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SHELF OFF ALAGOAS AND SERGIPE (NORTHEASTERN BRAZIL)
3. DIATOMS FROM THE SÃO FRANCISCO RIVER MOUTH.

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SUMÁRIO

O presente estudo está baseado em amostras qualitativas de plancton coletadas pelo navio pesqueiro Akaroa, durante o mês de dezembro de 1965, nas circunvizinhanças da desembocadura do rio São Francisco. Em tais amostras foi estudada a composição da flora das diatomáceas, assim como a distribuição das espécies em 9 estações pesquisadas.

A flora diatomológica revelou-se extremamente rica em especimens do gênero *Rhizosolenia*, cuja percentagem relativa atingiu 83% do número total das diatomáceas.

As 46 espécies identificadas são tôdas típicas de águas quentes, sendo que 32 são consideradas neríticas e 14 oceânicas.

Pela freqüência e abundância destacaram-se *Rhizosolenia calcar-avis, Rhiz. hebetata* f. *semispina, Rhiz. imbricata* var. *shrubsolei* e *Rhiz.styliformis*. Apenas pela freqüência *Chaetoceros coarctatus, Chaet. diversos* e *Nitzschia closterium*.

A influência do rio se fêz sentir mais acentuadamente sôbre *Rhiz. imbricata* var. *shrubsolei*.

INTRODUCTION

The present study belongs to a research programm supported by SUDENE wiht the purpose to localize fishing areas, between the latitudes 8°56' and 11°20'S. This programm has been made in three trips from September to December, 1965 by the vessel Akaroa. The data concerning oceanography, submarine topography and other information have been reported by Cavalcanti & others (1967).

This paper presents data on diatoms collected during the 3rd trip in the neritic waters influenced by the São Francisco river mouth. Few studies have been made on phytoplankton

in this region. Müller-Melchers (1955) referred to two samples collected near the São Francisco mouth, without details. Paranaguá (1966) studies plankton samples collected between the lattiudes 3° to 13°S dedicating special attention to zooplankton.

In this way, the present paper will contribute to a better knowledge of the diatom flora of northeastern Brazil, with the same purpose other studies are being prepared with samples collected in latitude between 2°and 12°S.

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MATERIAL AND METHOD

The plankton samples were collected by horizontal hauls with a qualitative net, 2m long and 1/2m diameter (mesh XX 13). The stations in a number of nine are show in Fig. 1.

The proportional percentages of the species were determined in sub-samples (usually 1/200 cc). Based on the principal characteristic of each identified genera a key is presented. For the systematic part were used the works of Cupp (1943), van Heurck (1896) and Schimidt (1885-1959).

SYSTEMATIC PART

In the following generic key mentioning to the species identified into each genera is made as well as some ecological references for these.

1.... Cells cylindrical, discoidal or polygonal, radial or concentrical symmetry, without raphe or pseudoraphe 2
..... Cells not cylindrical ,bilateral symmetry, usually with raphe or pseudoraphe 16
2.... Celles isolated or united in pairs 3
..... Cells united into chains 5
3.... Cell wall strongly silicious, valves with four eyes or knobs on the short elevations ..... EUPODISCUS

Eupodiscus antiquus. Neritic, marine species.

..... Cell wall weakly silicious, valves without knobs or eyes or one eye only 4
4.... Valves asymmetric, semi-lunar, generally united in pairs, sculpture arranged in relation to a central point ..... HEMIDISCUS

Hemidiscus hardmanianus. Oceanic, warm water species.

..... Cells prismatic, valves triangular with a central long spine ..... DITYLUM

Ditylum brightwelli. Neritic, South temperate species.

5.... Cells united by spines or setae 6
..... Cells united in other ways 8
6.... Valves with two long marginal setae, cells united by this setae ..... CHAETOCEROS

Chaetoceros affinis. Neritic, temperate species.
Chaetoceros coarctatus. Oceanic, tropical or subtropical species
Chaetoceros diversus. Neritic, tropical or subtropical species.
Chaetoceros mitra. Neritic.
Chaetoceros peruvianus. Oceanic, temperate to warm seas.
Chaetoceros tetrastichon. Oceanic, tropical and south temperate species.

..... Cells united by numerous spines or setae 7
7.... Cells short or elongated-cylindrical without visible structure, spines right, chain long .... SKELETONEMA

Skeletonema costatum. Neritic, cosmopolitan.

..... Valves circular, with radial setae .... BACTERIASTRUM

Bacteriastrum delicatulum. Oceanic, temperate species.
Bacteriastrum hyalinum. Neritic, temperate species.

8.... Cells united in chains by their valves 9
..... Cells united in other ways 10
9.... Cells short or cylindrical united by the center of the valves ..... MELOSIRA

Melosira granulata. Neritic, fresh water species.

..... Valves flat. Cells elongated with intercalary bands very delicate ..... LEPTOCILINDRUS

Leptocilindrus danicus, Neritic. temperate species.

10... Cells united by marginal horn 11
..... Cells united by other structures 15
11... Cell wall weakly silicious 12
..... Cell wall strongly silicious 14
12... Marginal horns with spines or claws, chains not very long 13
..... Marginal horns without spines or claws, long and twisted chains ..... CLIMACODIUM

Climacodium frauenfeldianum. Oceanic, tropical or subtropical species.

13... Curved or twisted colonies, marginal processes long or sometines short whit end tapered as claw ..... HEMIAULUS

Hemiaulus indicus. Neritic, warm water species.
Hemiaulus membranaceus. Oceanic, tropical species.
Hemiaulus sinensis. Neritic, warm water species.

..... Twisted chains, marginal processes with a short spine attaching the adjacent cells .... CERATAULINA

Cerataulina bergonii. Neritic, tropical or subtropical species.

14... Short and strong processes, when long ending in claws, frequently two spines on valve face .... BIDDULPHIA

Biddulphia aurita. Neritic, cosmopolitam.
Biddulphia titiana. Neritic, tropical or subtropical species.

..... Generally short horn, triangular and quadrangular valves, per-valver axe sometimes long .... TRICERATIUM

Triceratium contortum. Neritic, marine species.

15... Cells trapezoid united by a valve point, cell wall strongly silicious, zig-zag chains ..... ISTMIA

Istmia enervis. Neritic, epiphytic species.

..... Cylindrical cells, long per-valver axe, cells united by a exentrical horn or spine. Numerous intercalary bands ..... RHIZOSOLENIA

Rhizosolenia alata. Oceanic, temperate and warm waters species.
Rhizosolenia alata f. *indica*. Oceanic, warm waters species.
Rhizosolenia calcar-avis. Oceanic, warm waters species.
Rhizosolenia alata f. *indica*. Oceanic, warm waters species.
Rhizosolenia hebetata f. *semispina*. Oceanic, warm waters species.
Rhizosolenia imbricata. Oceanic, warm water species.
Rhizosolenia imbricata var. *shrubsolei*. Oceanic, warm water species.
Rhizosolenia setigera. Neritic, temperate species .
Rhizosolenia stholterfothii. Neritic, cosmopolitan.

16... Cells without raphe 20
..... Cells with raphe or pseudoraphe 17
17... Cells with septae united in zig-zag or band colonies 18
..... Cells without septae, linear, with base enlarged. Jointed at base to form star-like or spiral-like colonies ..... ASTERIONELLA

Asterionella japonica. Neritic, temperate species.
Asterionella notata. Neritic, marine species.

18... Septae undulating, few intercalary bands, colonies in zig-zag ..... GRAMMATOPHORA

Grammatophora marina. Neritic, cosmopolitan.

..... Septae not undulating, band-like colonies 19
19... Numerous intercalary bands with short septae. Valve structure delicate ..... STRIATELLA

Striatella unipunctata. Neritic, temperate species.

..... Numerous intercalary bands, strongly punctated, with numerous septae ..... RHABDONEMA

Rhabdonema adriaticum. Neritic, warm waters species, cosmopolitan.

20... Raphe in one valve only ..... COCCONEIS

Cocconeis scutellum. Marine, cosmopolitan.

..... Raphe present in both valves 21

21... Cell with a distinct, excentric keel in each valves. .. .. NITZSCHIA

..... Raphe without keel 22
22... Cells symmetrical with a central raphe. Valve structure well visible ..... MASTOGLOIA

Mastogloia fimbriata. Neritic, epiphytic.

..... Raphe and apical axe sigmoid ..... PLEUROSIGMA

Pleurosigma naviculaceum. Neritic, cosmopolitan.

QUALITATIVES REMARKS

Table I shows the systematic results of samples with a proportionale percentage for the 46 identified species. The examination of this table reveals the numeric importance of the genus *Rhizosolenia* whose proporcional percentage was very high. *Rhizosolenia* species dominated in all samples, reaching an average of 83% for the total number of diatoms. The higher *Rhizosolenia* percentages occurred at Sts. 160 and 187 with 94.2% and 94.1%, respectively (Fig. 2).

The *Rhizosolenia* species found are oceanic exepted *Rhiz. stholterfothii* and *Rhiz. setigera* (Curl, 1959). The cause of the large population of *Rhiz.* in neritic waters is difficult to explain. However, according to Smayda (1958) many species which usually inhabit oceanic regions can periodically become an active element in an inshore community searching for favorable conditions.

Because of this and considering that Müller-Melchers (1955) did not mention any of these species cited here, one can suppose that the *Rhiz* oceanic populations are ephemeral concentrations which dissappear when environmental conditions become unfavorable.

Fig. 3 shows the distribution of the principal *Rhizosolenia* species. In a general way this genus was represented by two groups of species.

a) species not dominating in any station, such as: *Rhiz. alata, Rhiz. alata* f. *indica, Rhiz. castracanei* and *Rhiz setigera;*

b) frequent and very abundant species in some stations such as:

Rhiz.calcar-avis — more abundant species off the shore stations reaching 40% of the total diatoms in St. 180.

Rhiz. hebetata f. *semispina* — common in all stations with more elevated percentages at higher salinities;

Rhiz. imbricata var. *shrubsolei* — common species in stations with river influence. In summer it can be well developed near the coast (Frenguelli, 1928). Eskinazi (1967) found this species in low salinity waters in Barra das Jangadas estuary (PE);

Rhiz. stholterfothii — found in all stations, always in a small quantity;

Rhiz. styliformis — common in all stations with the exception St. 187, where showing a great decrease.

Besides the genus *Rhiz.* some others were presented standing out *Chaetoceros* and *Nitzschia* (see Fig. 2).

Nine species were identified among the genus *Chaetoceros* being frequently *Chaet. coarctatus* and *Chaet. diversus* only.

With regard to genus *Nitzschia,* only *Nitzschia closterium* is important with a rather high relative percentage in St. 174 (see Fig. 2). No other species was found besides this one.

The species as a whole are marine excepted *Melosira granulata* which is a fresh water species (Moreira Filho; Maruo & Moreira, 1967). Among the marine species 31 are reported as neritic and 14 are reported as oceanic. Otherwise all are typical of warm tropical waters characterizing the region of collection.

RIVER INFLUENCE ON SPECIES DISTRIBUTIONS

The river influence was not properly considered since there were not sufficient data about it. However according to the salinity distribution and the river current some considerations can be given.

Generally, the coastal waters S of the river mouth were less saline than those N of it (Cavalcanti & others, 1967, Fig. 7). Thus the river had an important inflence on the stations south of the mouth where the salinity decreased until 23 °/oo. The station north of the mouth presented salinities higher than 35 °/oo.

From this fact and in comparison with fig. 3, it can be said that certain species shown preferences with regard to localization of the stations.

Rhizosolenia imbricata var. *shrubsolei* was most characteristic of these species dominating in all stations S of the river (162, 164, 174) and decreasing in frequency at the stations N of mouth (see Fig. 3). This shows the preference of this species for less saline waters.

Otherwise, *Rhizosolenia calcar-avis* and *Rhizosolenia hebetata* f. *semispina* show higher percentages in the stations located N of the mouth (160 ,170, 180, 172, 187)being therefore more saline. The distribution of these species was made independently. Although both dominate in stations free of river influence, one dominates in stations where the other decreases (see Fig. 3).

As for the identified species relations about the river influence were not observed.

CONCLUSIONS

The diatom flora of the São Francisco river mouth vicinity, during December 1965, appears to be extremely rich in *Rhizosolenia*. Although it was represented by 10 species only, it presented elevated concentrations, reaching up to 83% of the total diatoms number.

All 46 identified species are typical of warm waters, whereas 32 are reported as neritic and 14 as oceanic. *Rhiz. calcar-avis, Rhiz. hebetata* f. *semispina, Rhiz. imbricata* var. *shrubsolei* and *Rhiz. styliformis* were more representative by frequency and abundance. By frequency only one may note *Chaet. coarctatus, Chaet. diversus* and *Nitzschia closterium*.

The river had its inflence mot strongly on *Rhiz. imbricata* var. *shrubsolei* which shows a major development in stations where this influence is highest.

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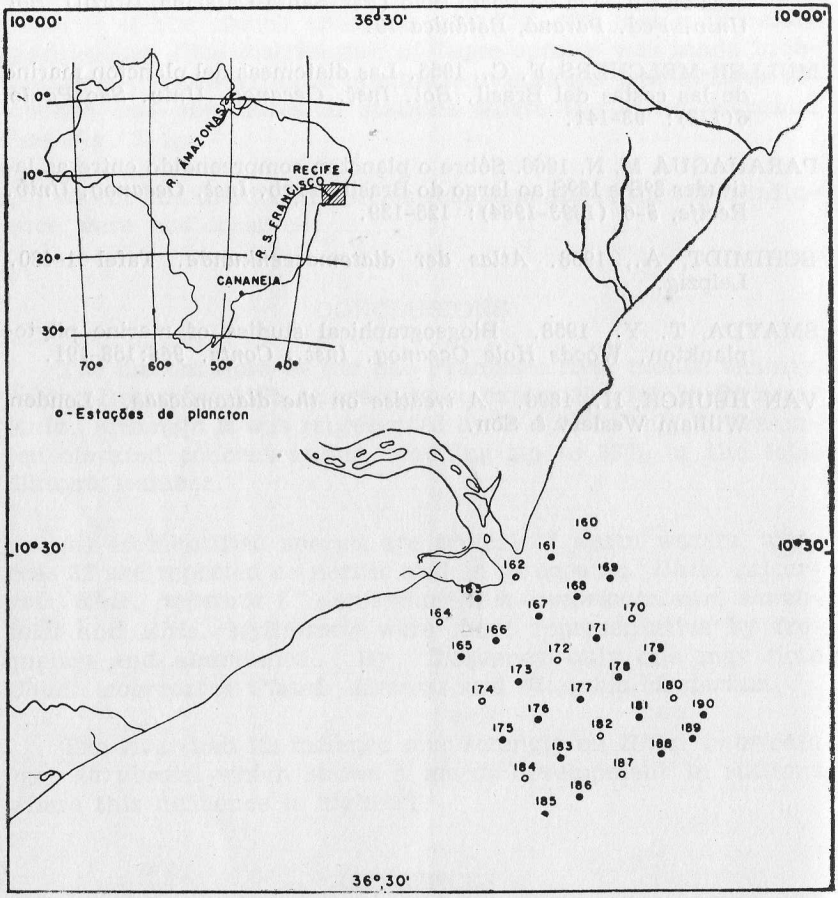

Fig. 1 — Map of the studied area with localization of stations.
Mapa da região estudada com a localização das estações.

Dia	3.12.65						4.12.65		
Hora (Hour)	6,45	8,15	9,45	13,45	15,50	17,30	7,55	10,05	16,00
Salinidade (Salinity o/oo)	36,69	26,67	32,94	36,91	36,07	35,32	36,48	33,49	34,02
Temperatura (Temperature)	26,3	27,7	24,9	27,2	27,3	26,9	26,5	27,1	27,06
Estação (Station)	160	162	164	170	172	174	180	184	187
Asterionella japonica Cleve	x	x	—	—	—	—	—	—	P
Asterionella notata Grunow	1,05	0,27	P	3,0	—	3,6	—	—	P
Bacteriastrum hyalinum Lauder	0,08	—	0,4	P	0,7	P	—	—	P
Bacteriastrum delicatulum Cleve	—	—	—	—	—	—	—	—	—
Biddulphia aurita (Lyngbye)	P	—	—	—	—	—	—	—	—
Biddulphia titiana Grunow	—	—	—	—	P	—	—	—	—
Cerataulina bergonii H. Peragallo	—	—	0,9	—	—	—	—	—	P
Chaetoceros affinis Lauder	—	—	04,	—	—	—	—	—	P
Chaetoceros brevis Schutt	—	—	—	0,5	—	—	—	—	—
Chaetoceros coarctatus Lauder	2,27	1,35	0,9	3,5	3,2	1,2	5,5	1,1	1,4
Chaetoceros didymus Ehrenberg	—	—	—	—	0,3	—	—	—	—
Chaetoceros diversus Cleve	—	0,13	0,9	0,5	1,4	0,6	—	2,2	P
Chaetoceros mitra (Bail.) Cleve	—	—	—	P	—	—	—	—	—
Chaetoceros peruvianus Brightwell	0,08	—	—	1,0	0,7	1,8	—	0,5	P
Chaetoceros rostratus Lauder	—	—	—	—	—	0,6	—	—	—
Chaetoceros tetrastichon Cleve	—	0,40	P	P	P	—	—	1,1	P
Chaetoceros sp.	—	0,94	—	5,1	1,7	1,8	—	3,9	—
Climacodium frauenfeldianum Grunow	—	—	—	—	P	P	—	—	1,4
Cocconeis scutellum Ehrenberg	—	—	—	—	—	P	P	—	—
Ditylum brightwelli (West) Grunow	—	0,13	—	—	—	—	—	—	—
Eupodiscus antiquus Cox	—	—	—	—	—	P	—	—	—
Grammatophora marina (Lyngbye)	—	—	—	P	—	P	—	—	—
Hemiaulus indicus Karsten	0,08	0,13	—	P	0,3	P	—	—	—
Hemiaulus membranaceus Cleve	P	0,13	—	1,06	0,3	P	—	—	—
Hemiaulus sinensis Greville	—	0,13	P	—	—	—	—	—	—
Hemidiscus hardmanianus Wallich	0,08	P	—	—	—	—	—	—	—
Istmia enervis Ehrenberg	0,24	0,13	P	P	P	P	1,8	P	1,4
Leptocilindrus danicus Cleve	0,16	—	1,4	P	—	—	—	—	P
Mastogloia fimbriata (Brightwell) Cleve	—	—	—	P	—	—	—	—	—
Melosira granulata (Ehrenberg) Ralfs	—	P	—	P	—	P	—	—	—
Nitzschia closterium (Ehrenberg) W. Smith	0,48	—	—	3,0	2,8	24,0	3,6	0,5	1,4
Pleurosigma naviculaceum Brebisson	—	—	—	—	—	P	—	—	—
Rhabdonema adriaticum Kutzing	P	—	0,4	P	—	—	P	—	P
Rhizosolenia alata Brightwell	0,16	—	0,4	0,5	0,3	—	0,5	0,5	P
Rhizosolenia alata f. *indica* (Peragallo) Ostenfeld	P	—	0,4	P	P	P	—	—	P
Rhizosolenia calcar-avis M. Schultz	13,0	16,3	10,0	32,1	17,5	16,0	40,0	37,9	26,7
Rhizosolenia castracanei Peragallo	—	—	—	—	P	P	—	0,5	P
Rhizosolenia hebetata f. *semispina* (Hansen)	32,5	22,7	13,0	12,7	32,2	20,0	10,9	20,9	33,8
Rhizosolenia imbricata Brightwell	—	0,13	P	—	—	P	—	—	P
Rhizosolenia imbricata var. *shrubsolei* (Cleve) Schroder	7,6	30,6	31,0	4,5	11,8	20,0	1,8	9,4	7,0
Rhizosolenia setigera Brightwell	P	0,54	2,9	0,5	—	0,6	—	—	P
Rhizosolenia stholterfothii Peragallo	0,7	4,32	1,9	1,0	0,7	1,8	P	—	P
Rhizosolenia styliformis Brightwell	40,2	17,5	22,0	28,5	24,0	7,7	21,8	20,8	26,7
Skeletonema costatum (Grev.) Cleve	—	—	0,9	—	P	P	—	—	—
Striatella unipunctata (Lyngbye) Agardh	—	—	—	0,5	P	P	—	—	P
Thalassionema nitzschoides Grunow	—	—	—	P	—	—	—	—	—
Triceratium contortum Shadbolt	—	—	—	—	P	—	—	—	—

P = Present in the samples but not in the sub-samples.

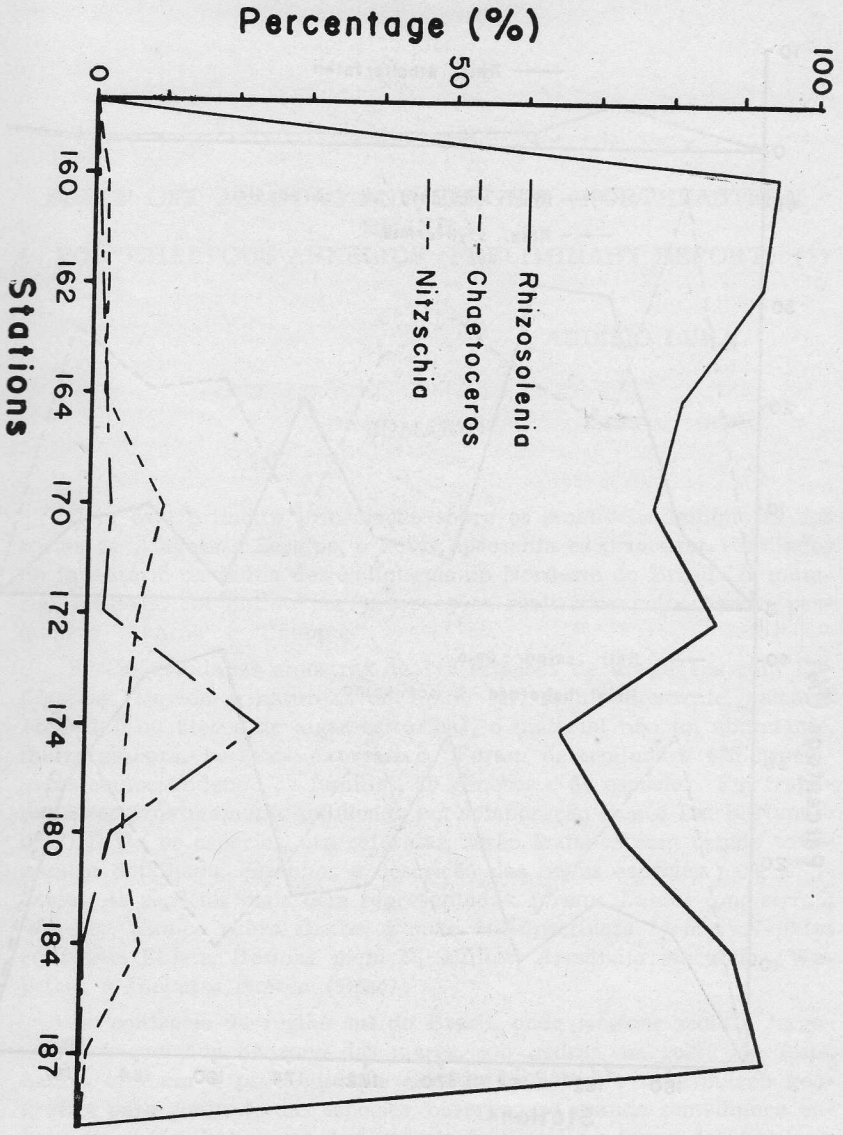

Fig. 2 — Distribution of the principal diatoms genera.
Distribuição dos principais gêneros de diatomáceas.

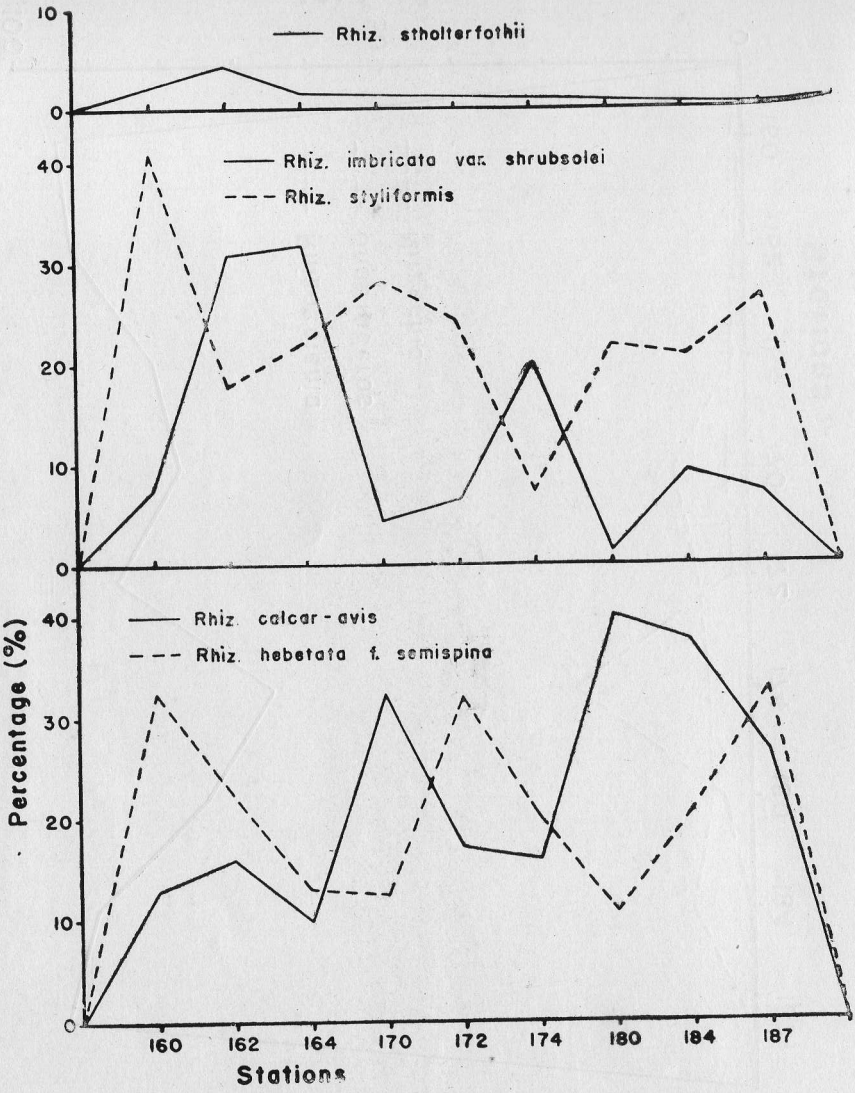

Fig. 3 — Distribution of the principal species of *Rhizosolenia*.
Distribuição das principais espécies de *Rhizosolenia*.