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FHYSIOGRAPHIC INFLUENCE IN THE STRUCTURE OF THE SUPRABENTHIC FISH ASSEMBLAGE IN THE ROCKY SHORE OF ARRAIAL DO CABO, RIO DE JANEIRO, BRAZIL*

[Influência fisiográfica na estruturação da ictiocenose suprabentica de costão rochoso em Arraial do Cabo, Rio de Janeiro, Brasil]

Marcelo VIANNA[1,2]

ABSTRACT

During Summer of 1991, the composition and distribution of the fish assemblage of rocky shore of Arraial do Cabo (RJ), Brazil was studied using the visual census by area method in five sampling stations. The stations were characterized by physiography and composition of benthic substrate to allow comparison regarding ichtyofauna. Results suggest that mainly physiographic variables affect ichtyofauna in the studied spots.

KEY WORDS: benthos, physiography, fish assemblages, community structure, visual census, Arraial do Cabo: RJ, Brazil

RESUMO

Durante o verão de 1991, a ictiocenose de costão rochoso de Arraial do Cabo (RJ) Brasil, foi estudada pelo método de censo visual por área, quanto a sua composição e distribuição em cinco estações de coleta. As estações foram caracterizadas quanto a fisiografia e composição do substrato bêntico de modo a relacioná-las com a ictiofauna. Os resultados indicam que nos locais estudados, a ictiofauna é influenciada principalmente pelas variáveis fisiográficas.

PALAVRAS-CHAVE: bentos, fisiografia, ictiocenose, estrutura de comunidade, censo visual, Arraial do Cabo: RJ, Brasil

1. INTRODUCTION

Knowledge of interactions between the ichtyofauna and the environment is fundamental for the management of coastal resources. This basic goal has been used to maintain the functional integrity of these ecosystems (BERWICK & FAET, 1988).

In a worldwide scale, the amount of studies on fish associated with rocky and reef coastal areas has increased since 1960 (SANO; SHIMIZU; NOSE, 1984). In Brazil, however, there are only scattered papers on the subject in spite of the cost an extension and hight icthyofaunal diversity. These environments are so poorly studied, that even the ichtyofaunal composition and zoogeographic boundaries are indistinct. (VIANNA & BOCKMANN, 1995). This lack of knowledge, along with the worldwide increase of coastal degradation by anthropic action (BERWICK & FAET, 1988) points to the need of ecological research on the subject.

Composition and abundance of fish assemblages are determined by a set of varied factors. The biotic factors that influence that structure include: territorialism (LOWE-McCONNELL, 1987), interspecific associations (SALE, 1988) and predation (HIXON & BEETS, 1993). Abiotic factors include physical and geographical features that may be altered by man.

According to STEPHENS; HOSE; DOVE (1988), anthropic changes in the environment have usually local effect on the population of fish species inhabiting the area, and may reflect in changes like migration or favoring of only some species.

Much has been written about differences between ichtyocoenoses as being caused by alterations in the water quality (e. g. SAMOILYS, 1988). These disturbances in water quality, however, may not directly affect the fish, but cause environmental changes such as killing of the prey or altering the benthos.

Other authors explain differences between neighbor ichthyofaunas by physiographic factors and variation in the composition of substrate. These factors are really closely associated, as in the view of GOMEZ; LICUANAN; HILOMEN (1988), who stated that both fish and benthos are related to the degree of embayment of the coast and exposure to waves. SANO; SHIMIZU; NOSE (1984) concluded that the ichthyofaunal diversity is generally higher in living coral colonies than in dead ones due to the decrease of structural complexity, which reduces the sheltering for resident species. BELL & GALZIN (1988) indicated that distribution and abundance of fish in an atoll are affected by the distance of the entrance channel and cover and diversity of living coral, suggesting that abundance of

* Artigo Científico - aprovado para publicação em 25/03/97
(1) Pesquisador Científico - Base de Ubatuba - Divisão de Pesca Marítima - Instituto de Pesca - CPA/SAA
(2) Endereço/Address: Estrada Cais do Porto, 2275 - C. Postal 28 - CEP 11680-000 - Ubatuba - São Paulo - Brasil

corals and number of microhabitats decrease towards the inner part of the atoll. DENNIS & BRIGHT (1988), by the comparison of the area of a wrecked ship with neighbor areas, concluded that the damage in the bottom reduced the fringes, resulting in lower values for the indexes of community structure for the fish. In a study on fishes in the Philippines, HILOMEN & GOMEZ (1988) observed the existence of three groups according to the degree of embayment: species from sheltered, semi-exposed and exposed areas, concluding that ichthyofaunal structure results from physical factors like wave beat. In a paper aiming to characterize bioindicators, ROBERTS; ORMOND; SHEPHERD (1988) observed that the abundance of corallivorous fishes is proportional to the cover of hard corals. OHMAN et alii (1993) connect the meagerness of ichthyofauna in reefs of Sri Lanka to damage caused to the substract by predation.

There are basically two methods for estimating fish populations in transparent waters: destructive and non-destructive. The former involves use of fishing devices, some of which may have drastic effects in the subject population, while the latter estimates the population by visual quantification from under water and are most widely used (BROCK, 1982 and BELLWOOD & ALCALA, 1988).

The technique of visual estimate in the field for studies in population ecology has long since been employed by botanists and ornithologists (JONES & THOMPSON, 1978). BROCK (1954) first used it for fish as an inexpensive and efficient method that causes little harm to the environment. Since then, the visual census has been exhaustively employed and improved by many researchers all over the world. In Brazil, this is the first paper to use this methodological approach regarding fish assemblages.

Aiming to know which environmental factors act structurize of the ichthyofauna of the rocky shore, I have chosen the coast of Arraial do Cabo, due to its peculiar features (VIANNA, 1992). The fish herein studied are considered as suprabenthic due to their close relationship with the bottom (JONES & THOMPSON, 1978). VIANNA & PARANHOS (1994) stated that water quality did not vary among stations either spatially or temporally regarding the nine hydrographic variables that were monitored during this research. For that reason, physiographic variables and composition of the benthos in the area studied were highlighted, aiming to correlate them to the ichthyofauna.

Description of the area studied

Arraial do Cabo (23°S 42°W), southeastern Brazil, northern of Rio de Janeiro (FIGURE 1). The area is a marine plain, the climate is quite dry, having one of the lowest pluviometric indexes recorded for the state (FEEMA, 1988). The city shows remarkable importance for tourism and fisheries, besides peculiar scientific interest. LABOREL (1987) stated that the bay of Arraial do Cabo is a "coralline oasis" in the southeastern Brazilian coast, due to the richness of tropical species. Owing to the coastal resurgence, the area contains a large number of marine organisms and marks the southern limit for many tropical species of the Western Atlantic (VIANNA & BOCKMANN, 1995).

Description and location of the collecting stations

The collecting stations were composed by two groups - the inner (Portos, Anjos and Forno), located between the island of Cabo Frio and the continent, within the cove of Arraial do Cabo, and the outer (Alcalis and Prainha), more to the north, in the Saco da Prainha (FIGURE 1).

PORTO. Located in the North of the Enseada dos Anjos, this station is an artificial rocky shore built as a breakwater for the harbor of Forno. It is 10 meters deep and formed by superposed stones of varied sizes. It is about 500 m from the beach.

ANJOS. Located in the South of the Enseada dos Anjos, this station is about 400 m from the beach, and has average depth of five meters.

FORNO. Shore with maximal depth of six meters, it is about 300 m of the beach of Forno, in the South of the Enseada do Forno.

ALCALIS. Northern shore of the Saco da Prainha, beyond Ponta do Sururu. It is located between the present gutter exit of the Cia Nac. de Álcalis and the former station, and it is eigth meters deep.

PRAINHA. Southern shore of the Saco da Prainha, about 500 m from the beach. Almost half of the station is formed by a single, very steep rock. Average depth five meters.

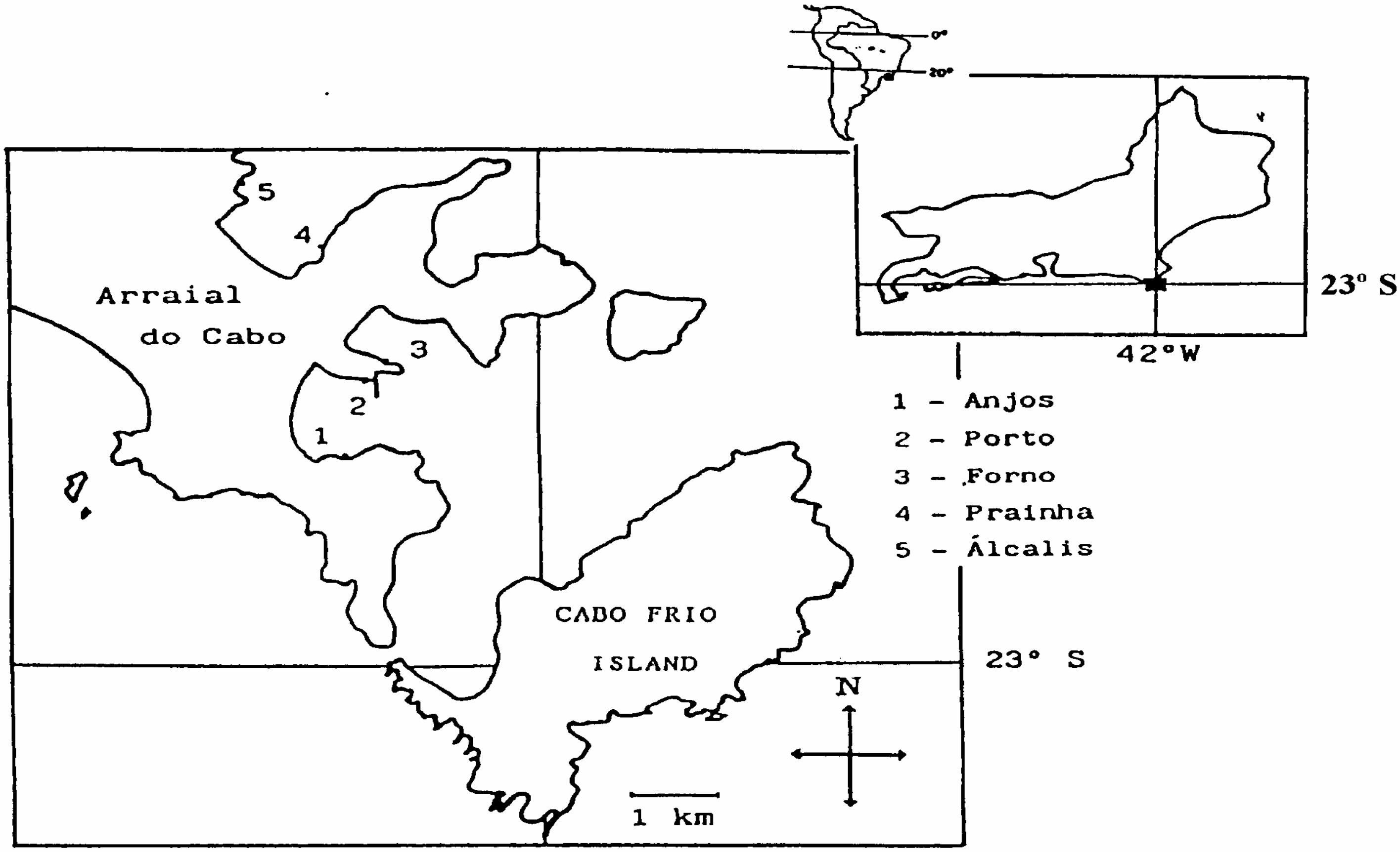

FIGURE 1 - Map of studied area, showing collecting stations in Arraial do Cabo, RJ, Brazil

2. MATERIAL AND METHODS

The main target of data gathering was to characterize the stations and the fish assemblage. This way, physiographic, benthic cover, and ichthyofaunal variables have been recored.

To characterize the stations regarding physiography the following features were studied - wave beat, embayment and average depth in the studied station. These variables were estimated and compared among stations, being weighted in increasing order. The scored values result from records along the work and geographical position.

The characterization of the benthic cover of the stations was obtained through line transect (LOYA, 1978), between August and September of 1991. In each station a tapeline marked in centimeters was stretched in a line 75 m long, taking as origin an indicative landmark. The substract has been quantified at three and five meters deep at 0.0 m tide. At each depth the cover of the varied kinds of substract was measured, and the frequency by station was calculated. In this way, the submarine landscape has been characterized, considering only the dominant components with horizontal distribution, like colonial organisms and types of sediment, which represent the main microhabitats.

Data of abundance and records of fish species came from the technique of visual census by area, based on the results by FOWLER (1987). A transect 75 m long with working area of 1 m each side has been censused, resulting in 150 m^2 of censused area in each station/collecting.

Each station possesses a landmark identical to that of benthic cover, showing the starting point of the transect cable, from which a cable 75 meters long was stretched and fastened to the bottom. The depth of the transect varied in all stations between three and six meters, and was restricted, whenever possible, to the hard bottom. The first census was done 30 minutes after the end of the cable fastening. The author, with scuba diving equipment, swam slowly over the cable one meter over the bottom, scoring all identifiable species in the sample area. When the first census was through, the author kept away from the cable for 15 minutes before starting the second survey. This process was repeated for the third census. The species was recorded if it occurred in any of the three surveys.

Reliance about identification of recorded fishes was improved by decreasing the number of sampled taxa, so that only species easily distinguishable from the others or species complexes were included. Only species easily distinguishable and very different from each other (VIANNA, 1992) were included in the survey. Taxa with inconspicuous species or highly homogeneous have been seen, but have not been recorded. The starting of the surveys was limited always to between 10:30 and 14:30 to avoid having circadian rhythm of the species influencing the results. Voucher specimens were collected, identified and later deposited in the collection of the Museu Nacional/UFRJ.

The surveys, totaling seven, were made during Summer in January (7-11 and 26-30); February (18-20); March (11-13); April (8-10 and 22-24) and May (15-23) of 1991. It was not possible to keep more regular intervals due to variations of sea conditions such as heavy seas and high turbidity which prevent the use of this method.

The degree of similarity among stations regarding the studied variables was obtained using the coefficient of Czekanowsky and afterwards clustering analysis (UPGMA), following LUDWIG & REYNOLDS (1988).

For the calculation of similarity among stations regarding physiographic variables, the method has been applied to the estimated weights to each variable per station.

Benthic cover has been analyzed including the two different depths sampled, where the same bottom type has been considered different at each depth, working this way as another variable for the analyses. The diversity indexes used were: Richness (Margalef), Diversity (Shannon) and Equitability (Pielou), as described in LUDWIG & REYNOLDS (1988), based on percentage of cover.

Constancy of fish occurrence was scored following DAJOZ (1972), falling in three categories - constant, above 50%; accessory between 25-50% and accidental, less than 25%.

The species deficit described by SCHAFER (1985) has been used to evaluate decrease in number of fish species in the stations compared to a control area - in this case I used Arraial do Cabo, that is, the total of species registered in the stations during the research.

To evaluate the degree of similarity of the ichthyofauna among stations, the values of frequency of occurrence, were used excluding the rare species, i. e., those which were not frequent in any station.

3. RESULTS

3.1. Physiographic characterization of the stations

In the characterization of stations regarding physiography (TABLE 1), it should be noted that Alcalis showed heavy wave beat, while at Porto, the beat was almost null. The degree of embayment is influenced by the island of Cabo Frio (FIGURE 1), which divides stations in embayed (the stations at Enseada dos Anjos), not-embayed (stations at the Saco da Prainha) and intermediate (Forno). The largest depths at rocky shore were registered at Porto and Alcalis.

TABLE 1

Physiographic characterization of stations in Arraial do Cabo during the studied period. 1 = low, 2 = medium, 3 = high

	FORNO	PORTO	ANJOS	ALCALIS	PRAINHA
Wave beat	2	1	2	3	2
Embayment	2	3	3	1	1
Depth	2	3	1	3	1

The clustering analysis for the physiography resulted in a dendrogram (FIGURE 2) whith clearly separates two groups only distantly related. The first, including stations of Anjos and Prainha, whith similar depths and wave beat and Forno, which similar wave beat. The second group, with the deeper stations the Porto and Alcalis.

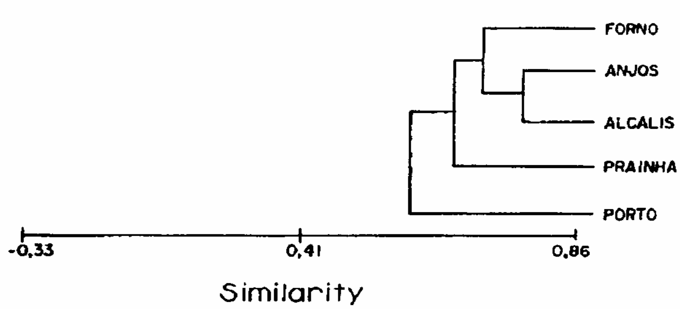

FIGURE 2 - Dendrogram of physiographic similarity among stations in the studied period, using czekanowsky coefficient

VIANNA, M. 1997 Physiographic influence in the structure of the suprabenthic fish assemblage in the rocky shore of Arraial do Cabo, Rio de Janeiro, Brazil. *B. Inst. Pesca*, São Paulo, *24* (único): 25 - 35.

3.2. Characterization of benthic cover

The kinds of bottom considered in the stations were: algae; sponges; hydrocoral (*Millepora alcicornis*); zoanthids (*Palythoa brasiliensis*, *Zoanthus nymphaeus* and *Z. sociatus*); scleractinia (*Mussismilia hispida* and *Siderastrea stellata*); bryozoans (*Schizoporella unicornis*); bare rock; sand and gravel. The percentage of benthic cover is showed in TABLE 2.

TABLE 2

Percentage of benthic cover in stations, at two different depths, in the studied period in Arraial do Cabo.

3 m deep	FORNO	PORTO	ANJOS	ALCALIS	PRAINHA
Algae	6.93	97.73	13.47	82.33	2.40
Sponges	0.80	0.00	1.13	0.50	0.50
M. alcicornis	3.67	0.40	1.07	0.70	1.33
Zoanthids	81.40	0.00	56.40	8.63	53.90
Scleractinia	0.00	0.00	3.87	0.00	0.00
S. unicornis	0.00	1.87	0.40	3.74	0.13
Bare rock	5.87	0.00	9.86	4.10	41.20
Sand and gravel	1.33	0.00	14.70	0.00	0.40
5 m deep	FORNO	PORTO	ANJOS	ALCALIS	PRAINHA
Algae	13.07	99.07	10.00	33.76	21.47
Sponges	1.07	0.00	0.93	0.40	4.40
M. alcicornis	9.07	0.53	0.80	7.67	0.80
Zoanthids	54.40	0.00	0.67	53.50	20.39
Scleractinia	2.94	0.00	4.26	2.10	0.94
S. unicornis	0.13	0.40	0.53	2.67	0.27
Bare rock	0.40	0.00	0.00	0.00	8.13
Sand and gravel	18.93	0.00	82.80	0.00	43.60

The diversity indexes applied to the benthos (TABLE 3) showed proportionally the same results, with higher values for the Prainha, followed by Anjos, Forno, Alcalis and lowest for the Porto.

TABLE 3

Diversity indexes applied to benthic cover of stations in the studied period in Arraial do Cabo

	FORNO O	PORTO O	ANJOS	ALCALIS	PRAINHA
Richness	2.45	0.94	2.63	2.10	2.64
Diversity	1.72	0.78	1.74	1.59	1.87
Equitability	0.65	0.45	0.65	0.64	0.69

The clustering analysis for the components of benthos (FIGURE 3) clearly shows two groups. The first with stations Forno, Anjos and Prainha, with heterogeneous bottom, and the other, formed by Porto and Alcalis, with high algae cover. The higher similarity occurs between station Anjos and Prainha, which are the shallowest.

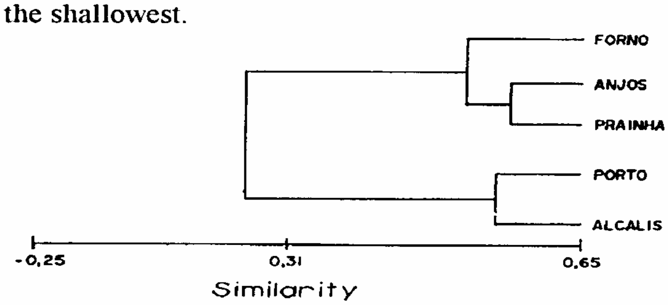

FIGURE 3 - Dendrogram of benthic component similarity among stations in the studied period, using czekanowsky coefficient

3.3. Composition and characterization of the ichthyofauna

In this survey 35 taxa were considered, 33 of which identified down to species and two at generic level only. The index of constancy of occurrence of the ichthyofauna showed that in the Forno station 11.4% of the fish were accidental, 22.9% accessory and 42.9% constant. In the Porto, 22.9% were accidental, 8.6% accessory and 34.3% constant. In the Anjos, 22.9% were accidental, 5.7% accessory and 40.0% constant. In the Alcalis, 14.3% were accidental, 8.6% accessory and 48.6% constant. In the Prainha, 11.4% were accidental, 11.4% accessory and 48.6% constant. In the global result, 42.9% were accidental, 20% accessory and 37.1% constant for all stations (TABLE 4).

TABLE 4

Constancy of occurence of fish species among stations in the studied period in Arraial do Cabo. ■ = constant, ⊠ = accessory and □ = accidental

Species\Stations	FORNO	PORTO	ANJOS	ALCALIS	PRAINHA	ARRAIAL
M. oculatus				□	■	□
O. vespertilio	□	□				□
H. ascensionis	⊠	□	□		⊠	□
F. tabacaria	⊠				■	□
H. reidi					⊠	□
D. volitans			■	⊠	■	⊠
S. baldwini	■		■	□	■	■
O. chrysurus	⊠	⊠	□	■		⊠
A. virginicus	⊠			■		□
H. aurolineatum	■	■	■	■	■	■
H. plumieri	■	■	■	■	□	■
H. steindachneri	■	■	■	■	■	■
D. argenteus	⊠	■	■	■	■	■
P. acuminatus	■	⊠	■	■	■	■
P. maculatus	■	■	■	■	■	■
P. schomburgki				□		□
C. striatus	■	■	■	■	■	■
C. aurantonotus			□			□
P. paru		□	□	■	□	□
H. ciliaris				□		□
A. saxatilis	■	■	■	■	■	■
C. multilineata	■			□	□	□
S. pictus	■		□		■	⊠
Stegastes spp	■	■	■	■	■	■
B. rufus	□	□				□
H. poeyi	■	□	■	■	■	■
L. nuchipinnis	⊠	□	■	■	■	⊠
Elacatinus sp	⊠	■	□			⊠
A. bahianus	■	■	■	■	⊠	■
A. chirurgus	⊠	⊠	□	■	□	⊠
B. vetula	□	□	□			□
Acanthostracion spp		□			■	□
C. rostrata	■	■	⊠	⊠		⊠
S. spengleri	■	■	⊠	■	■	■
C. spinosus	□			⊠		□

Using the species deficit index (Ds) for the ichthyofauna, the following results were obtained: Forno Ds=25.7%; Porto Ds=34.3%; Anjos Ds=31.4%; Alcalis Ds=28.6% and Prainha Ds=28.6%.

The clustering analysis showed a high similarity index among all stations. But three groups can be distinguished (FIGURE 4) - the first formed by Forno, Anjos and Alcalis, with very similar fish assemblages; the second formed only by Prainha, with a peculiar ichthyofauna, and the third formed by the Porto with an impoverished ichthyofauna. The highest similarity was recorded between Alcalis and Anjos.

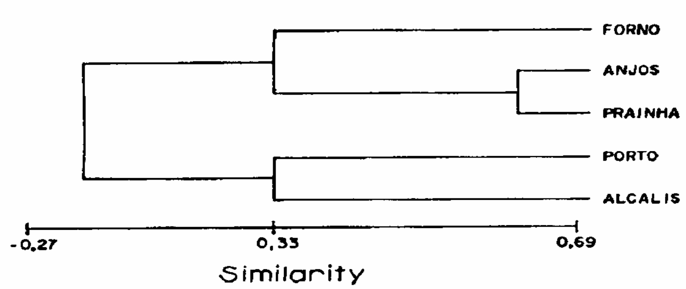

FIGURE 4 - Dendrogram of ichthyofaunal occurrence similarity among stations in the studied period, using czekanowsky coefficient

By the similarity analysis of the composition of ichthyofauna among species, seven groups could be detected (FIGURE 5). The first, only with *Chromis multilineata*, constant only at Forno. The second, with *Anisotremus virginicus, Pomachanthus paru, Acanthurus chirurgus* and *Ocyurus chrysurus*, which characterize the station Alcalis, where they have high occurrence values. The third includes *Stegastes* spp., *Chaetodon striatus, Pseudopeneus maculatus, Haemulon steindachneri, Abudefduf saxatilis, Haemulon aurolineatum, Acanthurus bahianus, Diplodus argenteus, Sphoeroides spengleri, Haumulon plumieri* and *Cantigaster rostrata*, constant or basically constant in all stations. The fourth, formed by *Pareques acuminatus, Halichoeres poeyi, Serranus baldwini* and *Stegastes pictus*, species with wide distribution, not occurring or occurring with low frequency in the Porto. The fifth group, contains *Dactylopterus volitans* and *Labrisomus nuchipinnis* which occur basically at stations of Anjos, Alcalis and Prainha. The sixth is formed by *Fistularia tabacaria, Myrichthys oculatus* and *Acanthostracion* spp., which characterize the station Prainha, being constant only there. The seventh group includes only *Elacatinus* sp., constant only at the Porto, not occurring at the Saco da Prainha.

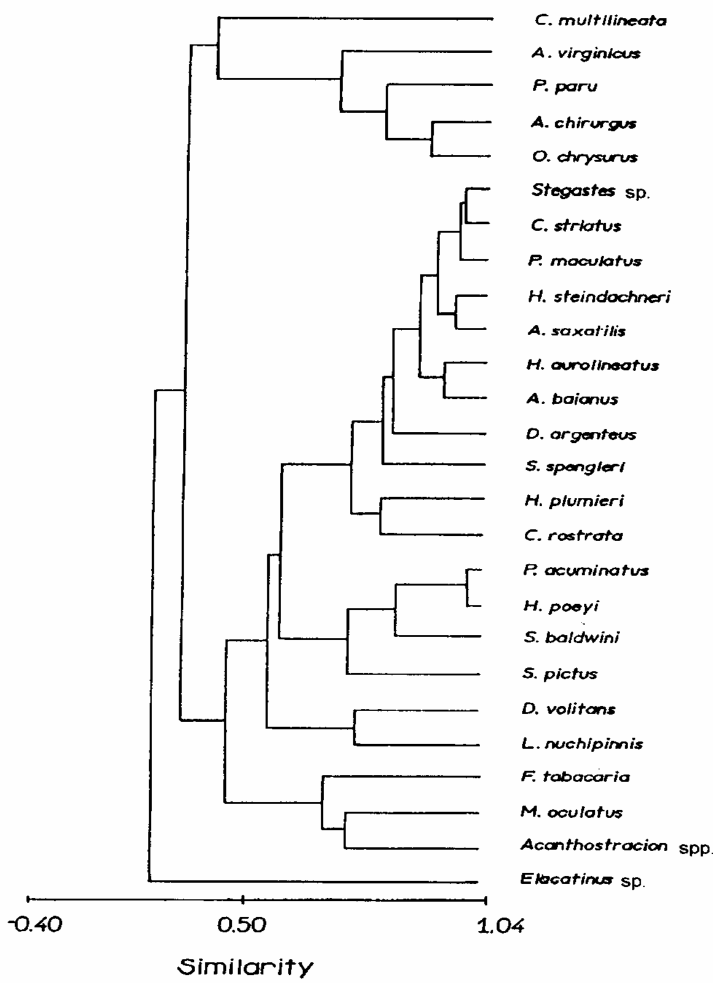

FIGURE 5 - Dendrogram of component similarity of the studied ichtthyofaunas of stations in the studied period, using czekanowsky coefficient

4. DISCUSSION

Many factors interact in the formation of fish assemblages. In this paper the main environmental variables have been studied, with observed action upon this kind of taxocoenosis. The employed methods followed standard paradigms for each kind of analysis.

Standardization of procedures, assuming constant error values, avoided influence of methodological errors on the comparative results among stations.

The technique employed for the characterization of benthic cover quantifies communities of hard substract, and it was the method used in papers which related coastal ichthyofauna with substract (e. g., SAMOILYS, 1988), being adequate for the objectives of this research.

The visual census method herein adopted does not reflect 100% of the ichthyofauna in the studied spot (SALE & DOUGLAS, 1981), and it should not be used for faunal inventories. As any other method, it shows limitations, which should be taken into account by the analysis of results. - rare, nocturnal or cryptic species are underestimated (BROCK, 1982 and HILOMEN & GOMEZ 1988), while species which form schools or are territorialist are overestimated. Issues like confidence in species identifications, personal preferences of the observer for some taxa, minute species or juveniles are also problems reported in the literature (e. g., SMITH, 1989). The validity of the method for censusing fish species, however, is shown by SALE & DOUGLAS (1981) and BROCK (1982), who compared visual census with collecting obtaining very similar lists regarding diurnal, conspicuous and resident species. The periodicity and the use of replications in the censes decrease the sampling errors (SALE & DOUGLAS, 1981). This procedure and the standardization of the technique make the method suitable to compare composition and abundance of conspicuous fishes between different stations. The negative occurrence report of a given species in a station does not imply that the species is absent in that station, but it means that if it is present, the density is less than in the other with positive reports.

The main two methods of visual census are based in the quantification of fishes by space or time. The method using space delimits a transect of any size where the researcher does the survey, in the other method, the quantification is done during a predetermined period. SANDERSON & SOLONSKY (1986) compared the methods and concluded that both are valid to estimate abundance and distribution, although the transect technique would be more quantitative, with less variation and more control over the kind of bottom, justifying its choice for the present research. A consensus about size of transects and other methodological variations is lacking. For this research, the technique used was based on the results obtained by FOWLER (1987). According to this author, this combination is the most recommended to census adult and sub-adult fishes. The use of replications in each transect is the best way of increasing the precision of censes, avoiding atypical observations and maximizing the records of less abundant species (SANDERSON & SOLONSKY, 1986). SALE & DOUGLAS (1981) recommend a minimum of two replications by census, while FOWLER (1987) suggests three - as used herein - as ideal. The interval between replications was 15 minutes, which was considered by FOWLER (1987) enough to dissipate the stress caused by the diver in the community.

The difference between the technique used herein and that recommended by FOWLER (1987) is that the cable was not unwinded simultaneously with the census, but previously. The beginning of the census 30 minutes after cable fastening is enough for the species recover their activity, ignoring the cable, and its longer than the time recommended by other authors: SANDERSON & SOLONSKY (1986) recommend 10 minutes and HILOMEN & GOMEZ (1988) 20 minutes.

In this research, species abundance has been obtained through frequency of occurrence along the study, in spite of some species being visually more abundant in determined stations than in others. Counting of individuals as a way of quantifying fish assemblages is used by many authors, but this technique is debatable TALBOT & RUSSELL (1978) counted the number of individuals when estimating the school forming species, BELLWOOD & ALCALA (1988) determined the abundance as logarithm of approximate counts and OHMAN et alii (1993) used an arbitrary scale of little, medium and much to the quantification. The count of individuals during a census is not safe, because species with different habits should have specific treatments and distinct methods of gathering data (SMITH, 1989). Particularly, in this research, in which replications were made over the same transect, the count would be inadequate, due to the impossibility of avoiding recounts of individuals.

The period covered in the study has been enough to accomplish the proposed goals and to minimize variation. SALE & DOUGLAS (1981) stated that long term projects including visual census may have to deal with death, migration and immigration, hindering the analysis. The period covered in this study is longer than that covered in most published similar researches. Papers comparing close stations are generally punctual (e. g., HILOMEN & GOMEZ; 1988) or short termed (e. g., SAMOILYS, 1988). Besides, SALE (1988) stated that the abundance in number of individuals in a given spot changes along time due to natural causes, but variation in species composition is small.

In terms of benthic cover, results showed that at low depths zoanthids prevail in stations with natural environments, with little or medium exposure to waves (Forno, Anjos and Prainha). In depths of five meters, the heterogeneity is larger. The substract depends on the depth, as in shallower stations, which show highest rates of sand and gravel.

Diversity indexes applied to the benthos showed higher variation of substract types in the stations Prainha, Anjos and Forno, while in the Alcalis, probably due to larger exposure to waves, larger depth and influence of the waste from Cia. Nac. Álcalis (VIANNA & PARANHOS, 1994), the variation was narrower. In the Porto station, the almost total cover of algae can be explained by influence of oils, since following LOYA (1976), these compounds prevent settling and survival of coral larvae.

The clustering analysis of benthos in the stations shows highest similarity caused by heterogeneity of substract and action of physiographic variables. The similarity between stations of Porto and Alcalis is evident. Both are deep, with extensive algae cover in the studied area, but the Porto station is homogeneously covered by algae down to the bottom, while the Alcalis station shows large increase in benthic diversity proportional to depth and consequent decrease of wave beat. Influence of physiographic variables in submarine landscape is so clear, that benthic cover and physiographic dendrograms can be superposed, indicating the same groups.

The alternative procedure of excluding nine fish species turned the results still stronger, since the chosen nine species are not well sampled by the method of visual census. *Ogcocephalus vespertilio* and *Hippocampus reidi* are cryptic, *Holocentrus ascensionis* and *Pempheris schomburgki* are nocturnal, *Chilomycterus spinosus* is not typical for spots of hard bottom, and the remnant species are rare in the studied area. Excluding such species from the analysis is recommended by SALE & DOUGLAS (1981).

Results indicate that the ichthyofauna of the station in Enseada dos Anjos is impoverished compared to the others. Porto and Anjos stations had highest species deficit, highest number of accidental species, and lowest number of constant species. Remnant stations, such the outer as the located in Enseada do Forno showed close values relative to the indexes applied, suggesting a more diversified recruitment. The clustering analyses, of fishes themselves and ichthyofauna among stations showed there is high similarity among ichthyofauna in all stations. This is due to the high number of species that do not reveal predilection for any station, being frequent in almost all. Some singularities should be noted - some stations, especially the extremes, may be characterized by high and low frequency of certain species.

According to TALBOT & RUSSELL (1986), variation in fish assemblages may be explained by environmental differences and trophic interactions; SHULMAN (1985) agreed and stated that ichthyofaunal composition results from survival to abiotic disturbance, competitive interaction and resource availability. LOWE-McCONNELL (1987) pointed that fish diversity increases with environment complexity; HIXON & BEETS (1993) stated that substract influences ichthyofauna, but not so much as predation. Likewise, OHMAN et alii (1993) demonstrated that tourist locals undergo collecting by aquariophilists and fishing for food, which differentiate fish assemblages. In Arraial do Cabo, all sampled spots underwent action of collectors and fishes in a similar way. This action, of troublesome quantification, is directed towards certain species, minoritary in the studied list. This way, the collecting impact is not considered herein. Likewise, there is no record in the last few years of any large environmental disturbance which could have affected composition and distribution of local ichthyofauna. The water quality was also found to show low variation among stations (VIANNA & PARANHOS, 1994), so other factors must contribute to recorded differences in the ichthyofaunas. According to SANO; SHIMIZU; NOSE. (1984), many fishes coexist and share the available resources from the environment, especially food and space, and if these resources differ between distinct spots, they are therefore suggested to be the cause of the differences among communities. To SALE (1988), composition and abundance of fish vary among spots and it is determined by specific requirements for kinds of microhabitats.

According to DENNIS & BRIGHT (1988), dominant epifauna, like corals and sponges are not primarily food resources, but constitute habitat to other invertebrates, which are the main food for the fish. Therefore, a complex epifauna increases structuration of fish assemblages. But independently of food, environment completion is very important, once that for fish, space is the most limiting resource in reefs environment (LOWE-McCONNELL, 1987 and SALE, 1988).

In the studied areas every local can be characterized by certain common and constant species, independently of environmental variations. But, some species showed preference for inner stations, others for outer. It seems that outer stations and Forno station possess a slightly richer ichthyofauna than station in Enseada dos Anjos, more sheltered and subject to variation of organic waste (VIANNA & PARANHOS, 1994). Within the inlet, however, the Anjos station is much more highly structured than Porto station, which shows impoverished ichthyofauna and also less variation in components of substract, suggesting lower diversity of microhabitats, in spite of the high number of rock shelters.

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5. CONCLUSIONS

It can be concluded that in the studied area, composition and distribution of suprabenthic ichthyofauna is mainly defined by geographic position and physical features of rocky shores. Physiography carries out effective action in the composition of submarine landscape, and consequently in the distribution of most resources used by these fish. Likewise, the ichthyofauna is directly affected by physical variables which affect its movement and food capture.

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