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Spatial distribution of Siphonophora species at Rio de Janeiro Coast, Brazil

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Resumo. *Distribuição espacial das espécies de Siphonophora na costa do Rio de Janeiro, Brasil.* A distribuição espacial das espécies de Siphonophora foi observada em 35 estações localizadas na região costeira do Rio de Janeiro (23°00' — 24°45'S e 42°30' — 44°30' W) coletadas em junho de 1977. Doze espécies foram identificadas, e as espécies *Agalma elegans, Nanomia bijuga, Abylopsis tetragona, A. eschscholtzi* e *Enneagonum hyalinum* foram observadas pela primeira vez nessa região. Foi possível identificar uma comunidade nerítica de *Mugiaea kochi* e uma comunidade oceânica de *Diphyes bojani.*

Abstract. The spatial distribution of siphonophores was observed at 35 stations off Rio de Janeiro (23°00' — 24°45'S and 42°30' — 44°30'W) in June 1977. Twelve species were identified, and the species *Agalma elegans, Nanomia bijuga, Abylopsis tetragona, A. eschscholtzi* and *Enneagonum hyalinum* were observed for the first time in that region. It was possible to identify a neritic community of *Muggiaea kochi* and an oceanic community of *Diphyes bojani.* **Key words:** Cnidaria; zooplankton; indicator; community; Siphonophora.

Siphonophores are carnivorous organisms belonging to the higher trophic levels, and represent an important fish food source[1]. These organisms were successfully utilized as biological indicators of water masses[2] and occur at high densities in the Deep Scattering Layer[3].

Few planktonic studies have been carried out off the coast of Rio de Janeiro, with the exception of the upwelling studies at Cabo Frio (23°00' — 23°30'S and 42°00' — 42°30'W)[4,5]. Hubold and Gurgel[6] presented preliminary results on plankton volumes and hydrographical conditions during the "Operação Rio de Janeiro I".

The only available data on Siphonophora for the Brazilian coast were published by Leloup[7], Seguin[8] and Alvarino[9].

The purpose of this work is to provide detailed information about the siphonophores spatial distribution off Rio de Janeiro coast.

Materials and methods

In June 1977, 51 stations were sampled during the "Operação Rio de Janeiro I", between Ponta Negra and Ponta de Juatinga (23°00' — 24°45'S and 42°30' — 44°30'W) (figure 1). At 35 stations the siphonophore species were sampled by oblique hauls using a 250 μm mesh conical zooplankton net of 260 cm length and 80 cm opening diameter, which was equipped with a calibrated flowmeter, a maximum depth recorder, and a hydrodynamic depressor of 16 kg. The net reached 100 m depth at the deeper stations and was retrieved from 5 m of the bottom in the shallower water. The haul speed had a constant velocity of 1 m/s, and the inclination angle was maintained between 65° and 70°.

After sampling, the material was preserved with 4% formaldehyde, buffered with borax. In the laboratory, subsamples were taken according to the method proposed by Russel and Colman[10]. The identification of organisms was based upon Totton[11] and Alvarino[1].

The planktonic biomass was evaluated by the displacement of water volume according to Beers[12].

The abundance of organisms was related to the occurence and middle dominance of species according to the criteria proposed by Palma[13], as following:

Occurrence (number of stations where the sp *a* occurred/total number of stations) × 100:
0.0 — 25.0% = accidental species
25.0 — 50.0% = accessory species
50.0 — 100.0% = constant species

Middle dominance (number of organisms of sp *a*/ total number of organisms) × 100:
0.0 — 2.5% = accidental species
2.5 — 5.0% = accessory species
5.0 — 100% = dominant species

These two classifications were grouped into:
Common species — constant and dominant
Intermediate species — constant and accessory
constant and accidental
accessory and accidental
Rare species — accidental and accidental

Communities were distinguished by the Sander's affinity index[14], and the diversity of the organisms was quantified by the Shanon-Weaver's diversity index[15].

Hydrographical conditions during the sampling period were described according to Hubold and Gurgel[6], who delineated coastal water (salinity < 35.4 ‰ and temperature > 23.4 °C), shelf water (35.4 < salinity > 36.0 ‰; temperature from 23.1 to 23.4 °C) and tropical water (Brazil current) (salinity > 36.0 ‰; temperature > 23.4 °C), as shown in figures 2 and 3.

Results

Of twelve species identified (table 1), two were physonects (*A. elegans and N. bijuga*) and the remainder calycophorans.

The species *Agalma elegans, Nanomia bijuga,*

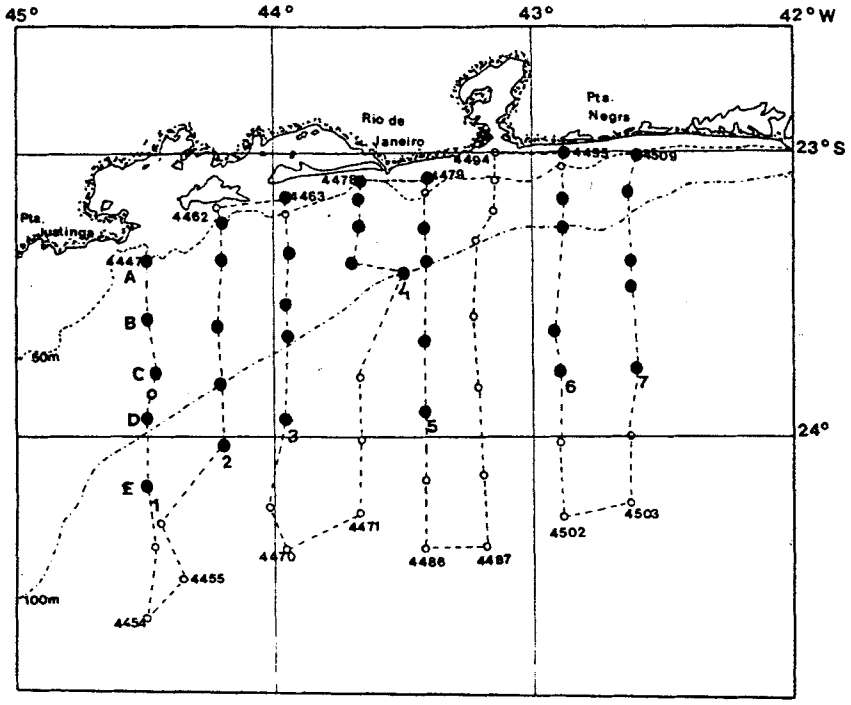

Figure 1
Stations of "Op. Rio de Janeiro I". The Siphonophora group were studied in the signed stations [•]. The letters A — E and the numbers 1 — 7 indicate the studied environmental matrix.

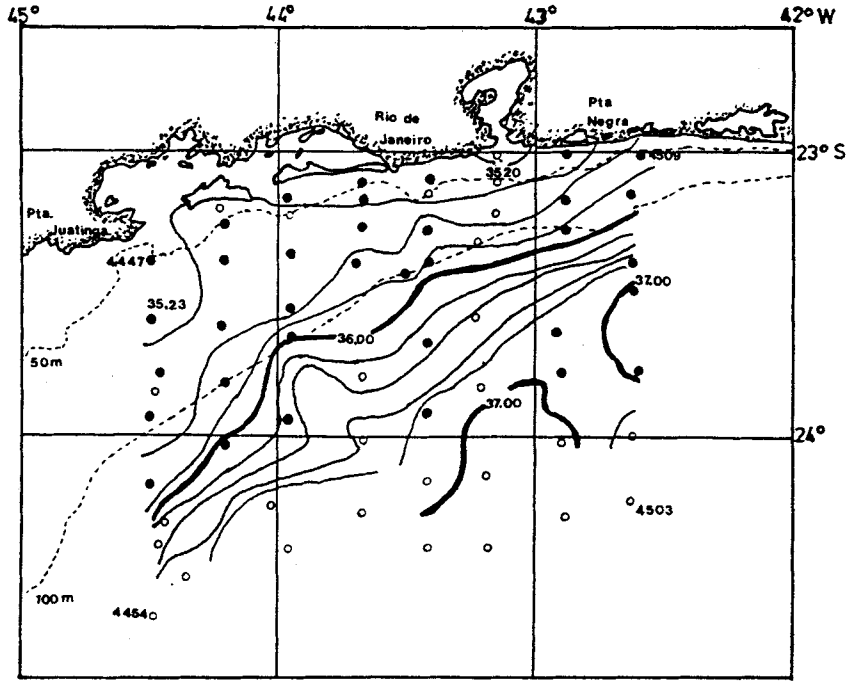

Figure 2
Salinity distribution at 10 m depth (adapted from Hubold and Gurgel[7]).

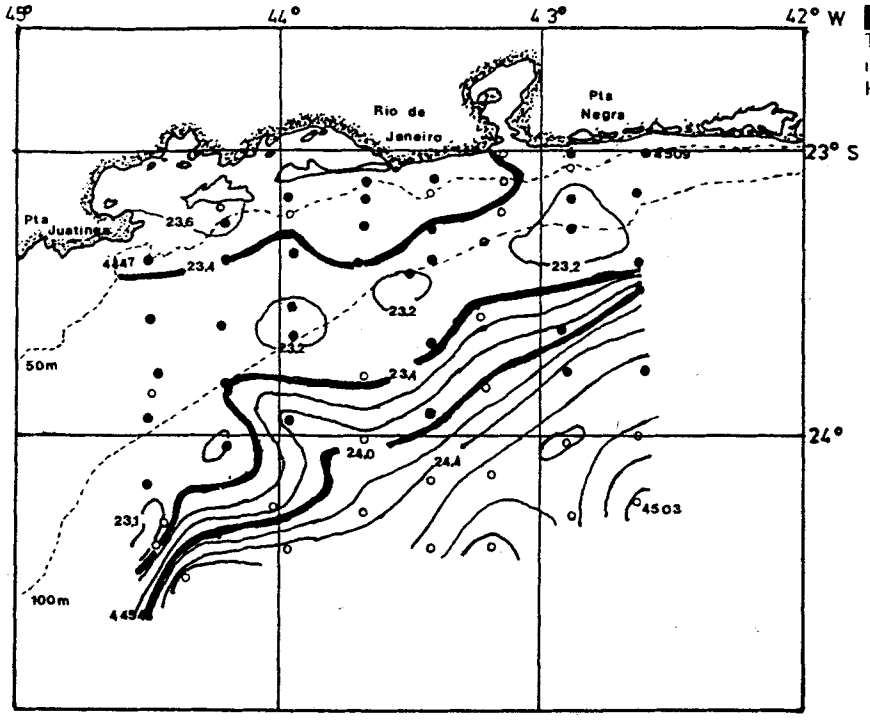

Figure 3
Temperature distribution at 10 m depth (adapted from Hubold and Gurgel[7]).

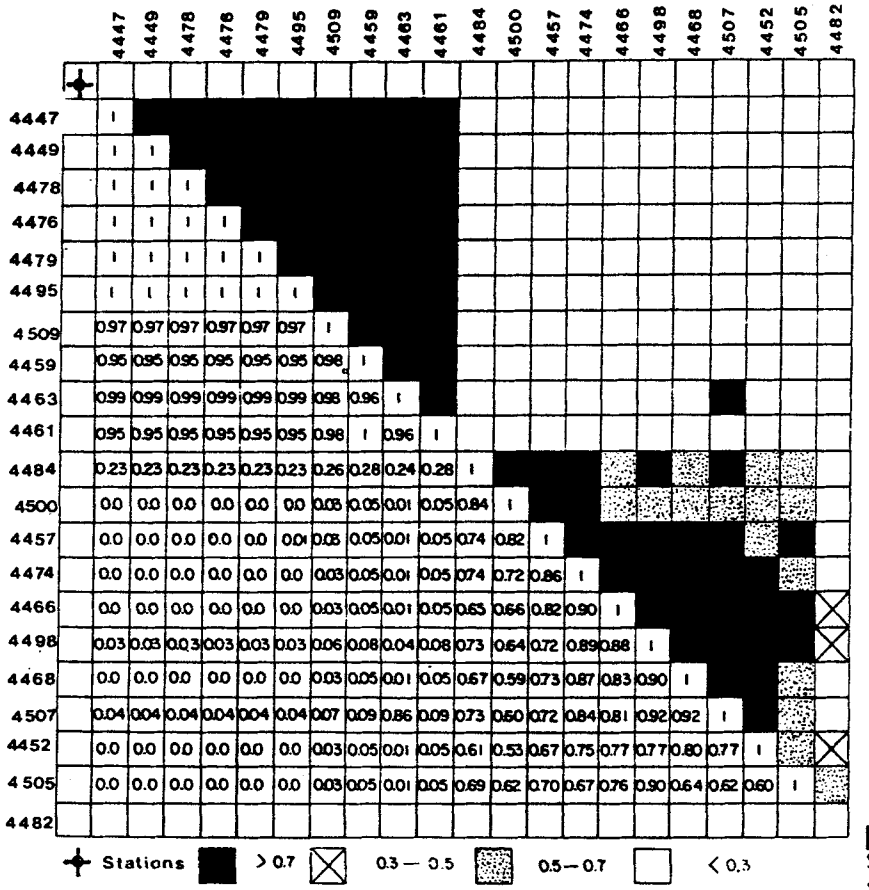

Figure 4
Sander's index diagram for 21 stations.

Table 1 Siphonophora species, occurrence and dominance.

Species	*Occurrence (%)*	*Palma's classif.*	*Middl. dominance (%)*	*Palma's classif.*	*General classif.*	*Community*
Muggiaea kochi	66.00	Constant	69.00	Dominant	Common	***Neritic/Oceanic
Diphyes bojani	74.00	Constant	24.00	Dominant	Common	**Oceanic/Neritic
Bassia bassensis	51.00	Constant	3.39	Accessory	Intermediate	**Oceanic/Neritic
**Abylopsis eschecholtzi*	37.00	Accessory	1.28	Accidental	Intermediate	Oceanic
**A. tetragona*	29.00	Accessory	1.00	Accidental	Intermediate	Oceanic
Eudoxoides spiralis	22.90	Accidental	1.06	Accidental	Rare	**Oceanic/Neritic
**Enneagonum hyalinum*	20.00	Accidental	0.22	Accidental	Rare	Oceanic
**Agalma elegans*	8.57	Accidental	0.14	Accidental	Rare	Oceanic
Chelophyes eppendiculata	8.57	Accidental	0.08	Accidental	Rare	Oceanic
**Nanomia bijuga*	2.86	Accidental	0.02	Accidental	Rare	Oceanic
Diphyes dispar	2.86	Accidental	0.008	Accidental	Rare	Oceanic
Sulculeolaria chuni	2.86	Accidental	0.004	Accidental	Rare	Oceanic

* Species registered for the first time in this region.
** Occurred in low density and frequency in the Neritic Community.
***Occurred in low density and frequency in the Oceanic Community.

Table 2 Environmental matrix, planktonic biomass, Shanon-Weaver diversity index, and Siphonophores density.

Environmental matrix (stations)

	1	*2*	*3*	*4*	*5*	*6*	*7*
A	4447	4461	4463	4478	4479	4495	4509
B	4448	4460	4465	4477	4481	4497	4508
C	4449	4459	4466	4476	4482	4498	4507
D	4451	4458	4467	4475	4483	4499	4506
E	4452	4457	4468	4474	4484	4500	4505

Shanon-Weaver diversity index for Siphonophora species

	1	*2*	*3*	*4*	*5*	*6*	*7*
A	0.0	0.02	0.01	0.0	0.0	0.0	0.02
B	0.03	0.0	0.0	0.01	0.0	0.10	0.07
C	0.0	0.02	0.10	0.0	0.13	0.08	0.07
D	0.0	0.20	0.07	0.07	0.10	0.22	0.05
E	0.07	0.13	0.04	0.11	0.15	0.19	0.11

Planktonic biomass (mg/m^3)

	1	*2*	*3*	*4*	*5*	*6*	*7*
A	330	130	290	340	150	250	340
B	70	180	70	230	80	120	90
C	80	120	210	160	160	110	90
D	140	30	20	100	190	80	60
E	80	70	90	130	90	50	30

Density of siphonophores per station (org/m^3)

	1	*2*	*3*	*4*	*5*	*6*	*7*
A	4.67	39.20	21.70	1.31	0.12	5.95	3.92
B	14.75	31.77	15.18	2.46	4.32	0.99	2.43
C	7.78	3.53	6.31	0.11	0.25	1.12	7.07
D	0.60	0.58	8.07	2.48	0.45	11.19	3.43
E	0.53	2.46	1.78	0.57	8.71	2.77	13.79

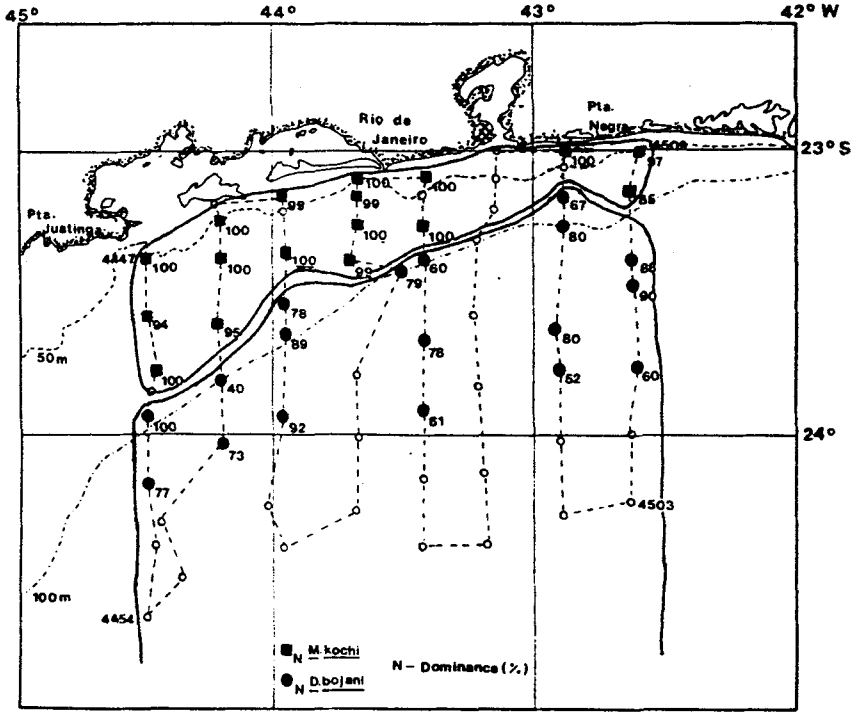

Figure 5 Neritic and Oceanic communities. In each station are registered the dominant species and the percentage of dominance.

Abylopsis tetragona, *A. eschscholtzi* and *Enneagonum hyalinum* were registered for the first time in this region.

The Sander's index diagram for 21 stations showed two distinct communities (figure 4). This information was transferred to the map of the region (figure 5) demonstrating the spatial distribution of these different communities, and the dominant species at each station. Since the common species *M. kochi* and *D. bojani* had the same distribution as the identified communities and were the dominant organisms (figure 5), we suggest the denomination Neritic Community of *Muggiaea kochi* and Oceanic Community of *Diphyes bojani* (table 1).

In table 2 we present the studied environmental matrix, with the plankton biomass, Shanon-Weaver diversity index and Siphonophora density values.

Discussion

Many factors like temperature and salinity [1,16,17,18], the presence of a thermocline [3,19,20,21], and the trophic conditions of the water masses [18,19,22] may determine the distribution of Siphonophora, but Fager and McGowan [23] showed that the usually abiotic factors are not sufficient to explain the distribution of these organisms.

A comparison of figures 2, 3 and 5 shows that the two characterized communities follow the limiting isopycnals of these coastal shelf and tropical waters, suggesting that the communities could be related to the physical-chemical characteristics of these water masses. On the other hand, the Neritic community is located in the region of maximum planktonic biomass, showing highest densities and lowest diversity of siphonophores (table 2); in contrast the oceanic stations showed high species diversity, but low planktonic biomass and siphonophore abundance (table 2).

Seguin [8] showed a major incidence of species (high diversity) with warmer waters, like the Brazil current. In fact, biomass and diversity of siphonophores can be directly related to the stability and trophic conditions of the water masses [16,19,22,24]. Since the coastal waters are more unstable and productive than oceanic waters due to continental drainage and turbulence caused by winds and coastal currents, the distribution of the two observed communities could also be related to these factors.

Although the results suggest a strong interaction between Siphonophora species and the coastal shelf and tropical water, more detailed ecological studies are necessary to discriminate which biotic or abiotic factors are limiting the distribution of these organisms off Rio de Janeiro coast. □

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