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Research Article

Distribution of Iospilidae (Annelida) along the eastern Brazilian coast (from Bahia to Rio de Janeiro)

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ABSTRACT. We present the spatial distribution and abundance of the holoplanktonic family Iospilidae (Annelida, Polychaeta), along part of the eastern Brazilian coast, and its relation to environmental variables in the region. Samples were obtained from two collections made in 1998 and 2000 between 13°-25°S, and 28°-42°W, on the Brazilian coast, between the Bay of Todos os Santos (BA) to Cape São Tomé (RJ). 216 stations were selected, covering the continental shelf, slope and oceanic regions, where plankton samples were collected for water and nutrient analysis. We analyzed environmental variables: temperature, salinity, dissolved oxygen, pH, ammonia, nitrite, nitrate, phosphate, silicate and chlorophyll-*a*. 363 individuals were collected, identifying two species, viz., *Phalacrophorus uniformis* and *Phalacrophorus pictus*, the first being the most abundant, with 354 individuals, while only nine specimens of *P. pictus* were found. Both species are mainly distributed in the oceanic region stations. The distribution of *P. uniformis* was related to the concentration of phosphate and nitrate. Significant differences between samples and between sectors of the continental shelf and oceanic region were found.

Keywords: pelagic polychaetes, zooplankton, taxonomy, plankton ecology, oceanographic features.

Distribución de Iospilidae (Annelida) a lo largo de la costa oriental brasileña (de Bahía a Río de Janeiro)

RESUMEN. Se presenta la distribución espacial y abundancia de la familia holoplanctónica Iospilidae (Annelida, Polychaeta), a lo largo de la costa oriental brasileña, y su relación con variables ambientales de la región. Las muestras fueron obtenidas de dos muestreos realizados en 1998 y 2000 entre 13°-25°S, y 28°-42°W, en la costa brasileña, entre Bahía de Todos los Santos (BA) y el cabo de São Tomé (RJ). Se seleccionaron 216 estaciones, cubriendo las regiones de plataforma continental, talud y oceánica, donde se colectaron muestras de plancton y de agua para el análisis de nutrientes. Se analizaron las variables ambientales de temperatura, salinidad, oxigeno disuelto, pH, amonio, nitrito, nitrato, fosfato, silicato y clorofila-*a*. Se recolectaron 363 individuos, identificandose dos especies, viz., *Phalacrophorus uniformis* y *Phalacrophorus pictus*, siendo la primera la más abundante, con 354 individuos, y la segunda con sólo nueve especímenes Ambas especies se distribuyeron principalmente en las estaciones de la región oceánica. La distribución de *P. uniformis* estuvo relacionada con la concentración de fosfato y nitrato. Se encontraron diferencias significativas entre los muestreos, así como entre los sectores de plataforma continental y la región oceánica.

Palabras clave: poliquetos pelágicos, zooplancton, taxonomía, ecología de plancton, características océano-gráficas.

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INTRODUCTION

Iospilids are holoplanktonic polychaetes with small and delicate bodies. They are cosmopolitan and relatively common from surface waters down to a depth of 200 m, mainly in the Southern Ocean near the Antarctic Peninsula (Halanych *et al*., 2007). Nevertheless, even though widely distributed geographically, their records are scarce and scattered. According to Dales (1957), Tebble (1962) and Fernández-Álamo (2009), this is due to the small size and fragility of the animal's body susceptible to easy breakage during tows. Thus, iospilids fragments, although often collected in plankton samples, are commonly overlooked.

The specimens of this family have elongated bodies, with a rounded prostomium carrying two small palps located near the mouth. The eversible pharynx is armed with a pair of jaws in one genera, and unarmed in the other. Two tentacular segments are fused bearing two pairs of tentacular cirri, and chaetae present along the second pair. The first 2 to 10 parapodia are reduced. More posterior parapodia are uniramous, with small dorsal and ventral cirri. Parapodial lobes are longer than the cirri, and with spinigerous chaetae. The chaetae are always compound, with elongated distal part. Antennae absent.

The family Iospilidae (Bergström, 1914), previously named Iospilinae, was considered by Ushakov (1972) as a subfamily of Phyllodocidae. Nevertheless, Day (1967), Dales & Peter (1972), Orensanz & Ramirez (1973), Fauchald (1977) and Fernández-Álamo (2009) adopted the family status for Iospilidae. This status will be followed in this work, as well. There are only two recognized genera in the family: *Iospilus* Viguier, 1886 and *Phalacrophorus* Greeff, 1879. The main difference between the two is the presence or absence of jaws on the proboscis. In Iospilus, (unarmed proboscis), there is only one species, Iospilus phalacroides Viguier, 1886, whereas in Phalacrophorus two species are known, *Phalacrophorus uniformis* Reibisch, 1895 and *Phalacrophorus pictus* Greeff, 1879.

Study area

The present study focused on the Brazilian coast between 13°-25°S and 28°-42°W, from Todos os Santos Bay (BA) to Cabo de São Tomé (RJ), all told approximately 1,100 km in coastal line extent. It also includes the area surrounding the Vitória-Trindade chain of submarine banks and the Trindade and Martin Vaz islands, accounting a total study area of approximately 800,000 km^2.

The region is dominated by the Brazil Current (BC), which carries the Tropical Water (TW) in the first 200 m of water column and the South Atlantic Central Water (SACW), down from 200 to approximately 700 m depth. Thermohaline characteristics of TW are temperatures above 20°C and salinities higher than 36 psu, whereas for SACW, temperatures range from 6° to 20°C and salinities from 34.6 to 36 psu. Below SACW, there are two further water masses, the Antarctic Intermediate Water (AIW) and the North Atlantic Deep Water (NADW) (Da Silveira *et al.*, 2001). Only TW and SACW will be discussed in this paper.

One of the most relevant oceanographic phenomena in the region is the presence of cyclonic eddies, formed by the meandering course of the Brazil Current. The meandering is caused by the geographic barrier of the Abrolhos banks and the Vitória-Trindade chain that cause a deviation in the current-flow. These eddies occasionally increase regional productivity by inducing SACW-outcropping (rich in nutrients), into the surface layers and shelf-break upwellings (Campos *et al.*, 2000).

Despite the wide extent of the study area, there are still few studies on polychaetes in this region (*e.g.*, Attolini, 1997; Zanol *et al*., 2000; Paiva, 2006), all of which referring to benthic polychaetes, with no published studies of local holoplanktonic forms.

The aim here is to report on the distribution of species from the family Iospilidae, along the eastern Brazilian coast, describe their morphology, and relate their distribution to the environmental variables of the area.

MATERIALS AND METHODS

The plankton samples analyzed for this study were collected during two surveys as part of a Brazilian government research program to study the biota of the country's exclusive economic zone, named REVIZEE. The first survey, Central III (CIII), was held in spring 1998, from October 26 to December 12, and the second, Central IV (CIV), during autumn 2000, from March 28 to May 1. Samples were collected along the eastern Brazilian coast in 108 stations for each survey, distributed in neritic and oceanic areas, 216 in total (Fig. 1).

Plankton samples were collected with 200 µm-mesh cylindrical-conical nets in vertical tows in the first 200 m of the water column. Samples were first fixed in 4% formaldehyde diluted in ocean water, and then preserved in 4% formaldehyde diluted in distilled water. In laboratory, stereomicroscopic analysis was

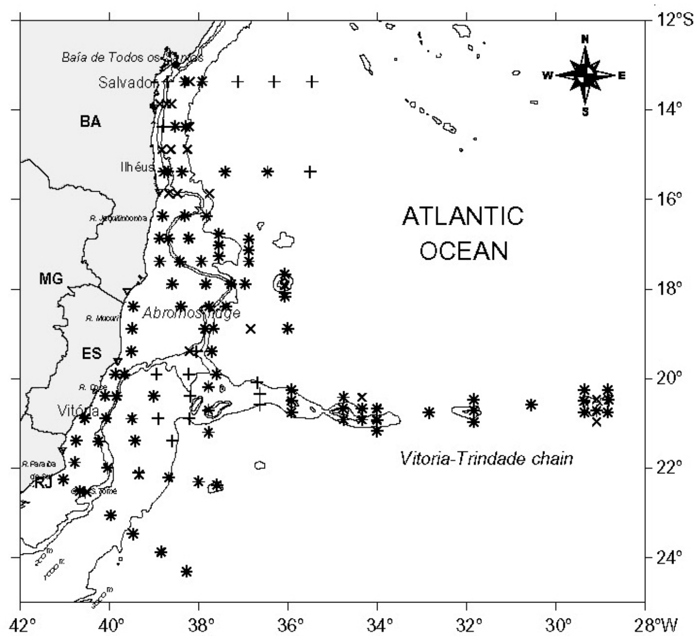

Figure 1. Study area showing the main oceanographic features (isobaths, Abrolhos ridge and Vitória-Trindade chain) and the sampling points. X: shows the sampling stations of Central III and the cross refers to sampling points in Central IV. Many stations are coincident in both surveys.

applied to separate polychaetes from other planktonic organisms and a compound microscope was used for pelagic polychaete identification at the species level.

In each station, water was collected in Niskin bottles. Temperature, salinity, dissolved oxygen (DO) and pH measures were obtained for each station at the moment of sampling. Temperature (°C) and salinity (S) were measured using a CTD. Dissolved oxygen (mg L^{-1}) was analyzed by the Winkler titration method, whereas pH was obtained with a pH meter. The nutrients, ammonia, nitrite, nitrate, silicate and phosphate concentration (µM), as well as chlorophyll-*a*, were analyzed in the laboratory, by the usual methods employed in oceanographic studies (Grasshoff *et al*., 1983; Parsons *et al*., 1984).

Software Surfer 8.0 was applied to plot iospilid distribution and abundance. The relative percentage of each species was calculated. For assessment of spatial distribution, stations were grouped into five regions according to their oceanographic and topographic features: Bahia (BAH), Abrolhos (ABR), Vitória (VIT), the Vitória-Trindade chain (VTC) and Cabo de São Tomé (CST), as shown in Fig. 2.

In order to investigate relationships between hydrochemical variables and species density, a Regression Model was applied by means of a General Linear Model (GLM), using quasi Poisson error terms and a log-link function. The use of quasi Poisson instead of regular Poisson error terms was due to the over-dispersion of residuals (Logan, 2010). The differences between the surveys and spatial patterns among the different regions (mentioned above) and sectors (shelf, slope and offshore) were also assessed by the GLM model, using quasi Poisson errors (Analysis of Deviance). Owing to the rare occurrence of *P. pictus*, both analyses were applied only to *P. uniformis* data.

RESULTS

From a total of 363 specimens examined in the two surveys, two species, both belonging to the genus *Phalacrophorus*, were identified, viz., *Phalacrophorus pictus* Greeff, 1879 and *Phalacrophorus uniformis* Reibisch, 1895. Both are very similar, except for the number of rudimentary parapodia on the anterior part of the body. *P. uniformis* has 8 to 10 (Fig. 3c), whereas *P. pictus* has only 2 to 3 (Fig. 3b).

Phalacrophorus pictus Greeff, 1879

Phalacrophorus pictus Greeff, 1879:249; Fauvel, 1923:196; Dales, 1957:109; Ushakov, 1972:184; Tebble, 1962:426-427; Day, 1967:171; Dales & Peter, 1972:62; Orensanz & Ramírez, 1973:33.

Phalacrophorus maculatus Treadwell, 1943:34

Phalacrophorus borealis Reibisch, 1895:15

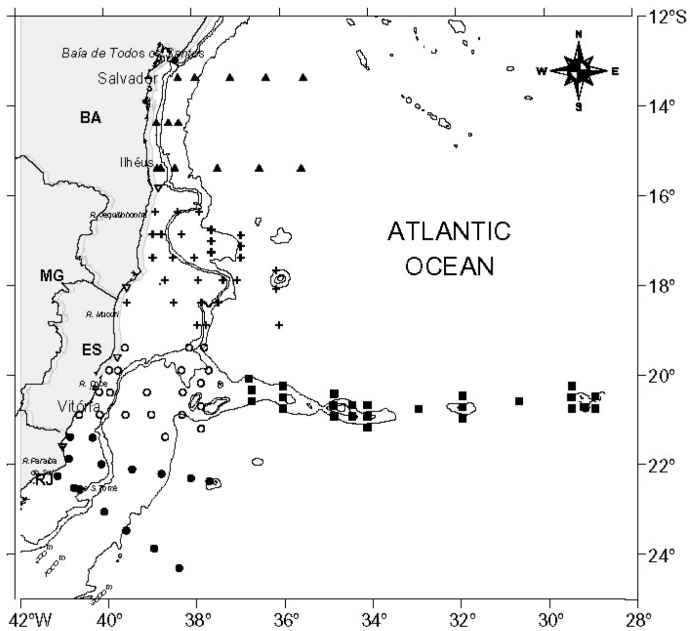

Figure 2. Study area showing the five main regions (the sampling stations were grouped): triangles: Bahia; crosses: Abrolhos; white circle: Vitória; black square: Vitória-Trindade chain, and black dot: Cabo de São Tomé.

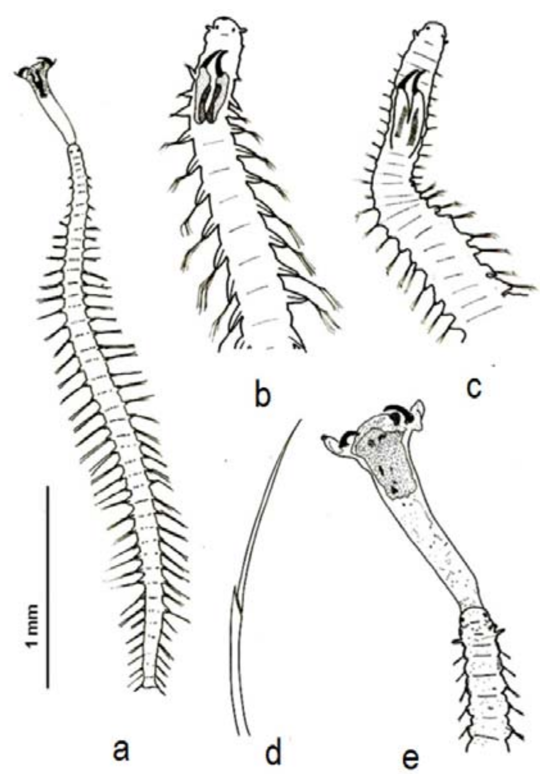

Figure 3. a) *Phalacrophorus uniformis*, entire body on dorsal view with pharynx everted, b) *P. pictus* anterior end on dorsal view, c) *P. uniformis*, anterior end on dorsal view, d) compound chaeta, common to both species, e) anterior end of *P. uniformis* on dorsal view with pharynx everted.

Material examined. A total of nine specimens were analyzed from the CIII survey. **CIII**: C9 (1); C18 (2); C26 (1); C37 (1); C51 (1); C55 (2); C108 (1) (Appendix 1).

Description. Posterior part of body lacking in all specimens. Fragments with about 10 mm and 10-15 chaetigers. Body cylindrical. Prostomium rounded with pair of short palps and two small eyes (present in all specimens). Pharynx thick, strong, with two falcate chitinous mandibles; not everted in any of the specimens analyzed, but observable through transparency (Fig. 3b). First three parapodia reduced, with two or three spinigerous chaetae and no cirri (Fig. 3d). Other parapodia developed, with small dorsal and ventral cirri. Parapodia along body gradually increase in size and number of chaetae (Fig. 3b). Chaetae compound, numerous, with long distal part.

Remarks. Through being extremely fragile, these animals are often found broken in plankton samples.

Phalacrophorus uniformis **Reibisch, 1895**

Phalacrophorus uniformis Reibisch, 1895:15-16; Fauvel, 1923:196; Dales, 1957:109; Ushakov, 1972: 184; Tebble, 1962:426-427; Day, 1967:171; Dales & Peter, 1972:62; Orensanz & Ramírez, 1973:33.

Iospilopsis antillensis Augener, 1922:41

Phalacrophorus attenuatus Treadwell 1943:34

Material examined. 354 specimens were examined, 133 from the CIII survey and 221 from the CIV. **CIII:** C3 (2); C4 (1); C6 (1); C11 (1); C17 (1); C18 (25); C21 (10); C22 (4); C25 (1); C27 (1); C33 (8); C35 (1); C37 (4); C38 (2); C39 (2); C42 (13); C43 (2); C46 (10); C50 (3); C51 (1); C52 (6); C55 (4); C58 (2); C59 (1); C60 (2); C65 (1); C66 (4); C67 (3); C70 (1); C77 (3); C78 (2); C80 (1); C82 (1); C86 (5); C93 (1); C94 (1); C95 (2); **CIV:** C13 (4); C9 (3);C10 (1); C11 (1); C20 (3); C21 (1); C24 (1); C25 (2); C26 (1); C30 (1); C31 (4); C34 (6); C36 (9); C37 (5); C38 (2); C43 (6); C44 (7); C46 (3); C49 (1); C50 (25); C52 (2); C60 (3); C62 (4); C67 (2); C68 (6); C72 (4); C73 (7); C74 (2); C76 (1); C79 (8); C80 (1); C81 (1); C83 (1); C84 (4); C87 (5); C89 (9); C91 (1); C92 (3); C95 (7); C96 (2); C97 (1); C100 (6); C102 (4); C103 (1); C104 (4); C106 (5); C108 (9); C109 (3); C110 (5); C112 (1); C117 (1); C119 (4); C121 (1); C122 (8) (Appendix 2).

Description. Few specimens complete. Posterior end lacking in most specimens. Body cylindrical. Prostomium rounded, with pair of short digital palps, two small eyes, no antennae. First 2 to 10 parapodia reduced, with small spinigerous chaetae, no cirri. Those following, well-developed, increasing in size along body, until reaching maximum by mid-portion, whence there is gradual decrease until posterior end (Fig. 3a). Parapodia, with dorsal and ventral cirri, smaller than parapodial lobe. Chaetae compound, numerous, with long distal part. Some specimens with everted pharynx opening into two falcate chitinous jaws (Fig. 3e). Pharynx muscles thick and strong, well-developed jaws dark, easily observable through transparency. Small parapodia and chaeta close to pigidium. Pygidium without appendages.

Remarks. This species is similar to *P. pictus*, the main difference being in the anterior end. *P. uniformis*, has the first 2 to 10 parapodia reduced, while *P. pictus* has the first 3 parapodia reduced. The pharynx of *P. uniformis*, through being long and fragile, requires care on manipulation to avoid breakage. It is easily observable, when not everted, through transparency, in the anterior part of the body.

Distribution. The most abundant species in both surveys was *P. uniformis*, representing 94% of Iospilidae abundance in CIII and 100% in CIV. *P. pictus* was encountered only in CIII, with 9 specimens, thus representing 6% of the total. In CIII, 133 specimens of *P. uniformis* were identified, against 221 in CIV. Both species were distributed throughout the study area (Fig. 4). Data from sampling stations are presented in Tables 1 and 2, respectively.

The two species occurred mainly in offshore stations, *i.e.*, those with local depths of over 250 m. In the CIII survey, *P. uniformis* was most abundant in ABR region (Figs. 2, 4), and in CIV survey, in CST region (Figs. 2, 4). Both regions are known as highly productive, ABR due to the coral reefs, and CST due to SACW upwelling, which induces an input of colder and nutrient richer water than the normally warmer and oligotrophic surface layers.

This was confirmed by Analysis of Deviance (Table 1), which revealed a significant difference in *P. uniformis* abundance, not only between the two surveys, but also among sectors (shelf, slope and offshore), and the five different regions.

Statistical tests showed the greater abundance of *P. uniformis* in the CIV survey, as well as significant differences between the ABR and CST regions, and between ABR and the VTC, but not among the other regions, which were considered intermediate (Fig. 5). This is probably due to the high abundance in ABR in both surveys, in contrast to the lowest abundance encountered in the VTC in the CIII survey and in CST in the CIV. In ABR, BAH and VIT, abundance was high in both surveys, whereas in the VTC, this ranged from the lowest in CIII to almost the highest in CIV, and in CST, low abundance in both surveys (Fig. 6).

On considering sectors, offshore and shelf were significantly mutually different ($P < 0.01$), whereas the continental slope did not differ significantly from either shelf or offshore (Fig. 5). Significant interaction ($P < 0.01$) was found only between surveys and regions, owing to the VTC, the only region where abundance from CIII to CIV increased sharply (Fig. 6).

The model selected for multiple regression showed that due to the high abundance in ABR, *P. uniformis*, distribution is related to offshore waters (higher local depth) at lower latitudes, characterized by lower temperatures and higher pH levels. Regarding nutrients, the relationship to nitrates is positive and negative to phosphates and chlorophyll-*a* (Table 2).

These results reflect differences in the spatial distribution of nutrients and *P. uniformis* abundance in the CIII and CIV surveys. In CIII, the highest concentrations of chlorophyll-*a* were detected in the CST region, and of phosphate in the VTC. In both regions, abundance was low. On the other hand, the high nitrate concentrations in the ABR region coincided with species abundance.

The contrary occurred in the CIV survey. Concentrations of chlorophyll-*a* and phosphate were high in the ABR region, and of nitrate, high in the CST region. In this survey, although *P. uniformis*

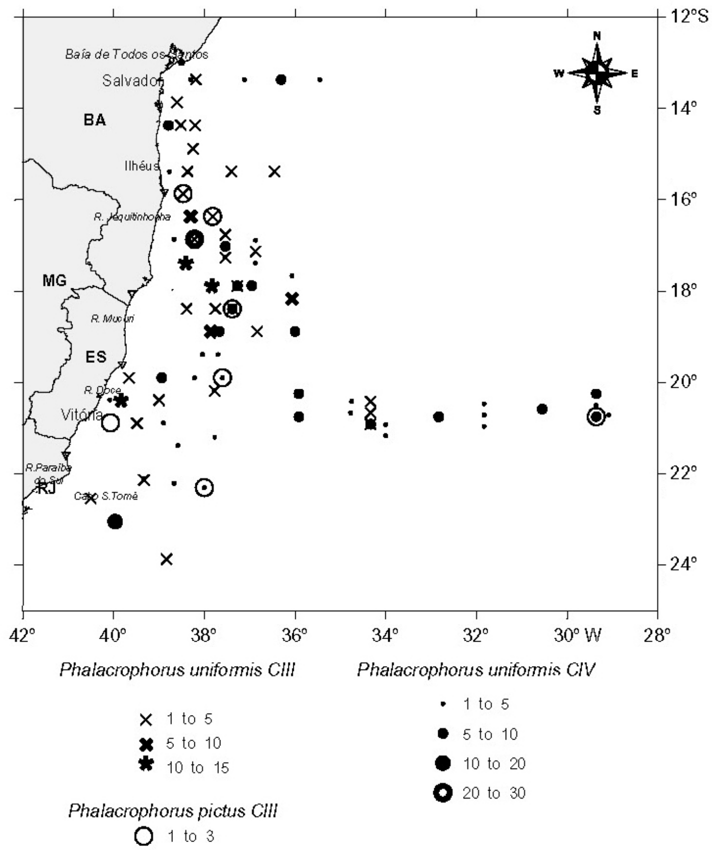

Figure 4. Distribution and abundance of *P. uniformis* and *P. pictus* along the study area in both surveys.

Table 1. Analysis of deviance table (GLM model). DF: degrees of freedom, DR: deviance residual, F: F statistics, *P*: probability of Type I error.

Factor	DF	DR	F	*P*
Survey	1	22.10	5.501	0.020
Area	4	42.25	2.629	0.035
Sector	2	77.08	9.591	<0.001
Survey × Area	4	75.93	4.724	0.001
Survey × Sector	2	11.88	1.479	0.230
Area × Sector	7	23.53	0.836	0.558
Survey × Area× Sector	6	26.78	1.110	0.357
Residuals	189	626.30		

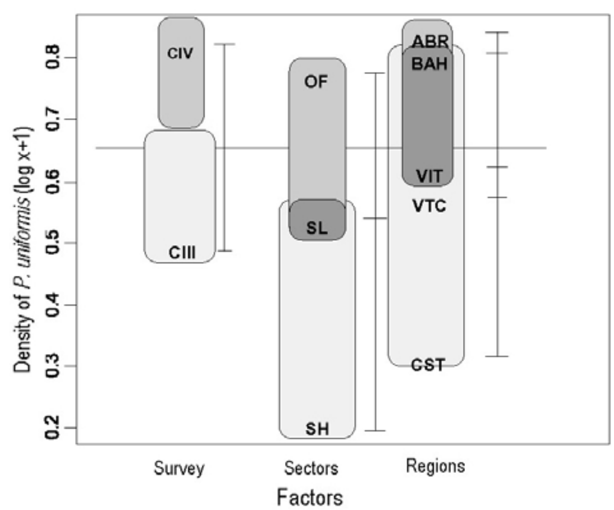

Figure 5. Plot of the design showing significant differences. OF: offshore sector; SL: slope sector; SH: shelf sector; ABR: Abrolhos region; BAH: Bahia region; VIT: Vitoria region; CVT: Vitoria Trindade Chain region; CST: Cabo de São Tomé region. Shaded polygons cover with homogeneous means in Tukey test.

abundance was also high in Abrolhos, the highest abundance was detected in one station in CST, thus leading to the positive relationship with nitrate content as selected by the regression model.

DISCUSSION

Overall, there are few studies of the taxonomy, biology and ecology of pelagic polychaetes, even less in the southern hemisphere. In this study, *P. pictus* occurred in all the study area, although in very low

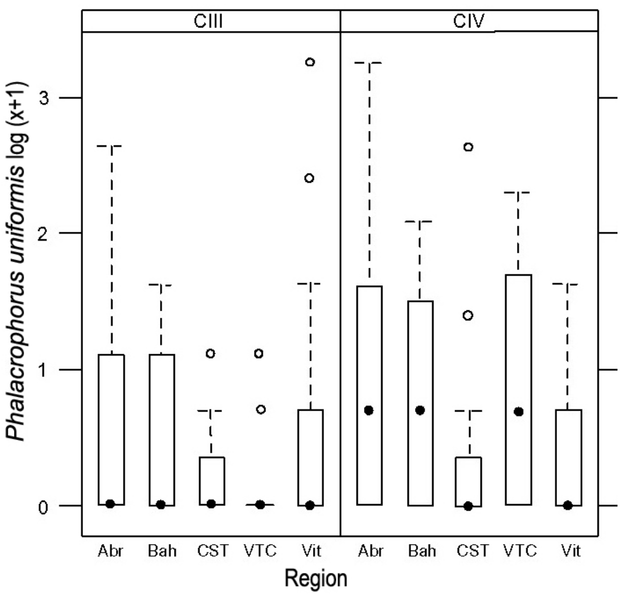

Figure 6. Box plots of *P. uniformis* abundance (in log (x+1)) in each region, showing median values (black dots), the interval of 25-75% of the data (box), the maximum value (dashed line) and the outliers (white dots). Abr: Abrolhos region; Bah: Bahia region; Vit: Vitória region; VTC: Vitória-Trindade Chain region; CST: Cabo de São Tomé region.

abundances. Notwithstanding, this species has been reported in literature to all oceans. *P. pictus* was found throughout the Pacific Ocean, off Japan and along the coasts of California and Peru (Treadwell, 1943); from the South Atlantic to the Antarctic region (Støp-Bowitz, 1951), for the Mediterranean Sea and Atlantic Ocean (Dales, 1957) and to the North Pacific Ocean, where it was frequent in the Sub-Arctic Zone and considered as related to cold waters (Tebble, 1962). According to Orensanz & Ramirez (1973), *P. pictus* is cosmopolitan, occurring from the Arctic to the Antarctic through the tropics, and a population differentiation is possibly related to geographic dispersion, due to intra-specific morphological differences.

P. uniformis was reported in several papers, from the South and Equatorial Pacific (Dales, 1957), as well as North Pacific Ocean (Tebble, 1962), the Atlantic, Pacific and Indic Oceans (Orensanz & Ramirez, 1973). Tebble (1960) studied the distribution of holoplanktonic polychaetes from the South Atlantic Ocean, including both Brazilian and African latitudes, but made no mention of Iospilidae. However, *P. uniformis* was reported for the African coast (Day, 1967) and now, from the Brazilian coast aswell. According to Orensanz & Ramirez (1973) and Fernández-Álamo (1996), this species is associated to surface tropical and subtropical waters.

Although the two species are considered cosmopolitan, having been reported worldwide, the difference in their distribution appears to be according to climate zones. *P. pictus* is more abundant and frequent in cold waters of higher latitudes and *P. uniformis* is abundant and frequent in warmer waters of lower latitudes. If true, this might explain the dominance of *P. uniformis* in this study where water masses are warmer, and thus, their greater abundance in a gradient from tropical (ABR) to subtropical (CST) climate. Fernández-Álamo & Färber-Lorda (2006) reported higher abundance and frequency of *P. uniformis* in the Baja California region (Eastern Pacific), in lower latitudes than polar zones, where *P. pictus* is more abundant. The authors also reported *P. pictus* as a rare species in Baja California, the same pattern observed in this study.

Near Madagascar, *P. pictus* was reported as being more common in neritic than oceanic waters (Day, 1975). Nevertheless, in the present study, this species occurred exclusively in oceanic stations with a local depth of 1000 m or over (except in one at 270 m). Despite the very low abundance, and except for the BAH region, distribution was widespread.

There were differences in *P. uniformis* abundance, both between surveys and among regions along the coast. The higher abundance in ABR is probably related to the intense regional biological activity, through regenerated primary production, supported by microbial loop-activity (Tovar-Faro, 2005).

Along the Brazilian coast, the ABR region is known for its high productivity (Gaeta *et al*., 1999; Susini-Ribeiro, 1999) preceded by small phyto-plankton species (*Prochlorococus*) (Zubkov *et al*., 1998, 2000; Susini-Ribeiro, 1999), and based on regenerate primary production, firmly dependent on the microbial loop, as observed in tropical oligotrophic oceans (Fernández-Álamo & Färber-Lorda, 2006). The close relationship between primary production, grazing and zooplankton excre-tion, as well as the importance of this excretion as a nutrient supply, have already been shown (Eppley *et al*., 1973).

High primary productivity, both new and regenerate, causes an increase in secondary production at all levels of the web chain, this including planktonic "top" predators, supposedly the case of *P. uniformis* and *P. pictus*, on considering their buccal apparatus morphology (Fernández-Álamo, 2009). Thus, the spatial distribution of *P. uniformis* seems to be related to primary production, with the consequential increase in prey-availability, once chlorophyll concentration is an indirect measure of primary production, and it was

Table 2. Variables selected by Regression Analysis (GLM). F: F statistics, *P*: probability of Type I error.

Variables	Coefficient	Deviance	F	*P*
pH	0.111	838.89	28.813	<0.001
Latitude	0.162	786.16	11.990	<0.001
Chlorophyll-*a*	-1.958	773.66	8.478	0.003
Temperature	-0.351	770.87	7.693	0.006
Phosphate	-0.714	769.83	7.402	0.007
Nitrate	0.229	765.76	6.255	0.013

high in the same regions where *P. uniformis* was abundant.

Furthermore, the relationship between plankton distribution and water-mass flow has been well-documented for other regions (*e.g.*, Fernández-Álamo & Färber-Lorda, 2006). Along the Brazilian coast, the ABR banks (and further south, the Vitoria-Trindade chain) form a natural geographical barrier to the BC, with the consequential occurrence of eddies formed by BC meandering. These eddies introduce nutrients into the euphotic zone, thereby contributing to an increase in primary production. The origin of this input is the SACW, which flow into BC under the TW. Besides being colder and richer in nutrients, SACW is less salty than TW (Da Silveira *et al*., 2001). This probably explains the correlation found between *P. uniformis* and lower temperatures and pH, both water-mass markers. Furthermore, there are seasonal variations in BC flow, as the entrance of SACW into the continental shelf causes coastal upwelling (Campos *et al*., 1995, 2000; Castro & Miranda, 1998), possibly the reason for the significant difference found between the two surveys, since they occurred at different seasons (spring and autumn). Nevertheless, one must consider that observed variability could also be due to processes both during and between the years, since surveys took place not only in different seasons, but also in distinct years (1998 and 2000). Thus, further surveys are required, in order to assess actual temporal patterns.

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Appendix 1. Data of the sampling stations where *Phalacrophorus pictus* occurred.

Station	Long (°W)	Lat (°S)	Date	Local depth (m)	Number of specimens
C 09	38.0000	22.3050	31/10/98	3400	1
C 18	40.0707	20.8840	02/11/98	270	2
C 26	37.6000	19.9000	05/11/98	2000	1
C 37	37.3833	18.3883	14/11/98	3400	1
C 51	37.8167	16.3667	22/11/98	2000	1
C 55	38.4667	15.8667	23/11/98	1200	2
C 108	29.3575	20.7500	11/12/98	4900	1

Appendix 2. Data of the sampling stations where *Phalacrophorus uniformis* occurred.

Survey	Station	Long (°W)	Lat (°S)	Date	Local depth (m)	Number of specimens
CIII	C 03	40.5025	22.5430	28/10/98	208	2
CIII	C 04	39.9667	23.0500	29/10/98	2700	1
CIII	C 06	38.8333	23.8700	29/10/98	3400	1
CIII	C 11	39.3333	22.1383	31/10/98	2200	1
CIII	C 17	39.4867	20.8925	02/11/98	2000	1
CIII	C 18	40.0707	20.8840	02/11/98	270	25
CIII	C 21	39.8373	20.3927	03/11/98	250	10
CIII	C 22	39.0000	20.3892	04/11/98	2000	4
CIII	C 25	37.7742	20.1833	05/11/98	2000	1
CIII	C 27	39.6598	19.9020	08/11/98	300	1
CIII	C 33	37.8557	18.8857	11/11/98	250	8
CIII	C 35	36.8333	18.8833	11/11/98	3700	1
CIII	C 37	37.3833	18.3883	14/11/98	3400	4
CIII	C 38	37.7595	18.3880	15/11/98	270	2
CIII	C 39	38.3873	18.3883	15/11/98	35	2
CIII	C 42	37.8333	17.8842	14/11/98	54	13
CIII	C 43	37.2708	17.8875	14/11/98	250	2
CIII	C 46	38.4090	17.3877	13/11/98	270	10
CIII	C 50	38.2167	16.8667	22/11/98	2300	3
CIII	C 51	37.8167	16.3667	22/11/98	2000	1
CIII	C 52	38.3000	16.3667	22/11/98	250	6
CIII	C 55	38.4667	15.8667	23/11/98	1200	4
CIII	C 58	36.4500	15.3833	19/11/98	4100	2

continuation

Survey	Station	Long (°W)	Lat (°S)	Date	Local depth (m)	Number of specimens
CIII	C 59	37.4000	15.3833	19/11/98	3900	1
CIII	C 60	38.3667	15.3833	18/11/98	2000	2
CIII	C 65	38.2500	14.8833	20/11/98	3000	1
CIII	C 66	38.2050	14.3717	24/11/98	3000	4
CIII	C 67	38.5167	14.3667	24/11/98	2000	3
CIII	C 70	38.6000	13.8667	25/11/98	2000	1
CIII	C 77	38.1883	13.3667	01/12/98	500	3
CIII	C 78	37.5383	16.7667	03/12/98	3000	2
CIII	C 80	37.5383	17.2667	03/12/98	1810	1
CIII	C 82	36.8717	17.1333	04/12/98	44	1
CIII	C 86	36.0667	18.1667	04/12/98	3000	5
CIII	C 93	34.3333	20.4167	06/12/98	4110	1
CIII	C 94	34.3333	20.6667	07/12/98	3450	1
CIII	C 95	34.3333	20.9167	07/12/98	3270	2
CIV	C 04	39.9667	23.0500	28/03/00	2700	13
CIV	C 09	38.0000	22.3050	30/03/00	3400	3
CIV	C 10	38.6667	22.2067	30/03/00	3200	1
CIV	C 11	39.3333	22.1050	30/03/00	2200	1
CIV	C 20	40.0833	20.3833	03/04/00	55	3
CIV	C 21	39.8373	20.3927	06/04/00	250	1
CIV	C 24	37.7700	21.2000	01/04/00	3900	1
CIV	C 25	37.7742	20.1833	06/04/00	2000	2
CIV	C 26	37.6000	19.9000	07/04/00	2000	1
CIV	C 30	38.0405	19.3907	08/04/00	250	1
CIV	C 31	37.7000	19.3917	08/04/00	2000	4
CIV	C 34	37.6667	18.8833	09/04/00	2000	6
CIV	C 36	36.0000	18.8833	25/04/00	4000	9
CIV	C 37	37.3833	18.3883	10/04/00	3400	5
CIV	C 38	37.7595	18.3880	10/04/00	270	2
CIV	C 43	37.2708	17.8875	11/04/00	250	6
CIV	C 44	36.9550	17.8842	10/04/00	3300	7
CIV	C 46	38.4090	17.3877	12/04/00	270	3
CIV	C 49	38.6667	16.8667	13/04/00	250	1
CIV	C 50	38.2167	16.8667	13/04/00	2300	25
CIV	C 52	38.3000	16.3667	13/04/00	250	2
CIV	C 60	38.3667	15.3833	14/04/00	2000	3
CIV	C 62	38.7687	15.3840	14/04/00	47	4
CIV	C 67	38.5167	14.3717	16/04/00	2000	2
CIV	C 68	38.7873	14.3717	16/04/00	1100	6
CIV	C 72	35.4550	13.3667	17/04/00	4440	4
CIV	C 73	36.3050	13.3667	17/04/00	4300	7
CIV	C 74	37.1167	13.3667	17/04/00	3970	2

continuation

Survey	Station	Long (°W)	Lat (°S)	Date	Local depth (m)	Number of specimens
CIV	C 76	38.3000	13.3667	18/04/00	2000	1
CIV	C 79	37.5383	17.0217	12/04/00	48	8
CIV	C 80	37.5383	17.2667	12/04/00	1810	1
CIV	C 81	36.8717	17.3833	24/04/00	3100	1
CIV	C 83	36.8717	16.8833	24/04/00	3000	1
CIV	C 84	36.0667	17.6667	24/04/00	3700	4
CIV	C 87	35.9167	20.2500	26/04/00	2615	5
CIV	C 89	35.9167	20.7500	26/04/00	3390	9
CIV	C 91	34.7712	20.6695	27/04/00	62	1
CIV	C 92	34.7500	20.4167	27/04/00	760	3
CIV	C 95	34.3333	20.9167	27/04/00	3270	7
CIV	C 96	34.0000	21.1667	28/04/00	4500	2
CIV	C 97	34.0000	20.9217	28/04/00	83	1
CIV	C 100	32.8333	20.7550	28/04/00	4300	6
CIV	C 102	31.8333	20.9667	29/04/00	4000	4
CIV	C 103	31.8333	20.7167	29/04/00	84	1
CIV	C 104	31.8333	20.4667	29/04/00	4100	4
CIV	C 106	30.5500	20.5833	30/04/00	4900	5
CIV	C 108	29.3575	20.7500	30/04/00	4900	9
CIV	C 109	29.3667	20.5000	30/04/00	65	3
CIV	C 110	29.3570	20.2500	30/04/00	5000	5
CIV	C 112	29.0833	20.7167	01/05/00	4200	1
CIV	C 117	38.5833	21.3833	01/04/00	2800	1
CIV	C 119	38.9000	20.8892	02/04/00	2350	4
CIV	C 121	38.2167	19.9000	07/04/00	58	1
CIV	C 122	38.9383	19.9000	07/04/00	1500	8