The influence of population structure and reproductive aspects of the genus *Stellifer* (Oken, 1817) on the abundance of species on the southern Brazilian coast

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Abstract

The differences between abundance and the relationship with aspects of population and reproductive S*tellifer rastrifer*, S*tellifer stellifer* and S*tellifer brasiliensis* were analysed. Data were collected monthly trawl directed for capture of seabob shrimp in Armação do Itapocoroy, an important fishing area on the southern Brazilian coast. The chi-square test showed that the population of *S. rastrifer* presented values of capture significantly higher than others in all evaluated periods. The frequency distribution of total length curves combined with records of the size at first maturity (L_{50}) showed that *S. rastrifer* is a species with a majority of the adults effectively participating in the reproductive period. The frequency of occurrence of individuals in reproduction monthly examined together with changes in the gonadosomatic index (GSI) and the reproductive activity index indicated that spring was the main breeding season for the three species. However, it was observed that the reproductive period of *S. rastrifer* was more pronounced and more extensive than that of its congeners, apparently providing it with ecological advantages and enabling a more effective population balance given the pressure exerted by fishing in the study area.

Keywords: fish reproduction, gonadosomatic index, reproductive activity index, population dynamics, bycatch, species coexist.

A influência da estrutura populacional e dos aspectos reprodutivos na abundância de espécies do gênero *Stellifer* (Oken, 1817) no litoral sul brasileiro

Resumo

As diferenças nas abundâncias numéricas e a relação dessas com os aspectos reprodutivos e populacionais de S*tellifer rastrifer*, S*tellifer stellifer* e S*tellifer brasiliensis* foram analisadas. Os dados foram coletados em arrastos mensais destinados à captura do camarão sete-barbas em Armação do Itapocoroy, uma importante área pesqueira do litoral sul brasileiro. O teste de qui-quadrado demonstrou que a população de *S. rastrifer* apresentou valores de captura significantemente superiores que as demais em todos os períodos avaliados. A distribuição em classe de tamanho sobreposta ao valor de primeira maturação sexual (L_{50}) evidenciou que *S. rastrifer* foi a espécie com a maior proporção de indivíduos capturados considerados adultos, ou seja, que efetivamente participam do evento reprodutivo. A frequência de ocorrência mensal dos estádios de maturação sexual analisada conjuntamente com as variações do índice gonadossomático e do índice de atividade reprodutiva indicaram que a principal estação reprodutiva para as três espécies foi a primavera, Entretanto, observou-se que o período reprodutivo de *S. rastrifer* foi mais acentuado e mais extenso do que o de suas congenéricas, aparentando lhe fornecer vantagens ecológicas e possibilitando um equilíbrio populacional mais eficaz frente à pressão exercida pela pesca na área de estudo.

Palavras-chave: reprodução de peixes, índice gonadossomático, índice de atividade reprodutiva, dinâmica de populações, fauna acompanhante, coexistência de espécies.

1. Introduction

The genus *Stellifer* (Oken) belongs to the family Sciaenid and comprises 24 species of fish that inhabit the coastal regions of the Atlantic and Pacific along the north, central and South American coast (Froese and Pauly, 2010). Along the Brazilian coast, there are six species. Whilst *Stellifer stellifer* (Bloch), *Stellifer rastrifer* (Jordan), *Stellifer brasiliensis* (Schultz) and *Stellifer* sp. can be found along the whole stretch of coast, the species *Stellifer naso* (Jordan) and *Stellifer microps* (Steindachner) are restricted to northeastern and northern Brazil (Menezes et al., 2003).

Populations of *Stellifer* spp. are frequent and abundant in trawl fisheries carrying out shrimp catches, especially in seabob shrimp *Xiphopenaeus kroyeri* (Heller) fisheries, due to habitat overlap among these species (Menezes and Figueiredo, 1980). Based on specific composition of the fish fauna data gathered from shrimp trawls conducted in several localities, it is quite notable that *S. rastrifer* is invariably more abundant than its congeners (Giannini and Paiva-Filho, 1990a; Chaves and Vendel, 1998; Graça-Lopes et al., 2002; Sousa and Chaves, 2007; Souza et al., 2008), although all share the same habitat and have great morphological similarity (Menezes and Figueiredo, 1980). For over a decade, the monitoring of the associated fauna in a fishing area confirms the numerical predominance of *S. rastrifer* in relation to the other species (Branco and Verani, 2006).

The analysis of reproductive traits may aid understanding of the differences in numerical occurrences of these species. Previous studies have addressed aspects related to the population of the above species separately, being only describing without inter-specific comparisons (Coelho et al., 1985, 1987; Giannini and Paiva-Filho, 1990b, 1995; Chaves and Vendel, 1997; Almeida and Branco, 2002).

Therefore, this study aims to test the following hypotheses: a) whether there are differences between the abundances of species of the genus *Stellifer* spp. caught as bycatch in Armação do Itapocoroy; b) If existing, can these differences be explained by the population structure and reproductive patterns of the three species?

2. Material and Methods

2.1. Study area and data collection

Armação do Itapocoroy (26° 40'-26° 47' S and 48° 36'-48° 38' W), located in the municipality of Penha, Santa Catarina state, is a traditional fishing area of the seabob shrimp, (*Xiphopenaeus kroyeri),* in southern Brazil (Branco and Verani, 2006). Samples were collected once a month from April 2007 to February 2008 in three traditional fishing spots of seabob shrimp (Figure 1).

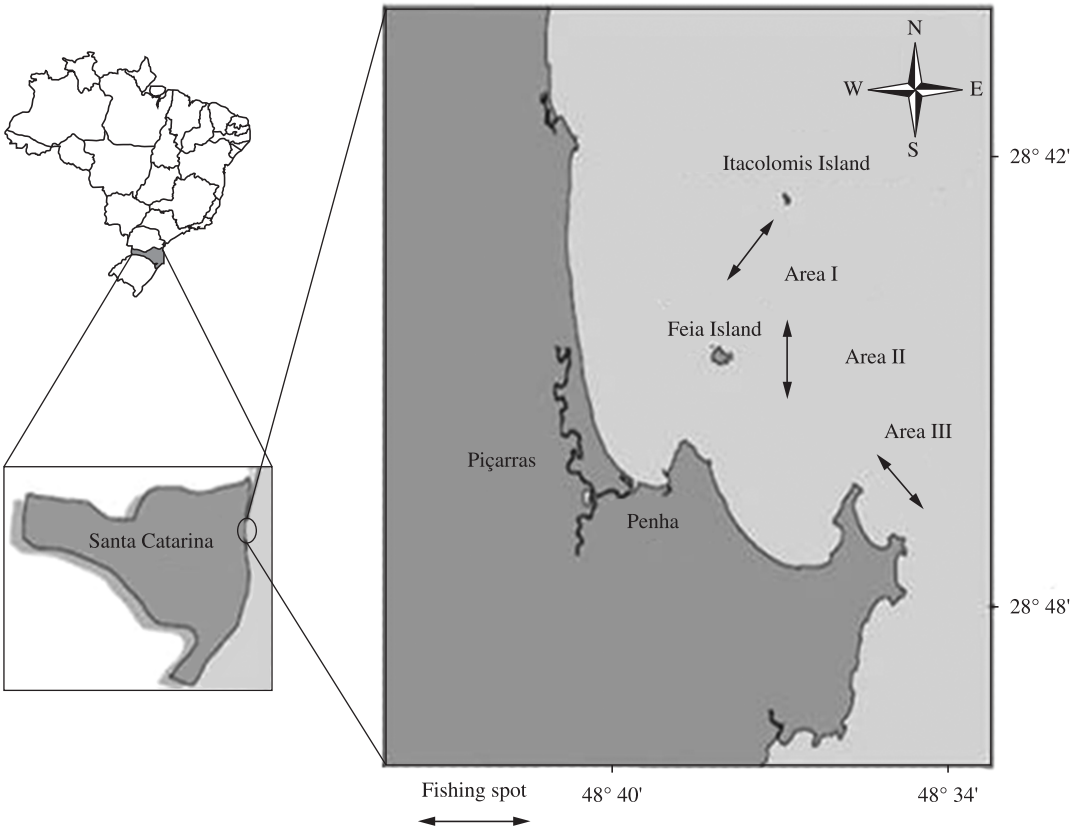

Figure 1. Map of Armação of Itapocoroy, Penha, SC (26° 40'-26° 47' S and 48° 36'-48° 38' W) with three points of traditional fisheries of sea bob shrimp where sampling was conducted.

A single boat (double-rigged) for bottom trawling was used (Galbraith et al., 2004) with a trawl of 3.0 cm mesh in the wings, square, belly, baitings and extension and 2.0 cm at the cod end, towed by a boat at an average speed of 2.0 knots. Three half-hour replicas were done in each traditional fishing spot, totalling 108 trawls (54 hours).

The material caught was placed in plastic bags, labelled with details of the date and site of collection, packed in cooler boxes for subsequent screening.

Stellifer spp. were separated from the fish fauna originated from shrimp trawls and identified to species level based on morphological features according to Menezes and Figueiredo (1980). In the laboratory, the total length and weight of each specimen were recorded to an accuracy of 1.0 mm and 0.01 g, respectively.

Specimens were then slit open from the urogenital orifice and their gender and level of gonad maturation were determined according to Vazzoler (1996). They were thus classified into four stages: A (immature), B (maturing), C (mature) and D (emptied). The gonads were weighed on a Sciencetech SA210 scale accurate to 0.0001 g.

2.2. Data analyses

The reliability of the data for the study of population dynamics of each species in the area was checked using the total number of fish caught and the number of monthly samples for its calculations on a scale of 0 to 5+ (Pauly, 1984).

The hypothesis of difference abundance for seasonal and annual congeneric species in the region was tested by comparing the frequency of occurrence of each specie by Chi-square (χ^2) test with p = 0.05 (Zar, 1999). For the seasonal analysis, months were grouped into: autumn (April, May, and June), winter (July, August, September), spring (October, November, December) and summer (January, February, March).

Annual and seasonal variations of the population structure were analysed with the help of frequency distributions of total length classes (range of 1.0 cm). From the frequency distribution of total length classes for the studied species, by analysing the occurrence of individuals in small size classes, recruitment period can be estimated.

Using the values of the total weight and the gonad weight of the individuals, the gonadosomatic index (GSI) was calculated according to Santos (1978). The Kruskal Wallis test (p = 0.05), complemented by Dunn's Multiple Comparisons Test, was applied to the GSI data intending to identify differences among the values of the species (Zar, 1999).

The GSIs of females were used for the calculation of the reproductive activity index (*RAI*), considering the categories: null (RAI 2); incipient (2 < RAI 5); moderate (5 < RAI 10); intense (10 < RAI 20); and very intense (RAI > 20) (Agostinho et al., 1993).

To determine the period of reproduction for each *Stellifer* species, the monthly variations of the average values of GSI, the frequency of occurrence of individuals in maturation (stage B) and in reproduction (stages C and D) and the values of RAI were analysed. Size at first maturity (L_{50}) and size when the whole population was mature (L_{100}) were obtained (Santos, 1978).

The combination of the records of the female's L_{50} and the length frequency distribution curves permitted an estimate of the fishing impact on the different *Stellifer* population's strata (young and adults). Use of the L50 of females is justified because these reach sexual maturity with values usually greater than that of males (Vazzoler, 1996), which leads to greater reliability on the strata (young or adult) in which the individuals were.

The sex ratio was estimated monthly and the Chi-squared (χ^2) test with Yates's correction (Pearson, 1947) was applied to detect significant differences ($p < 0.05$).

The length-weight relationship was analysed for the three species and the values of slope (b) were compared by analysis of covariance (ANCOVA) with p = 0.05 (Zar, 1999). The condition of the fish in the sampling areas was established with the condition factor (K) and by the relative condition factor (K_r) (Le Cren, 1951). The three series of K_r were compared using the Kruskal Wallis test supplemented by the non-parametric Dunn's test (p = 0.05), as in Zar (1999) and the average values of Kr were compared with the central value 1.0 (Le Cren, 1951).

3. Results

A total of 1396 *S. rastrifer*, 839 *S. brasiliensis*, 570 *S. stellifer* and 23 *Stellifer* sp. were collected during the sampling period.

The values of reliability of the sample data were 5 for *S. rastrifer*, 4 for *S. brasiliensis* and *S. stellifer* and 0 for *Stellifer* sp. The low value for *Stellifer* sp. hampers the analysis of population dynamics of this population.

The chi-square test showed that there were significant numerical differences between species in the study area ($p \geq 0.05$) and *S. rastrifer* was the dominant species in all analysed periods (Figure 2).

Captured specimens of *S. rastrifer* had an average length of 8.09 cm, which was the greatest total length among the species. The length of this species varied between 3.6 and 20.2 cm. However 74.07% were in the range 5.0 to 9.0 cm (Figure 3a) with the most numerous classes 5.0 and 6.0 cm.

The specimens of *S. stellifer* in the catch ranged in total size from 3.4 to 17.2 cm, but the majority were below 8.0 cm. The average size was 6.7 cm and the modal class was 5.0 cm, followed by classes of 6.0 and 7.0 cm (Figure 3b).

The average total length of *S. brasiliensis* was 7.6 cm, with a range between 3.3 and 17.0 cm, the most numerous classes being those of 4.0 to 9.0 cm, which represented 87.72% of the total catch of this species. The modal classes were 6.0 cm, with 21.33%, and 7.0 cm, with 20.86% (Figure 3c).

The seasonal frequency distributions of total length for the species of *Stellifer* spp. showed that the frequency of small individuals was highest in the summer (January, February, March), indicating that this is the main period

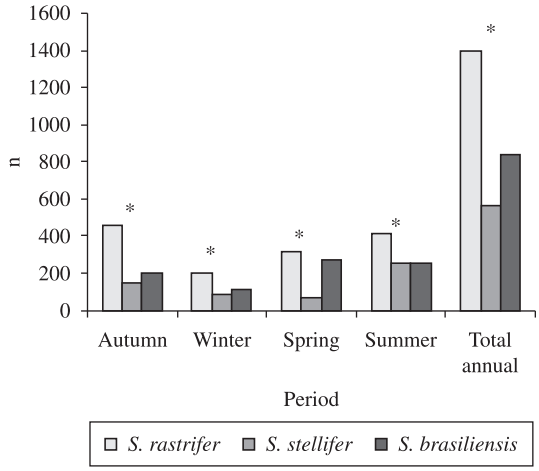

Figure 2. Seasonal and annual abundance of species of the *Stellifer* spp. captured in Armação of Itapocoroy, Penha, SC, during the period April 2006 to March 2007. *indicates statistical differences between the abundances of species ($p < 0.05$), i.e., χ^2 calculated $>\chi^2$ critical.

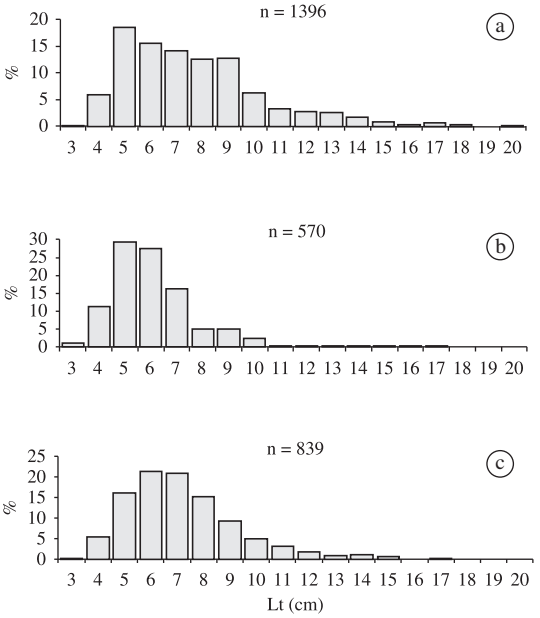

Figure 3. Frequency (%) of the total length of classes *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* captured in Armação of Itapocoroy, Penha, SC, during the period April 2006 to March 2007.

of recruitment of the young ones. The spring (October, November and December) exhibited the highest frequency of larger individuals and this appears to be related to the reproductive period of the three species (Figure 4)

The GSI variations of *S. rastrifer* indicate the reproductive period may start at the end of winter (September) and reach its peak during spring (October and November) (Figure 5a). In the following months, the fall in GSI indicates the spawning period. A second increase, though to a lesser extent, in this index can be seen in summer (February) indicating another spawning period at the end of summer (March). Macroscopic analysis of the female gonads showed that during the months of highest values of GSI there is a high frequency in the population of individuals at stage C of gonad maturation, while in the subsequent months (November / December and March/ April) there is a high frequency of individuals at stage D (empty), indicating that spawning occurs in those months.

The plot of monthly average values of GSI for *S. stellifer* suggests that the species has a reproductive period that extends from the winter (August and September)/spring (December) until the summer (January, February and March), with greatest intensity in spring (Figure 5b). Outside these periods, the species had a high frequency of individuals whose gonad morphology was effectively at the start of maturation, stage B.

The distribution of monthly average GSI values of female *S. brasiliensis* (Figure 5c) indicated that the reproductive period starts from the winter (August and September)/spring (October, November and December) and extends until the summer (January and February); this is corroborated by the greater frequency during this period of females in the advanced stages of gonad maturation (stages C and D).

The Kruskal-Wallis test showed significant difference between the values of GSI species ($p \geq 0.05$). According to the Dunn test, *S. rastrifer* differently from the others ($p \geq 0.05$) and *S. stellifer* and *S. brasiliensis* showed no significant differences ($p < 0.05$).

The Reproductive Activity Index (RAI) showed that the peak of reproductive activity occurred during spring, and reproduction activity was categorized as intense for the three populations studied. In summer, the reproductive activity for *S. rastrifer* was considered moderate and for the others species null (Figure 6).

The estimated values of L_{50} and L_{100} for females were, respectively, 8.2 and 14.6 cm for *S. rastrifer*, 7.7 and 11.8 cm for *S. stellifer* and 9.4 and 13.2 cm for *S. brasiliensis* (Figure 7). The L_{50} for males were 7.0, 7.2 and 8.7 for *S. rastrifer*, *S. stellifer* and *S. brasiliensis,* respectively (Figure 7)

The overlapping of the female's estimated values of L_{50} to the frequency distribution of length graphics, demonstrated that fishing on the Armação do Itapocoroy captures predominantly small sized individuals that have not reached sexual maturity. Comparing the effect of fishing on different populations, it was noted that a large percentage (90% of *S. stellifer*, 87% of *S. brasiliensis* and about 67% of *S. rastrifer*) of the catch consisted of young individuals (Figure 8).

The collected specimens of all three species were composed mainly of females (Table 1). The ratio of males to females among *S. rastrifer* for the period was 1: 2.03. *S. stellifer* demonstrated the highest proportion of females among the three species, with a ratio of 1: 2.53, and *S. brasiliensis* demonstrated a sex ratio of 1: 2.33.

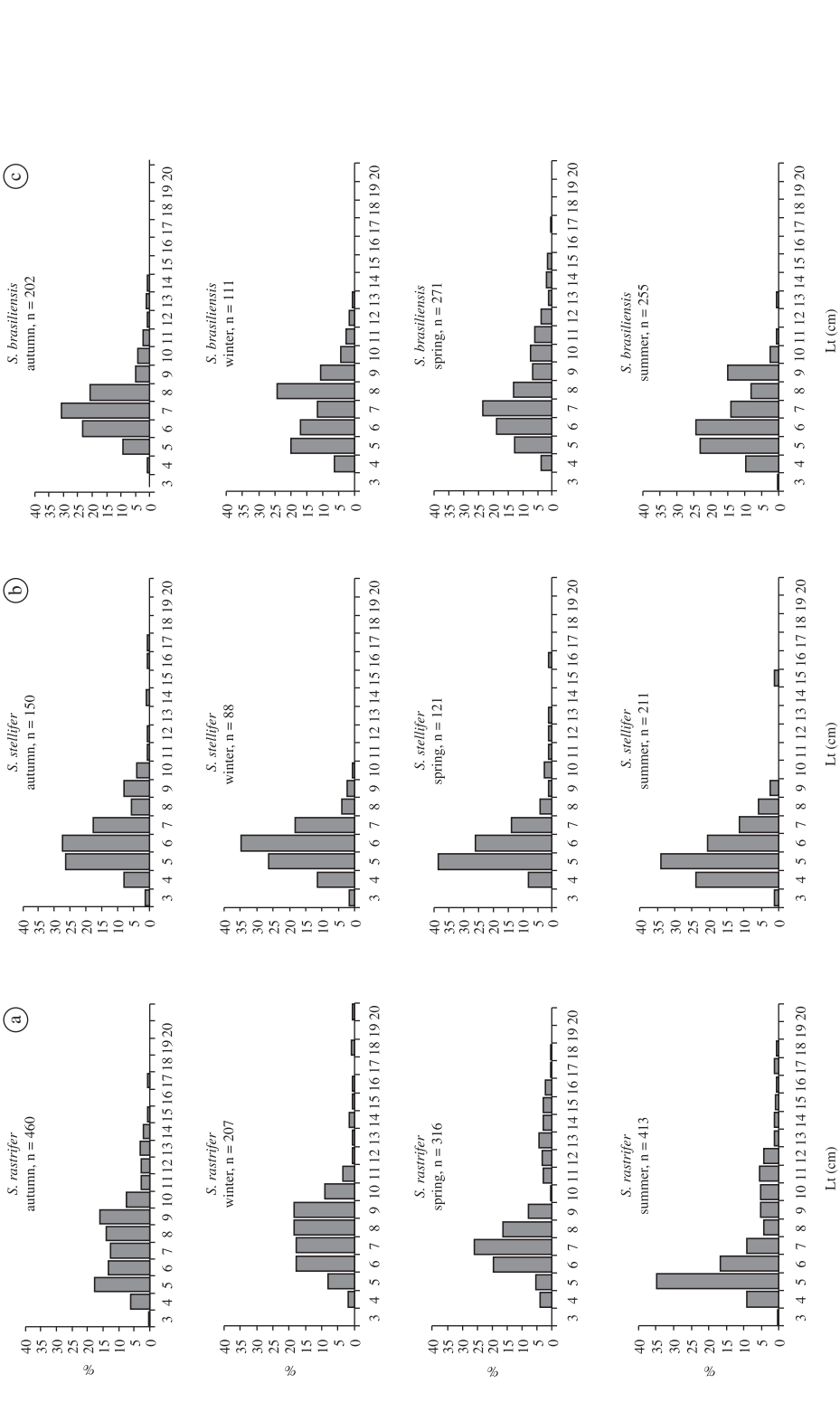

Figure 4. Frequency (%) of classes of total length recorded during the seasons of the year of *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* captured in Armação of Itapocoroy, Penha, SC, from April 2006 to March 2007.

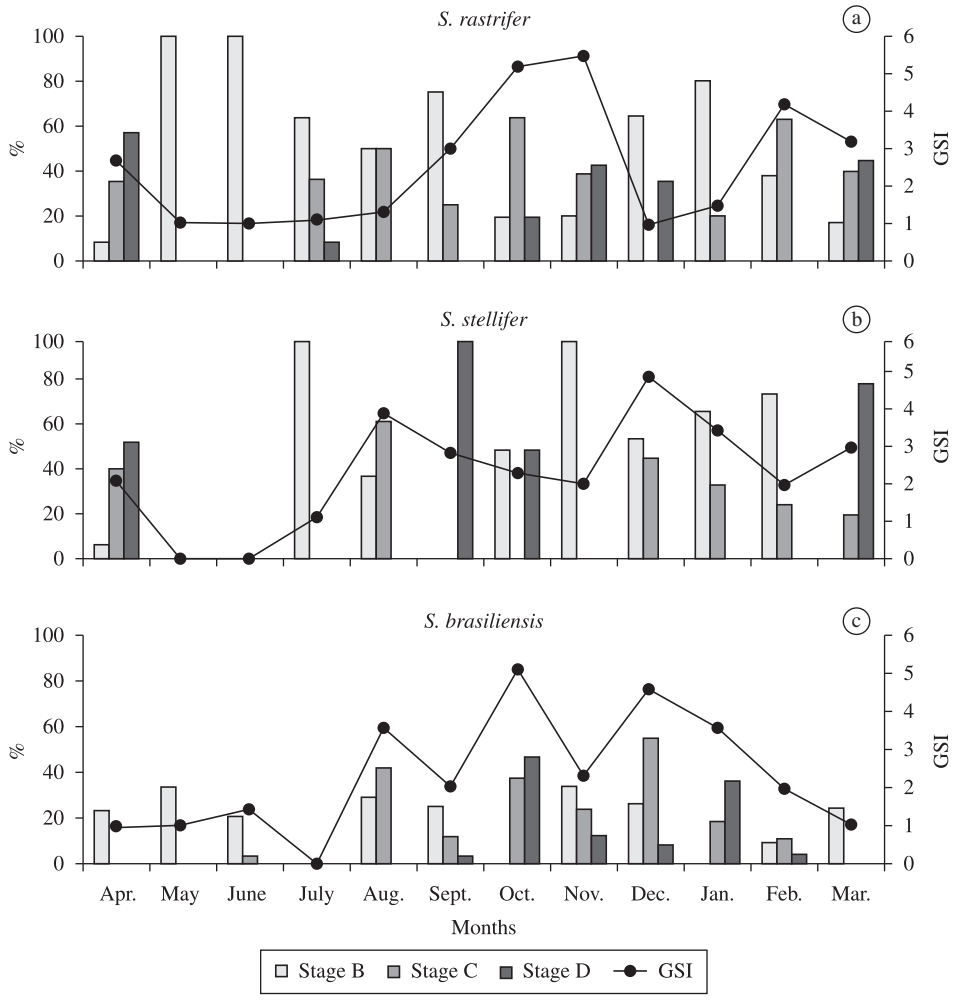

Figure 5. Frequency of stages of gonad maturation and monthly change of average values of female's Gonadosomatic index GSI of *S. rastrifer, S. stellifer* and *S. brasiliensis* caught in Armação do Itapocoroy, Municipality of Penha, SC.

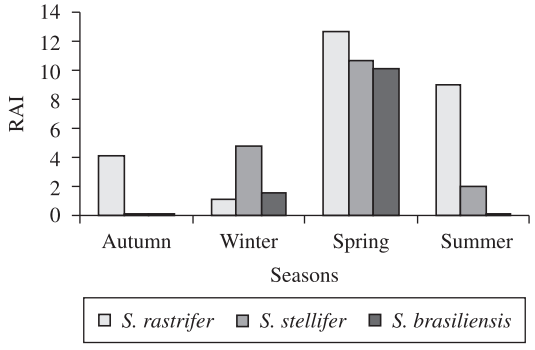

Figure 6. Reproductive activity index (RAI) of *Stellifer rastrifer*, *Stellifer stellifer and Stellifer brasiliensis* caught in Armação do Itapocoroy during the period April 2006 to March 2007.

The total weight of the *S. rastrifer* was plotted against total length, resulting in the following equation: $W_t = 0.0065L_t^{3.2613}$. This equation was linearised by applying a logarithmic transformation to the variables, resulting

Table 1. Monthly proportion of male (M)/female (F) of *Stellifer rastrifer* (a), *Stellifer stellifer* (b) and *Stellifer brasiliensis* (c) sampled in Armação do Itapocoroy.

Month	M:F (a)	M:F (b)	M:F (c)
Apr./06	1:1.92*	1:3.00*	-
May	1:2.54*	-	1:2.78*
June	1:1.75*	-	1:3.25*
July	1:2.08*	1:2.60*	-
Aug.	-	1:1.50*	1:1.07
Sep.	1:1.87*	1:7.00*	1:2.70*
Oct.	1:1.54*	1:3.00*	1:2.75*
Nov.	1:0.67*	1:3.33*	1:1.29
Dec.	1:3.37*	1:3.67*	1:2.25*
Jan./07	1:1.46	1:2.03*	1:1.75*
Feb.	1:1.20	-	1:2.67
Mar.	1:2.49*	1:1.36	1:2.70
Total	1:2.03*	1:2.53*	1:2.33*

*There was a significant difference ($p < 0.05$).

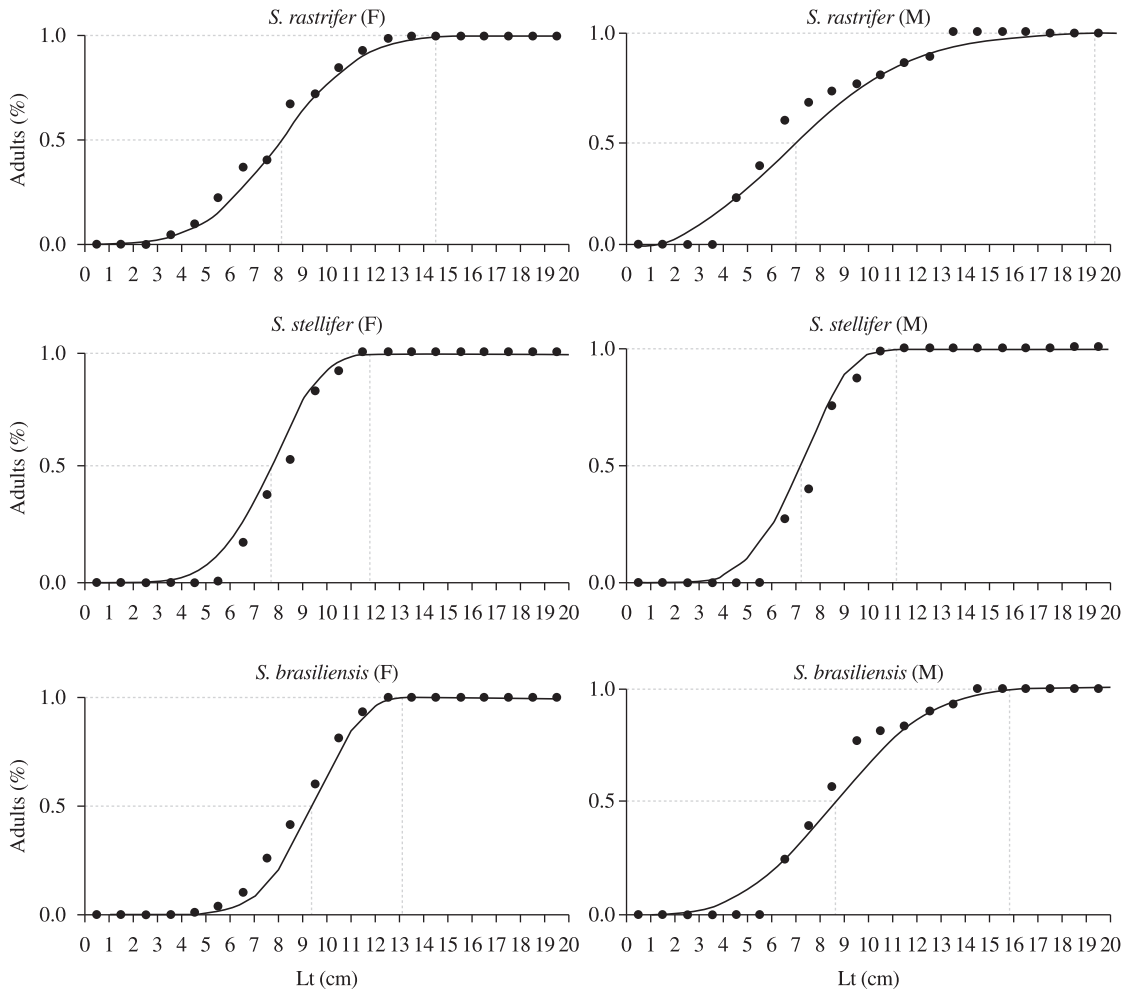

Figure 7. Curve of size of the first maturity of *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* in Armação do Itapocoroy, Penha, SC. *(F) and (M) means female and male, respectively.

in a coefficient of determination (r^2) of 0.9763, which was the highest value obtained among the three species (Figure 9). The weight-length relationship for *S. stellifer* was $W_t = 0.0073L_t^{3.1752}$, with $r^2 = 0.952$ for the linearised equation (Figure 9). *S. brasiliensis* also showed a similar trend, with the equation $W_t = 0.0079L_t^{3.1283}$, whose linear form had a coefficient of determination $r^2 = 0.9451$ (Figure 9). According to multiple comparison test (ANCOVA) applied to the slopes (b) of the above equations, there were no statistically significant differences between the values of b ($p < 0.05$), indicating that these species have the same growth pattern

The average value of condition factor (K) for S. *rastrifer* reached a maximum in winter and declined through the year, reaching its lowest point in the summer. *S. stellifer* and *S. brasiliensis* showed higher values in the fall and, like *S. rastrifer*, showed a gradual reduction until summer (Figure 10).

When comparing the values of relative condition factor (K_r) of the population by Kruskal-Wallis test, a significant statistic difference between samples was observed ($p < 0.001$). According to the Dunn test, there was no statistical difference between *S. rastrifer* and *S. stellifer* ($p \geq 0.05$). However, when these were compared with *S. brasiliensis,* a significant difference was observed ($p < 0.05$).

4. Discussion

The ichthyofauna caught incidentally by the trawls directed for the capture of seabob shrimp in Armação do Itapocoroy, was characterised by a considerable amount of fish of the genus *Stellifer* spp. as supported by the study of Branco and Verani (2006). The numerical dominance of *S. rastrifer* compared to its congeners is similar at other locations along the southern and southeastern Brazilian coasts (Giannini and Paiva-Filho, 1990a; Chaves and Vendel, 1998; Graça-Lopes et al., 2002; Sousa and Chaves, 2007; Souza et al., 2008). Although the abundance of *S. stellifer* and *S. brasiliensis* is significantly lower than

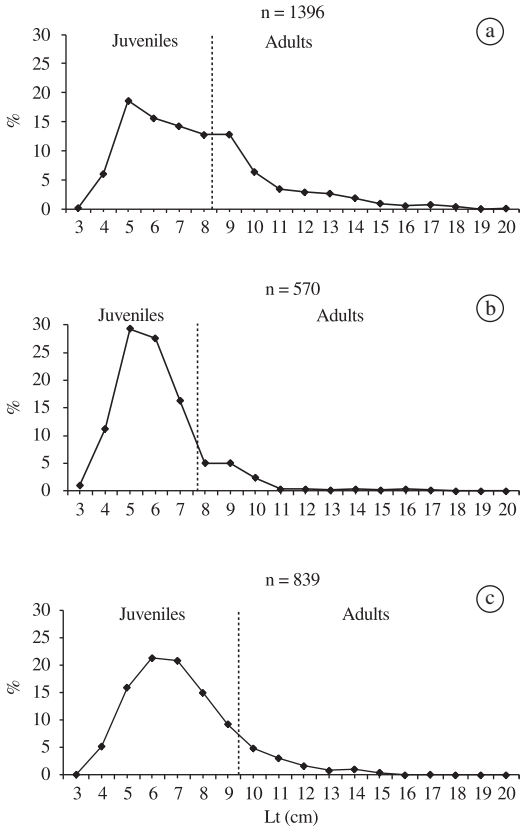

Figure 8. Distribution of frequency (%) of length of *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* overlapped to the female's size of the first maturity.

that of *S. rastrifer,* values from accumulated captures enabled Pauly (1984) to make a reliable analysis of the structures of these populations.

According to Nikolsky (1969), the composition of a population in different length classes is a function of environmental change and may vary according to population fertility. In this present case, variations become more distinct in different seasons of the year, since it can be observed that, for the three species, summer is the time of recruitment of the young ones, so that a greater number of larger individuals were seen in the spring, corroborating what was reported by Giannini and Paiva-Filho (1990b) and Almeida and Branco (2002).

The high number of juveniles present in the trawls can be attributed to the low selectivity of gear and, when compared to length data for *S. rastrifer* (Coelho et al., 1985; Giannini and Paiva-Filho, 1990b), *S. stellifer* (Almeida and Branco, 2002) and *S. brasiliensis* (Coelho et al., 1987; Giannini and Paiva-Filho, 1995), an increased fishing pressure from the lower strata of the population can be observed in Armação do Itapocoroy than elsewhere. By overlapping the female's size of sexual maturity (L_{50}) with the frequency distribution of length, the impact of fishing of juveniles is highlighted. This can compromise the maintenance of fish stocks of these populations (Diamond et al., 2000). On the other hand, a greater impact on adults of *S. rastrifer* (33%) compared to that of *S. brasiliensis* (13%) and *S. stellifer* (10%), can probably be a reproductive advantage over other species because these individuals might have already participated in one reproductive period assisting in the maintenance of its population.

The fact that males *Stellifer* spp. reach sizes at first maturity less than those of females appears to be related to the tendency of these invest more resources in the formation of gametes (Futuyma, 1992). This is recorded for most marine sciaenids (Lowerre-Barbieri et al., 1996; Hutchings et al., 2006).

The sizes at first maturity (L_{50}) estimated for the species *S. rastrifer* and *S. stellifer* were lower than those recorded by Coelho et al. (1985) and Almeida and Branco (2002) respectively, whereas *S. brasiliensis* showed a value of L_{50} greater than those estimated by Coelho et al. (1987). Such changes in the estimated values of L_{50} reported here may be related to intraspecific variations due to environmental conditions such as temperature, availability of food or influence of fishing on these populations (Vazzoler, 1996).

The characterisation of the reproductive cycle is essential for understanding the dynamics of fish populations and the establishment of programmes for management of exploited ecosystems. The gonadosomatic index (GSI) and reproductive activity (RAI) associated with the information of maturation stages showed that spring is the main breeding season of *Stellifer* spp., confirming the findings of Longhurst and Pauly (2007) for tropical fish and by different authors for individuals of genus *Stellifer* (Chaves and Vendel, 1997; Gianini and Paiva-Filho, 1990b; Almeida and Branco, 2002; Sousa and Chaves, 2007). The decrease in reproductive activity occurred in the summer for all species of this genus. However *S. rastrifer* remained with moderate reproductive activity values at this season, indicating that their reproductive period, besides being more pronounced in spring, extends for a longer period of time than the other species.

Considering that the genus *Stellifer* have gonads with the presence of follicles at different stages of development and multiple spawning (Chaves and Vendel, 1997), as well as weekly maturation of the gonads, we chose to use the reproductive stage B (Maturing) indicative of reproductive activity. This method proved effective, as confirmed by the GSI variations, represented by small increases in value during the months prior to the main reproduction period for the species.

The catches were mainly composed of females and, as mentioned by Coelho et al. (1987), this higher bycatch of females could, over the years, causes great damage to the population, since the abundance of females is the main factor contributing to the reproductive potential of a population. According Nikolsky (1963), the ratio of females is greater when the food availability is abundant, which appears to occur in the present study, since the water mass in the Armação do Itapocoroy is influenced by nutrient input Itajai-Açu river (Schettini et al., 1999). In a study in the Sepetiba Bay, Vicentini and Araujo (2003) reported

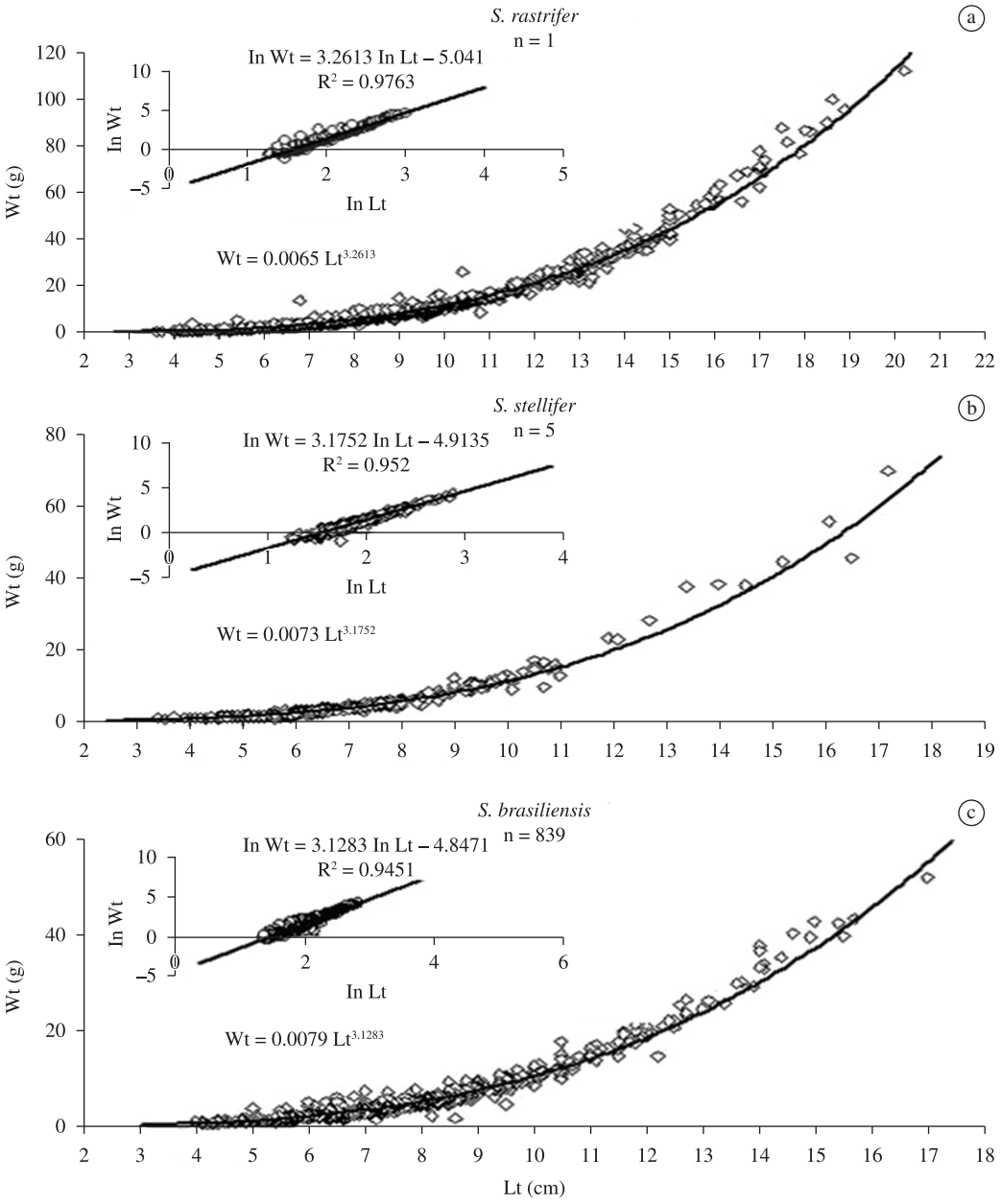

Figure 9. Weight/length relationships (a) and linear relationship (b) of the population of *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* captured in Armação do Itapocoroy.

similar results, with the largest proportions of sciaenid females recorded in the areas containing high amounts of organic material.

Relationships between weight and length of species are important in promoting the exploitation and management of species of importance to fisheries (Santos, 1978; Anderson and Gutreuter, 1983). The growth patterns for the *Stellifer* species were allometric positive (b > 3.0), as found in the works of Coelho et al. (1985), Gianinni and Paiva-Filho (1990b), Gianinni and Paiva-Filho (1995), Chaves and Vendel (1997) and Almeida and Branco (2002).

The condition factor (K) is widely used in the study of fish biology and may indicate how the animal explores the energetic resources on the assumption that individuals with greater mass in a given period are in better physiological conditions (Le Cren, 1951; Lima-Junior and Goitein, 2006). The association between the variations of condition factor and reproduction in fish has been mentioned by Barbieri and Verani (1987) and Vazzoler (1996) and for individuals of the genus *Stellifer* spp. by Chaves and Vendel (1997). In this study, there was an increase in condition factor before the main breeding period, indicating that individuals store reserves to support future energy losses. The considerable

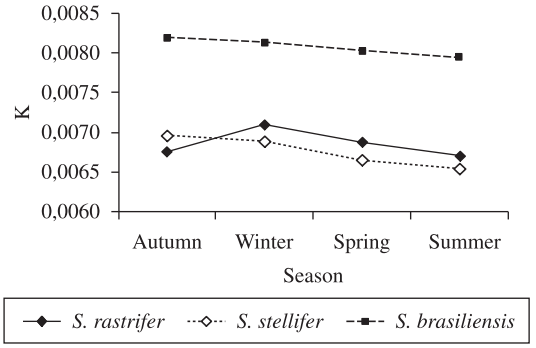

Figure 10. Variations in the average value of total condition factor *Stellifer rastrifer*, *Stellifer stellifer* and *Stellifer brasiliensis* in the different seasons of the year.

fall in values of condition factor in the aftermath of reproduction shows the intense metabolic expenditure in the process and its subsequent reorganization of gonads.

The used of average relative condition factor (K_r) enabled the comparison with the estimated central value 1.0, regardless of species and population size, allowing the monitoring of feeding activity of the species, verifying whether or not it is making appropriate use of their food resources (Anderson and Gutreuter, 1983). This factor reflects the physiological status of the individual, providing information for comparing two or more populations living under the same conditions (Weatherley and Gill, 1987).

According to the results presented here, it can be inferred that the population of *S. brasiliensis* is using the food resources in the study area most effectively. The population of *S. rastrifer* obtained values of $K_r > 1$, and is thus also subject to favourable conditions for growth, while for *S. stellifer*, $K_r < 1$, indicating that the latter species is subjected to unfavourable conditions for growth or even stress in the studied region.

Frehse (2009) found that for *S. rastrifer* and *S. brasiliensis*, despite consuming largely the same resources, have different feedings strategies, as supported the values greater than 1.0 for the condition factor of these populations, indicating the occurrence of overlapping niches and interspecific competition between them. However their coexistence is made possible due to different feeding strategies, reducing competition for resources. Anatomical differences are related to the choice of optimal food for a species (Futuyma, 1992), as evidenced by an oblique and terminal mouth of *S. rastrifer* and quasi-ventral and subterminal mouth of *S. brasiliensis* (Menezes and Figueiredo, 1980), which appears to influence the composition of benthic food predominant for *S. brasiliensis* and pelagic *S. rastrifer* (Frehse, 2009).

In this context, it appears that the niche overlap and the interspecific competition between *S. rastrifer* and *S. stellifer* are more accentuated by the similarity of the oral apparatus (Menezes and Figueiredo, 1980), resulting in disadvantages to both species, especially for *S. stellifer* due to reproductive characteristics of *S. rastrifer* that provides maintenance of the a larger population, supporting the lowest values of relative condition factor obtained from them.

The previous results on the trophic ecology of fishes associated with seabob shrimp on the coast of Santa Catarina confirmed the sharing of food items in the diet of *S. rastrifer* and *S. Stellifer* (Branco, personal communication). However, such species should only share some resources, not being limited by the same, different enough to allow the coexistence of species of the genus *Stellifer* spp. in the same habitat (Gause, 1934; Hutchinson, 1978).

An overlapping niche denotes redundant ecological functions in the ecosystem and an increase in competition among species (Abrams, 1983). However, this overlap can increase the resilience of the environment. According to Rosenfeld (2002), functional redundancy is based on the observation that species with similar tasks in the biota, and their replacement may damage sensitive ecosystem processes.

Our results demonstrate that even though the genus *Stellifer* spp. shares the same habitat, *S. rastrifer*'s reproductive strategies and population aspects will provide its population with ecological advantages against others, helping to maintain a greater abundance. According Siepielski and McPeek (2010), myriad ecological processes can promote or hinder species coexistence, but the capacity to increase when it is rare and the others are at their typical abundances (Invasibility) is the hallmark of all mechanisms promoting species coexistence. Thus, the low abundances of *S. brasiliensis* and, especially, *S. stellifer* apparently cause demographic advantages to these populations and satisfies the invasibility criterion, allowed the coexistence of the species in the study area.

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