P < 0.01)	

material should be a more reliable basis for comparison of the efficiency of the two grabs. However, in Fig. 2 (B) no relationship was apparent, probably because more samples were required, as evidenced by the wide scatter of points.

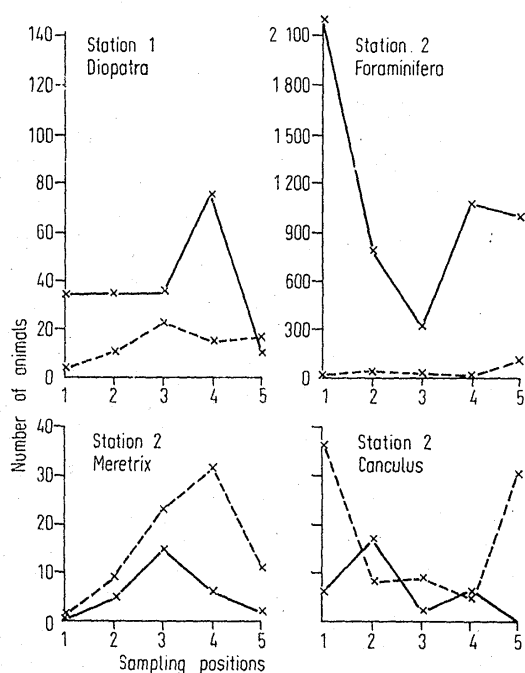


Fig. 4. Comparison of the number of animals sampled by the two grabs at different sampling positions in the two stations. —x— van Veen grab; ---x--- 'Petersen' grab

The high scatter of points in Fig. 2 may be due to the peculiar distribution of the various organisms when their distribution at a sampling station is highly 'bunched'. This seems to be true for all the main organisms in the sample since the variance is always found to be greater than the mean (Table 1). Therefore, the data were again examined in the following way.

Since at each sampling position the two grabs were hauled almost simultaneously both of them might sample the same community and under similar sampling conditions. The number of the main groups of organisms from each sampling position collected by the two grabs can therefore be compared; the error due to any possible difference in the amount of material brought by the two grabs will cancel out if an adequate number of samples are taken. Five such pairs of samples taken at each station are compared in Fig. 4. The data now show a more definite trend although there is still some discrepancy. The Polychaete, *Diopatra neopolitana* and the foraminiferans occurred in much larger numbers in the van Veen than in the 'Petersen' grab while the reverse is the case with the bivalve, *Meretrix ovum*. The significance of the means of the samples was further examined by the 't'-test. Since the variance is found to increase with the mean, the data were first transformed by taking their logarithm to make the variance of samples homogeneous. The results of the analysis are given in Table 1. The probability (P) levels corresponding to the 't'-values given in the table also show that foraminiferans and *Diopatra* were significantly more abundant in the van Veen, but *Meretrix* and *Canculus* occurred in larger numbers in the 'Petersen' grab. The abundance of the settling stages of gastropods in the two grabs however, were not significantly different. From Fig. 4 it can be seen that at almost all sampling positions the foraminiferans and *Diopatra* were much more abundant in the van Veen grab. The relatively small number of foraminiferans in the samples brought by the heavier grab at Station 1 is due to the muddy substratum. As mentioned earlier this grab may become filled before the jaws fully close and part of the surface mud containing the foraminiferans might escape through the cleft on the dorsal side of the jaws (Fig. 1) while the grab is closing. But the larger number of *Meretrix* and *Canculus* in the heavier grab seems rather due to the occurrence of one or two large samples than due to an actual difference in the efficiency of the two grabs in

sampling these organisms. Hence, if the presence of these two large samples in the 'Petersen' grab is accidentally due to the peculiar distribution of these species, it may be concluded that the van Veen grab is the more efficient of the two.

The slight discrepancy noticed in Fig. 4 may disappear if all the samples taken at a station were from a single sampling position. The results also indicate that when the distribution is highly 'contagious', it is desirable to haul the grabs after the boat is anchored so that they may sample the same community (see also BIRKETT, 1958). Sufficient number of samples should also be taken in this manner in order to reduce the sampling error and thus to make the samples brought by the two grabs statistically comparable.

### Summary

1. The design of the van Veen grab is superior to that of the 'Petersen' type grab employed in the present study, although the latter, being heavier, brings more material in a sandy substratum.

2. The main defect in the 'Petersen' type grab seems to be that its capacity is less than the maximum material it could sample. Hence, in a muddy substratum the grab is filled before the jaws fully close and part of the surface mud might even escape through the cleft on the dorsal side of the jaws while the grab is closing.

3. When the distribution of the organism is patchy it is suggested to anchor the boat so that the two grabs sample the same community. It is also suggested that the grabs should preferably be of the same weight and biting area if a comparison of the efficiency between the two is sought.

*Acknowledgements.* We are grateful to Dr. N. K. PANIKKAR, Director, National Institute of Oceanography, India, for constant encouragement and interest in this work and to Dr. A. D. MCINTYRE, Marine Laboratory, Aberdeen and Dr. S. Z. QASIM, National Institute of Oceanography, India, for reading the manuscript and suggesting improvements.

### Literature cited

- BIRKETT, L.: A basis for comparing grabs. *J. Cons. int. Explor. Mer.* **23**, 202—207 (1958).
- DESAI, B. N., and M. KRISHNAN KUTTY: Studies on the benthic fauna of the Cochin backwater. *Proc. Indian Acad. Sci.* 1966 (in press).
- — A comparison of the marine and estuarine benthic fauna of the nearshore regions of the Arabian Sea. Read at the NISI/INCOR symposium on 'Indian Ocean', March 1967. *Proc. natn. Inst. Sci. India* 1967 (in press).
- ELLIS, D. V.: Marine infaunal benthos in Arctic North America. *Arctic Inst. North America, Tech. paper No. 5*, 53 pp. (1960).
- GALLARDO, V. A.: Observations on the biting profiles of three 0.1 m<sup>2</sup> bottom samplers. *Ophelia* **2**, 319—322 (1965).
- HOLME, N. A.: The biomass of the bottom fauna in the English Channel off Plymouth. *J. mar. biol. Ass. U. K.* **32**, 1—49 (1953).
- HOPKINS, T. L.: A survey of marine bottom samplers. *In: Progress in oceanography*, **2**, 213—254. Ed. by E. M. Sears. New York: Pergamon Press 1964.
- SMITH, W., and A. D. MCINTYRE: A spring-loaded bottom sampler. *J. mar. biol. Ass. U. K.* **33**, 257—264 (1954).
- THAMDRUP, H. M.: Der van Veen-Bodengreifer. Vergleichsversuche über die Leistungsfähigkeit des van Veen- und des Petersen-Bodengreifers. *J. Cons. int. Explor. Mer.* **13**, 206—212 (1938).
- URSIN, E.: Efficiency of marine bottom samplers of the van Veen and Petersen types. *Medd. Danm. Fisk.- og Havunders (Ser. 1)* **7**, 8 (1954).
- Efficiency of marine bottom samplers with special reference to the Knudsen sampler. *Medd. Danm. Fisk.- og Havunders (Ser. 1)* **14**, 6 (1956).
- WELCH, P. S.: *Limnological methods*. p. 381. Philadelphia: Blakiston 1948.

Date of final manuscript acceptance: September 28, 1967. Communicated by N. K. PANIKKAR, New Delhi