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Short communication

A new benthic macrofauna and sediments sampler for attaching to otter trawl nets: comparison with the Van Veen grab

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ABSTRACT. Most bottom trawling around the world occurs in shelf areas covered by unconsolidated sediments, which can negatively affect bottom communities in several ways. We present a new bottom sampler device that can be attached to trawl nets or other bottom fishing gears. This device consists of a steel tube with a piston positioned in the interior to slide the material collected after the trawling and two lateral supports for fixing the device to the footrope of the trawl. Sampling design consisted in comparison two distinct sites, in each of them were conducted three tows with the sediment sampler device and at the begin and final of each tow it were collected sediment samples with Van Veen grab. PERMANOVA test on macrofauna composition indicated no significant difference in relation to both sampler devices. During the experiment, was not detected any problems in relation to positioning and using the new sampler. The addition of extra weight to the ballast cord did not unestablished the net and the device returned to the surface full of sediment in all the trawls, thus enabling the analysis of macrofauna and sediment particle size. Since this device does not interfere with the operation of the vessel or fishing performance, suggest a promising use of this equipment to collect samples in soft bottoms, as well as analysis of macrofauna and determining the size and composition of sediment.

Keywords: sediment sampler, benthic community, trawl fisheries, macrofauna.

Nuevo instrumento adosado a redes de arrastre de fondo para muestrear macrofauna bentónica y sedimentos: comparación con la draga Van Veen

RESUMEN. En el mundo la mayoría de las faenas pesqueras que utilizan arrastre de fondo se realiza sobre la plataforma continental, que está usualmente cubierta con sedimentos no consolidados, que pueden afectar negativamente a las comunidades bentónicas de variadas maneras. Se presenta un nuevo dispositivo de toma de muestras de fondo que se puede conectar a redes de arrastre u otros aparejos de pesca. El dispositivo consiste en un tubo de acero con un pistón en su interior para descargar la muestra obtenida de sedimentos y dos soportes laterales para fijar el dispositivo al cable al borlón inferior de la red de arrastre. Para comprobar la eficiencia de este equipo se tomaron muestras en dos ambientes distintos; en cada una de ellos se efectuaron tres arrastres con este dispositivo, a la vez que al inicio y final de cada uno ellos se recogieron muestras de sedimentos con una draga Van Veen. Para comparar la composición de la macrofauna obtenida con ambos equipos se realizó una prueba PERMANOVA, que señaló que no hubo diferencias en la composición faunística obtenida. Dado que este dispositivo no interfiere en la operación de la embarcación o en el rendimiento de pesca, sugiere un uso prometedor de este equipo para la recolección de muestras en fondos blandos, así como en el análisis de la macrofauna y la determinación del tamaño y composición del sedimento.

Palabras clave: muestreador de sedimentos, comunidad bentónica, pesquería de arrastre, macrofauna bentónica.

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The distribution and abundance of marine benthic and demersal fauna are influenced by several abiotic and biotic factors, including mainly the nature of the bottom (Colloca *et al*., 2003; Abad *et al.*¸ 2007; Mutlu *et al*., 2008; Gray & Elliot, 2009). Shelf areas covered by unconsolidated sediments are the main sites for developing of bottom trawling fisheries around the world (Watling & Norse, 1998), an activity that can negatively affect bottom communities in several ways (Gray & Elliot, 2009).

Along the Brazilian Economic Exclusive Zone (EEZ), most of the benthic and demersal industrial fisheries are concentrated in the northern and in the southeastern/southern regions, where industrial pair trawlers, stern trawlers and double-rig vessels can easily complete their operations due to a fairly even, extensive, and sediment-covered continental shelf (Muehe & Sequeira-Garcez, 2005; MMA, 2006; Valentini & Pezzuto, 2006). Concerning the latter region, several authors have provided information on its bottom characteristics (Figueiredo Jr. & Madureira, 2004; Figueiredo Jr. & Tessler, 2004) and its respective fauna (Gonçalves & Lana, 1991; Paiva, 1993; Almeida *et al*., 2012; Martins & Almeida, 2014). Most of this biological knowledge was acquired during expensive, spatially and temporally surveys aboard research vessels, which restricts a full understanding of the structure and dynamics of local bottom communities. Contrarily, hundreds of commercial trawling vessels operate all year round along the entire southeastern and southern region. These operations are a potential source of data on both the biotic and oceanographic characteristics of the shelf and slope fishing grounds, when scientific sampling is coupled with regular commercial operations.

In the region, a few studies have been conducted on the benthic and demersal megafaunas sampled aboard fishing vessels (*e.g*., Haimovici & Mendonça, 1996; Kotas, 1998; Perez & Wahrlich, 2005; Schroeder *et al*., 2014). However, none of these studies has sampled the smaller organisms of the macrofauna or produced sediment samples for the description of their habitat. The lack of vertical winches for launching grabs and box corers and conflicts with the crew due to changes in the routine and the productivity every time the vessel stops for sampling are only some of the technical and operational limitations to the conduction of oceanographic studies during commercial fishing trips.

This paper presents a new bottom sampler device that can be attached to bottom trawl nets and other fishing gears. This device consists of a steel tube with a piston positioned in the interior to slide the material collected after the trawling and two lateral supports for fixing the device to the footrope of the trawl. The sampler has an opening of 7 cm in diameter and a depth of 28 cm (area of 0.00384 m^2), and can collect 692.72 cm^3 of sediments (Fig. 1).

The study area consisted of two sites (Brava and Navegantes beaches) along the Brazilian southern continental shelf where there is intense fishing activity that targets the capture of sea-bob shrimp. Both sites are considered exposed and of high energy, although the Navegantes Beach suffers greater influence of the continental input and, consequently, of fine-grained terrigenous material.

During each trip, we collected three sediment samples in three trawls; two using a Van Veen grab in a sampling area of 0.042 m^2, and one using the prototype sampler attached to the fishing net (area of 0.00384 m^2).

Samplings were conducted with an artisanal double rig vessel (9 m total length) equipped with a 60 Hp engine. Each tow lasted 5 min at a constant velocity of *ca*. 2 knots. The gear used was a typical shrimp otter trawl measuring 11 m (length) x 5.5 m (horizontal opening) x 2.6 cm (codend mesh size). An aliquot of 100 g of sediment was extracted from all the samples for particle size analysis. The portion that was extracted for fauna analysis was wrapped in cloth bags with a 0.5 mm mesh opening and fixed in 4% formaldehyde solution. In the laboratory, the extracted material stored in the 0.5 mm mesh was screened and identified to the lowest possible taxonomic level using a stereoscopic microscope. The particle size was analysed according to the methodology suggested by Suguio (1973).

To analyse the abiotic characteristics, we applied principal component analysis (PCA) based on the variables percentage of gravel, sand, silt and clay.

Sampler efficiency was assessed using a PERMANOVA applied to the similarity matrix by means of the Sørensen index (Anderson, 2001). The following factors were considered for this stage: Sampler (two levels, fixed and orthogonal, Van Veen grab and Prototype); Sites (two levels, random and nested in Sites, Brava Beach and Navegantes Beach) and Trawl (three levels, random and nested in Sites and Sampler, 1, 2 and 3), with trawling and sites treated as hierarchical factors for both of the tested samplers. The similarity matrix was represented by nonmetric multidimensional scaling (nMDS). The contribution of the taxa was calculated for the average similarities within the significant groups (Clarke & Warwick, 2001).

The principal component analysis (PCA) allowed the extraction and interpretation of two factorial axes that jointly explained 81% of the total variation. Axis 1, responsible for 55% of the variation, was formed by the negative coordinate resulting from the largest con-

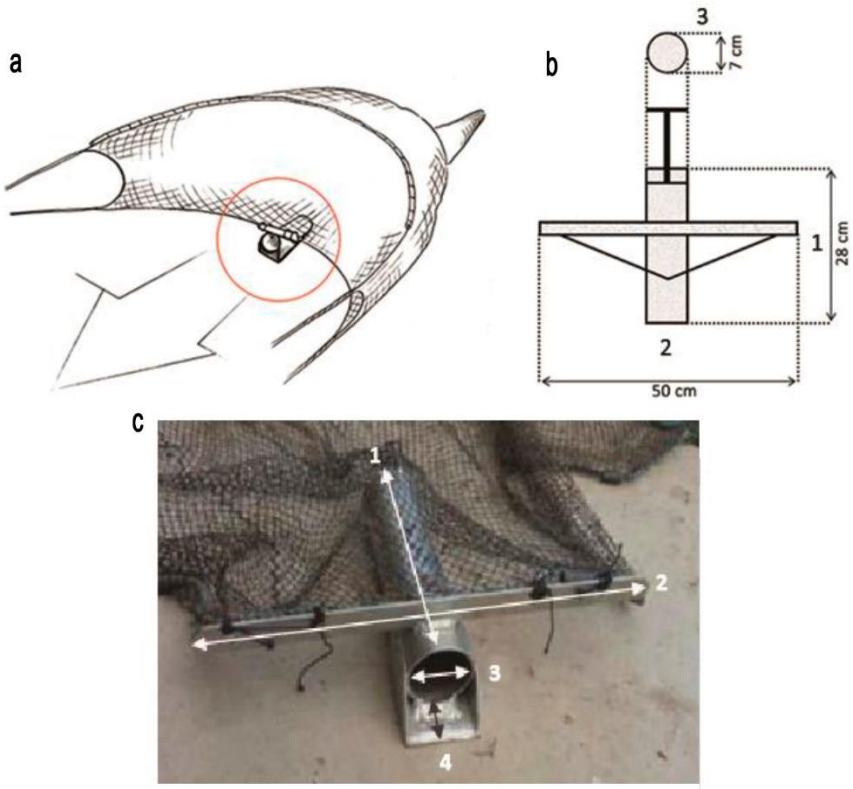

Figure 1. a) Attached position of the new sampler device on trawl nets, b) and c) sampler device scheme with the respective dimensions. 1: 28 cm, 2: 50 cm, 3: 7 cm, 4: 8.5 cm.

centrations of silt and the positive coordinate resulting from the largest concentrations of sand. Axis 2, responsible for 26%, was formed by the positive coordinate resulting from higher concentrations of clay and the negative coordinate resulting from the largest concentrations of gravel.

The ordering of the points along axis 1 allowed the separation of the sampling stations according to the concentrations of sand. The samples collected at Brava Beach were positioned on the positive side of the axis and associated to the greater concentrations of sand. The ordering of the points along axis 2 allowed the separation of the sampling stations according to the percentages of coarse sediments. The samples collected at Brava Beach were positioned on the negative side of the axis and associated to the greater concentrations of gravel (Fig. 2).

The sediment composition of the samples revealed differences between the two sampled sites. Brava Beach presented higher concentrations of gravel and silt, while Navegantes Beach presented a greater concentration of sand. These differences in the sediment characteristics influenced the composition of the fauna. This result agrees with the findings of several studies where the sediment characteristics were mainly responsible for the spatial variation of organisms (Van Hoey *et al.*, 2004; Lourido *et al.*, 2010).

A total of 557 individuals were collected. Of this total, 362 were collected in the site of Brava Beach and 195 were collected in the Navegantes Beach. In the latter site, the polychaetes of the family Capitellidae and the class Bivalvia were the most abundant, with 114 and 44 individuals respectively. In the site of Brava Beach, the most abundant organisms were the Amphipoda and polychaetes of the family Paraonidae, with 137 and 42 individuals respectively (Table 1).

The variance analysis did not detect significant differences between the total number of individuals collected by the different samplers (Table 2), regardless of possible differences in the areas sampled using the Van Veen grab (0.042 m^2) and the prototype trawler attached to the net (7 cm in diameter - area of 0.00384 m^2).

Nonparametric multidimensional scaling (nMDS) revealed two major groups that were mainly formed according to the location. The samples collected at the Navegantes Beach formed a cluster on the right side of the diagram, while the samples taken from Brava Beach

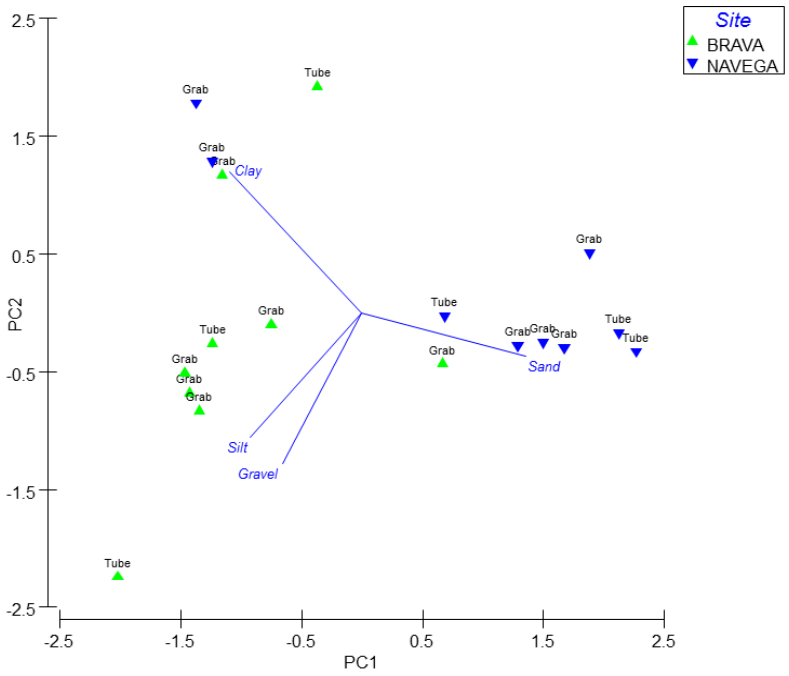

Figure 2. Results of the principal component analysis on sediment composition of the two sampled areas. Total variance explained by both axis were 81% (axis 1: 55%; axis 2: 26%). Sites: NAVEGA = Navegantes; BRAVA= Praia Brava; New sampler device =Tube; Grab = Van veen.

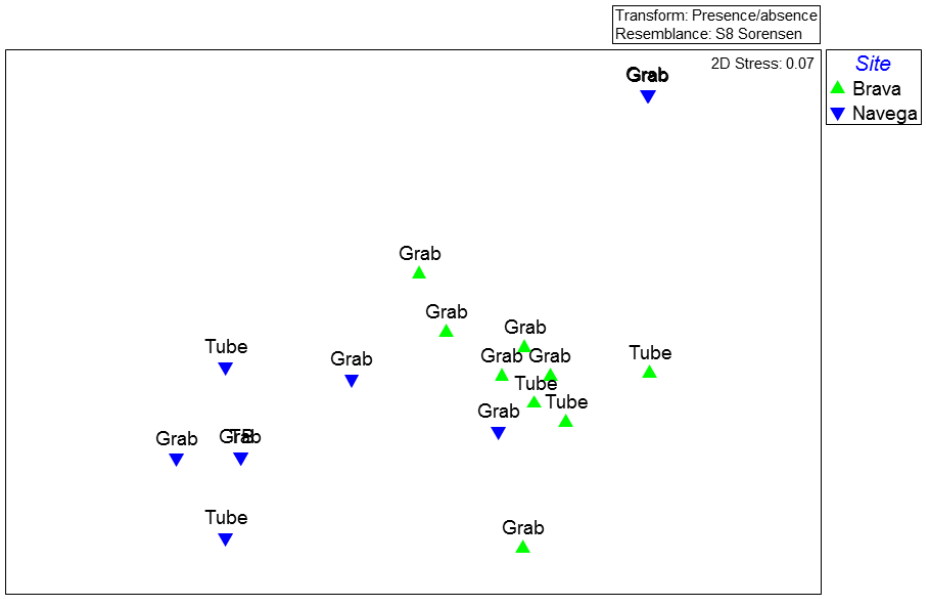

Figure 3. Multidimensional non-parametric scale analysis (nMDS) results. Sites: Navegantes' Beach as Navega and Brava's Beach as Brava. Van Veen grab as Grab and new sampler device as Tube.

formed a cluster on the left side of the diagram. The diagram also shows that there was no distinction between the samples that were collected using the different samplers (Fig. 3).

The PERMANOVA test applied to the taxonomic composition of the macrofauna did not detect significant differences between the samplers (Pseudo-F = 0.20281; P = 0.838). Only the difference between the locations where the experiments were carried out was

Table 1. Macrofauna composition in the two sites sampled in this experiment, Brava's and Navegantes' beaches.

Phylum	Taxa	Brava Beach	Navegantes Beach	Total
Annelida	Capitellidae	8	114	122
	Paraonidae	42	11	53
	Lumbrineridae	35	0	35
	Spionidae	25	5	30
	Onuphidae	25	1	26
	Mageloniidae	17	2	19
	Orbiniidae	7	0	7
	Pilargidae	4	2	6
	Oweniidae	4	1	5
	Goniadidae	3	0	3
	Nereidae	3	0	3
	Ampharetidae	1	0	1
	Flabelligeridae	1	0	1
	Glyceridae	1	0	1
	Magelona variolamellata	1	0	1
	Poecilochaetidae	1	0	1
	Sigalionidae	1	0	1
	Sigambra	1	0	1
Arthropoda	Amphipoda	137	3	140
	Cumacea	13	11	24
	Brachyura	7	0	7
	Decapoda	3	0	3
	Tanaidacea	2	0	2
Echinodermata	Ophiuroidea	1	0	1
Enteropneusto	Enteropneusto	1	0	1
Mollusca	Bivalvia	15	44	59
	Gastropoda	3	1	4
	Heleobia	1	0	1
Nemertea	Nemertea	7	2	9
Total		362	195	557

Table 2. PERMANOVA results on macrofauna composition.

Source of variation	df	SS	MS	Pseudo-*F*	*P* (perm)	Perms
Sampler	1	1817.4	1817.4	0.20281	0.838	6
Sites (Sampler)	2	19560	9780.1	4.9999	0.005	995
Trawl (Sites (Sampler))	8	15648	1956.1	0.81195	0.759	999

considered significant (Pseudo-F = 4.9999; P = 0.005) (Table 3).

The contribution to similarity analysis (SIMPER) showed that the same taxa contributed to the similarity regardless of the type of sampler. For the Brava Beach, the main taxa responsible for the similarities between samples were crustaceans of the class Amphipoda, with a similarity percentage of 18% for the samples collected with the grab and of 35% for the samples obtained using the prototype sediment sampler. For the Navegantes Beach, the taxa responsible for the similarities between the samples were the polychaetes of the family Capitellidae, with a similarity percentage of 50% for the samples collected using the grab and of 100% for the samples collected using the prototype (Table 4).

The prototype test initially consisted of investigating whether the net would support more weight, and whether attaching the device in the ground rope would destabilise the net and hinder the fishing activity. During the experiment, we did not detect any problems in relation to positioning and using the new sampler. The addition of extra weight to the ballast cord did not destabilise the net and the device returned to the surface

Table 3. Summary of macrofauna contribution on similarity mean by significant factors in PERMANOVA.

Brava Beach Site							
Grab - Model Van Veen				Prototype of sediment sampler			
Taxa	Freq.	S (%)	Accum. (%)	Taxa	Freq.	S (%)	Accum. (%)
Amphipoda	2.59	18.64	18.64	Amphipoda	4.77	35.29	35.29
Lumbrinerida	1.86	14.07	32.70	Onuphidae	1.62	13.51	48.80
Paraonidae	2.07	12.24	44.95	Nermertea	1.00	12.14	60.94
Spionidae	1.72	11.98	56.92	Lumbrineridae	1.55	12.14	73.08
Bivalvia	1.15	8.34	65.26	Brachyura	1.05	5.26	78.34
Cumacea	1.02	7.66	72.92	Mageloniidae	0.67	5.11	83.45
Onuphidae	1.31	7.35	80.27	Oweniidae	0.67	3.31	86.76
Mageloniidae	1.25	6.57	86.84	Paraonidae	0.91	3.31	90.07
Nermertea	0.67	4.72	91.56				
Navegantes Beach Site							
Grab - Model Van Veen				Prototype of Sediment Sampler			
Taxa	Freq.	S (%)	Accum. (%)	Taxa	Freq.	S (%)	Accum. (%)
Capitellidae	2.91	50.09	50.09	Capitellidae	2.19	100	100
Amphipoda	0.5	36.25	86.34				
Bivalvia	1.65	11.89	98.23				

full of sediment in all the trawls, thus enabling the analysis of fauna and sediment particle size.

It is well known that sediment characteristics can significantly influence the associations of macrofauna species. Despite the differences between the sites, the results of the multivariate analyses indicated that there was no difference between the samplers. Both showed the same efficiency when compared to the abundance and composition of the sampled fauna. This indicates that the new sampler attached to trawl nets can be used both in muddy and sandy sediments, with a similar representation to a Van Veen grab. This efficiency, and the fact that the device does not interfere with the routine of the vessel or the performance of trawl fishing, suggests the promising use of this equipment for the routine sampling of fauna and sediment aboard commercial fishing vessels. These results allow proposing tests that these conditions are maintained when the equipment is used in a more expensive expedition, as large industrial vessels and at greater depths.

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