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THE COLLAPSE OF THE SCALLOP *EUVOLA ZICZAC* (LINNAEUS, 1758) (BIVALVIA: PECTINIDAE) FISHERY IN BRAZIL: CHANGES IN DISTRIBUTION AND RELATIVE ABUNDANCE AFTER 23 YEARS OF EXPLOITATION

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ABSTRACT

In Brazil, an industrial trawling fishery directed to *Euvola ziczac* started in 1973 and collapsed after 1980, when scallop landings reached 8,800 t. Since 1995 *E. ziczac* landings have not surpassed a few hundred kilograms. Based on surveys carried out in 1974-1975 and in 1995-1996, this work assesses temporal changes occurred in scallop distribution and relative abundance patterns and analyzes the current stock situation under the present management regimes applied to the local demersal trawling fishery. In the 1970's *E. ziczac* was concentrated in a main bed extending from southern São Paulo to northern Santa Catarina States and between 30 and 50 m depth. This pattern changed dramatically during the 1990's, when only two very small and low-density concentrations were found in the region. Cumulative effects of reducing areas and density within the remnant concentrations produced a reduction in the stock biomass of 98%. Management of the local double rig trawler fishery has always focused on its first main target, the shrimps *Farfantepenaeus paulensis* and *F. brasiliensis*. Additional measures have not been implemented, even after substantial part of the fleet has directed its effort to alternative shelf and slope resources. The collapse of the Brazilian scallop fishery provides a striking example of irreversible damage caused by uncontrolled fishing redirection allocated to other resources, demonstrating the need of changes in the Brazilian demersal fishery management model.

RESUMO

No Brasil, uma pesca industrial de arrasto dirigida à vieira *Euvola ziczac* teve inicio em 1973 e colapsou após 1980, quando foram desembarcadas 8.800 t. Atualmente os desembarques não têm ultrapassado algumas centenas de quilos. Baseado em cruzeiros de prospecção realizados em 1974-1975 e em 1995-1996, este trabalho descreve as alterações nos padrões de distribuição e abundância relativa do recurso e discute a sua situação atual frente ao ordenamento local da pesca demersal de arrasto. Nos anos 70 *E.ziczac* concentrava-se num grande banco localizado entre o sul de São Paulo e o norte de Santa Catarina e entre 30 e 50 metros de profundidade. Tal padrão foi profundamente modificado nos anos 90 quando somente duas pequenas agregações muito pouco densas foram encontradas. Os efeitos cumulativos da redução da área de ocorrência e das densidades do recurso sugerem que a sua biomassa foi reduzida em 98%. O enfoque do manejo da pesca industrial de arrasto da região tem se mantido sobre seu antigo recurso-alvo (o camarão-rosa, *Farfantepenaeus paulensis* e *F. brasiliensis*), e medidas adicionais não têm sido implementadas, mesmo depois da frota ter redirecionado seu esforço para recursos alternativos da plataforma continental e do talude. Desta forma a situação da vieira *E. ziczac* fornece um exemplo concreto dos danos irreversíveis que o redirecionamento do esforço pesqueiro não controlado pode ocasionar sobre os estoques, e demonstra a necessidade de mudança no enfoque do manejo da pesca demersal brasileira.

Descriptors: Stock assessment, fishing collapse, southwestern Atlantic, inner continental shelf.
Descritores: Avaliação de estoque, colapso pesqueiro, Atlântico sul, Plataforma continental interna.

INTRODUCTION

Scallops support valuable artisanal and industrial fisheries in several regions of the world. In the southwestern Atlantic Ocean *Aequipecten tehuelchus* (d'Orbigny, 1846) and *Zygochlamys patagonica* (King & Broderip, 1832) have been exploited in Argentina (Orensanz *et al.*, 1991a; Ciocco *et al.*, 1998; Lasta & Bremec, 1998) and the latter species has demonstrated some economic potential for exploitation in Uruguayan waters (Gutiérrez & Defeo, 2003).

In Brazil, an industrial scallop fishery directed to *Euvola ziczac* (previously *Pecten ziczac*) was developed by local shrimp double rig trawlers in the early 1970's. Motivated by declining penaeid shrimp yields and attractive international market opportunities (Pezzuto & Borzone, 1997a), a scallop fishery developed and collapsed within a few years, a striking example of "gold-rush" fishery (Perry *et al.*, 1999). Previously discarded or only locally consumed, *E. ziczac* was firstly recorded in official fishing statistics in 1972 when 4.5 t (live weight) were reported landed in Santos (São Paulo State). After this, scallop production increased steadily and showed strong oscillations, with peaks largely concentrated in two main periods: 1973-1975 and 1979-1980, when a maximum of 8,800 t was recorded (Fig. 1). Because scallops were never considered a target species by the trawling fleet (the resource was regarded as a minor by-catch item in the local shrimp fishery), the scallop fishery was not managed and collapsed after 1980. Since 1995 *E. ziczac* landings have never surpassed a few hundred kilograms per year (Fig. 1).

In spite of its importance in Brazil, information about the species during its main period of exploitation is very scarce, limited to official reports on distribution and relative abundance patterns during the 1970's (see Material and Methods), industrial processing (Morais & Kai, 1980) and parasites (Amato & Amato, 1982).

For this reason, the causes of diminishing landings and, ultimately, the collapse of the fishery remained poorly understood and the current status of the *E. ziczac* stock is unknown. The present work was conducted with the aims of a) assessing possible changes in the distribution and relative abundance patterns of the resource over time, based on surveys conducted during the developmental phases of the fishery (1974-1975) and 15 years after its collapse (1995-1996), and b) analyzing the current stock situation under the present management regimes applied to the local demersal trawling fishery.

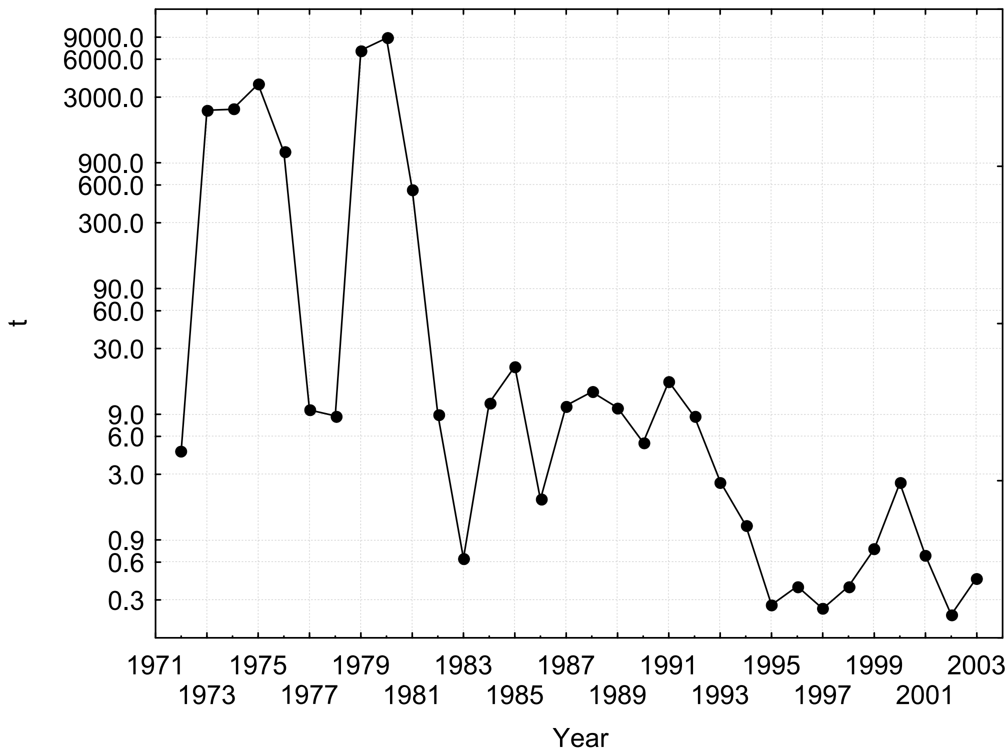

Fig. 1. Annual landings (mt) of the scallop *Euvola ziczac* in Brazil. Sources: SUDEPE, IBAMA, Instituto de Pesca (Santos), CTTMar/UNIVALI (2001, 2002, 2003), Ávila-da-Silva & Carneiro (2003); Ávila-da-Silva *et al.* (2004a; 2004b).

MATERIAL AND METHODS

Data from 1974-1975 were obtained from R/V Diadorim and R/V Riobaldo survey reports published by SUDEPE (the former Brazilian Fishing Department) in the 1970's, based on several cruises conducted along the southeastern and southern Brazilian continental shelf (24° to 27° S) with the aim of assessing penaeid shrimp and scallop stocks (Jones *et al.*, 1974; Sachet *et al.*, 1974; Zenger *et al.*, 1974; Agnes *et al.*, 1975; Agnes & Jorge, 1975; Agnes & Zenger, 1975; Zenger *et al.*, 1975). Data from 1995-1996 were produced during three cruises conducted between December 1995 and April 1996 by CTTMar/CEM with the R/V Diadorim (Borzone & Pezzuto, 1997). The first cruise was designed to describe more recent spatial patterns of the resource within its main distributional area, as previously defined by SUDEPE. A total of 24 stations were sampled along 7 transects positioned between 25°19'S and 26°19'S, and between the 26 m and 50 m isobaths. Five additional stations supposedly corresponding to areas of high scallop abundance (as suggested by 1974-1975 surveys and local fishermen information) were also sampled. The March-April 1996 cruises concentrated sampling effort respectively at 10 and 14 new stations located in the area of the two beds identified in December, in order to obtain a more detailed description of the spatial pattern of the resource (Borzone & Pezzuto, 1997; Pezzuto & Borzone, 1997b). A total of 118 and 78 hauls were analyzed for 1974-1975 and 1995-1996 surveys, respectively.

Data of different periods were not readily comparable as: a) different sampling gears were used during SUDEPE and CTTMar/CEM (two otter trawls and four beam-trawls, respectively) surveys and, b) nocturnal catch rates of the species are significantly higher than diurnal ones at the same sites. As a consequence, all data might be standardized before the analysis. After comparing the relative efficiencies of the several gears, catches recorded in each tow were converted to catch rate units defined as the number of scallops caught per hour in nocturnal tows conducted at four knots using SUDEPE's "Semi-balão" otter trawl (details of the gears and standardization procedures are found in Pezzuto & Borzone, 2001). We preferred this gear because of its similarity with the commercial otter trawls used by local fishermen during the main scallop fishing period (Pezzuto & Borzone, 2001). However, as the gear efficiency (the fraction of the scallops in the path of the gear that were actually caught) could not be assessed, it was impossible to obtain absolute estimates of stock density and biomass by the "swept area" method (Gunderson, 1993). Therefore, relative modifications in the stock abundance with time were analyzed by comparing the size of the areas over which scallops were found in both periods and their respective mean catch rates.

In order to quantify changes in scallop distribution and relative abundance patterns between the two periods, latitudes and longitudes of the several standardized hauls were transformed from geodetic to UTM (Universal Transverse Mercator) coordinates system, converting degrees to meters. For each period (1974-1975 and 1995-1996), contour maps of standardized catch rates were produced by ordinary kriging interpolation (Isaaks & Srivastava, 1989) with *Surfer – Surface Mapping System* – software (Copyright 1993-96, Golden Software, Inc.). Size (area) of the several strata defined by the contour intervals was estimated. The contour line of 50 ind.h^{-1} was arbitrarily defined as the limit of the stock distribution over the surveyed area, and the contour line of 200 ind.h^{-1} as the limit of the commercial beds. Then, mean catch rates were estimated for stock and commercial bed areas as follows:

$$\overline{Cr_d} = \frac{\sum_{i=1}^{n} Cr_i * A_i}{\sum_{i=1}^{n} A_i} \qquad (1)$$

and,

$$\overline{Cr_b} = \frac{\sum_{i=1}^{n} Cr_i * A_i}{\sum_{i=1}^{n} A_i} \qquad (2)$$

where, Cr_i is the mean catch rate at the *i*th stratum, A_i is the area estimated for stratum *i*, and *n* is the number of strata above isolines of 50 ind.h^{-1} (Cr_d) and 200 ind.h^{-1} (Cr_b).

Temporal changes in resource distribution and mean catch rates were quantified by calculating the ratio between the areas and mean catch rates estimated for 1995-1996 and 1974-1975 periods. Finally, we estimated separately the relative changes in *E. ziczac* stock (ΔS) and commercial beds (ΔB) sizes by dividing the product between the stock or beds mean catch rates and their respective area in the 1990's by the same product calculated for the 1974-1975 period, as follows:

$$\Delta S = \frac{\left(\sum_{i=1}^{n} Cr_i * A_i\right)_{(1995-1996)}}{\left(\sum_{i=1}^{n} Cr_i * A_i\right)_{(1974-1975)}} \qquad (3)$$

and,

$$\Delta B = \frac{\left(\sum_{i=1}^{n} Cr_i * A_i\right)_{(1995-1996)}}{\left(\sum_{i=1}^{n} Cr_i * A_i\right)_{(1974-1975)}} \qquad (4)$$

Changes in scallop distribution and relative abundance were also analyzed through the same procedures, but considering catch rates in terms of weight units (*i.e.* kg.h^{-1}).

RESULTS

Data from SUDEPE's (1974-1975) surveys revealed that during the beginning of the fishery *E. ziczac* had a relatively uniform distribution along a strip of the inner continental shelf, between 24°26' S and 26°30' S and from 30 m to 50 m depth (Fig. 2). A main bed was identified extending from the south-southeast of Bom Abrigo Island, where catch rates up to 2100 ind.hr^{-1} were obtained, to the northeast of São Francisco do Sul Island. A smaller and deeper scallop concentration was found also at 26^{o} S and 60 m depth, near the southern limit of the main bed.

These patterns changed as the fishery collapsed. The CTTMar/CEM (1995-1996) cruises showed that the previously large, continuous and dense bed identified in the 1970's was split into two small and low-density concentrations distributed along the 38 m isobath (Fig. 3). While the northernmost concentration (hereafter named Bom Abrigo bed) is clearly a remnant of the high scallop densities previously found near Bom Abrigo Island, the second one (São Francisco bed) seems to have developed with the expansion of the original bed towards the south. The deeper concentration found at 26^{o} S in the 1970's was not found during the last survey (Fig. 3).

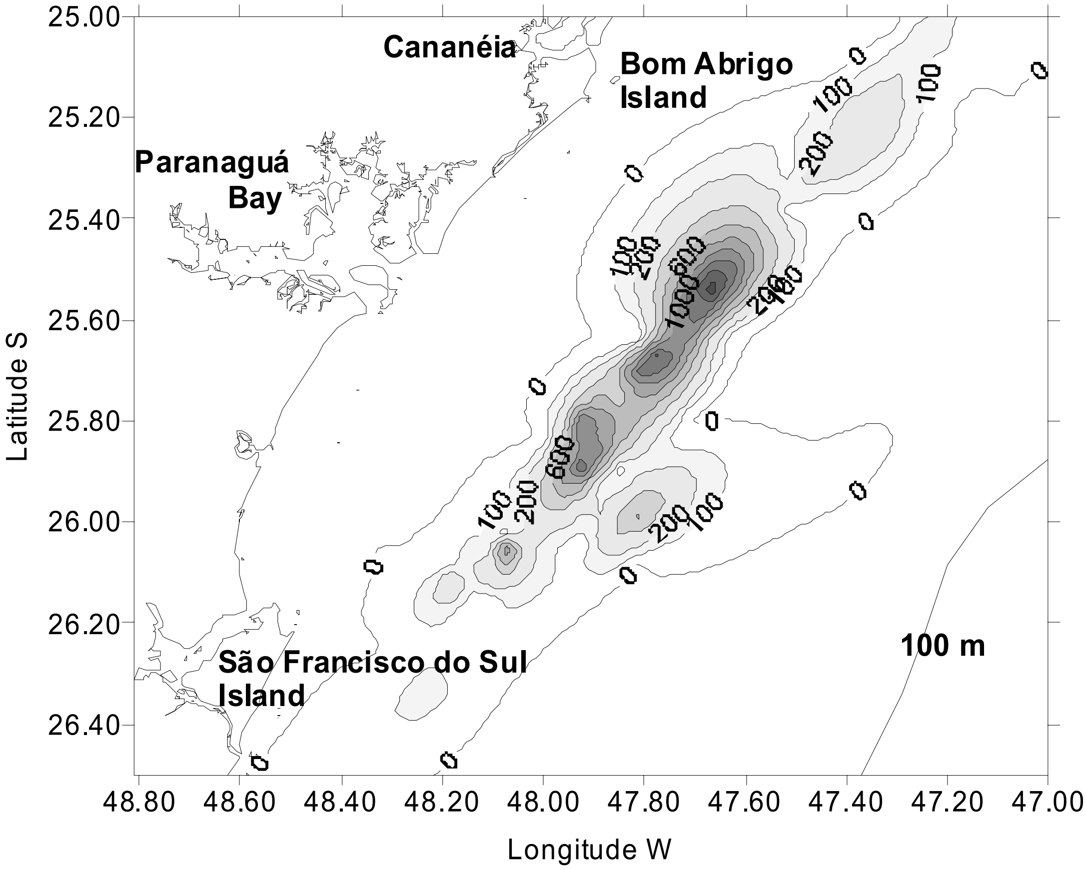

Fig. 2. Distribution of *Euvola ziczac* in Brazil as obtained from standardized catch rates observed during 1974-1975. Contour line values refers to ind.h^{-1}.

Comparing the two periods, areas exhibiting catch rates higher than 50 ind.h^{-1} were nearly 58% smaller in 1995-1996 than in 1974-1975, decreasing from 5,241 km^2 to 2,202 km^2 (Tables 1 and 2). Changes in the stock area were accompanied also by a reduction of 48% in the respective mean catch rates (Tables 1 and 2). Considering only regions producing catch rates higher than 200 ind.h^{-1} (commercial beds), the reduction observed in their sizes and mean catch rates were of 79% and 44%, respectively (Tables 1 and 2). Combined effects of reducing areas (contraction) and density (dilution) of the resource produced a global reduction in the stock numbers of 78% above the 50 ind.h^{-1} isoline and of 88% in the commercial beds (Table 2).

Besides reduced abundance, *E. ziczac* exhibited significant changes in its population structure. Mean shell height of individuals caught during SUDEPE's cruises was 84 mm, corresponding to a mean weight of 101 g. Mean size and weight of specimens sampled in the 1990's were 70 mm and 55 g, respectively, revealing a decline of almost 50% in mean individual weight since the beginning of the fishery.

Table 1. Areas of distribution and respective mean catch rates (ind.h^{-1}) estimated for the scallop *Euvola ziczac* in Brazil based on 1974-1975 and 1995-1996 surveys.

Period	Stratum of catch rate (ind.h^{-1})	Mean catch rate within the stratum (ind.h^{-1}) (A)	Stratum area (km^2) (B)	Cumulative area above the stratum (km^2)	Mean catch rate within the stratum x Stratum area (A) x (B)	Cumulative (A) x (B) above the stratum	Weighed mean catch rate above the stratum (ind.h^{-1})
	> 1700	1750	0.38	0.38	659.50	659.50	1,750.00
	1600 – 1700	1650	2.97	3.35	4,899.36	5,558.87	1,661.26
	1500 – 1600	1550	5.92	9.27	9,181.49	14,740.35	1,590.16
	1400 – 1500	1450	9.59	18.86	13,905.92	28,646.27	1,518.89
	1300 – 1400	1350	26.52	45.38	35,796.20	64,442.47	1,420.20
	1200 – 1300	1250	39.94	85.31	49,919.13	114,361.59	1,340.53
	1100 – 1200	1150	66.40	151.71	76,363.45	190,725.04	1,257.14
	1000 – 1100	1050	94.87	246.59	99,614.55	290,339.59	1,177.44
1974 – 1975	900 – 1000	950	103.16	349.74	97,997.25	388,336.84	1,110.36
	800 – 900	850	99.24	448.98	84,354.85	472,691.69	1,052.81
	700 – 800	750	124.74	573.72	93,556.50	566,248.19	986.97
	600 – 700	650	159.27	732.99	103,522.90	669,771.09	913.75
	500 – 600	550	179.00	911.99	98,452.20	768,223.29	842.36
	400 – 500	450	245.40	1,157.39	110,428.65	878,651.94	759.17
	300 – 400	350	350.97	1,508.36	122,839.50	1,001,491.44	663.96
	200 – 300	250	803.33	2,311.69	200,832.50	1,202,323.94	520.11
	100 – 200	150	1,506.82	3,818.51	226,023.00	1,428,346.94	374.06
	50 – 100	75	1,422.40	5,240.91	106,680.00	1,535,026.94	292.89
	400 – 500	450	23.87	23.87	10,739.84	10,739.84	450.00
	300 – 400	350	155.25	179.12	54,339.15	65,078.98	363.32
1995 – 1996	200 – 300	250	307.02	486.14	76,754.50	141,833.48	291.75
	100 – 200	150	840.96	1,327.10	126,144.15	267,977.63	201.93
	50 – 100	75	875.35	2,202.45	65,651.25	333,628.88	151.48

Table 2. Relative change in area and mean catch rate (ind.h^{-1}) estimated for the scallop *Euvola ziczac* in Brazil based on 1974-1975 and 1995-1996 surveys.

Stratum of catch rate	Estimated area (1974-1975) (km^2)	Estimated area (1995-1996) (km^2)	Reduction in the área (%)	Mean catch rate (1974-1975)	Mean catch rate (1995-1996)	Reduction in the mean catch rate (%)	Reduction in the stock abundance (%)
≥ 400	1,157.39	23.87	97.94	759.17	450.00	40.72	98.8
≥ 200	2,311.69	486.14	78.97	520.11	291.75	43.91	88.2
≥ 50	5,240.91	2,202.45	57.98	292.89	151.48	48.28	78.3

As a consequence of the simultaneous reduction in numbers and mean individual weight, biomass was severely depleted between the two study periods (Figs 4 and 5). While catch rates up to 240 kg.h^{-1} were not uncommon during the 1970's, highest yields recorded during 1995-1996 cruises in general did not surpass 40 kg.h^{-1} and were observed only in isolated hauls. Tables 3 and 4 shows that the area occupied by the resource and mean catch rate above the isoline of 5 kg.h^{-1} (corresponding roughly to the 1970's contour line of 50 ind.h^{-1}) declined by 73% and 63%, respectively. On the other hand, beds (defined by the isoline of 20 kg.h^{-1}) which covered almost 2350 km^2 in 1974-1975 appeared restricted to only 71 km^2 after the 1995-1996 survey, indicating that most of the scallop concentrations were completely eliminated between the two study periods (Table 4).

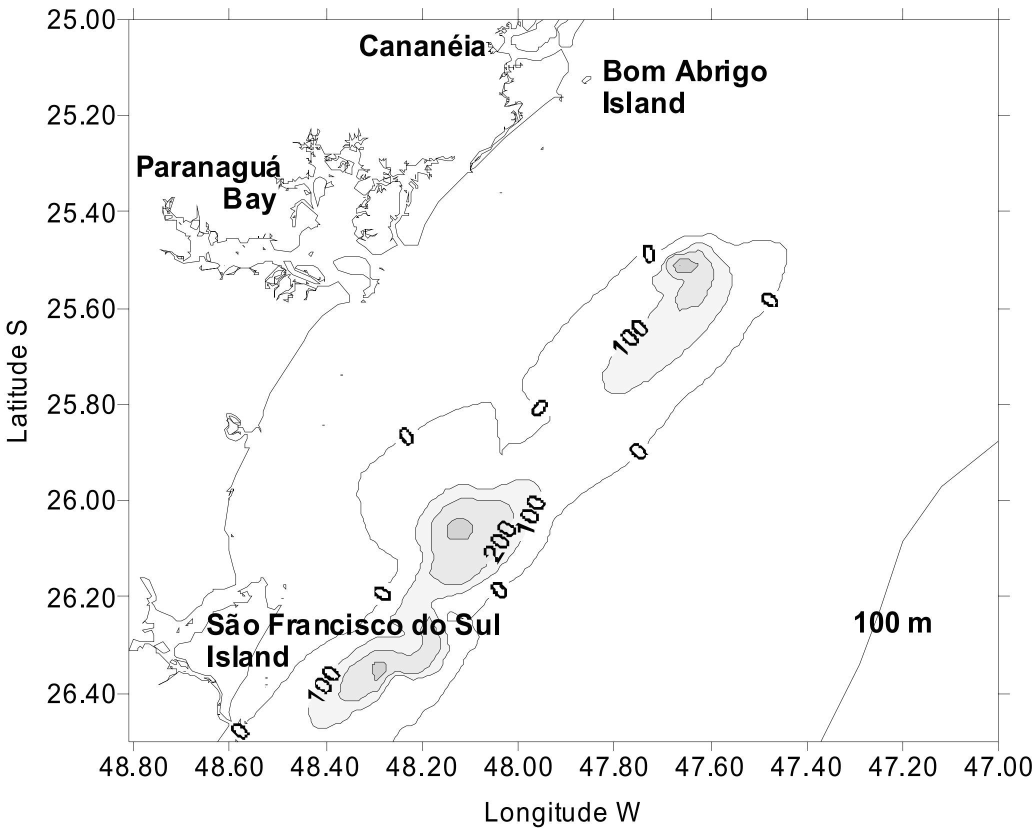

Fig. 3. Distribution of *Euvola ziczac* in Brazil as obtained from standardized catch rates observed during 1995-1996. Contour line values refers to ind.h^{-1}.

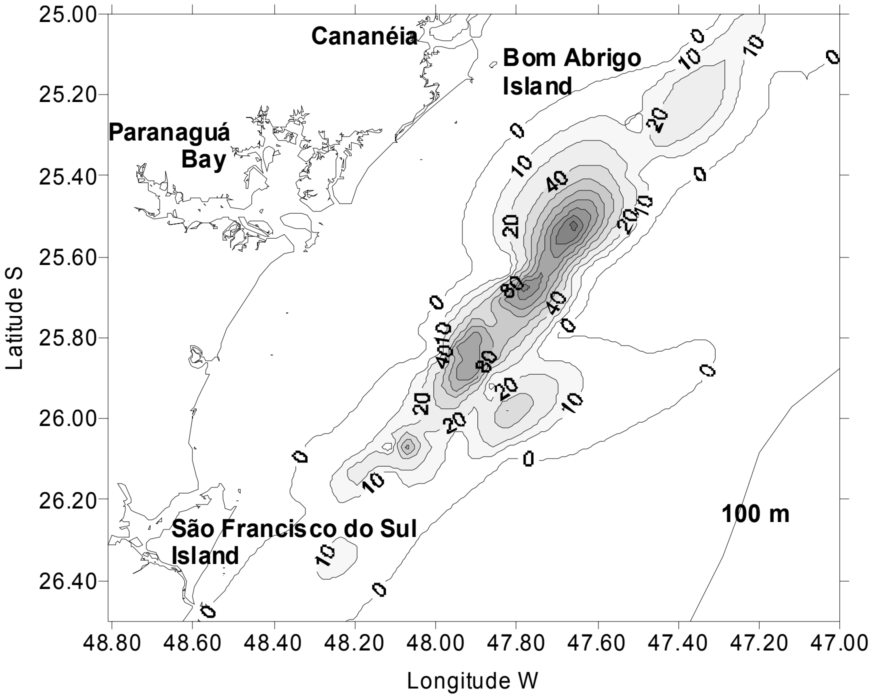

Fig. 4. Distribution of *Euvola ziczac* in Brazil as obtained from standardized catch rates observed during 1974-1975. Contour line values refers to kg.h^{-1}.

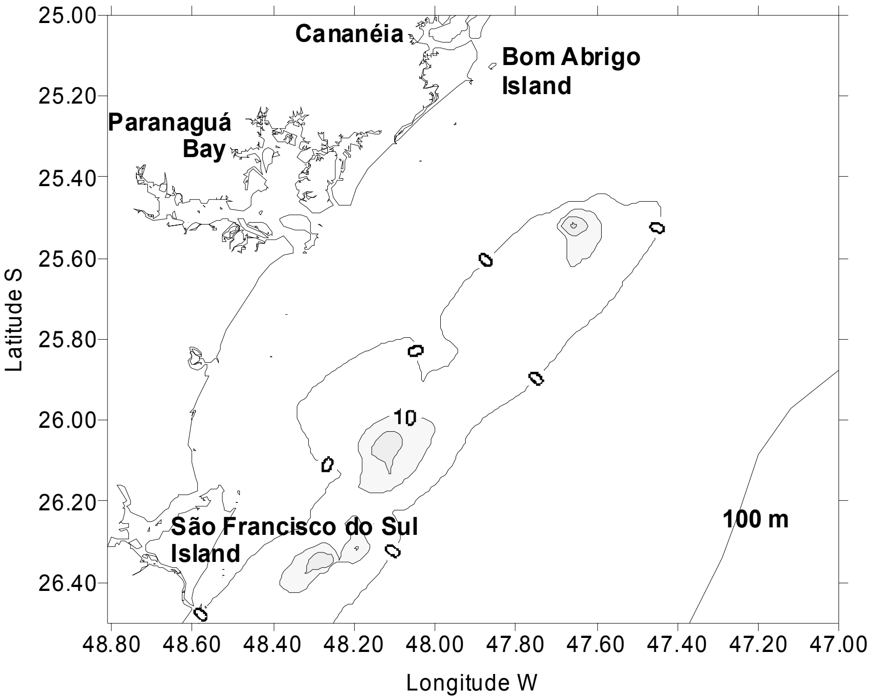

Fig. 5. Distribution of *Euvola ziczac* in Brazil as obtained from standardized catch rates observed during 1995-1996. Contour line values refers to kg.h^{-1}.

Table 3. Area of distribution and respective mean catch rate ($kg.h^{-1}$) estimated for the scallop *Euvola ziczac* in Brazil based on 1974-1975 and 1995-1996 surveys.

Period	Stratum of catch rate ($kg.h^{-1}$)	Mean catch rate within the stratum ($kg.h^{-1}$) (A)	Stratum area (km^2) (B)	Cumulative area above the stratum (km^2)	Mean catch rate within the stratum x Stratum area (A) x (B)	Cumulative (A) x (B) above the stratum	Weighed mean catch rate above the stratum ($kg.h^{-1}$)
1974 – 1975	> 160	170	0.62	0.62	104.64	104.64	170.00
	140 - 160	150	22.84	23.45	3,425.64	3,530.28	150.52
	120 - 140	130	60.95	84.40	7,923.70	11,453.97	135.70
	100 - 120	110	176.86	261.27	19,454.64	30,908.61	118.30
	80 - 100	90	190.68	451.95	17,161.29	48,069.90	106.36
	60 - 80	70	294.19	746.13	20,593.09	68,662.99	92.03
	40 - 60	50	435.62	1,181.75	21,780.85	90,443.84	76.53
	20 - 40	30	1,161.92	2,343.67	34,857.60	125,301.44	53.46
	10 – 20	15	1,503.41	3,847.08	22,551.15	147,852.59	38.43
	5 – 10	7.5	1,426.46	5,273.54	10,698.45	158,551.04	30.07
1995 – 1996	40 - 60	50	0.02	0.02	0.95	0.95	50.00
	20 - 40	30	71.00	71.02	2,129.96	2,130.90	30.01
	10 – 20	15	507.28	578.30	7,609.19	9,740.10	16.84
	5 – 10	7.5	869.36	1,447.66	6,520.22	16,260.32	11.23

Table 4. Relative change in area and mean catch rate ($kg.h^{-1}$) estimated for the scallop *Euvola ziczac* in Brazil based on 1974-1975 and 1995-1996 surveys.

Stratum of catch rate	Estimated area (1974-1975) (km^2)	Estimated area (1995-1996) (km^2)	Reduction in the area (%)	Mean catch rate (1974-1975)	Mean catch rate (1995-1996)	Reduction in the mean catch rate (%)	Reduction in the stock biomass (%)
≥ 40	1,181.75	0.02	99.99	76.53	50.00	34.67	99.9
≥ 20	2,343.67	71.02	96.97	53.46	30.01	43.86	98.3
≥ 5	5,273.54	1,447.66	72.55	30.07	11.23	62.65	89.7

Cumulative effects of the contraction and dilution within the remnant places shows that the stock was severely depressed as its total biomass was reduced by 90% within areas with catch rates above 5 $kg.h^{-1}$ and by over 98% in areas above 20 $kg.h^{-1}$ (Table 4).

Discussion

Our results together with historical landing data reveal that the stock of *E. ziczac* has collapsed in Brazil, and has not shown any signs of recovery after its 1980 production peak. Moreover, although some oscillation in annual landings had been detected after 1981, the general pattern of *E. ziczac* production throughout the last two decades is clearly declining.

Biological data and information about fishing effort and fleet dynamics before and during this period are scarce or unavailable. Therefore, it is difficult to explain the significant differences in scallop production between the 1973-1975 (ca. 2,800 t) and 1979-1981 (ca. 8,800 t) peaks, as well as to evaluate the relative contribution of biological, oceanographic and fishing processes to the scallop biomass changes that occurred since the fishery beginings.

According to their fluctuation patterns, stocks of pectinids have been classified as: a) steady or predictable stocks, in which abundance remains at about the same level year after year; b) cyclical stocks, with alternation of low and high abundance periods at relatively constant time intervals; c) irregular stocks, exhibiting irregular fluctuations with time, mostly when its recruitment is strongly influenced by hydrographic conditions and, d) spasmodic stocks, in which irregular pulses of abundance are followed by periods of scarcity or even collapse (Caddy & Gulland, 1983; Orensanz *et al.*, 1991b). While some high-latitude pectinids seem to behave as steady stocks, most of them tend to show large fluctuations in abundance with time. These fluctuations have been associated mainly to: a) strong variability in recruitment; b) catastrophic mortality related to natural processes as predation, diseases, red tides and storms; and c) low longevity of many species, which renders their total biomass largely dependent on recruitment (Orensanz *et al*., 1991b).

For most of the exploited species, fluctuation in stock size can be significantly increased by fishing mortality, especially during periods of low recruitment. Therefore, most scallop fisheries have been managed with the aim of maintaining the respective stocks within biologically and economically safe limits. Whether managed or not, scallop fisheries have collapsed in several places as New Zealand (Bull, 1991); Australia (Zacharin *et al.*, 1990; Zacharin, 1991; Gwyther *et al.*, 1991; Fuentes, 1994; McLoughlin, 1994), USA (Blake & Moyer, 1991); Argentina (Ciocco *et al.*, 1998); Chile (Stotz & Gonzalez, 1997) and Mexico (Félix-Pico *et al.*, 1997), among others.

E. ziczac is a fast-growing and short-lived species (Vélez *et al.*, 1995; Lodeiros & Himmelman, 1994, 1996, 2000; Pezzuto & Borzone, *unpubl. data*), attains sexual maturity at the age of 6 to 8 months (Lodeiros & Himmelman, 1994, Pezzuto & Borzone, *unpubl. data*) and reproduces almost continuously in our study area (Borzone *et al.*, 2003). Such life-history traits are associated with the strong influence that local oceanographic conditions (*i.e.* circulation and primary productivity cycles) exert on the reproduction of the species (Borzone *et al.*, 1999; Borzone *et al.* 2003) favoring strong and unpredictable fluctuations in stock abundance. *E. ziczac* is likely to fit the irregular or even spasmodic stock category, responding to favorable environmental changes through rapid population increases, which could explain the remarkable recovery in scallop landings after its first major fishing period observed between 1978 and 1979. Apart from this apparent resilience to natural fluctuation and fishing effort, *E. ziczac* seems to have been severely and permanently overexploited after its second fishing period because: a) biomass has been reduced to nearly 2% from its 1974-1975 levels, b) population densities over the center of São Francisco and Bom Abrigo beds were lower than 1 ind. 90 m^{-2} and 1 ind. 180 m^{-2}, respectively, as estimated by direct observations conducted by scuba divers during the March-April 1996 cruises (Pezzuto & Borzone, 1997b), and c) the species landings declined continuously since 1981, reaching only 452 kg in 2003, in spite of the high economic value of the resource.

Considering the more than two decades of decline, it is suggested that overexploitation levels experienced by the stock had been sufficiently high to prevent its recovery regardless the small fluctuations observed in the landings over that period. While not targeted at present by the shrimp trawling fleet, *E. ziczac* is incidentally caught, mainly during winter and summer months, when part of the fleet operates over both scallop beds, directing its effort to profitable concentrations of penaeid shrimp (*Farfantepenaeus paulensis* and *F. brasiliensis*) and squid (*Loligo plei*) (Perez & Pezzuto, 1998).

The apparently small incidental catch levels of scallops, as suggested by very small landings during recent years can, in effect, represent a significant mortality to the stock when considering its actual size. In fact, we observed an almost complete depletion of the Bom Abrigo bed during the cruises conducted along the first six months of 1996, when a substantial part of the trawler fleet operated in that region. After reaching catch rates of up to 36 ind.h^{-1} with a 2 m-wide beam-trawl in December 1995, catches in the same areas declined to a maximum of 6 ind.h^{-1} over one year, with some hauls producing no scallops at all (Borzone & Pezzuto, 1997; Pezzuto & Borzone, 1997b; Pezzuto *et al.*, 1998).

Being just one item of a demersal multispecific offshore fishery (Perez & Pezzuto, 1998), alternatives for the recovery and management of the resource are unclear and difficult to implement. Apart from its ineffectiveness due to fragile enforcement and political interference, management of the double rig trawler fishery in Brazil has always focused on its first main target (the shrimps *F. paulensis* and *F. brasiliensis*) through measures such as size limits, fishing closure periods and limited access to the fishery (Valentini *et al.*, 1991). Additional measures have not been implemented, even after substantial part of the fleet has redirected its effort to alternative shelf resources as flatfish (*Paralichthys* spp.), bluewing searobin (*Prionotus punctatus*), octopus (*Octopus vulgaris*) (Perez *et al*., 2001; Perez *et al.*, 2003), other shrimps (*Pleoticus muelleri* and *Artemesia longinaris*) (Haimovici & Mendonça, 1996a, 1996b; D'Incao *et al.*, 2002), squid (*Loligo plei* and *L. sanpaulensis*) (Perez & Pezzuto, 1998; Perez, 2002; Perez *et al.*, 2002a) and, more recently, upper slope resources such as monkfish (*Lophius gastrophysus*), argentine hake (*Merluccius hubbsi*), gulf hake (*Urophycis cirrata*), and argentine squid (*Illex argentinus*) (Perez *et al.*, 2001; Perez *et al.*, 2002b; Perez *et. al.*, 2003). As was before the case for *E. ziczac*, some of these resources also experienced "gold rush" style episodes, and have not been managed even when substantial scientific information and advice were available to decision makers. The recent development and decline of a valuable monkfish fishery in Brazil is another remarkable example, as its annual landings increased from a few tons to more than 8,800 t in 2001, mostly produced by the local double rig trawling fleet (Perez *et al.*, 2002b). A monkfish stock assessment conducted in 2002 estimated that nearly 60% of its virginal biomass may have been removed from its higher concentration areas only during 2001, when the fishery started. Concerns about the sustainability of the resource and the fishery led to a series of scientifically substantiated management recommendations to the national fishing authority (Perez *et al.*, 2002c) which, however, have not been implemented.

The collapse of the otherwise promising Brazilian scallop fishery and the critical situation of the stock offer an important lesson. Irreversible damage demonstrates the neeed for change in the management model for the demersal fishery of Brazil. As pointed out by Perez *et al.* (2001), it is evident that uncontrolled effort exerted by more than 500 trawlers over shelf and slope resources from southeastern and southern Brazilian sets an uncertain path for the future of the trawl fishery.

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